MINISTRY OF CONSTRUCTION

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DESIGN STANDARD
WATER SUPPLY – EXTERNAL NETWORKS AND FACILITIES

(this translation is for reference only)

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CONTENT

DESIGN STANDARD
WATER SUPPLY – EXTERNAL NETWORKS AND FACILITIES

1 GENERAL INSTRUCTIONS

1.1. This standard applies to new construction or reform and expansion of water supply system in urban, rural residential place and industrial zones

Note: 1 – When designing water supply system, it need to comply with related standards issued by State.

2- Emergency water supply is according to TCVN 2622 -1995

1.2. Designing water supply for an object shall:

- examine protection and synthetic use of water sources, combine water consumption points and its future development capacity, also rely on water supply schemes of regional planning, general planning schemes and projects designed to build residential and industrial areas;
- combine with drainage system design

1.3. Water supply system is divided in 3 grades by water supply reliability level, in accordance with table 1.1.

1.4. When mapping the water supply of industrial enterprises, it has to balance the amount of water used in factories.

To conserve spring water and to avoid contamination of water sources, if economic and technical conditions allow, when refrigerating machinery and equipments manufacturing, condensing water and general technology products, it must apply water cooling scheme by air or water to circulate again.

When using the direct spring water for cooling then discharging back to the source, it shall base on technical and economic basis and have agreement of water resource protection and management authorities

1.5 When designing a water supply system for an object, it have to select the appropriate technology which satisfies technical, economic and sanitary conditions of work, ability to reuse existing works, the ability to apply advanced techniques and equipments.

1.6. Water supply system must ensure network and other projects to economically work during estimated period as well as in specific water use modes.

1.7. It must consider the ability to put in use of pipelines, networks and projects under each construction phase. At the same time, it needs to anticipate system and main works expansion capacity in comparison with calculated capacity.

1.8 It is not allowed to design emergency work running only when break down comes.

1.9. When designing household water supply systems and mixed household and production water supply systems, it must expect a sanitary protection zone as defined in Section 11.

1.10. Household drinking water quality must satisfy requirements stipulated in standards issued by State and industry standards (see Annex 6).

In the handling, transporting and storing drinking water, it must use chemicals, materials, equipment ... which do not cause adverse impacts to water quality.

Water quality for industrial use and the use of water treatment chemicals must comply with industrial requirements in considering the impact of water quality for the product.

1.11. The main technical methods and solutions which are applied to design water supply systems must be based on comparison of the technical and economic criteria include:

- Cost of construction investment;
- Annual management costs;
- Construction costs for $1m^3$ of water per day, calculated up to daily average capacity to both systems and treatment stations;
- Electric, chemical costs for $1m^3$ of water;
- Processing and production costs of $1m^3$ of water

Note: The above criteria must be considered on the whole phase and each construction phase during operation of the system.

1.12. Optimal method must have the cost value converted over time to the minimum present value, taking into account the cost of building sanitary protection zone. Note: When determining the capital investment for project comparison, it must consider the real value between imported equipment and materials and domestic ones.

Table 1.1.

Water user's characteristics	Reliability level of water supply system
Water supply system of the population over 50,000 people and other water user objects is allowed to reduce the water flow not exceeding 30% of calculated water flow in 3 days and stop water supply not above 10 minutes.	I
Water supply system of the population up to 50,000 people and other water user objects is allowed to reduce the water flow not exceeding 30% of calculated water flow in 10 days and stop water supply not above 6 hours.	II
Water supply system of the population over 5000 people and other water user objects is allowed to reduce the water flow not exceeding 30% of calculated water flow in 15 days and stop water supply for 1 day.	III

Note: 1- Production units having closed water supply system shall be in level II
2- Special users approved by competent authorities shall not be applied these above levels.

2 REGIONAL WATER SUPPLY PLAN

2.1. Water supply schemes shall be established to determine the capacities and economic rationality in the use of water sources to be allocated to the objects having different requirements on water use mode, quantity and quality in order to select sustainable water supply and drainage projects according to development objectives in the region.

2.2. Establish regional water supply plan according to Annex 1

2.3. Standard for integrated water use per capita including water used for: household activities; Industry, Public works; trees watering, street cleaning; loss; ... shall be in accordance with the table 2.1. (Details for each type of water demand are taken from the table 3.1-Section 3)

Table 2.1.

Water use objects	Water supply standard per capita (average day per year) in l per capita per day (l/per. day)
Big cities, tourist and holiday cities, big industrial zones	300-400
Medium and small cities and towns, small industrial zones	200 - 270
Towns, industrial and agricultural centres, industrial and fishing centres, rural residential places	80 - 150
Countryside	40 - 60

Note Allow to change the household water use standard of residential points from ± 10% to 20%, depending on climatic conditions, level of comfort and other local conditions.

2.4. Water use standard for industrial production purpose must be determined on the basis of available design documents, or compared with similar production conditions. If there are not concrete data, it can get an average:
- For the industries of beer, milk, canned food, food processing, paper, textile: 45 m^3/ha/day.
- For other industries: 22 m^3/ha/day

2.5. When balancing zonal water supply demands, it should primarily identify existing water sources in the area, and then determine the content and technical - economic effectiveness of measures such as flow supplement from surrounding areas, supplying ability of the large lakes when conditioning the flow.

2.6. When using a combination of water sources for household consumers having different reliability levels, the balance of water supply needs must be conducted with all calculated reliability levels for all consumers. Consumers have lower reliability levels, it allows a specific check.

2.7. When using surface water sources without regulating the flow to balance, water supply works must be calculated according to the minimum flow line. In this case, it should set up the balance table of the water work in accordance with an average month flow corresponding to calculated frequency of the water sources.

2.8. Where water demand exceeds the flow of surface water sources, it needs to consider flow regulating by reservoir basin.

2.9. It should regulate the flow by the following measures:
- Construction of seasonally adjusted reservoir basin when water demand is less than or equal to minimum annual flow corresponding to calculated frequency including loss of water flow in the reservoir basin.
- Construction of reservoir basin which adjusts the runoff for many years when annual water demand exceeds the minimum annual flow corresponding to calculated frequency but is smaller than the flow of mean annual runoff.

2.10. When using a combination of underground water and surface water sources, it must set up the balance table of seasonal water sources usage for evaluating the use of surface water sources under the terms above. For underground water sources, when flow supplement is needed, it must apply according to Section 5. Used and supplementary flows of both types of water sources must be synthetically determined on the basis economic and technical base.

3 STANDARD AND APERIODIC WATER USE RATIO, EMERGENCY WATER FLOW AND FREE WATER PRESSURE

3.1. Capacity of household and fire fighting water supply systems in urban and residential areas, depending on local conditions, must be calculated to ensure water supply planning time in short term of 10 years and long term of 20 years and must meet the following requirements:

- Household water demand in the residential house and public work areas;
- Irrigation and cleaning streets, squares, trees, fountain;
- Watering nursery garden;
- Drinking and operation water supply in the industrial and agricultural production;
- Production water supply for manufacturing facilities that quality of water should be as household water quality, or if the construction of private water supply systems are not economically reasonable;
- Water supply for fire fighting;
- Water supply for the specific requirements of water treatment stations;
- Water supply for other needs, including the rinse of supply and drainage pipe network, and water loss during distribution and use of water.

3.2. Water use criteria for household and other needs per capita for residential place is taken from table 3.1

3.3. Calculated daily flow (mean annual) for concentrated water supply system is defined by the formula:

$$Q_{day.mean}\ (m^3/day) = \frac{q_1N_1f_1 + q_2N_2f_2 + \dots}{1000} + D = \frac{\sum q_iN_if_i}{1000} + D \quad (3\text{-}1)$$

Where:

q_i : household water supply criteria according to table 3.1.

N_i: Calculated population corresponding to water supply criteria q_i.

f_i: Water supplied population ratio according to table 3.1.

D: The water amount of irrigation, street cleaning, urban services, industrial zones, loss and water need for treatment plant itself shall be calculated according to table 3.1 and water reserve. The amount of water reserves for industrial development, population and other water amounts which have not defined yet are allowed to take a plus of 5 -10% of the total household water volume of the residential place. When there are justifiable reasons, it is allowed get more but not exceeding 15%.

Calculated water flow used in maximum use day and minimum use day (m^3/day) is defined by the formula:

$$Q_{day.max} = K_{day.max} \times Q_{day.mean}$$
$$Q_{day.min} = K_{day.min} \times Q_{day.mean} \quad (3\text{-}2)$$

Coefficient of aperiodic water use per day including the way of social life organization, working mode of production facilities, comfort levels, changes in seasonal water demand to be taken as follows:

$$K_{day\ max} = 1,2 \div 1,4$$
$$K_{day\ min} = 0,7 \div 0,9$$

For large-scale city, located in areas with annually dry climate conditions (such as Ho Chi Minh City, Dong Nai, Vung Tau, ...), may apply at:

$K_{day\ max} = 1,1 \div 1,2$

$K_{day\ min} = 0,8 \div 0,9$

Calculated hour flow q m^3/h, must be defined as:

$$Q_{hour.\ max} = K_{hour.max} \frac{Q_{day.max}}{24}$$

$$Q_{hour.\ min} = K_{hour.min} \frac{Q_{day.min}}{24} \quad (3\text{-}3)$$

Coefficient of aperiodic water use K is defined by the formula:

$K_{hour\ max} = \alpha_{max} \times b_{max}$

$K_{hour\ min} = \alpha_{min} \times b_{min}$ (3-4)

A: Ratio taking into account work comfort levels, working mode of production facilities and different local conditions is defined as:

$\alpha_{max} = 1,2 \div 1,5$

$a_{min} = 0,4 \div 0,6$

b: Ratio taking into account population number in residential area is defined in Table 3.2.

Table 3.1.

No	Water use objects and water supply categories	Period	
		2010	2020
I.	The special municipality, the municipality of grade I, tourist and holiday areas		
	a)Household water:		
	- Water supply standard (l/per.day): + Interior	165	200
	+ Exterior	120	150
	- Water supply population ratio (%): + Interior	85	99
	+ Exterior	80	95
	b) Water used for public services (tree watering, street cleaning, fire fighting…); calculated basing on % of (a)	10	10
	c) Water used for service industry in urban area; calculated basing on % of (a)	10	10
	d) Water for industrial zones (according to clause 2.4-Section 2)	22÷ 45	22÷ 45
	e) Water loss; calculated basing on % of (a+b+c+d)	< 25	< 20
	f) Water for treatment plant itself, calculated basing on % of (a+b+c+d+e)	7 ÷10	5 ÷ 8
II.	Grade II and |Grade III municipalities		
	a)Household water:		
	- Water supply standard (l/per.day): + Interior	120	150
	+ Exterior	80	100
	- Water supply population ratio (%): + Interior	85	99
	+ Exterior	75	90
	b) Water used for public services (tree watering, street cleaning, fire fighting…); calculated basing on % of (a)	10	10
	c) Water used for service industry in urban area; calculated basing on % of (a)	10	10
	d) Water for industrial zones (according to clause 2.4-Section 2)	22÷ 45	22÷ 45
	e) Water loss; calculated basing on % of (a+b+c+d)	< 25	< 20

	f) Water for treatment plant itself, calculated basing on % of (a+b+c+d+e)	8 ÷10	7 ÷ 8
III.	Grade IV and grade V municipalities; rural residential places		
	a)Household water: - Water supply standard (l/per.day): - Water supply population ratio (%): b) Water used for services, calculated basing on % of (a) c) Water loss; calculated basing on % of (a+b) d) Water for treatment plant itself, calculated basing on % of (a+b+c)	 60 75 10 < 20 10	 100 90 10 < 15 10

Table 3.2.

Population (1000 persons)	0.1	0.15	0.20	0.30	0.50	0.75	1	2
b_{max}	4.5	4.0	3.5	3.0	2.5	2.2	2.0	1.8
b_{min}	0.01	0.01	0.02	0.03	0.05	0.07	0.10	0.15
Population (1000 persons)	4	6	10	20	50	100	300	≥ 1000
b_{max}	1.6	1.4	1.3	1.2	1.15	1.1	1.05	1.0
b_{min}	0.20	0.25	0.40	0.50	0.60	0.70	0.85	1.0

Note:

1. b_{max} coefficient is used to determine the pump pressure and water tower height in order to ensure the necessary pressure of the network in the maximum use hour. b_{min} coefficient is used to determine the residual pressure of the network in minimum use hour.
2. When determining flow to calculate project and network, including network inside the housing, the coefficient b must be taken by served population, but in the zoned water supply system, it must be calculated according to population of each region.

3.4. The water distribution per hour per day of concentrated water supply system must be in accordance with urban synthetic water use diagrams. These diagrams shall be created basing on water use diagram of each object or referring to the actual diagram of the similar residential area.

3.5. Irrigation, cleaning water standard in residential and industrial areas, depending on type of road surface, washing way, plants and other local conditions must be in accordance with Table 3.3.

Table 3.3.

Water use purpose	Unit	Standard for 1 irrigation time(l/m^2)
Mechanical washing of finished roads and squares	1 time	1,2÷1,5
Mechanical watering of finished roads and squares.	1 time	0,5÷0,4
Manual watering (with flexible hose) of finished pavement and road.	1 time	0,4÷0,5

Watering of urban plants. Watering of lawns and parterre. Watering plants in nurseries of all kinds.	1 time - 1day	3÷4 4÷6 10÷15

1. When lacking data on planning (road, trees, nursery), the irrigation water flow by population shall be not more than 8-12% of domestic water supply standard, depending on climatic conditions, water source capacity, improvement level of residential areas and other natural conditions.

2. In the industrial zones having production water supply network, it allows to use water from this network for street cleaning and tree watering if the water quality is in accordance with hygiene requirements and cultivation techniques.

3.6. Irrigation is from 1 to 2 times according to local conditions

3.7. Domestic water demand in industrial production facilities must be taken from Table 3.4.

Table 3.4.

Atelier category	Domestic water standard in industrial production facilities per capita per shift (l/capita/shift)	Hourly aperiodic ratio
Atelier emitting above 20 Kcalo/m^3. hour	45	2,5
Other ateliers	25	3

3.8. Hour flow of shower group in industrial production units should obtain 300l /h. Shower use time must last 45 minutes after the shift. Number of shower should base on the number of workers in the largest shift and the hygienic characteristics of the production process according to table 3.5.

Table 3.5.

Hygienic characteristics of the production process	Users per shower group
a) Do not dirty clothes and hands and feet	30
b) Dirty clothes and hands and feet	14
c) Use of water	10
d) Discharge dust or toxic substances	6

Note Livestock and poultry water standard shall be taken from Ministry of Agriculture's standard.

3.9. Production water flow of industrial units shall be identified based on technological requirements.

3.10. If needed to determine the calculated concentration flow of separately standing houses and public housing, water use standard shall be taken from inside water supply design standard.

FIRE FIGHTING WATER FLOW

3.11. In residential areas and the agricultural and industrial production units, it must design fire fighting water supply system combined with domestic or production water supply system. When designing fire fighting water supply, it should follow the standard of fire prevention and fire fighting (TCVN-2622: 1995).

FREE WATER PRESSURE

3.12. Minimum free pressure in domestic water supply network of residential areas, at draw-off point from the ground shall be not less than 10 m.
Notes: For isolated high buildings as well as for houses or housing group located at high points, it allows to install local boosting devices.

3.13. Free pressure of the external network of domestic water supply system at consumers should not exceed 40 m.

Notes:

1. In special cases, it can take up to 60 m.
2. When pressure on the network is greater than permitted pressure for the isolated houses or areas, it allows installing pressure regulating devices or zone water supply system.

3.14. Fire fighting water supply system must use low pressure. It allows only building high pressure fire fighting water supply system when there is sufficient technical and economic basis.
In high pressure fire fighting water supply system, the fixed fire pumps must have device that ensures the opening no later than 3 minutes after it receives a fire signal.

3.15. Free pressure in low pressure fire fighting water supply network shall be not less than 10 m from the ground, and length of fire nozzle no more than 150 m.
Note: At the ranch, free pressure for fire fighting shall be calculated with conditions of fire nozzle located at highest point of one storey ranch.

4. WATER SOURCES

4.1. Water source selection must be based on testing documents according to selection criteria of surface water, groundwater sources for domestic water supply systems given in TCXD-233-1999; Hydrogeologic and hydrometerologic survey documents; ability to protect water sources and other documents. Volume on the exploration and investigation should be determined depending on the characteristics and available documentation of this area; Depending on needed water flow and quality; Type of household user and the design phase.

4.2. In a water supply system, it allows to use different water sources having different hydrological and hydrogeological characteristics.

4.3. Monthly or daily average flow reliability of surface water sources must be taken from Table 4.1, depending on reliability level

Table 4.1.

Water supply reliability level	Monthly or daily average flow reliability (%)
I	95
II	90
III	85

Note: Water supply reliability level is given in Clause 1.3.

4.4. The evaluation of ability using water sources for water supply purposes and the selection of areas to build storage basin must comply with the instructions of Annex 2.

4.5. Selection of water sources must follow the regulations of the authority planning and management of water sources. The quality of water used for drinking and domestic activities must comply with standard TCXD 233-1999. The quality of water used for production must be based on each user object's requirements.

4.6. It needs savings in the use of underground water. If surface water sources comply with standard TCXD-233-1999, give priority to use surface water sources.

4.7. Not allowed to use underground water for consumption needs without permission of the water management authority.

4.8. If conditions allows, it is necessary to study the possibility of complement groundwater reserves by artificial replenishment works in the case where natural underground water reserves are not enough for exploitation.

4.9. It allows treating mineral water or marine water for supplying domestic water system but in the basis of economic - technical comparison with other water sources.

4.10. It allows using geothermal water for domestic and production activities when it ensures specification given in Clause 4.5.
Highest temperature of water for domestic use shall not exceed 35^{o}C.

4.11. Water source selection projects must be comprehensively reviewed on economic aspect, including construction costs, management, power consumption ... At the same time, it must consider the impact of the water sources exploitation on water use needs of other economic sectors.

4.12. Selecting measures to regulate the flow and storage basin capacity should be based on the hydrological characteristics and rules on the water sources use issued by water source planning and management authorities

4.13. Storage basin to supply drinking and domestic water should be constructed outside the residential areas, in sparse population, a lot of forests and shall not be discharge by dirty water and timber raft.

5. WATER COLLECTORS

UNDERGROUND WATER COLLECTORS

GENERAL INSTRUCTION

5.1. Selection of location, type and scheme of underground water collectors must be based on geological and hydrogeological documents , capacity of works, type of equipments, construction conditions and sanitary protection conditions of the area; In general, it must consider:

Characteristics of water fielding stratum and underground water replenishment conditions.

- Conditions ensuring sanitary and organization of sanitary protection areas, protection of water sources against contamination by domestic and production waste water, and against suction by high degree mineralized or toxic water.
- Area without land erosion, sliding or other types of distortion causing work destruction.
- Availability or possibility of execution of construction road, roads serving work

management and water supply pipes.

- Well drilling being away from architectural buildings at least 25 meters.

5.2. Using underground water sources for water supply purposes must be agreed by sanitary and phytosanitary agencies, water source management agencies.

Large capacity water collectors must be approved by water source management competent authority.

Documentation determining reserves to design exploitation well must be submitted to National Reserve Council for approval.

Exploratory drilling combined with exploitation drilling must be approved by competent authorities.

5.3. When designing new water collector and expanding existing work, it need to consider the operating conditions combined with the existing collection work or work in process of building in the neighboring area.

5.4. The type of groundwater collectors which can be used consist of:

1) Deep wells used to collect shallow spring water that run in from surrounding or bottom at appropriate depth.

2) wells collecting open flowing groundwater

3) tunnel or horizontal water collecting pipes used to exploit water layer at the depth under 8m, or collecting water in the aquifer layers located near surface waters (such as rivers, lakes ...), constructed by open excavation, if at greater depth and groundwater at high level, use pressure drilling methods, the diameter of vertical well for horizontal pressure drilling must be $\geq$ 2m.

4) Bored well with or without pressure, completed or uncompleted

Select any type of work must base on the conditions stipulated in Clause 5.1 and on technical economic calculations to decide.

BORED WELLS

5.5. For the well design project, specify well structure, drilling methods, depth determination, well diameter, filter pipe style, pump types and cover of the well pumping station.

5.6. Choosing method of well drilling should be based on geological, hydrogeological conditions, depth and diameter of the well, taken as directed in Annex 4.

5.7. Well depth depends on the strata depth, thickness of aquifer or aquifer system, flows subjected to be exploited and corresponding dynamic water levels.

5.8. Determine the diameter and length of the first well wall tube. The final diameter of bore hole must be based on flow needed to be exploited, on type and size of pumps, on the depth setting pump system if using submersible pump and vertical axis pump or on the depth setting suction tube if using horizontal axis pump, allowable slope of well, equipment to measure dynamic water levels in the pumping process.
Note: The diameter of the fist wall tube of wells is the inside diameter of the tube in which the pump or suction parts of pump are placed.

5.9. Size and structure of filter pipe shall be determined on the basis of geological and hydrogeological conditions, depending on the quantity and exploitation regime, as given in Annex 5.

5.10. The length of the working part of filter pipe, if the water collection occurs in aquifers with pressure and aquifer thickness less than 10 meters, shall be taken by the aquifer thickness. If the water collection occurs the aquifer without pressure and below 10 meters in thickness, the length of the working part of filter pipe shall be equal to the difference between the aquifer thickness and water lowering level in well when exploited (filter tube shall be submerged below calculated water level). When the aquifer thickness is greater than 10m, the length of the working part of filter pipe must

be determined depending on the soil permeability, exploited flows and filter pipe structure.

5.11. The working part of filter pipe must be placed at least 0.5-1m apart from top and bottom of aquifer.

5.12. When exploiting in many aquifers, the working parts of filter pipe must be placed in each exploited aquifer and be joined together by undrilled pipe.

5.13. The transition points where diameters of the wall tube are changed, or point of transition from wall tube to filter tube can be constructed by connecting string welded pipes (using the transitional cone) or interlocking joining. For waterproofing the interlocking joints, it can use compressed joining parts (jacket pipe using oiled jute fiber inside).

Filter pipes ends must be higher than the base wall pipe kicker not less than 3m when well depth is up to 30m and not less than well depth is over 50m.

5.14. The internal diameter of the wall pipe at the interlocking joint with the filter pipe when executing a percussion drill, must be larger than the external diameter of the filter pipe at least 50mm, and at least 100mm if it must pour gravel around the pipe filters When executing rotary drill, if well wall are not reinforced by tube, the final diameter of the bore hole must be larger than the external diameter of the filter pipe at least 100mm.

The structure of well head must ensure absolute tightness to prevent surface water from penetrating into the well.

5.15. The space between the wall pipe or between wall pipe and well wall should be carefully blocked by concrete or ball clay (φ 30mm), carefully compacted to avoid surface water penetration causing well contamination.

In a bore well, if there is water bearing loose stratum above the impact line of aquifer to be exploited, the space between the well wall and the outer wall pipe must be carefully compacted by concrete or ball clay. In the necessary case, construct multiple support pipe layers in order to limit water level from upper layer to draw down and carry away fine grain which emptying soil then causing well foundation landslide.

5.16. The length of deposit pipe must be taken depending on soil characteristics but not exceed 2m.

5.17. The well wall pipe must be placed higher than the pump floor at least 0.3 m. After completing the well drilling and filter pipe installation, it is necessary to scour the wells and test pumping. The well scouring and pump testing should follow the instructions in Annex 3.

5.18. Before put into operation, well must to ensure the following quality requirements:
- Depth complying with design, dynamic water level and static water level must ensuring long-term operation even when influenced by the around exploited wells.
- Slope of well is smaller than 1:1500
- Sand content in pumped water is <5mg / l
- Test pump flow is higher than exploited flow at least 7%.

5.19. When placing motor pump on well mouth (well pivot pump) or using submersible pump, the operation diameter of the wall pipe must be greater than the conventional diameter of pump at least 50mm.

5.20. Depending on the specific conditions and equipment types, well mouth must be placed in the house or in the sunken hole. When using motor pump placed on the well mouth, a cover is absolutely necessary.

5.21. To exploit the well group when the dynamic water level not exceeding 8-9m, allow using siphon collection tube.

5.22. Where more complete collection equipment can not be used, if technical and economic basis are available, it is permitted to use the air compressor with condition that the air must be taken at an altitude of at least 4 meters above ground. Air intake gate must

have to filter mesh and protected from rain falling, at the same time, ensure to entirely remove oil for air behind compressor.

5.23. Well pumping station height calculated from the ground must be taken according to the size of equipment but not less than 3.5 m. Minimum pump station area must be at least equal to $12m^2$ to locate devices, control equipments, measuring and inspection instruments and to ensure ventilation.

The exit door of the well pumping station must ensure the easy access to the devices. It must have windows for ventilation. At the well, it must have a support to fit or remove device or a mobile tripod placed on flat roof of the well. Pumping station ceiling must have holes and be expected a load lifting device to fit and remove the engine and pump.

5.24. To keep aquifers away from water contamination, wells that were contaminated or damaged and unable be used anymore must be filled by clay or concrete. It is necessary to fill out the exploration well if they are not used as exploitation or observation wells.

5.25. The number of backup wells should be obtained from Table 5.1.

Notes:

1 - Depending on the hydrogeological conditions and when there are appropriate reasons, it can increase the number of backup wells but no more than 2 times stipulated in Table 5.1.

2 - For any type of water collector, it should have backup pump placed in store. When the working pump number is under 10, get 1 backup pump; if the number is above 10, backup pump is equal to 10% of the working pumps

3 - Reliability of water collectors shall be taken by insurance level of water supply under Clause 1.3.

Table 5.1.

Number of working pump	Backup pumps according to reliability level		
	Level I	Level II	Level III
1 - 2	1	0	0
3 - 9	1 - 2	1	0
10 and above	20%	10%	0

DEEP WELL

5.26. The depth of deep well shall not be greater than 15 m. Well diameter shall be defined by exploration documents, ensuring equipment layout and convenient construction requirements, at least of 0.7 m and not greater than 5 m. Wells can have shape of a circular cylinder or frustum of a pyramid; the well wall can be built of brick, stone or assembly reinforced concrete.

5.27. Water collected in deep wells may enter from the wall, the bottom or from both the wall and bottom, or by fan shaped collection tubes. Type selection shall be decided depending on hydrogeological documents, water demands and techno-economic calculations.

5.28. The water inlet holes of deep wells can be designed with a gravel filter layer or two layers which layer thickness is at least 100mm. The particle diameter of the filtering layer adjacent to the aquifer shall be taken from Annex 5. Calculated diameter ratio of particles between two layers of filtering material adjacent to not less than 5. Can insert the holes collected by the hollow precast concrete members, according to the gradation

from 5:29

5.29. Selection of gravel particle composition, water cement ratio for hollow concrete filter layer must base on calculation of the lava types of external aquifers. Preliminary selection of particle components shall be done as follows:
Gravel size by 16d50 (d50 is the average particle diameter of the aquifer, i.e. the sieve mesh size can let pass through 50% of the experimental grains).

- Grade 400 cement dose is equal to 250kg per $1m^3$ of concrete.

Ratio of water/cement = 0,3 - 0,35 for particle size of 7-10mm
= 0,3 - 0,4 for particle size of 2 - 6mm.
= 0,35 - 0,45 for particle size of 2 - 3mm.

5.30 When taking water from bottom, well bottom should be equipped with a filling layer to prevent sand from pushing up, this layer consists of 3 to 4 layers with increasing grain diameter and minimum thickness for each layer should not be less than 100mm. Composition of filling material is stated in Annex 5.

5.31 When designing deep well, following requirements should be met to protect against contamination for water:

1. Well wall is higher than ground surface at least 0.8m. There should be exploratory hole for manager to enter and exit for control or repair.
2. Around well mouth, there should be incline surface for water drainage which is built by waterproof material with a width of 1.5m and inclination i = 0.05 outward. Well wall should be surrounded by a clay ring of 0.5m wide and deep no less than 1m.
3. Tight well should have ventilation pipe with pipe end covered from raindrops and covered by grid.

5.32. When designing a well group, if able, it is suggested to use siphon for gathering water, then active water level in the well should be higher 1m compared with suction end of the siphon. Depth of conduit should not be greater than 4m. Depth measured from conduit centre to active water level in the well should not be greater than 7m.

5.33. Water speed in siphon will be 0.5-0.7m/s. Inclination of pipe piece from well to gathering well should not be less than 0.001.

HORIZONTAL WATER COLLECTOR

5.34. Horizontal water collector is designed for water-bearing formations at depth < 8m and near surface source.

Horizontal water collector structure should be designed in form of open channel: collector gutter of stone with tunnel or collector pipe.

5.35. Ballast collector structure should only be use for temporary water supply. For this type, water is collected via underground gutter filled by ballast or rocks with size of 0.1-0.15m and surrounded by two or three layer of ballast or gravel of small grain size to form a back-filter layer of which minimum thickness of each layer is 150mm. Grain diameter between adjacent layers is stated as in Annex 5.

Dimension of gutter depends on output for exploitation and hydrological geology condition of each water-bearing formation. Above filter stratum requires a clay

layer for preventing surface water from penetrating into the gutter.

5.36. For water supply with reliability level type I and II, it is required to design water collector tunnel. Horizontal water collector tunnel is made of hollow concrete block aggregated depending on external stratum as in 5.29. There should be a thick gravel layer of 150mm outside the tunnel, with gravel grain size as guided in Annex 5.

5.37. For water collector tunnel under river bed or alluvial land, depending on erosion condition of the river then protection solution will be selected for upper component of the filter layer. When designing horizontal collector tunnel under river bed, depending on quality of river water and application time then reservation coefficient will be chosen reasonably.

5.38. Cross section of water collector tunnel should be hydraulic estimated under condition of water not fully flow and meeting following requirements:

- Flow speed in tunnel is equal to 0.5-0.8 m/s
- Thickness of water layer is normally 0.4D (D is diameter of collector tunnel)
- Internal diameter of collector tunnel $D \geq 200mm$

5.39. Horizontal water collector pipe is designed when depth of water-bearing formation is less than 5m. Water collector can be porcelain pipe, concrete or plastic pipe, with round orifice, gaps at both sides and on pipe body. Lower part of the pipe (not over 1/3 height) is not perforated or gapped. Minimum diameter of pipe is 150mm.

Note:

1) It is allowed to use metallic pipe if reasonable

2) Plastic pipe is only used when meeting sanitary and hygiene requirement and not affecting water quality.

5.40. Collector pipe should be surrounded by back-filter layer. Mechanical components of back-filter layer are determined by calculation. Thickness of each layer should not be less than 150m. Aggregation is stated in Annex 5.

5.41. Diameter of water pipe of horizontal water collector structure should be determined in compliance with the period of lowest underground water level; estimated thickness is equal to 0.5 time of pipe diameter

5.42. Inclination of pipe toward receiving well should not be less than:

0,007 when D = 150mm

0,005 when D = 200mm

0,004 when D = 250mm

0,003 when D = 300mm

0,002 when D = 400mm

0,001 when D = 500mm

Speed of water flowing inside the pipe should not be less than 0.7m/s.

5.43. It is required to install exploratory well for observing operation mechanism of collector pipe and collector tunnel as well for ventilation and repair: For collector pipe with diameter from 150mm-600mm, distance between exploratory wells will not exceed 50m. For greater diameter than 600mm, distance between exploratory wells will be 75m. For tunnel, distance between wells will be within 100-150m. It is also required to install exploratory well where collector pipe or tunnel changes

direction by layout or vertical surface

5.44. Exploratory well should have diameter of 1m. Well mouth is higher than ground surface at least 0.5m. Surrounding area of the well should be covered with waterproof material of 1m wide and filled with clay. Exploratory well should have ventilation pipe.

5.45. Pump station in horizontal collector structure should be used in combination with gathering well. Private pump is allowed if reasonable.

SPRING WATER COLLECTOR

5.46. For collecting open spring water, collector chamber is built. For upward spring water, collection work will be implemented via bottom, for downward spring water, collection is implemented via submerged orifices on wall of collector chamber.

5.47. Dimension of the site, spring structure and water level structure (overflow pipe structure) in collector chamber should base on geological condition, hydrological condition and exploitation flow rate.

5.48. For collecting spring water from soil layers with cracks, it is allowed not to use filter stratum. For collecting water from mellow soil layer, it is required to use graded filter.

5.49. Collector chamber should have overflow pipe with structure measured by flow rate of spring. If located too high, static pressure in front of injection tube will increase, flow rate is reduced and spring may turn to other place with lower pressure. If overflow pipe is too low, flow rate of the spring will not be fully used. Exhaust pipe of collector chamber should have minimum diameter of 100mm.

5.50. For settling water with great sediments, overflow wall should divide collector chamber into two spaces, on for sedimentation and another for collecting water.

5.51. Construction of collector chamber should meet sanitary and hygiene requirements as in 5.31.

ARTIFICIAL SUPPLEMENTATION OF UNDERGROUND WATER DEPOSIT

5.52. If required, it is able to supplement underground water deposit by surface water sources via special constructions, continuously or periodically operating. In addition to water filtering intake, water collector and pump, cleansing and decontamination construction should be considered for water basing on specific condition.

5.53. Artificial supplementation of underground water deposit is for:

- Increasing water supply power and ensuring stable operation of available water collector construction or newly build water collection construction.
- Increasing quality of underground water penetrated and being exploited.
- Protecting surrounding environment (prevent underground water level going down lower than allowable value causing influence on floral system in the

area).

- Protecting water-bearing formation from salinity, contamination due to production wastewater, domestic waste water.

5.54. When using impregnated water source for domestic use and drinking, quality of surface water source for supplementation should meet sanitary and hygiene requirement regulated by the Government. When reasonable and under agreement of sanitary and epodeniologic authority, water for cooling and other water types can be used for supplementation of underground water deposit.

5.55. Constructions for supplementing underground water deposit should be approved by authority of planning and management of surface water source

5.56. There should be equipment and tools on all constructions for supplementing underground water deposit for observing operation of the submerged orifice construction and permeability of water via thickness of water-bearing formation

5.57. Artificial constructions for supplementing underground water deposit for supplying domestic use and drinking should have hygiene protection area (as guided in Part 11).

SURFACE WATER COLLECTOR

5.58. Surface water collector should ensure:

- To collect water from estimated flow rate
- Not to create local sedimentation in exploitation area.
- Not to allow garbage, alga or fish going into the construction.

5.59. Design of surface water collector should base on:

- Estimated water flow rate
- Reliability level of collector structure
- Hydrologic characteristics of water source, both highest and lowest water level.
- Requirements stated by sanitary and epodeniologic authority, water source management authority, water navigation management authority.

5.60. Water collector construction is classified into 3 reliability levels in accordance with reliability of the construction (see 1.3)

5.61. Design level of water collector construction is mainly determined by its reliability level.

Note:

Design level of water-raising dam and storage dam in structure of surface water collector facility should be in compliance with design for irrigation structure, but not lower than:

- Type II with water supply reliability level of I
- Type III with water supply reliability level of II
- Type IV with water supply reliability level of III

5.62. Designing water collector construction should take into account ability of increasing demand for water in the future.

5.63. Location of surface water collector facility should ensure following requirements:

a) At starting point of water flow from residential area and industrial area.

b) Sufficient water amount required in short-term and in the future

c) Collecting water of good quality and convenient for arrangement of hygiene protection for water source.

d) At sided area, stable river bed, little erosion or change of water current, deep enough; to be at good geological condition and not being influenced by other hydrological phenomena such as wave, tide…

e) Arrangement water supply system (including collecting, conducting, treating and distributing water) reasonably and economically.

g) Near power supply area

h) Solving requirements of industry, agriculture and waterway transportation

5.64. Water collector structure in general should be able to decontaminate primarily water from floating objects, wastes and river deposit. When water collector structure is located at area where there are big floating objects such as timber, bamboo in flood, it is required to have solution for directing these objects out of collector structure or for fencing at upper pool of collector structure. When designing great surface water collector in complicated hydrological condition, it is required to have model testing.

5.65. It is not allowed to install collector structure within traffic path of vessels, in area with river alluvium moving at river bed or at upper pool of container tank, at fish area at outfall of river or where there are many algae.

5.66. It is not allowed to install collector structure at lower pool adjacent to hydraulic plant, in area right under river outfall

5.67. Collector structure should be installed:

- At a depth no less than 3 times of estimated height of wave in lowest wave condition.
- In wave-tight area
- Out of soil stripe in parallel with river side or opposite to river side, discontinuing flow.

5.68. Water collector structure at sea or great lake should be installed in bay, behind breakwater works or in area without waves

5.69. Water collection condition from water source is classified basing on complication of water collection, instability of river bed, hydrological condition and contamination of water source by indicators in Table 5-2.

5.70. Diagram of water collector is in compliance with Table 5-3 depending on required reliability and complication of water collector condition.

5.71. To ensure required water supply reliability level in difficult water collection condition, it is required to installed water collector at two positions not being stopped from water supply at the same time. Output of each collector construction with water supply reliability level I should be equal to 75% of estimated flow rate; for water supply reliability level II, equal to 50% of estimated flow rate. Water supply reliability level II and III in easy or medium water collection condition can be increase 1 level.

Table 5-2

Water collection characteristics	Water intake condition	
	Alluvium and stability of river side and bed	**Other factors**
Easy	Suspended agents P≤ 0.5 kg/m^3. River (lake) bed and side stable, without flood.	No alga, clams in water source. Some wastes and dirt.
Average	Suspended agents ≤ 1.5 kg/m^3 (average in flooding season). River bed, side and river bank are stable. Water level vibration ≤ 1m. Alluvium moving along side without influence on stability of the side.	Some alga, waste and dirt not causing difficult to water collector. With raft and vessels passing by.
Difficult	Suspended agent P ≥ 5 kg/m^3. River bed moves with vibration of river side and bottom, causing change in river bottom structure from 1-2m per year. River side is changed with alluvium moving along river side with slope of variable inclination.	With great floating objects (timer, bamboo pieces…) in flood, with waste causing difficulty for water collector and treatment.
Very difficult	Suspended agent P ≥ 5 kg/m^3. River bed randomly changes or changed much in river side or structure, causing sliding.	With great floating objects (timer, bamboo pieces…) in flood, with waste causing difficulty for water collector and treatment.

Table 5-3

Water collector construction	Reliability of water collector construction								
	Natural condition of water collector								
	Easy			Medium			Difficult		
	Diagram of water collector construction								
	a	b	c	a	b	c	a	b	c

Water collector construction near the bank with collecting inlet easy for access to manage and to have required protection and support construction.	I			I			II	I	I
Water collector construction of all types, far from the bank, in accessible in all time of the year	I			II	I		III	II	I
Mobile water collector construction - Floating type - Sliding type	II III	I II		III	III	II			

Note:

1) Above table is created for 3 constructions of water collection:

- Diagram a with one water inlet
- Diagram b, similar to above condition but including some water collecting chambers with equipment preventing alluvial and other difficulties.
- Diagram c with 2 water collector inlets far from each other a sufficient space to eliminate ability of interruption at the same time during water collection.

2) For water collector construction of reliability level I and II, it is required to divide water collector construction into chambers. Number of independent operation chambers is not less than 2.

5.72. When depth at river side ensures a normal water collection or depth can be increased due to adjustment construction as well as ensuring condition and geological condition, water collector structure of combination type is also required.

In geological condition of structure, hydrological condition and construction ability, water collector structure of small output is allowed and collector inlet can be installed near the side, pump station is independently located and connected to each other by chimney.

5.73. When depth at river side is not sufficient for water collecting and vibration of water level up to 6m, water collector structure of smallest output will have structure:

- Collection inlet installed deep into river bed
- Collection chamber having trash grid installed at the bank.
- Gravity conduit or siphon connecting collection inlet with collection

chamber

- Pump station located independently or in combination with collection chamber.

When water level vibration is greater than 6m and when vertical shaft pump is used, it is required to combine operation of pump and collection chamber with trash grid at the side.

5.74. For collector construction with reliability level of I with average or great output, it is required to consider ability of using a bay or channel for collecting water at high side when:

- Need to collect a great water amount at insufficient depth.

- There are alluvium and alluvial sand in water source.

5.75. Selection of type, structure and shape of collection bay should base on result of practical investigation, hydraulic model test in laboratory.

5.76. When using water source from river with insufficient depth, it is required to consider construction ability of:

- Collector construction of combination type or special type for ensuring a reliable collection of water
- Local conditioning construction for water flow or river bed to increase collection ability or local depth, giving convenience for transporting of alluvium in river bed.
- Water-raising dam.

5.77. For water collector construction with average or small output at river with many alluvium where water collection is difficult or collector construction can not be installed at river bed for ensuring waterway transportation, it is required to consider ability of building a collection bay in front of collector construction, allowing flooding in high water condition without accumulating alluvium or alluvial sand

5.78. **.** For collector construction at midland or mountainous area, transportation of solid objects around collector construction by:

- Building water diverting structure for carrying alluvium, alluvial sand without dam.
- Exhausting alluvium and alluvial sand via washing equipment of water-raising dam.
- Using sedimentation tank at collector structure.
- Moving mud, sand, rock current by the river

5.79. When combining collector structure of water-raising dam, it is required to estimate ability of repairing internal dam while collector construction normally works.

5.80. When collector construction is installed in fish reservoir, it is required to have protection equipment for fish under a form of a component of collection tube or an individual structure on water gutter. Installation and selection of equipment for fish protection should be approved by marine products authority.

5.81. It is allowed not installing fish protection equipment when:

- Filtering water collector type
- Collector tube is submerged under river water and flow speed passing

by the tube in dry season is greater 3 times compared with flow speed into the tube.

- Collector tube of the collector construction having low output when in spawning season, garbage bar is replaced by trash grid with small mesh and the grid can be cleaned by return water current.

5.82. Dimension of main components of collector construction (receiving inlet, grid, pipe, channel…) as well as height of pump axis should be determined by hydraulic calculation with estimated water flow rate and lowest water level (in table 5-2), taking into account stopping of one of suction pipe or a collection chamber for repairing or checking.

5.83. Dimension of receiving inlet should be determined by average speed of water flowing through bars or trash grid (in consideration of requirement for fish protection)

Allowable speed of water flowing into receiving inlet (not in consideration of requirement for fish protection) in average collection of water and difficult condition should be as follows:

- Into receiving inlet at non-flooded side: V = 0.6-0.2 m/s
- Into collector tube of flooded water: V = 0.3 -0.1 m/s.

When arising requirement for fish protection (using flat trash grid with mesh size of 2-3 mm installed in front of receiving inlet) but not taking into account complication of water collection condition in rivers with flow speed greater than 0.4 m/s, allowable water speed via receiving inlet is 0.25m/s. If collecting water from river with flow speed not greater than 0.4 m/s and collecting from lake, water flow speed via collecting inlet is 0.1 m/s.

Note:

1) Speed value stated above is for total area of bar submerged orifice area or grid.
2) In easy collection condition at fish reservoir, speed value is selected depending on requirement for fish protection and equipment for blocking fish.
3) For deep installed construction, water is collected in layers, estimated speed value will be specifically determined.

5.84. Dimension and area of water collecting inlet for all chambers working at the same time (excluding backup chamber) is determined by formula:

$$\Omega = 1{,}25\frac{Q}{v}K \qquad (5\text{-}1)$$

Ω - Area of receiving inlet of receiving chamber (m^2)

v – Speed of water flowing into receiving inlet (m/s), by clearance area of the inlet.

Q - Estimated flow of a receiving chamber (m^3/s)

K - Coefficient taking into account the area narrowed by bar or grid

$$K = \frac{a+c}{a} - \quad \text{for bar}$$

$$K = \frac{(a+c)^2}{a} - \quad \text{for grid}$$

c - Width of the gap between bars or net (cm)

a - Thickness of the bar or net (cm)

1,25 - Coefficient taking into account the jammed submerged orifice due to garbage

5.85. In filtering collection structure, area of filter layer is also determined by formula (5-1) but with coefficient $K=\frac{1}{P}$ where *P* is void of filter layer, equal to 0.3-0.5 (for permeability layer with filter layer of gravel and ballast) and equal to 0,25-0,35 (with filter layer of hollow concrete).

Note: It is not allowed to use filtering type water collector construction for fixed collector construction from contaminated water sources when not sure about repairing the contaminated filtering layer.

5.86. Collector structures should be protected against erosion due to annular flows by building deep foundation and reinforcement for the foundation around construction.

5.87. Collector construction should be protected against damages due to floating objects and anchoring of vessels. Depending on reliability level for water supply system and complication of collection condition, collector structure should ensure to be protected against consolidation of the alluvium. Location of collector structure should be fenced by floating buoys.

5.88. Collector structure at the river side should be protected against erosion due to influence of water flow and wave by reinforcement of the river side and bed.

5.89. Lower edge of water receiving inlet should be higher than river or lake bed at least 0.5m Upper edge of receiving inlet or submerged construction should be lower than wave valley 0.3m.

Submergence of water receiving inlet when collecting water in layers should be determined by estimation for layered stability of water density in the reservoir.

5.90. When building collector structure, it is required to consider the ability that clams and alga can cause jam for collector components to have proper solution (Chlorination …) as guided in 10.13.

5.91. . It is allowed to use siphon at collector structure with reliability level of II and III. For water collector structure with reliability level of I, siphon is only used if having proper reason.

5.92. Gravity conduit with water exhausts should be designed by underground pipe or gutter of stainless material (concrete pipe, iron-cast pipe, concrete underground gutter…)

5.93. Gravity conduit and siphon under water without exhausts should be made of welded steel with reinforcement joints and having stable foundations

5.94. It is required to check connection of gravity conduit and siphon made of steel and there should have anticorrosive insulation, and if required, cathode solution or surface protection method will be applied.

5.95. Siphon and gravity conduit in river bed limitation should be externally protected from corrosion due to bed load and from damages due to anchoring of vessels by locating them deep under the bed depending on local condition, but at least 0.5m depth or they should be covered by soil with anticorrosive reinforcement.

5.96. Dimension of cross section of suction tube by gravity principle or siphon can be determined by hydraulic calculation for normal working condition of collector structure by following velocity value:

- For gravity conduit: 0.7-1.5 m/s

- For suction tube 1.2- 2 m/s

In this case, cross section of siphon or gravity conduit which is determined basing on allowable speed should be checked ability of self-washing of grains deposited in pipeline.

5.97. Minimum estimated water level in collector chamber is determined by hydraulic calculation, corresponding with situations:

- Minimum water level in water source
- When one chamber of collector construction does not work.
- When arising disadvantageous conditions (jam at trash grid, jam at conduit…)

Note:

When arising ability of jamming conduit by clams, it is required to calculate water loss on pipeline with stop value of 0.02-0.04

For siphon with greater length, it is required to design equipment for opening from exhaust valve of the pump.

5.98. Selection of grid for primary decontamination of water should base on characteristics of lakes, rivers and power of collector constructions.

If rivers and lakes are contaminated at medium level, serious level and very serious level and water collecting power is greater than $1m^3/s$, rotating grid will be used.

5.99. Operation area of flat grid or rotating grid should be designed basing on minimum water level in grid chamber and water velocity through grid is selected as follows:

a) Not greater than 0.4 m/s when fish can get into grid chamber.

b) 0.8-1.2m/s when there is equipment for stopping fish outside grid chamber.

5.100. For collector construction compulsorily requiring vertical centrifugal pump, minimum number of pumps is selected.

For collector construction with small output, pump for a well is allowed.

5.101. To increase output of collector construction, it is required to design a supplemented pump assembly in pump station or to replace by pump with greater power as well as to install telescopic pipes inside pump station for adding siphon or gravity conduit...

5.102. Pump station (stage 1) of collector construction should be designed basing on guidelines in chapter 7.

When designing pump station, it is required to design pump for draining leakage water or pump for mud suction from water collector chamber and washing pump (when it is not able to take water from pressure pipeline).

6. WATER DECONTAMINATION AND TREATMENT

GENERAL INSTRUCTIONS

6.1. Water treatment method, ingredient and estimated parameters of decontamination construction, estimated content of chemicals should be determined by: source water quality, function of water supply system, output of decontamination station, local

conditions, technical and economic condition and technological researching data as well as operation of construction in similar condition. For water treatment construction with great output or quality of water source is complicated, it is required to establish experimental model for determining technical line for water treatment and required technical parameters.

6.2. When selecting treatment method by chemical agents, it is required to be in compliance with article 6.1. For primary calculation, table 6.1 can be used.

6.3. When designing water decontamination and treatment station, it is required to consider reusing washing water. Filtered washing water, exhausted water from chemical house and auxiliary constructions is not allowed to directly exhaust into lake or river to be water supply source but should be exhausted into container construction for treatment before going to receiver construction or reuse. Exhaustion of wastewater from water treatment factory after being treated should meet requirements of environment protection authority.

6.4. To check technological procedure for water decontamination and treatment, there should be sampling equipment for analysis installed in front of and behind each construction (mixing tank, clarification tank, sedimentation tank, container tank, pump station…)..

6.5. Surface water sources are classified as follows:

a) In term of sediment content:

- Less turbid water: up to 50mg/l
- Medium turbid water: from 50 mg/l to 250 mg/l
- Turbid water from 250mg/l to 1500 mg/l
- Very turbid water over 1500 mg/l.

b) In term of color degree

- Low color water: less than 35 TCU
- Water with medium color: 35 TCU to 120 TCU
- - Water with high color over 120 TCU

6.6. Estimated output of decontamination construction should be calculated from the day with maximum water consumption added with water flow rate for the station; it is also required to check reinforced operation condition to ensure supplemented water amount in fire condition.

6.7. Water flow rate for clarifier station; de-color station, de-ferrous station… is equal to 3-4% of water supply for household if water after washing filtering tank is used. This value is equal to 5-10% when water is not used after washing filtering tank . For softening station and desalt station, this value is equal to 20-30% and should be accurately determined by calculations.

6.8. Decontamination and treatment station should be designed in consideration with moderating operation condition all day and night and ability of interrupting each construction for investigating, replacing and repairing. For station with output up to 3000 m^3/person, operation partially in day and night is allowed.

Table 6.1

Water quality indicator	Chemical treatment method	Chemicals
Very turbid water	Flocculation, flocculation support	Aluminum, ferrous alum, flocculation auxiliaries (Polyacrylamide, siliceous acid…)
Water with high color, organic material and ephemera	First ozonization, chlorination, flocculation, flocculation support, alkalization	Ozone, chlorine dioxide, ferrous alum, flocculation materials (polyacrylamide, active siliceous acid), lime, soda, caustic.
Low alkalinity causing difficulty for flocculation	Alkalization	Lime, soda, caustic
Colored and flavored	Ozonization, chlorination, adsorption via active coal.	Ozone, chlorine dioxide, active coal.
Water with solid salts	Softening by lime-soda, ion exchanging, reverse osmosis	Lime, soda, common salt, sulfuric acid
Salt content greater than standard	Ion exchanging, electrolytic, distilling, reverse osmosis	Sulfuric acid, caustic
With H_sS	Chlorination, aeration	NaOCl
Dissolvable oxygen	Oxidation-reduction reaction	Sodium thiosulfite, hydrazine
Unstable water with negative saturation index	Alkalization	Lime, caustic, soda
Unstable water with positive saturation index	Acidulation, bonderizing	Sulfuric acid, sodium phosphate.
Water having bacterium	Chlorination, ozonization	Chlorine, chlorine dioxide, hypochlorite, ozone
Water with high ferrous content	Aeration, chlorination, alkalization, flocculation, ion exchanging	Chlorine, chlorine dioxide, hypochlorite, ozone, sodium permanganate, lime, caustic, soda, flocculation

6.9. Main technological constructions of water treatment station should be as in table 6.2 and guidelines in 6.1

Table 6-2

Components of main constructions	**Application condition**		
	Source water quality		**Source water quality**
	Suspended material (mg/l)	**Depth (degree)**	
Water treating with alum:			
1- One-stage filtering			
a. Pressure filtering	up to 30	up to 50	up to 3.000
b. Open filtering	up to 30	up to 50	up to 5.000
2- Vertically filtering- high rate filtering	up to 1.500	≤ 120	up to 5.000
3. Horizontally filtering – high rate filtering	up to 1.500	≤ 120	> 30.000
4. Two-stage filtering. Stage 1: contact filtering. Stage II: High-rate filtering	up to 300	≤ 120	Any
5. Clarifying with suspended sediment- High rate	50 up to 1.500	≤ 120	Any
6. 2-level sedimentation, high-rate	>1.500	≤ 120	Any
7. Contact filtering	up to 100	≤ 120	Any
8. Horizontal sedimentation or clarification with suspended sediment for partial clarifying	up to 1.500	≤ 120	Any
9. Coarse-grain filtering for partially clarifying	up to 80	≤ 120	Any
10. Thin layer sedimentation- High rate filtering	up to 1000	≤ 120	
Water treatment without alum			
11. Low-rate filtering	up to50	≤ 120	Any
12. Primarily filtering- Low rate filtering	up to1000	≤ 120	Any

13. Coarse-grain filtering for partially clarifying **Treatment method for ferrous-contained water** :	up to150	≤ 120	Any
14. Spraying – 1 stage filtering	Fe < 5 mg/l; pH ≥ 7; H_2S < 0,2 mg/l	≤ 120	Any
15. Natural aeration – Contact sedimentation – High rate filtering	Fe < 10 mg/;l pH ≥ 6,8; H_2S < 0,2 mg/l	≤ 120	Any
16. Forcing aeration (using fan) – High rate filtering	As point 15	≤ 120	Any
17. Air compressor – Pressure filtering	As point14	≤ 120	< 3.000
18. Natural aeration or forcing – Chemical preparation – Sedimentation – High rate filtering	pH < 6,8; Low alkalinity; Ferrous in flocculation form; Organic form ; Great Fe content	≤ 120	Any

Note:

1- Column: "suspended material" is total amount of maximum deposit including reactive material added in water and produced by alum electrolytic procedure.

2- When selecting components of construction in technical line, it is required to consider annual studying data and change in water quality in the year and time period of highest sedimentation and color.

3- Clarification tank with suspended sediment layer is only used when water inputted into construction having conditioning flow rate or gradually changing within ± 15% in one hour and water temperature does not change over ± 1^oC in 1 hour.

4- When treating very turbid water, for primarily cleaning, it is able to use horizontal sedimentation tank, natural sedimentation submerged orifice or other constructions.

5- At water collector construction and decontamination construction, grid with mesh size of 5-7mm should be installed to eliminate suspended garbage in water. When ephemera density in water exceeds 1000 units/ml, in addition to flat grid or rotating grid at collector construction, it is required to install micro filter

PREPARATION OF CHEMICAL AGENTS

6.10. Content of chemical agents estimated by periods of the year depends on quality of original water source and will be adjusted accurately in operation of the factory so that total content of chemical agent remained in water after the treatment should

be within allowable values according to "Hygiene standard for quality of domestic water" (Annex 6).

6.11. Alum content as for $AL_2(SO_4)_3$, $FeCl_3$, $Fe_2(SO_4)_3$. Waterless product, primarily selected as follows:

a) For turbid water treatment (as in Table 6-3)

b) For treatment of colored water as in formula:

$$P_p = 4\sqrt{M} \text{ (mg/l)} \qquad (6\text{-}1)$$

Where:

P_p - Alum content measured by waterless product

M - Color of source water treated by scale as in Platinum- Cobalt color scale

Note: When treating water both turbid and colored, alum content will be determined as in Table 6-3 and formula (6-1), whichever greater value will be selected.

Table 6-3 - Alum content for water treatment

Sediment content (mg/l)	Waterless alum content for treatment of turbid water (mg/l)
up to100	25 - 35
101 - 200	30 - 40
201 - 400	35 - 45
401 - 600	45 - 50
601 - 800	50 - 60
801 - 1.000	60 - 70
1.001 - 1.500	70 - 80

Note:

1) Small value is for water with great sediment
2) When contact filtering tank or filtering tank working with flocculation principle in filtering material layer, alum content will be smaller than values in Table 6-3 and formula (6-1) about 10-15%.

6.12. Auxiliary material content for flocculation (added into alum) should be as follows
a) Polyacrylamide (PAA):

- When adding into water before sediment tank or there is floating sediment inside the tank, this content will be as in Table 6-4.
- When adding into water before filtering tank by cleansing chart level 2, the content is equal to 0.05 to 0.1 mg/l.

- When adding into water before contact filtering tank or filtering tank by 1-stage filtering diagram, the content is equal to 0.2 to 0.6mg/l.

b) Active silica acid (SiO_2)

– When adding into water before sediment tank or tank with a floating sediment layer, the content is equal to 2-3 mg/l.

– When adding into water before filtering tank by stage 2 filtering diagram, the content is equal to 0.2 to 0.5 mg/l.

– When adding into water before contact filtering tank or filtering tank by 1-stage filtering diagram, the content is equal to 1 to 3 mg/l.

6.13. Content of chemical containing Chlorine (according to active chlorine) when chlorination in advance and promoting flocculation, decolorizing and decontamination procedures as well as for ensuring hygiene condition for construction should be 3-6mg/l.

Table 6-4 – PAA content for adding into water

Sediment content (mg/l)	Color degree (degree)	Content of waterless PAA (mg/l)
up to10	> 50	1 - 1,5
11 up to100	30 - 100	0,3 - 0,6
101 - 500	20 - 60	0,2 - 0,5
500 - 1.500	-	0,2 - 1

6.14. When there is phenol in source water, it is required to add ammoniac or ammonium salt with content of 20-25% (according to NH_3) of chlorine content, before chlorination process.

6.15. Chemical agent content for alkalization D_K (mg/l) is determined by formula:

$$D_K = K\left(\frac{P_p}{e} - k + 1\right) \qquad (6\text{-}2)$$

Where:

+ P_P: Maximum alum flow in alkalization time (mg/l)
+ e: Alum equivalent (waterless) in mg/mg-l

For

$Al_2(SO_4)_3$ e = 57
$FeCl_3$ e = 54
$Fe_2(SO_4)_3$ e = 67

+ k: Minimum alum content of water in mg-l
+ K: Gram equivalent of alkalization agent

For lime (according to CaO) K =28
For soda (Na_2CO_3) K = 53

6.16. For eliminating flavor and smell, following chemicals are used:

a. Active coal powder
b. Potassium permanganate

c. Ozone

Content of above chemical agents is determined by practical use.

Note: When treating seriously contaminated water, it is able to use ozone, or combination of potassium permanganate and active coal. In that case, active coal is added into water after potassium permanganate or ozone.

6.17. Steps for adding chemicals into water and time spaces between additions of chemical should be as in table 6-5

If it is not able to ensure necessary time space for addition of chemical into pipe before cleansing station and mixing tank, it is allowed to install additional mixing tank and contact tank of which structures should not allow chemical to be added into in form of deposit suspension.

Table 5

Source water characteristics	**Chemicals for treatment**	**Steps for inputting chemical into water**
1. Flavorless water	Chlorine, alum	Adding chlorine first, 1-3 minutes later adding alum
2. Flavored water - Chlorine phenol	Alum, ozone	Alum, ozone before or after filtering tank .
	a) Chlorine or $KMnO_4$	First adding chlorine or $KMnO_4$. 2 - 3 minutes later adding alum.
3. High content of organic agents, flavored but not phenol	b) Chlorine, active coal, alum	a) Adding chlorine first, 10-15 minutes later adding active coal, 2-3 minutes later adding alum. b) Adding chlorine first, 2-3 minutes later adding active coal, alum with content up to 5 mg/l before filtering tank
3 –As above, having flavor of chlorine phenol when chlorination	a) Ammoniac, chlorine, alum	Ammoniac, 2-3 minutes later adding chlorine, 1-3 more minutes adding alum.
	b) Alum, ozone	Alum, ozone before filtering tank
	c) $KMnO_4$, alum	$KMnO_4$, 1-3 minutes later adding alum.

	d) Ammoniac, chlorine, $KMnO_4$, alum	Ammoniac, 2-3 minutes later adding chlorine, 10 more minutes adding $KMnO_4$, 1-3 minutes later adding alum
	e. $KMnO_4$, chlorine, alum, active coal.	$KMnO_4$, 2 - 3 minutes later adding active coal, 1-3 more minutes adding alum.

Note:

1) When alkalinity is not enough for flocculation, it is required to add soda together with alum.
2) For decontamination, chlorine should be added into filtered water
3) Flocculation auxiliaries will be added into water after alum in 2 to 3 minutes.
4) For flavor elimination, it is able to use filtering tank with active coal granular filter (behind clarifier) or to use two-layer filtering tank with upper layer as active coal filter.
5) It is required to estimate ability of changing in contact time and mixing time of water with chemicals.

6.18. Chemicals should be made up and quantified under form of solution or suspension. Quantification of chemicals should be ensured with accuracy of ± 5% of stated quantity. Number of quantitative equipment for chemicals should be based on number of additions of chemical into water, but not less than 2 (1 equipment for backup aim).

Note:

1. It is allowed to quantify chemical at dry condition in special case.
2. Quantitative equipments should be placed at visible locations with sufficient light and should have equipments for testing..

6.19. Before adding reaction agents into water, it is required to dissolve them into solution, adjust concentration and contain in tank or container for consumption.
a. Capacity of mixing tank is determined by formula:

$$W_1 = \frac{q.n.p}{10.000 b_h.\gamma} (m^3) \qquad (6\text{-}3)$$

Where:

q - Water flow rate for treatment (m^3/h)

p: Content of chemical intending for adding into water (g/m^3).

n: Number of hours between two times of dissolving with output
up to1200 m^3/; n = 24
1200 -10.000 m^3/day; n = 12 hours
10.000 -50.000 m^3/day; n = 8 - 12 hours

> 50.000 m^3/day; n = 6 - 8 hours

b_h: Concentration of chemical solution in mixing tank, %

γ: Specific volume of solution, 1T/m^3

b. Capacity of consumption tank is determined by formula:

$$W_2 = \frac{W_1 . b_h}{b_t} (m^3) \qquad (6\text{-}4)$$

Where: b_t is concentration of chemical solution in consumption tank, %.

6.20. Alum solution concentration in the dissolving tanks shall be taken by 10-17%, in the consumption tank by 40-10% calculated according to unhydrated products.

6.21. Structure of dissolving tank must ensure to use unclean alum and clean alum. Number of consumption tanks shall not be less than 2, number of dissolving tank shall be chosen depending on method of alum delivery to treatment station, as well as the type of alum and alum dissolving time.

6.22. To dissolve the alum cake and mix the alum solution in tanks, if using compressed air, standard intensity shall be taken as follows:

- To dissolve alum: 8 – 10 l/s.m^2.
- To stir when diluting to needed concentration in consumption tank: 3-5 l/s.m^2.

In order to distribute air, it needs to use pipes with holes made from acid resistant materials.

Air speed in the pipe must be taken by 10-15 m/s. Air speed through the hole must be taken by 20- 30 m/s. Diameter hole shall be from 3-4 mm; holes must be downward and compressed air pressure shall be from 1 to 1.5 at.

Allow to use of an agitator or circulating pump to dissolve alum powder and mix the alum solution. When using an agitator, propeller number must not be less than two, turn round number equal to 20-30 rounds/min. For the treatment station with capacity under 500 m^3/day, alum can be manually mixed.

6.23. The alum dissolving and mixing tanks must be designed with the bottom wall inclined at an angle of 45-50^0 compared to horizontal plane. To discharge sediment and exhaust the tank, it must arrange pipe with a diameter not less than 150mm. When using alum cake in dissolving tank, it shall have a removable grid which slot is from 10-15 mm.

When using alum powder in grid, put a lattice with hole size of 2mm. To wash sediment and dissolve alum in the tank part below the grid (part where is placed water collection tube), it must have a device conducting water and air into the tank.

6.24. Consumption tank bottom must have a slope not less than 0.005 toward the discharge pipe. Discharge pipe diameter must be not less than 100 mm. Pipes conducting prepared solution must be placed apart from the bottom by 100 - 200mm. When alum is not clean, use alum solution in the upper layer by flexible pipe.

6.25. Interior face of dissolving and consumption tanks must be protected by acid resistant material layer to resist corrosive effects of alum solution.

6.26. When using iron alum in solution state, it can directly put it into mixing tank then adjust its concentration. When using a dry iron alum, at the upper part of the mixing tank must be set a grid and use water jet spray to dissolve. These tanks must be placed in a separate room well ventilated.

6.27. To pump alum solution, use an acid resistant pump or an Ejector.

All chemical pipes must be made of acid resistant materials. Chemical pipe structure must ensure quick rinse capacity..

6.28. Polyacrylamid must be used in solution state with concentrations from 0.1 to 0.5%.

Polyacrylamid solution preparation (PAA) in gel state must be conducted in tank with an propeller agitator with round number of axis from 800-1000 rounds/min. Stir continuously for 25 to 40 minutes. For dry PAA, stirring time is 2 hours and the solution concentration is from 0.5 to 1%.

6.29. Agitator number and consumption tank volume must be determined according to storage term of PAA solution which must not exceed 2 days when concentration is from 0.1 to 0.3%; and not exceed 7 days when the concentration is 0.4 - 0.6% and no more than 15 days when concentration is from 0.7 to 1%.

6.30. Active silicic acid (AK) preparation is done by treating the liquid glass with aluminum sulphate solutions or chlorine.

6.31. Activation by the aluminum sulphate solution shall be conducted in equipments continuously or periodically operating. Calculation for device preparing active silicic acid is presented in Annex 7.

6.32. To alkalinize and stabilize water, use lime or soda

6.33. When choosing the technology scheme of the lime preparation process, it must consider the quality of lime and lime product types supplied by the manufacturer, the demand for lime, position where lime is put into water...

Note: When used lime dose is below 50 kg/day (as CaO), it is allowed the use of lime solution usage scheme including wet stockpile, equipment getting hydrated lime, two times saturated tanks and quantifying equipment.

6.34. Number of tank containing milk lime or lime solution shall not be less than 2, milk lime concentrations in consumption tank shall not be more than 5% according to CaO.

6.35. When stabilizing water, used chemicals should not contain impurities and toxic substances.

To clean the milk lime, when stabilizing water, it must use vertical deposit tanks or hydraulic cyclone. Milk lime speed up in the vertical deposit tanks shall be taken by 2 mm/s.

6.36. For continuous mixing of milk lime, it can use one of the following measures: hydraulic (lime circulation pumps), an agitator or compressed air.

For hydraulic mixing, the milk lime speed going up in tank shall not be less than 5 mm/s. Tank should have a pyramid bottom inclined at the angle not smaller than 45^0 and exhaust pipe diameter of Φ100mm.

When mixed with air compression, standard strength should be equal to 8-10l/s.m^2, compressed air pressure from 1 to 1.5 at.

Speed of stirring by agitator shall not be under 40 rounds/min.

6.37. Milk lime conduct diameter shall be determined as follows:

- Pressure pipe conducting clean products must not be less than 25 mm, unclean products not less than 50mm.
- Gravity pipe shall not be less than 50mm. Speed of milk lime flowing in pipes shall not be less than 0.8 m/s. The bend of milk lime conduct must have a curve radius not less than 5D (D is pipe diameter).

Pressure pipe designed with a slope toward pump shall not be less than the 0.0. Gravity pipes must be sloped not less than 0.03 toward discharge mouth. It must take into account ability for convenient cleaning and dismantling of these pipes.

6.38. Use specialized pumps to deliver milk lime. Pump must be placed under water. Do not place one-way valve.

6.39. Capacity of twice saturation tank for lime solution preparation must be determined from the calculated lime flow and lime dissolubility taken from Table 6.6

Table 6.6.

Water temperature	5	10	20	30
Lime dissolubility in g/m^3 by CaO	1.430	1.330	1.230	1.120

Volume of saturation tank W_0 (m^3) must be defined by the formula:

$$W_0 = K_1.K_2.Qc \qquad (6\text{-}5)$$

Where:

- Qc: Power of saturation tank (m^3/h)
- K_1: Temperature dependence ratio of saturated water , given in Table 6.7.
- K_2: Coefficient depending on rate between the calcium hardness and the total hardness
- K_2 = 1, when the calcium hardness is of 70% greater than the total hardness.
- K_2 = 1,3, when the calcium hardness is of 70% smaller than the total hardness..
- Deposit compartment of saturation tank must be checked with liquid speed up given in Table 6.7

Table 6.7.

Criteria	Water temperature, °C			
	5	10	20	30
K_1 ratio	7	6	5	4
Allowable speed of liquid in deposit compartment of saturation tank (mm/s)	0,15	0,2	0,26	0,33

6.40. Soda solution concentration shall be equal to 5-8%. Soda solution quantification should be in accordance with instructions in Clause 6.18.

6.41. To quantify the coal in paste form, macerate coal with water during an hour in the hydraulic or mechanical mixing tank. Pump to mix and transfer the pasty coal powder must withstand abrasive effect of coal. The concentration of coal powder shall be equal to 50-10%.

6.42. Pasty coal powder conduits shall be calculated for a speed not less than 1.5 m/s. On the conduit, it must have a sound for cleaning. The bend must have a radius and slope as directed in Clause 6.37.

6.43. The structure of solution quantifying device must ensure hydraulic stir and keep the constant concentration of pasty coal powder in the device.

6.44. Devices containing, mixing, quantifying coal powder must be locally ventilated and have a safe fire protection measure.

6.45. The capacity of tank preparing potassium permanganate $KmnO_4$ solution must be determined from working concentration of solution of 0.5-2% (by market products). The time for complete dissolution of chemical must be from 4-6 hours when the water temperature is under 20^0C and from 2-3 hours if water temperature is equal to 40^0C

6.46. Number of potassium permanganate dissolving tank (tank also is consumption one) is not less than two (one for backup)

To quantify potassium permanganate solution, it must use the quantifying device used for deposited and corrosion resistant solution.

ROTARY NET AND MICROFILM

6.47. Rotary net is used to separate floating and suspended matter. Microfilm is used to separate the seaweed and plankton organisms from the water.
Rotary net with mesh sizes of 5-7mm shall be placed in water collectors. Microfilm shall be located at the cleaning station. When there are reasons it is allowed to be placed at water collectors

6.48. Number of backup rotary nets and microfilms is stipulated as follows:
When there are from1-5 working ones, there is one backup one
When there are from 6-10 working ones, there are from 1-2 backup ones.
When there are more than 11 working one, there are from 2-3 backup ones.

6.49. Rotary nets and microfilms must be placed in the compartments. It is allowed to set 2 if working number is greater than 5. Microfilms and rotary nets must be washed when the water level difference before and after the net reaches 10 cm.

6.50. Washing net and microfilm should be performed by pressure water flow sprayed over the net towards the opposite direction with the current. With that purpose, it is required pipelines having pressure not less than 1.5 bar.
Flow of water to wash net shall be equal to 0.5%; to wash microfilm, it shall be equal to 2% of water flow conducted into the station.
Washing water conduits and drainage systems must be calculated with a maximum flow equal to 3% of capacity for the nets and to 5% of capacity for microfilm.

MIXING DEVICES

6.51. Mixing devices must ensure to mix chemicals to water by the correct procedures of time, as well as ensuring evenly and rapid distribution of chemicals in treated water.

6.52. To mix the chemical with water, it can use hydraulic mixing devices (mixing tank having punched bulkhead, mixing tank with horizontal bulkhead, vertical mixing tank, shading ring, Venturi tubes ...).

Allow mixing chemicals with water in conduits and pumps to water purification work. Mixing tube length must be determined by calculation; pressure loss in this tube including partial loss shall not be less than 0.3 to 0.4 m.
Notes:
1. Mixing tank structure shall not let sediments and chemicals put in the water set the form of deposited suspension, not let water saturated by air bubbles.
2. Allow to use mechanical mixing device.
3. Allow to use pumps to mix the chemicals that have no effect destroying the pump.
4. To mix lime, use vertical mixing tank.

6.53. Mixing tank having punched bulkhead, mixing tank with horizontal bulkhead, vertical mixing tank must be at least two compartments with the water retention time not exceeding 2 minutes, in the tank with punched bulkhead and horizontal bulkhead must project the ability to remove the bulkhead.
No need to backup tank design, but need conduits taking a short- cut apart from mixing tank.

6.54. Mixing tank with punched bulkhead must have 3 punched bulkheads; water flow rate through the holes must be of 1m/s. The upper edge of top hole range must be submerged in the water from 10-15cm. The ratio between the hole area of the bulkhead area can get from 30-35%.

6.55. Mixing tank with bulkhead must be placed in the rectangular ditch to create turning movement of water flow in vertical and horizontal direction. Turning times can get from 6 to 10 turns. Pressure loss through a turning time shall be defined by the

formula:

$$h = \xi \frac{v^2}{2g}$$

Where:

ξ: Loss coefficient, equal to 2.9.

v: water speed in mixing tank, equal to 0.5-0.7 m/s.

g: Acceleration of gravity, equal to 9,8 m/s^2.

6.56. For the vertical mixing tank, surface shape can be round or square. Lower part has conical or pyramidal forms with bottom of 30-40 and water going from the bottom up.

The speed of water came out of conduits and into the tank bottom must be equal to 1-1.5 m/s. Speed at the upper water collection point shall be equal to 25 mm/s. The collection of water can be done by coil or punched trough. The speed of water in pipe end or collection trough must be taken by 0.6 m/s.

6.57. In the uncovered mixing tank, it must arrange overflow pipes and sediment discharge pipes. When determining the height of tank and pipe placement, it must consider the requirements given in Clauses 6.54 and 6.55.

When using closed mixing tanks, overflow pipes must be placed in the water input compartment, deposited flocculation compartment or other works near the mixing tank

6.58. Pressure loss in the shading ring type mixing device must be taken by 0.3-0.4 m. In mechanical mixing tank, water retention time must be from 45 to 90 seconds. Stirring intensity according to speed gradient shall be from 500 to 1500 s^{-1}.

6.59. Pipeline from the mixing tank to the flocculation compartment, the deposit tank with suspended sediment layer or contact filtering tank must be calculated with the speed of water flowing in pipes from 0.8-1m/s and the water retention time in pipe not more than 2 minutes

GAS SEPARATION COMPARTMENT

6.60 Gas separation compartment should be designed when using sedimentation tanks with having reaction compartment inside placed; clarified deposit tank with of suspended sediment layer and contact filtering tank .

Area of gas separation compartment should be determined by calculating the speed of water going down no more than 0.05 m/s and the water retention time not less than one minute.

Gas separation compartment can be designed for all projects or tailored for each project.

In the case where mixing tank structure can ensure the separation of air bubbles and in the way of water distribution from mixing tank to other projects, no air is able to get in the water, it should not design the gas separation compartment.

DEPOSIT TANKS, FLOCCULATION TANKS, CLARIFIED DEPOSIT TANKS WITH SUSPENDED SEDIMENT LAYER.

6.61 Deposit tank and clarified deposit tank with suspended sediment layer are used to deposit sediment in water before water is brought in the filtering tank or taken directly to users of production purpose.

Sediment content in water after deposit and clarified deposit shall not be more than 10 mg/l. In specific case, it can be up to12 mg/l.

6.62. When clarifying water in the deposit tanks, the composition of the cleaning work

should include of flocculation compartment placed in adjacency or inside of deposit tanks.

The calculated parameters of flocculation compartment shall be taken as directed in the Clauses 6.80 - 6.83.

Notes:

1. When using clarified deposit tank with suspended sediment layer as well as contact filtering tank s is not required to have flocculation compartment.

2. When using flocculation compartment located next to or placed separately, the speed of water in the output pipes or troughs shall not be greater than 0.1 m/s for turbid water and 0.05 m/s for colored water.

6.63. When the number of deposit tanks and clarified deposit tanks is less than 6, it needs one backup tank.

VERTICAL DEPOSIT TANK

6.64 Vertical deposit tank is used for treatment stations with capacity up to 5000m^3/day.

6.65. The vertical deposit tank must have sediment depositing, containing and compressing regions, as well as the reaction compartments of whirling type or mechanical type located in the middle tank. The water enters through the nozzles to the reaction compartment in the tangent direction. In the lower part of reaction compartment, it must have a masking frame with size of 0.5 x0, 5 m; 0.8 m in height, which intend for remove the water whirling motion. Stirring the intensity of the mechanical type reaction compartment in speed gradient shall be from $30s^{-1}$ for colored water and to $70s^{-1}$ for turbid water.

Pressure loss in the nozzles of whirling reaction compartment shall be defined by the formula:

$$h = 0{,}06V_{tt}^2 \qquad (6\text{-}6)$$

where:

h – pressure loss in nozzles, in meter;

V_{tt} – Speed of water out of nozzle opening, equal to 2-3 m/s. Nozzle must be placed away from whirling reaction compartment wall of 0.2D (D is diameter of compartment) and submerged into water of 0.5m.

6.66. Cross section area of deposit region in deposit tank must be defined as follows:

$$F = \beta \frac{q}{3{,}6.V_{tt} - N}(m^2) \qquad (6\text{-}7)$$

Where:

- Q: Calculated water flow (m^3/h)
- V_{tt}: Calculated speed of water rising up, in mm/s

This speed shall not be greater than deposit speed of sediment given in Table 6.9., Clause 6.71.

- N: Number of deposit tanks
- b: Coefficient taking into account usage of tank volume in the limit of 1.3 – 1.5 (lower limit of ratio between diameter and height equal to 1, upper limit of this ratio is 1.5).

Area of the reaction compartment placed in the tank shall be determined by the formula:

$$f = \frac{q.t}{60.H.N}(m^2) \qquad (6\text{-}8)$$

Where;

- t: Time of water retention in reaction compartment, taken from 15-20 min;
- H: Height of reaction compartment, taken of 0.9 of deposit region height;

- Height of deposit region should be from 2.6-5m depending on production line level. Ratio between deposit tank diameter and deposit region height shall not be more than 1.5.

If in the deposit region of vertical deposit tanks mounted by thin layer deposit blocks which creating sedimentation compartments of hexagonal, octagonal, square or circle shapes with equivalent diameter of 5-10 cm; the sedimentation compartments of 0.8-1m in length inclined by an angle of 60^0 in comparison with horizontal direction; the distance from the sedimentation compartment top to edge of clean water collection troughs from 1.2 to 2 m; the horizontal area of the deposit region(region where are placed thin layer deposit blocks) is determined by the formula:

$$F = \frac{q}{a}(m^2) \qquad (6\text{-}9)$$

Where:

q – Water flow, in m^3/h

a - Load surface of the sedimentation tanks for light turbid water having color taken from 3 to 3.5 $m^3/m^2.h$, for medium turbid water from 3.6 - 4.5 $m^3/m^2.h$ and for turbid water from 4.6 -5.5 $m^3/m^2.h$

6.67. Part containing and compressing sediment of deposit tank must be constructed by a pyramid or cone shape with the angle formed between the walls inclined from 60-70^0.

6.68. For hydraulic sediment discharge, when discharging the sediment, it should not stop tank working. Working time between two sediment discharge times T in hours (h) shall be determined by the formula:

$$T = \frac{W_{c.}.N.\delta}{q(c-m)}(h) \qquad (6\text{-}10)$$

Where:

Wc: Capacity of sediment containing part in tank, in m^3

N: number of deposit tank

q: Calculated flow (in m^3/h)

δ: Average concentration of well compacted sediment, calculated in g/m3 depending on sediment content in water and time containing sediment in tank, according to the table 6.8.

C: Sediment concentration in water conducted into deposit tank, in g/m^3, shall be defined as follow:

$$C = Cn + KxP + 0{,}25M + V(mg/l) \qquad (6\text{-}11)$$

Where;

Cn: sediment content in source water (mg/l)

P: Alum dose calculated according to unhydrated products (g/m^3)

K: Ratio taken with clean alum equal to 0.5; with unclean alum, equal to 1.0; with iron chloride equal to 0.7.

M: Color index of source water calculated by degree (platinum cobalt color scale).

V: Lime dose (if available) put in water (mg/l)

m: Sediment content after deposited, 10-12 mg/l.

Working time between two sediment exhausts shall not be less than 3 hours. When the sediment content is over 1000 mg/l, this time must not exceed 24 hours.

The amount of water used for discharging sediment calculated in percentage of treatment water flow must be determined by the formula:

$$P = \frac{K_K . W_c . N}{q.T} x100\% \qquad (6\text{-}12)$$

Where:

Kp: Sediment dilution factor, equal to 1.2-1.15.

Table 6.8.

Sediment content in source water	Average concentration of compacted sediment, in g/m^3 after time of		
	6 h	12 h	24 h
Up to 50	9.000	12.000	15.000
Above 50 to 100	12.000	16.000	20.000
Above 100 to 400	20.000	32.000	40.000
Above 400 to 1.000	35.000	50.000	60.000
Above 1.000 to 1.500	80.000	100.000	120.000
(When treated without alum)	200.000	250.000	300.000
When softening water (magnesium hardness is less than 25% of total hardness) with lime or lime with soda.			
As above, water has magnesium hardness greater than 75% of total hardness.	28.000	32.000	35.000

6.69. Deposited water collection in vertical deposit tanks have to by radial trough or bypass having holes running by submerged way along trough wall or openly running through serrated overflow edges.

When the deposit tank area is up to 12 m^2, make a bypass around the tank wall. When this area is larger, make more troughs or punching pipe with fan shaped holes which focus on the main trough. Area is up to 30 m^2; make 4 branches, larger area should make 6-8 branches. Water flows in pipes with speed from 0.5 to 0.6 m/s. The troughs have submerged holes, hole diameter taken by 20-30 mm, the speed of water running through the hole taken by 1m/s.

Exhaust pipe diameter of the deposit tanks should be taken from 50-200 mm.

HORIZONTAL DEPOSIT TANK

6.70 When designing horizontal deposit tank, it must plan the mechanical sediment discharge or hydraulic sediment discharge (without stopping deposit tank) or manual discharge of sediment when dry the tank; cleaning the tank walls and bottom with sprinklers; the reuse of water in deposited area when exhausting.

In general, horizontal deposit tank of one floor is used. If required, it should do a horizontal deposit tank of multiple floors.

6.71. Total plan area of horizontal deposit tank that collects surface water at the second haft of the tank shall be defined by the formula:

$$F = \frac{\alpha.q}{3,6.U_0}(m^2) \qquad (6\text{-}13)$$

Where:

q: water flow into deposit tank (in m^3/h).

a: Coefficient of volume use of deposit tank, equal to 1.3.

U_0: Speed of sediment falling in deposit tank (in mm/s).

U_0 shall be determined by experimental document or by management experience of works taken in similar conditions must be in the most unfavorable season of the year while sediment content of deposited water shall not be more than 10 mg/l. For preliminary calculation speed can be obtained by Table 6.9

Table 6.9.

Source water characteristics and treatment methods	Falling speed of sediment U_0 (mm/s)
Light turbid water, colored and treated by alum	0,35 - 0,45
Medium turbid water, treated by alum	0,45 - 0,5
Turbid water, treated by alum	0,5 - 0,6
Turbid water, not treated by alum	0,08 - 0,15

Note:

In the case of using clot adjutant substances, it needs to get a falling speed of sediment up to 15-20%.

When in the deposit area of horizontal deposited tank are placed thin layer deposited blocks arranged along the tank length, the deposit plan area of the horizontal deposit tank shall be calculated according to formula 6.9 and comply with the conditions stated in Clause 6.66.

6.72. Length of deposit tank L (m) shall be defined by the formula:

$$L = \frac{Htb \times Vtb}{Uo} \qquad (6\text{-}14)$$

Where:

Vtb: Average speed of the runoff at the top part of deposit tank, equal to 6-8 mm/s; 7-10 mm/s; 9-12 mm/s respectively corresponding to light turbid, medium turbid and turbid water.

Htb: Average height of deposit area (m) taken in the limit of 3-4m depending on the station's height plan taking into account instructions given in Clause 6.107.

Deposit tank should have flow direction partition to divide tank into many compartments along the length. The width of each compartment shall not exceed 6m. When the compartment number is under 6, it must construct a backup compartment.

6.73. For mechanical exhaust deposit tank, the capacity of the area containing and compressing sediment located in the tank top must be determined according to the size of the sediment discharge device and time to complete one rotation cycle of the scraper. For hydraulic exhaust deposit tank, the capacity of the area containing and compressing sediment Wc should be determined by the formula (6.10) with working time between the two discharge shall not be more than 6 h, when exhausting sediment by drying and then removing sediment from the tank, it must not be less than 24 h.

Average concentration of sediment when using alum for water treatment is taken

according to table 6.8 of Clause 6.68.

6.74. For deposit tank which discharge sediment by hydraulic method, it must design below the deposit area a sediment collection and compression system by conical or amputated pyramidal shaped compartments having bottom under $1m^2$; angle formed between the inclined wall from $60\text{-}70^o$. To discharge sediment, each compartment is put a drain tube, which works on the principle of direct discharge or siphon discharge. Tube top shall be placed at 200 mm from the bottom; exhaust valves that are placed at the end of the tube must be an instant out and in valves. Discharge pressure shall be taken equal to height of water column calculated from the discharge mouth at the tube end to the water level that has been decreased in the deposit tanks at the end of one discharge time.

Velocity of the sediment at the end of pipes or troughs shall be not less than 1 m/s. Sediment discharge time is from 10-20 minutes.

6.75. Height of deposit tank shall be equal to the total height of the deposit area, sediment containing and compressing area taking into account requirements given in Clause 6.107. Construction height must be higher than the calculated water level at least 0.3 m

6.76. Volume of water discharged when cleaning and discharging sediment from the tank must be calculated according to the tank's working time between the two discharge time, taking into account sediment diluted coefficient. This coefficient is equal to 1.3 when discharging sediment by exhausting water and reuse of the water of deposit area. If do not reuse this water, this coefficient is taken equal to the ratio between deposit tank volume and the sediment contain and compression area volume. When using the hydraulic sediment discharge this coefficient is equal to 1.5. When using mechanical discharge, it is equal to 1.2

6.77. To distribute evenly over the entire cross-sectional area of the deposit tanks, it must put the punched bulkhead at the tank top, at 1-2 m apart from wall. Water velocity through bulkhead holes shall be equal to 0.5 m/s.

Below the bulkhead section within 0.3 to 0.5 m of height calculated from the surface of the sediment contain and compression area should not need to be punched.

6.78. The bottom of horizontal deposit tank when cleaned and discharged by flexible pipe must have a longitudinal slope no less than 0.02 in the opposite direction of the way water flows and the horizontal slope in each compartment no less than 0.05.r Exhaust period of deposit tank shall not exceeding 6 hours.

6.79. When using horizontal deposit tanks and thin layer deposit tanks, it must pretend the design flocculation tank of bulkhead style or vertical style with or without suspended sediment or mechanical flocculation tank.

6.80. For flocculation tank, the bulkhead must be designed so that water will flow horizontally or vertically. The speed of water flow in the corridors Vh shall be taken by 0.2 to 0.3 /s at the tank top and by 0.05 to 0.1 m/s at the tank end due to width of the corridor increased.

Time of water retention in the flocculation tank shall be equal to 20-30 minutes (upper limit for the colored, the lower limit for turbid water).

The width of corridors shall be no less than 0.7 m. If there are special reasons, allow to use two-storey flocculation tank.

6.81. Pressure loss inx flocculation tank with bulkhead h_k shall be defined as follows:

$$h_k = 0{,}15.\ V_h^2.S\ (m) \qquad (6\text{-}15)$$

Where:

V_h: water speed in the corridors, in mm/s.

S: number of turning points of water flow, equal to 8-10.

6.82. The vertical flocculation tank without suspended sediment layer must be designed with vertical wall or inclined wall (angle between two walls should be get between

50-70% depending on the height of the tank. The time of water retention in tank must be equal to 60-10 minutes (upper limit for colored water, lower limit for turbid water).

The speed of water going to tank shall be 0.7 to 1.2 m/s. The speed of water going up at the exit point of the tank shall be 4-5 mm/s.

Water conducting parts from the flocculation tank to deposit tank shall be calculated with the speed of water flowing in troughs, pipes and through holes in less than 0.1 m/s for turbid water and 0.05 m/s for colored water.

6.83. For flocculation tank with suspended sediment layer which is placed in horizontal deposit tank, get the average speed of water going up in the upper section as follows: When depositing light turbid water with sediment content under 20 mg/l, it is 0,9 mm/s; the sediment content above 20 to 50 mg/l, it is 1.2 mm/s; with medium turbid water, it is 1.6 mm/s, while the turbid water, it is 2.2 mm/s.

Suspended sediment layer is not less than 3m; the water retention time is not less than 20 minutes. Width of reaction compartment is usually equal to width of horizontal deposit compartment. In the flocculation tank, arrange flow direction walls spacing no larger than 3 m. Height is equal to suspended sediment layer height. The distribution of water in flocculation tank with suspended sediment layer must be conducted by troughs placed along the tank surface while combining with gas separation compartment. Water from the trough bottom shall be evenly distributed to the tank bottom Y-branch riser. The distance between risers along with the trough should be from 1.2 to 1.5 m. At the end of each Y-branch riser, 3 nozzles shall be set. The distance between the nozzles on a riser shall be from 1.2 to 1.5 m; nozzle mouth shall be 0.2 to 0.3 m away from the tank bottom. Speed of water flowing in the trough end must be 0.5 to 0.6 m/s. Riser diameter shall not less than 25 mm. Water going from the flocculation tank to the deposit tank must flow through the overflow wall that divides these two tanks above, speed of overflow water shall not exceed 0.05 m/s. Behind the overflow wall, it must place a half way hanging wall but submerged down in a quarter of the deposit tank height to direct water flow down toward the bottom. Speed of water flowing between the overflow walls and half way hanging wall shall be no more than 0.03 m/s.

When using a flocculation tank with suspended sediment layer placed in the deposit tank, rate of calculated sedimentation in deposit tank while dealing with turbid water shall be taken up by 30%, with medium turbid water, it is took up by 25%, with light turbid water, it is took up by 20% in comparison with to figures in Table 6.9, clause 6.71. The flocculation tank must have discharge pipe intending to be exhausted. Note: Allow to use flocculation tank having mechanical agitator with speed gradient decreasing from 60-70s^{-1} down to 40-50 s^{-1} and then down to 25-35 s^{-1} corresponding to colored water and turbid water.

6.84. To evenly collect water on deposit tank surface, it must design horizontal troughs or submerged hole pipes with hole diameter not less than 25 mm, the speed of water through a hole must be get by 1 m/s; speed of water flowing at the trough end or tube must be 0.6 to 0.8 m/s.

The superior edge of the trough must be higher than the highest water level in the tank by 0.1 m; pipe must be submerged below water level, immersion depth of pipe must be determined by hydraulic calculations. Troughs and pipes must be placed on 2/3 of deposit tank length calculated from the butt diaphragm at the tank end. For thin-layer deposit tanks, water collection troughs must be placed throughout the deposit area length. Trough holes must be placed higher than trough bottom by 5-8 cm, pipe holes is horizontal direction. Water from troughs or pipes must freely overflow to the main collection trough. The distance between the axis of trough or

tube should not exceed 3 m. The distance to the tank wall shall not be less than 0.5 m and not exceed 1.5 m.

6.85. Water input conduits, distribution pipes, water output conduits from the deposit tanks shall be designed for capacity of carrying an larger volume of water flow than calculated flow from 20-30%.

CLARIFIED DEPOSIT TANK WITH SUSPENDED SEDIMENT LAYER

6.86. Clarified deposit tank with suspended sediment layer shall be only used in cases of water conducted into the treatment plant having constant flow and temperature (as noted in Clause 6.9) and must be calculated with the annual change of quality of water subjected to treatment.

If there is no technology research data, the speed of water raising up in the clarified deposit region and the water flow division coefficient between the clarified deposit region and the sediment compression containing region Kpp should take the data in Table 6.10 for the same time taking into account the instructions given in Table 6.9 notes.

Table 6.10

Cotent of suspended matters in water flowing to deposit tank(mg/l)	Speed of water rising up in deposit region, above suspended sediment layer, Vmm/s		Flow division coefficient Kpp
	Winter	Summer	
To 50	0,4-0,5	0,6-0,7	0,65-0,6
50-100	0,5-0,6	0,7-0,8	0,8-0,70
100-400	0,6-0,8	0,8-1	0,75-0,7
400-1.000	0,8-1,0	1,0-1,1	0,7-0,65
1.000-1.500	1,0-1,2	1,1-1,2	0,65-0,6

6.87. Area of deposit region and sediment compression containing region should be taken by the largest value after being calculated by the two schemes:
- For the smallest turbidity period and the minimum flow (dry season).
- For the largest flow period in flood season and the respective largest turbidity.

Area of clarified deposit region F_{lt} (m^2) shall be determined by the formula:

$$F_{lt} = \frac{K_{pp}.q}{3,6.v}(m^2) \qquad (6\text{-}16)$$

Where:

Kpp: the water flow division coefficient between the clarified deposit region and the sediment compression containing region, taken from Table 6.10, clause 6.86.

V: Speed of water rising up in deposit region, in mm/s, taken from Table 6.10.

Area of sediment compression containing region Ftc (m^2) shall be defined by the formula:

$$F_{tc} = \frac{(1 - K_{pp}).q}{3{,}6.V}(m^2) \qquad (6\text{-}17)$$

6.88. Suspended sediment layer height (the distance from the lower edge of sediment collection gate or upper edge of sediment discharge pipes to lower surface of suspended sediment region) must be taken from 2 m to 2.5 m. Lower edge of sediment collection gate or upper edge of sediment discharge pipes should be set higher from 1 to 1.5 m than the side moving from inclined wall to vertical wall of the suspended sediment.

For corridor type clarified deposit tank, the angle between the inclined walls in lower part of suspended sediment region must be obtained in the limit of 50^o – 60^o. Height of clarified deposit region (from suspended sediment layer to the surface) shall be from 2 to 2.5 m (large number for colored water, small number for turbid water)

The distance between the collections troughs or tubes in the deposit region shall be no more than 4.5 m. Full height of the clarified deposit tank is identified taking into account requirements given in Clause 6.107.

6.89. Capacity of sediment compression containing region must be calculated by the formula (6.10). The time needed for sediment compression must be from 3-6 h (smaller values for the water having sediment content over 400mg/l, larger values for colored water and light turbid water). When automatically discharging sediment, time of sediment compression shall be from 2-3 h.

6.90. Sediment discharge from the sediment compression compartment should be conducted periodically or continuously, without stopping tanks to work. Volume of water discharged with sediment determined by data in table 6.8, clause 6.68 and taking into account the coefficient of dilution, shall be equal to 1.2 to 1.5.

6.91. Water distribution on clarified deposit tank area must be done by troughs having Y branch risers, spaced apart from each other no more than 4.5 m. Speed of water flowing in the main top shall be from 0.5 to 0.6 m/s. Speed of water exiting main spigots at the Y branch shall be from 0.3 to 0.4 m/s; the distance between the spigots is not larger than 1.5 m, the spigots must be downward and at 200-300 mm away from the bottom.

Speed of water flowing in the downward pipe and the slot between the lower edge of the downward pipes and inclined wall of deposit tanks should be taken by 0.6 to 0.7 m/s.

6.92. When calculating sediment collection windows, it should get the speed ò water going with sediment through the window from 10-15 mm/s, speed of water going with sediment in the discharge pipe from 40-50 mm/s (large value is for water contains primarily inorganic sediment). Sediment collection distance shall be no more than 5.5 m.

6.93. To collect water in deposit region, use serrated troughs or submerged holes troughs, combining with use of water input distribution troughs and water output collection troughs by the systems serrated or with submerged holes on both sides of the trough. Calculated speed of water flowing in troughs, submerged holes structure, layout and umber of troughs for clarified deposit tank must follow instructions given in Clause 6.69 and 6.88.

6.94. To collect clean water in the sediment compression containing compartment, it should use pipes with submerged holes. For vertical sediment compression compartment, the upper edge of the punched collection tube must be placed lower than water level in the deposit tank at least 300 mm and higher than upper edge of sediment collection window at least 1.5 m.

On the collection pipe, at the connection with the common water collection trough it must locate a valve.

Difference between the lower edge of the collection pipes and the water level in the common collection trough of clarified deposit tank should get no less than 0.3 m.

6.95. Pressure loss in the Y branch distribution riser, in collection pipes and troughs, as well as in the submerged holes of collection trough shall be determined by the formula:

$$h = Z\frac{V^2}{2g} \qquad (6\text{-}18)$$

Resistance coefficient Z must be taken as follows:

For uncovered trough having submerged holes in two sides of trough:

$$Z = \frac{3.2}{W^{1,7}} + 3$$

For collection pipes with holes working full pipe:

$$Z = \frac{3,3}{W^{1,8}}$$

Where:

W: ratio between total area of holes on the pipes (or troughs) and cross section area at the end of the pipes (or troughs). $0.15 \leq W \leq 2$

V: The speed of water flowing in the top of distribution pipe having holes or in the end of pipes or collection troughs, in m/s.

Pressure loss in pipes in front of and behind the punched pipe or trough parts must be calculated separately.

Pressure loss in the suspended sediment layer shall be of 1-2 cm per a meter of suspended sediment layer thickness.

6.96. Exhaust pipe in the sediment compression compartment must be calculated with the conditions of sediment exhausting in 10-15 minutes. Exhaust pipe diameter should not be less than 150 mm. The distance between two adjacent pipes shall not be greater than 4 m.

Average speed of the sediment flowing through the pipe must be taken not less than 1 m/s; speed at the end of pipes or punched troughs shall be no smaller than 1 m s. Exhaust valves fitted at the end of pipe must be a quick open and close valve. Angle between the inclined walls of sediment compression compartment should be $\leq 70^0$.

PRELIMINARY DEPOSIT WORKS

6.97. Preliminary deposit works are used when water has many sediment (from 1.500mg/l or more) in order to primarily deposit heavy sediment that may cause difficult for the discharge of sediment, reduce the capacity of the region containing sediment of deposit tank and reduce the dose of reagents.

Allow to use horizontal deposit tanks, natural lakes, or combine with canal draining water from the river to pump station I in order to construct preliminary deposit works

6.98. Calculating preliminary deposit works should have the experimental data on water sedimentation and existing work management experience. It can be in accordance with the following provisions:

When using sedimentation lake to deposit water treated without reagent usage, its depth shall be from 1.5 to 3.5 m. Time of water retention in the lake is from 2-7 days

(large value used for light turbid water at high scale of color), water flow speed shall not exceed 1 mm/s. It need to schedule for one time of exhaust and clean lake for each 4 months to 1 year taking into account volume of sediment containing region. Measures and equipments must be planned to exhaust and clean the lake such as: the lake divided into two separate discharge compartment, sludge suction pump, pipe drawing directly from the river, increasing the dosage of the reagents, reducing filtration speed... Waterside must be higher of 0.5m than outside land; water suction mouth must be placed higher than the highest calculated mud surface of 0.5 m. When using horizontal deposit tanks for preliminary deposit, falling speed of sediment shall be from 0.5-0.6 mm/s. Other calculation parameters shall be in accordance with instructions given in Clause 6.71 and 6.76.

6.99. Structure of horizontal deposit tanks intending to preliminary deposit should be made by reinforced concrete, brick or soil embankment, semi submerged and semi raised or deeply undergrounded. When it is made of soil, it should taken into account the wall reinforcement and also the waterproofing measures if needed.
For structure of natural deposit lake made by soil embankment, semi submerged and semi raised or deeply undergrounded, selection of type must be based on geological exploration as well as local conditions and through comparison economic and technical to make decisions

6.100. When designing the preliminary deposit works made from soil, it must ensure convenient cleaning conditions, protection against erosion and sanitation for projects

QUICK FILTERING TANK

6.101. Filtering tank s must be calculated according to two working modes, normal mode and enhanced mode.
In treatment stations having filtering tank s up to 20, it must expect to stop a filtering tank to repair, if this number is more than 20, it should plan to stop two tanks to repair simultaneously.

6.102. Filtration speed in normal working mode and enhanced working mode in the absence of data on technological research can be got from the Table 6.11, clause 6.103 with the calculations that ensure the time of a working cycle of filtering tank be more than 12 h in normal mode, and not less than 6h in enhanced mode or in fully automatic washing. Time of a filter cycle in the enhanced mode Ttc when the number of filtering tank s in station is more than 20, it must be determined from continuous washing conditions of filtering tank s by the formula:

$$Ttc \geq [N-(N_1+a)] .t_2 \qquad (6\text{-}19)$$

Where:
N – Total number of filtering tank s in treatment station.
N_1 – Number of filtering tank s stopped for repair
a – Number of filtering tank s simultaneously washed
t_2 – Time stopping filtering tank for washing, equal to 0.35h.
Note:
To obtain an optimal working regime of filtering tank , it must ensure the ratio t_{bv}=1.2+1.3 $t_{gh.}$
t_{bv} – Time for protective effect of filter material, in that period the stipulated clean water quality has been ensured.
t_{gh} – Time for reaching the pressure loss in permitted limit.

6.103. Area of filtering tank s in treatment station shall be determined by the formula;

$$F = \frac{Q}{TV_{tb} - 3{,}6aWt_1 - at_2V_{tb}} (m^2) \qquad (6\text{-}20)$$

Where:

Q – Effective power of station(m^3/day)

T – Working time of station in a whole day (h)

V_{tb} – Calculated filtration speed in normal mode taken from Table 6.11 and taking into account the enhanced filtration speed according to formula (6-21).

a – Washing number of each filtering tank per a whole day in normal mode (see Clause 6.102)

W_{tl} – wash water intensity (1/s.m^2), see clauses 6.115 and 6.124.

t_1 – Washing time (h) see clauses 6.115 and 6.124.

t_2 – Time stopping filtering tank for washing, see clause 6.102.

Table 6.11.

Filtering tank type	Filter material layer characteristics					Filtration speed in nomal working mode Vtb (m/h)	Permitted filtration speed in enhanced working mode Vtc (m/h)
	Minimal diameter (mm)	Maximum diameter (mm)	Effective diameter d_{10} (mm)	Unhomo--geneity ratio K	Filter material layer thickness (mm)		
Quick filtering tank with one layer, filter material is quartz sand	0,5	1,25	0,6-0,65	1,5-1,7	700-800	5-6	6-7,5
	0,7	1,60	0,75-0,8	1,3-1,5	1300-1500	6-8	7-9,5
	0,8	2,0	0,9-1,0	1,2-1,4	1800-2000	8-10	10-12
Quick filtering tank with two filter material layers	0,5 0,8	1,20 1,8	0,6-0,65 0,9-1,1	1,5-1,7 1,5-1,7	Quartz sand 700-800 Anthracite coal 400-500	7-10	8,5-12

Note:

1. Calculated filtration speed in the limits given in the table must be taken according to the source water quality, water treatment technology and the specific conditions in their localities.
2. To filter water used for production purposes which require lower water quality standards than domestic water standards, the filtration speed can be greater.
3. When using other filter materials, it needs to revise parameters based on experimental data.
4. Effective diameter d_{eff} must be equal to the sieve diameter d10.
5. Unhomogeneity coefficient K = d60/d10; d60 and D10 is the diameter of sieve (mm) allowing 60% and 10% of sand falling through.

6.104. Determining the number and area of a filtering tank must be based on the scale of production, equipment supply conditions, building conditions and management... and on the technical and economic comparisons. Number of filtering tank s is not less than 2. A filtering tank area shall not exceed 120m^2.

6.105. Calculated filtration speed in the enhanced working mode Vtc (m/h) should be defined by the formula:

$$V_{tc} = V_{tb} \frac{N}{N - N_1} \qquad (6\text{-}21)$$

Where

Vtb – Stipulated in Table 6.11, Clause 6.103

Note:

Vtc in this above formula should be smaller than the values indicated in the Table 6:11, if it exceeds permitted value, it must reduce appropriately Vtb.

6.106 Pressure loss in the opened filtering tank shall be from 3-3.5 m, from 6-8 m in the pressure filtering tank

Height of water layer on the filter layer surface in opened filtering tank should be no less than 2 m, as the same time pay attention to the Clause 6.107. The construction height of the tank must exceed the calculated level in filtering tank s at least 0.3 m.

6.107. When stopping one or two filters to clean, filtration speed in the rest tanks also can get fixed or changed, filtration speed is allowed to increase by 20%. When the filtering tank number in station is less than six, it must let filtering tank s working with fixed filtration speed. In this case, it need expect an additional height Hph (m) above the normal water level in the works (filtering tank s, deposit tanks, clarified deposit tanks ...) to be able to store excess water when one or two filtering tank s is stopped to wash.

Height of this water layer shall be determined by the formula:

$$H_{ph} = \frac{W}{\Sigma F}(m) \qquad (6\text{-}22)$$

Where:

W – Water mass (m^3) cumulated during a filtering tank washing time.

F – Total area of works cumulating water (m^2)

6.108. Filter material shall be made from quartz sand, crushed anthracite or other materials with necessary mechanical and chemical. Chemical durability and mechanical durability of the filter material must be taken according to standard TCXDVN 310:2004.

Crushed anthracite coal must have cube shape or near round grains, ash is no more than 10%, sulfur content is not exceeding 3%.

Anthracite having layer structure is not allowed to be used as filter materials.

6.109 Large hindrance distribution system must be designed so that water is sprayed directly on the support layer thickness, and must expect abilities to test, rinse and fix the distribution system.

6.110. Particle size and support layer thickness when the large hindrance distribution system is used must be taken from Table 6.12.

Table 6.12.

Particle size of support layer (mm)	Support layer thickness (mm)
40-20	The top surface of this layer is at same level of top surface of the main but higher than the distribution holes at least 100 mm.
20-10	100-150
10-5	100-150
5-2	50-100

Notes:

1. The distance from the main bottom to the bottom of the filtering tank must be taken by 80-100 mm.
2. When washed with water and air combination, it needs to take the support layer thickness with particle sizes of 5-2 mm and 10-5 mm by 150-200 mm per layer.

3. For support materials, it can use gravel, macadam or other materials meeting clause 6.108.

6.111. Cross section area of the main pipes, conduits or water troughs of the big hindrance manifold system must be fixed for whole length. Speed of water flowing in pipes or troughs conduction water to filtering tank should be from 1.5 to 2 m/s; in the main manifold top shoul be from 1 to 2 m/s; in the branch pipe top be from 1.6 to 2 m/s .

On the manifold frame, it needs to drill holes with a diameter of 10-12 mm. The total area of all holes must be equal to 0.25 to 0.5% of cross section area of the filtering tank . Holes must be arranged in two alternate bars at the pipe bottom and inclined 45^o in comparison with the vertical pipe axis.

The distance between the axes of the branch pipes should be equal to 250-350 mm, between hole centers should be equal to 150-200 mm.

Pressure loss h(m) in the distribution system by drilled holes of filtering tank shall be defined by the formula:

$$h = \zeta \frac{V_c^2}{2g} + \frac{V_n^2}{2g}(m) \qquad (6\text{-}23)$$

Where:

V_0: Speed at main manifold top, in m/s

V_n: Speed at branch pipe top, in m/s

ζ : Resistance ratio, selected corresponding to instructions in Clause 6.95.

Pressure loss in big hindrance manifold system when cleansing tank must not exceed 7m of pressure head.

6.112. Distribution systems with filters designed to capture measure wash with water and washing water combined with wind, taking the number of filters from not less than 35-50 for a 1m2 area of the filtering tank .

Pressure loss h (m) in the distribution system having intermediate bottom and filters should be defined by the formula:

$$h = \frac{V^2}{2g\mu^2} \qquad (6\text{-}24)$$

Where:

V: Movement speed of water or a mixture of water and wind through the filter's air -leak not less than 1.5 m/s.

Flow ratio of filter: For filter air leak $\mu = 0.50$

Note: When using filter, it should have a gravel layer that supports filtering materials with particle size from 2-4 mm and 100-150 mm of thickness.

6.113. To exhaust air in filtering tank cleaning water conducts, at the high points it need to put the exhaust riser having diameter of 75-150 mm with automatic valve to discharge air. On the main pipe of filtering tank , it must install exhaust riser of Φ 32 mm of diameter. When tank area reaches 50 m^2, put 1 riser, when it is larger, put 2 risers (located at the two top of main pipe). Exhaust pipe must be higher than the filtering tank not less than 0.3 m.

At the highest point of the filtering tank , it must fix an automatic exhaust valve and an exhaust pipe of Φ20 fitted with valve to open and close.

6.114. To restore the filtering capacity of filtering material, it can be washed away by water from the bottom up or the simultaneous use of both water and wind.

It allows the use of surface cleaning method by distribution system located on the surface of filter material layer.

6.115. Water washing intensity depends on the necessary relative expansion of the material given in table 6.13, corresponding to the filtering materials recorded in table 6.11 and Clause 6.103.

Table 6.13.

Types of filtering materials and filtering tank	Relative expansion of filtering material (%)	Tank washing intensity ($l/s\text{-}m^2$)	Time for tank washing (min)
Quick filtering tank with 1 filtering material layer			
d_{eff} = 0,6 - 0,65	45	12-14	
d_{eff} = 0,75-0,8	30	14-16	6-5
d_{eff} = 0,9-1,1	25	16-18	
Quick filtering tank with 2 filtering material layers	50	14-16	7-6

Note:

1 – Great washing intensity must correspond with small washing time.

2 - When using fixed device to wash the surface, it should take intensity equal to 3-4 l/m^2, pressure equal to 30-40 m water column, and the distribution pipe should be placed 60-80 mm apart from sandy surface. The distance between the holes of the distribution pipe or between nozzles must be equal to 80-100mm. When using rotary device, washing intensity shall be taken from 0.5 to 0.75 $l/s.m^2$, pressure equal to 40-50 m water column. Washing time shall be 7-8 minutes which 2-3 minutes is for washing before coordination with washing from the bottom up.

6.116. Capacity of water tower must be calculated for the two washing times if washing a tank; 3 washing times if simultaneously washing two tanks.

Pump pushing water to towers must ensure filling them within time no greater than time between two washing times at the enhanced working mode.

Water brought up by the pump station must come from lead pipes or drain water from the tank or water.

Water conduits from tower to filtering tank s must be protected against air suction.

Power of filtering tank washing water pumps need to be calculated for washing a tank. Water must come from clean water tank, which reserves sufficient water for two washing times.

To wash filtering tank , put one or two working pumps and a backup pump.

6.117. To collect and conduit washing water, design of troughs having half round or pentagonal

section and other devices. Distance between adjacent trough hearts shall not be greater than 2.2 m. Width of B trough (m) is determined by the formula:

$$B = K_5\sqrt{\frac{q^2 m}{(1{,}57 + a)^3}}(m) \qquad (6\text{-}25)$$

Where:

Qm: Washing water flow drained away by trough (m^3/s).

a: Ratio between the height of the rectangle with half of the trough width, taken from 1 to 1.5.

K: Coefficient equal to 2 with half round section trough, to 2.1 with pentagonal section trough.

Upper edge of all troughs shall be at the same height and absolutely horizontal. Collection trough bottom must have a slope of 0.01 toward the concentration trough.

6.118. In filtering tank having concentration trough, distance from the collection trough bottom to the concentration trough one H in (m) shall be determined by the formula:

$$H = 1{,}73\sqrt[3]{\frac{q^2}{g\Delta^2}} + 0{,}2 \qquad (6\text{-}26)$$

Where:

q – Flow of water running into concentration trough, in m^3/s.

Δ – Concentration trough width, not less than 0.6m.

g = 9.81 m/s^2.

Water level in concentration trough must be lower than collection trough bottom of 0.2m

6.119. Distance from filtering layer surface to collection trough, in metre, shall be defined as:

$$h = \frac{He}{100} + 0{,}30 \qquad (6\text{-}27)$$

Where:

H: filtering layer height (in m)

e: relative expansion of filtering material layer, given in Table 6.13, clause 6.115.

6.120. Size of conduits or filters trough shall be calculated according to enhanced working regime with the water speed as follows:

- In the water conduits to filtering tank : 0.8 - 1.2 m/s
- In the drinking water conduits: 1- 1.5 m/s
- In the wash water drainage pipes: 1.5-2m/s.

6.121. The exhausted discharge of filtering tank should be performed through the distribution system or through the release pipe having diameters from 100-200 mm (depending on filtering tank area) and fitted with lock. Release pipe top which is connected to the bottom of filtering tank must be protected by special mesh or shield; excluding the case where filtering tank has intermediate bottom. Filtering tank bottom must slope about 0.005 toward this release pipe.

6.122. When washing by combination of water and wind, wind should be passed through the distribution system that has specific filter or by separate distribution system for water and wind.

Cross section area of the main pipe, troughs and conduits in the wind distribution system must be fixed on the entire length.

Wind distribution system is placed directly into the upper layer of support layers on the filtering tank . The main wind conduit should be located higher than the water distribution system.

The total area of the holes must be equal to 0.35 to 0.4 of cross section area of main pipe. Wind speed in the main pipe and branch pipes should be taken by 15-20 m/s.

When having a support gravel layer, the distribution holes on pipes with diameter of 2-5 mm, the filter cap number should be from 36-40 per 1 m^2 of filtration area. Without support gravel layer, take 50 filter caps and width of the filter slit shall be less than 0.1mm of smallest particle size filter material, put holes in the pipe underside by 2 alternate rows and beveled at an angle of 45^0 compared with the vertical axis of the pipe.
The distance between holes or filter caps must be taken within the limits of 140-180 mm. The distance between the branch pipes should be from 250 to 300 mm. Wind pressure escaped from the holes or slits of the filter caps must be taken by double height of water column in the filtering tank , calculated from the hole heart when washing.
Pressure loss in wind distribution system must be taken by 1m.
The main wind conduit must be placed above the highest water level in the filtering tank and equipped with device resistant to water kick back into wind machine when filtering tank washing is stopped.

6.123. Water and wind washing regimes must be taken as follows:
Wash by wind with intensity of 15-20 l/s.m^2 in 1-2 minutes then wash by water and wind combination during 4-5 minutes with the wind intensity of 15-20 l/s.m^2 and water intensity of 2.5-3 l/s.m^2, so that the sand shall not pass into the wash water collection trough. Finally, stop washing by win and continue simple washing by water with intensity of 5-8 l/s.m^2 in 4-5 minutes.
Notes:
Stronger water and wind intensity must be taken corresponding with a larger particle size of filter materials. When there are appropriate technical data, allow to apply washing regime changed in comparison with instructions.

6.124. When using the combined water and wind washing methods, it should expect a surface wash water sweeping system in the horizontal direction with a sand keeping trough that is formed by inclined walls on the top of trough's overflow wall.
Sand partition is placed on overflow wall top by a slope of 45^o toward filters tank. The edge surface must be flat and absolutely horizontal.
Basic dimensions of parts composing sand keeping troughs shall be taken from Table 6.14; depending on the wash water flow per a meter in length and equal to Wl. In which W (l/s.m^2) is the water intensity while combined washing with water and wind, l is the distance from opposite wall to the overflow wall.
Edge below sand partition must be placed above filter material layer surface by 50-100mm.
To discharge sediment detached from the filter layer surface, in the horizontal flow top, it must make a speed no less than 3 mm/s through a flow direction device or punching pipe in order to add necessary water flow.

Table 6.14.

Wl (l/s.m^2)	25	20	15	10
Dimension of sand keeping trough Height difference between upper and inferior edge of overflow and sand keeping wall (mm)	180	140	120	100

Speed of water flowing in the trough top and punching pipe should not be more than 1.2 m/s; hole diameter shall be taken by 10-12mm, holes shall be placed in a row and directed towards the flow. Total area of holes should be taken by 0.35 to 0.5 of cross-section area of the troughs and pipes. Water flow conducted must be from 1 to 1.5 l/s per a metre in tank width.

Trough or pipe bottom must be placed of 100 mm above filtering layer surface. Water conducted into this pipe and trough must be taken from the trough or pipe that conduct deposited water to filtering tank .

SLOW FILTERING TANK

6.125. Calculated filtering speed in slow filtering tank should be taken in the limits from 0.1 to 0.3 m/h, depending on sediment content in water conducted into the filtering tank and filtering speed> 0.1 m/h just work during the time of washing other filtering tank s in the station.

6.126. Slow filtering tank number must be not less than 3. When washing the sand in the filtering tank , each tank compartment width shall not greater than 6 m and length no greater than 60 m.

6.127. Particle size and filtering material layer depth in slow filtering tank must be taken from Table 6.15.

Table 6.15.

No	Fltering material and suppor layer designation	Filtering material particle size(mm)	Depth of filtering material layer (mm)
1	Sand	0,3-1	500
2	Sand	1-2	50
3	Gravel or macadam	2-5	50
4	Gravel or macadam	5-10	50
5	Gravel or macadam	10-20	50
6	Gravel or macadam	20-40	100
		Total	800

6.128. Water flow Wr (m^3) per once time washing filter compartment should defined as follows:

$$Wr = q_0.b.tr \qquad (6\text{-}28)$$

Where:

q_o: water flow unit to wash a range of section of 2m in width, equal to 0.009m^3/s.

tr: Time to wash a range of 60m in length, in second with a limit of 20 minutes

b: filter compartment width, in meter.

6.129. Water used to wash filtering tank must be supplied by a separate pump or tower. Allow washing filtering tank by strengthening the power of the pumps conducting water into the treatment station or use a portion of the water stored in alternatively working compartments.

6.130. Water layer on the filter section shall be equal to 1.5 m. When the filtering tank is covered, the distance from the filter section to the roof must be sufficiently calculated to ensure the filter sand washing and replacement.

6.131. In the slow filtering tank having an area of 10-15 m^2, collect inside water by troughs sunk in the tank bottom. In larger tank area, it need to have collection system by punching pipes, bricks or concrete pipe with slits, hollow concrete pipe ...

LARGE PARTICLE SIZE FILTERING TANK

6.132. Large particle filtering tank is used to clarify a quantity of water supplied for production with use or without use of reagents.
The amount of sediment retained in the filtering tank which is not mixed with alum shall be taken from 50-70% of sediment content in water sources, when it is mixed with alum, sediment content is from 50-10 mg/l.

6.133. For large particle filtering tank , pressure must be calculated with pressure loss limited in filter material layer and water collection system to 15 m of water column. In the uncovered filtering tank , in order to maintain calculated filtration speed, height of water layer on the filter sand surface shall be equal to 1.5 m; pressure loss equal to 3.5 m.

6.134. Large particle filtering tank should be washed by combination of water and wind. The water and wind distribution systems or water and wind combined distribution system must be calculated in accordance with instructions in Clauses 6.111-6.113 – 6.115-6.117. Water and wind intensity is given the table 6:16.

Table 6.16.

Filter material	Filter material's particle size (mm)	Heterogeneity ratio	Filter material layer height (m)	Speed	Washing intensity(l/s.m^2)	
					Water	Wind
Quartz sand	1-2 1,6-2,5	1,5 1,7	1,5-2 2,5-3	10-12 13-15	6-8 6-8	15-20 18-25

6.135. To make filter materials, use quartz sand or other materials having necessity chemical and mechanical durability. Characteristics of filter materials are given in the table 6.16.

6.136. Design of part for filtering tank washing water discharge must comply with instructions in clause 6.123.

6.137. When calculating the large particle filtering tank, it needs to take a cleaning regime as follows:
Wash filter materials by water with intensity of 6-8 l/s.m^2 in a minute; wash by water and wind combination with the water intensity of 3-4 l/s.m^2, air intensity of 15-25 l/s.m^2 in 5 minutes, wash by water with intensity of 6-8l/s.m^{2}in two minutes.

6.138. Large particle filtering tank area F (m^2) must be determined by the formula:

$$F = \frac{Q}{TV_t - 3,6W(W_1T_1 + W_2T_2 + W_3T_3) - nt_4V_t} \qquad (6\text{-}29)$$

Where:

Q – Active capacity of filtering tank s, in m^3/day

T – Working time of station per day (h)

Vt – Calculated filtration speed (m/h)

n – Number of washing a filtering tank per day

W_1t_1 - Intensity (l/s.m^2) and time (h) for scouring filter materials in initial phase.

W_2t_2 – Water intensity (l/s.m^2) and time for washing by water and wind combination (h).

W_3t_3 - Intensity (l/s.m^2) and washing time (h) at the final phase.
t_4 – Time stopping filtering tank for washing (h)

6.139. When the filtering tank number reaches 10 ones, it is permitted to stop a filtering tank to repair, when this number is bigger, it is allowed to stop two tanks to repair. While washing, filtration speed in the rest working filtering tank s shall not exceed the maximum value given in table 6.16, clause 6.134.

PRELIMINARY FILTERING TANK

6.140. Preliminary filtering tank is used to preliminarily clean the water before the thorough washing in the slow filtering tank and in the fast filtering tank in washing scheme by two step filtration.
Calculated filtration speed through a preliminary filtering tank should be about 3-5m/h, depending on turbidity of water subjected to filtration.

6.141. Number of preliminary filtering tank in a station shall not less than two. Particle size of sand, gravel and height of material layers must be taken from Table 6.17.
Height of water layer on the filter material layer surface shall be taken by 1.5 m

6.142. Washing water distribution system in the preliminary filtering tank must be a large hindrance system and be calculated according to instructions given in clause 6.109-6.124.
Washing regimes must be taken as follows: The water intensity of 12-14l/s.m^2, washing time of 6-7 minutes. Use clean water to wash filtering tank.

Table 6.17.

Particle size of filter materials (mm)	Height of each layer (mm)
1-2	700
2-5	100
5-10	100
10-20	100
20-40	150

CONTACT FILTERING TANK

6.143. Contact filtering tanks are used to clean water by one step filtration scheme. In the contact filtering tank, filtration process occurs from bottom to top.
Without technology survey data, it is necessary to take calculated filtration speed from Table 6.18. Time of a filtration cycle with calculated filtration speed shall not less than 8h.

Table 6.18.

Number of contact filtering tank	3	4	5	6 and greater
Calculated filtration speed m/h	4	4,5	4,8	5

6.144. When repairing a tank, the rest tanks must work in enhanced regime with filtration speed not exceeding 5.5 m/h and duration of a working cycle not less than 6h. When the number of contact filtering tank s is greater than 20, the time of working cycle between two washing at enhanced regime must be determined in accordance with Clause 6.103.

Time stopping filtering tank for washing must be taken by 0.33 h.

6.145. Area of contact filtering tank must be defined by the formula 6-20 taking into account the time to discharge initial filtered water which is determined as follows: When purely washing by clean water for 5-10 minutes, by unclean water for 10-15 minutes; by combination of wind and water, taken respectively by 5-7 minutes and 7-10 minutes, taking into account the requirements stated in the clauses 6.102, 6.143 (table 6.18); 6.151, 6.152 and 6.155.

6.146. Contact filtering tank can work with a constant filtration speed during a working cycle or with an inconstant filtration speed descending to the end of cycle so that the average filtration speed is equal to the calculated filtration speed.

6.147. Number of contact filtering tank in a station shall be taken according to instructions in clause 6.104.

6.148. Filter materials for contact filtering tank shall be quartz sand and gravel or other materials meeting the requirements stated in Clauses 1.10 and 6.108 and not be suspended in the filtration process.

6.149. If there are no available technologic survey data, filter sand layer thickness must be taken depending on the type of contact filtering tank and distribution system by 2 to 2.3 m; effective diameter of the particle equal to1-1.3 mm; heterogeneous coefficient to 2.0; particle size of filter material of contact filtering tank equal to 0.7-2 mm.

6.150. Cleaning filter material in contact filtering tank should be done by upward water or by water and wind combination.

To distribute the water evenly throughout the tank area, use the big hindrance distribution system having or not gravel support layer....

6.151. Can use clean water or unclean water to wash filtering tank. When using clean water to wash, it need to ensure stable work of other tanks by taking wash water from overflow's back then putting it in front of gate conducting water into storage tank. Washing by unclean water is allowed in the conditions: there is a preliminary treatment with rotary net or microfilm as stipulated in Note 5 of Table 6.2, the clause 6.9, turbidity shall not exceed 10 NTU, coli index not exceed 1000 units/litre and disinfected. Equipment for wash water supply must be taken as stipulated in the clauses 6.115 and 6.116.

6.152. Wash water intensity shall be equal to 13-15 $l/s.m^2$, in period of 7-8 minutes

6.153. When using a big hindrance distribution system, the ratio between the hole area of distribution systems and filtering tank area shall be equal to 0.2% with a gravel support layer; to 0.25 - 0.27% without a gravel support layer.

6.154. Calculation and design of big hindrance distribution systems having a gravel support layer and a collection trough of contact filtering tank shall be taken as directed in the clauses 6.111, 6.116, 6.119 and 6.124.

The thickness and particle size of the gravel layer must be taken from the table 6:12; the clause 6.110. When washing coordinated by wind and water at filtering tank having a gravel support layer, the height of 5-10mm size gravel layer must be taken by 150-200mm, 2-5mm gravel layer must be taken by 300-400mm.

The distance between the tube axis and holes must be taken from the table 6.19, between filter caps from clause 6.122.. To exhaust discharge of contact filtering tank , it should put discharge pipe having protection mesh devices to prevent the filter materials fall out

6.155. When washing filter materials by wind and water combination, expect a drainage system toward horizontal direction as given in the clause 6.124 at a distance of 200-300mm from the inferior edge of the overflow wall to section. Wind must be conducted in a separate distribution main with the intensity of 18-20 $l/s.m^2$. When cleaning surface, it can collect water from trough or conduits deposited to.

Washing regimes must be taken as follows:

Blow wind in 1-2 minutes, wash with water and wind coordination with water intensity

of 2-3 l/s.m^2 in 6-7 minutes and finally wash with water at the intensity in of 6-7 l/s.m^2 in 4-6 minutes.

6.156. To ensure uniform collection of water in whole tank area, collection trough edge must have triangular overflowing slot of 40-60mm in height.
The distance between the hearts of overflowing slots shall not be greater than 100-150mm.

Table 6.19.

Distribution system dimension of contact filtering tank		
Diameter of branch pipe(mm)	Distance between hearts of branch pipes (mm)	Distance between hole hearts (mm)
75	240-260	130-140
100	280-300	140-160
125	320-340	160-180

6.157. Contact filtering tank pipes must be calculated according to clause 6.120, at the same time, the bottom edge of the pipes conducting water from the tank must be higher at least 0.3m than water level in the concentration trough.

6.158. When clean water for domestic needs, free surface of contact filtration must be sealed and fitted by ventilation pipe and the up and down gate.

6.159. The necessary pressure before contact filtering tank calculated from the height of overflow trough edge must be equal to total pressure loss in the filter layers in the support layer (for sand, take equal to sand thickness) and in the conduits taking into account all local losses, including loss through measuring device used to determining the filtration rate. To bring water into the filtration, before contact filtering tank it shall have air separation compartment and water level stability. Air separation Capacity of air separation compartment shall be calculated according to water retention time of 3 min. Compartment divided into two chambers. Each chamber is fitted with overflow pipes and exhausted discharge pipes. Prior to come into the filtering tank, water was evenly mixed with chemicals in accordance with Clause 6.17; Table 6.5.

DISINFECTATION OF WATER

6.160. When selecting water disinfection method, it should pay attention to the water quality requirements, water treatment efficiency, reliability of disinfection measures, technical and economic basis, the mechanization of labor and chemical storage conditions.

6.161. Chemicals containing chlorine to disinfect water should be added to the filtered water conduits (water conduits flowing into the tank). For the groundwater with good quality which does not need to be treated, add chlorine before storage tanks.
Note: In case that need to use ammonia, add ammonia in the filtered water conduits. If the water has phenol, add ammonia into water before adding chlorine for 2-3 minutes.

6.162. When there are not available technologic survey data, in order to preliminarily calculate chlorine equipment, it should take dosage of chlorine to disinfect water as follows: 2-3 mg/l for surface water by active chlorine, from 0.7 to 1 mg/l for underground water. Concentration of free chlorine remaining in water after contact time from 40 minutes to 1 hour in clean water reservoir shall be no less than 0.3 mg/l and not greater than 0.5 mg/l or the concentration of linked chlorine not less than 0.8 mg/l and not greater than 1.2 mg/l.
Note: When reserving domestic water in the storage tank, during the period that o tank is

stopped working for washing or repair, it need to double the dosage of chlorine in the rest storage tanks than usual dosage.

6.163. Chlorination of water requires a daily chlorine consumption store, equipment for chlorinating water into steam (if needed) and a Chlorator chamber (chlorine quantifying equipment).

It need to ensure preliminary chlorination of water before treatment works and the ability of water chlorination after treatment works to disinfect.

Make sure to evenly stir and mix chlorine for water treatment.

6.164. The vaporization of chlorine should be conducted in the vessels, containers or in private evaporation equipments. Chlorine vaporization productivity without heating vessel wall at the normal room temperature shall be taken as follows:

- For vessels of chlorine from 0.7 to 1.0 kg/h
- For large containers: 3-4 kg/h

Per $1m^2$ of vessel or container wall surface.

6.165. It is required an equipment to periodically discharge and remove toxic gases chloride nitrogen (NCl_3) from the evaporation equipment and compressed air pipes…

6.166. Chamber keeping chlorine quantifying device if separately used shall have 2 doors, a door through the buffer chamber and a door out. All doors shall have wing opened to the outside. Allow arranging store of chlorine consumption close to the chlorine quantifying chamber, in this case, it must separate them by fire resistant blind walls with no windows. Chlorine store should be designed according to standards for store of strongly hazardous materials.

6.167. If chlorine quantifying chamber is designed to block with treatment works, it shall be isolated from the other chamber and must have two doors in which a door passes through buffer chamber and its two wings must open outwards.

6.168. In the chlorine quantifying chamber designed to block with treatment works, allow storing liquid chlorine amount not exceeding 50 kg, and a backup vessel is required.

6.169. It need to ensure water supply with domestic water quality which pressure shall not be less than 3 kg/cm^2 for chlorine quantifying chamber when using vacuum type Chlorator .

Calculated water amount needed to make Chlorator working shall be equal to $0.6m^3$ per 1kg of chlorine.

Chlorine water discharged out where the chlorine quantifying chamber has incidents must be passed through the tank containing deacidification agents.

Chlorine water pressure after Chlorator and Ejector must be taken by 5-7m of water column.

6.170. The dosage of chlorine should be performed by automatic vacuum Chlorator or by means of weight. Allow combination method. It need combine with manual control Chlorator. It should have a machine automatically measuring chlorine residual in the clean water storage tank.

Before imported in quantifying device, chlorine gas should be preliminarily cleaned through the intermediate vessel and air filtration equipment.

6.171 The number of backup technological equipment in the chlorine qualifying chamber shall be taken as:

- When there are two working Chlorator - a backup Chlorator.
- Over 2 working Chlorators - 2 backup Chlorators
- Device analyzing chlorine residual in water - one backup device, not depending on the number of working analysis devices.
- Ejector - a backup, regardless of the number of working devices.

6.172. To carry gas and liquid chlorine it must use pipes ensuring the tightness and resistant to pressure. When chlorine gas transported from the store to the quantifying device, number of chlorine conduits shall not be less than 2, in which a pipe is backup.

Chloride conduits and accessories are taken into account with working pressure of 16 kg/cm^2 and testing pressure of 23 kg/cm^2.

Chloride conduits exposed to air should have a protection layer against the effects of sunlight.

Chlorine conduits placed inside the room must have a rack mounted on the wall, if located outside the house must have its support.

If pipes are connected by sleeves, it must weld two sleeve ends, if connected by flanges, it must use chlorine resistant washer and stainless steel bolts.

Chlorine conduits need to have common slope of 0.01 toward the liquid chlorine containers and they are not allowed to have any joint that may form the hydraulic barrier or gas button.

Chlorine conduit diameter d_{cl} (m) with length up to 500m shall be defined by the formula:

$$d_{cl} = 1,2\sqrt{\frac{Q}{V}}(m) \qquad (6\text{-}30)$$

Where:

Q – largest flow by second of gas chlorine or liquid chlorine (m^3/s), greater of average hourly flow from 3-5 times, weight volume of liquid chlorine - 1.40 T/m^3, the gas chlorine - 0.0032 T/m^3.

V - speed inside the pipeline, taken by 2.5 to 3.5 m/s for gas chlorine and 0.8 m/s for liquid chlorine. Chlorine conduit diameter shall not be greater than 80 mm.

6.173. Chlorine water conduits must be made of materials withstanding chlorine water. After Ejector and Chlorator standing apart, the chlorine conduit are only allowed to join together through a tank fitted with a overflow wall stabilizing water level. Chlorine water conduits inside the house should be placed in the ditch under floor or mounted on the walls with a hook, if outside the house; it must be placed in grounded ditches or in sleeves.

6.174. When chlorine consumption store is located apart from above 100m and the liquid chlorine consumption per day is not greater than 3 vessels, it is allowed to arrange a room in the chlorine quantifying chamber to conserve reserved chlorine amount in three days, but it need a private exit door to outside. This room also must meet the requirements as for consumption store.

6.175. Respirator and protective clothing for workers need to be stored in private cabinets located in buffer rooms of the chlorine quantifying chamber. Dashboard of lamps in the chlorine quantifying chamber must be located in the buffer room.

6.176. To mix and maintain powder calcium hypochlorite solution, it must use tanks (tank number no smaller than 2); capacity of the tanks shall be calculated under concentration conditions of solution from 0.5 to 1% and mixed for 1-2 times per day. Tanks should be made from corrosion resistant materials or covered by anti-corrosion coating and it is imperative to have an agitator.

6.177. To quantify calcium hypochlorite, use quantifying devices with elutriated solutions. It must have methods for exhausting sediment from tank and quantifying devices.

6.178. Electrolyze salt solution to obtain sodium hypochlorite must be conducted by electrolysis vessels. When there are 1-3 working electrolysis vessels, it must need a backup vessel. Note: If it is necessary to put together multiple working electrolysis vessels, allow the construction of solution tanks and consumption tank as well as the common reservoir. The number of each tank group shall not be less than 2.

6.179. The electrolysis vessels must be placed in separate rooms. Lighting lamps must be covered by glass to protect against the chlorine gas. A buffer chamber must be located in

front of the electrolysis chamber.

6.180. Tank for mixing salt saturated solution must be placed inside treatment work area or at store.

Mixing tank capacity should ensure the sufficient reserve of electrolyte for electrolysis vessel working continuously in 24 hours or more. The preservation of salt should comply with the instructions in the clause 6.338.

6.181. The working tanks used for mixing solution to the specified concentration (regardless of the type of electrolysis vessel) must be taken according to figures recorded in history and should be equipped with machine parts separately for each average quantitative electrolysis. When there is a number of electrolysis, the average quantity should be performed by preventing the stable. The working tanks should be arranged so that electrolyte solution can flow itself into the electrolytic vessel, while the tank capacity must ensure the continuous working of electrolysis vessels in 12 hours.

6.182. Hypochlorite storage tank need to be placed outside of electrolyte chamber in a room with a ventilation system. Hypochlorite shall be flowed into the tank by gravity. Tank capacity must ensure the continuous working of electrolysis vessels from 8-16h.

6.183. For mixing tanks, consumption tank and storage tank must be equipped with water supply pipes, sediment exhausting and washing pipes.

6.184. All parts of devices contacting with salt solution and hypochlorite should be made from corrosion resistant materials.

6.185. Equipments providing electricity for the electrolyte vessels must be placed in separate dry and ventilated rooms.

6.186. When using chlorine for disinfection of water and needed to prevent Chlophenol odors, it must arrange devices conducting ammonia gas in water.

Ammonia must be stored in vessels or containers located at the consumption store. Ammonia gas dose must be checked by flow meter, supplementary checked by bench scale which is placed at the same location of ammonia vessels or containers. Ammonia devices are arranged in the isolated chamber, away from the chlorine quantifying chamber and must be mechanized to displace the vessels and containers Ammonia quantifying chamber must be designed as directed in the clauses 6.166 and 6.167.

All equipments of ammonia systems must use anti-explosive types.

6.187. Contact time of the chlorine and hypochlorite with water from its mixture to use shall not be less than an hour.

The contact of chlorine compounds with water should be done in clean water tanks or in private contact storage tanks. When it is not water supply along the pipeline, allow taking into account the contact time inside pipelines.

6.188. If the technical material facilities allow, use Ozone disinfection method. Ozone dose needed for disinfection of groundwater shall be taken from 0.75 to 1 mg/l; for disinfection of surface water from 1-3 mg/l.

6.189. Average calculated amount of air for preparation of 1 kg of Ozone at normal pressure conditions and temperature of 20^{o}C shall be taken as 70-80 m^{3}.

Air should be taken from uncontaminated area and the air suction device should be placed 4 m above the roof.

6.190. Ozone station includes the ozone preparation device and ozone water stirring device. To prepare ozone, it needs an air transportation system, power generator and Ozone maker. In the air handling system, it must have a dust filter, silica gel absorption purifier or aluminum gel to dry air and other equipment for recycling of absorption agents. Air handling system should be automatically operated

6.191. The humidity of the air after passing through the adsorption device shall be not greater than 0.05 g/m^{3}, corresponding to flashpoint of - 45C°.

For the ozone station with a capacity greater than 6 kg/h Ozone, the air must be dried by

two grades (grade I is to artificially cool air by cooling device up to temperature of 7^{o}C and grade II is to dry air in absorption device up to residual moisture of 0.05 g/m3).

6.192. When designing equipment providing air and ozone-air mixture, it should calculate the pressure loss in equipments, pipes, the mixing tank and distribution system.

6.193. Power supplied to ozone preparation station should be taken as 30-40 KW/h for 1 kg of ozone.

6.194. Ozone preparation equipment shall be put in separate room or in treatment work block. The ozone preparation must be done away from high humidity (cooling tower, injection wells and open water tank) above 200m.

6.195. Ozone devices must be arranged in a separate room which is opened to other chamber by the hermetic door. The ozone preparation device to the first and second ozonization (as required) should be arranged in a chamber.

6.196. When arranging ozone water tanks below ozone preparation chamber, its ceiling and the floor must be resistant to humidify air penetration.

6.197. The water amount needed to cool ozone must be taken as 3 m^3 per 1kg of ozone (more accurate calculation based on data of machine history in factories).

6.198. Dissolve mixture of ozone air and water must be done by an agitator in the pipe column or by foaming in the storage tank and the Ejector mixing tank.
When water disinfection with ozone, residual ozone concentration in water after mixing compartment should be equal to 0.1-0.3 mg/l.

6.199. Allow water disinfection by ultraviolet radiation in the boost stations and the local water supply distribution stations having completely enclosed distribution network, capable of completely prevent bacteria re-enter into system, when the physical and chemical indicators of water meet drinking water standards, the iron concentration in water is less than 0.3 mg/l and Coliform index is less than 1000 MPN/l. The number of UV generators and their layout shall be determined by the device power, but not be greater than 5 (including one backup set). Disinfected point must be located discharge tube or drawtube of the pums that conducting water into consumption network.

TREATMENT FOR STABILIZATION OF WATER

6.200. The instructions in this section apply to water treatment for domestic and production purpose, not to water cooling technology equipments.
Notes:
1 - This section does not study water stability treatment methods for hot water and heat supply systems.
2 – Treatment of easily cooled circulation water must follow instructions given in Section 10.

6.201. Stability of water shall be evaluated according to the results obtained from the "technology analysis method -Determination of stability of water"

6.202. Without technology analysis data, determine the stability to assess water quality by saturation index J.

$$J = pH_o - pH_s \qquad (6\text{-}31)$$

Where:
pH_o – pH index of water, defined by pH meter
pH_s – pH index of water after being carbonate saturation to equilibrium, defined by the formula:

$$pH_s = f_1(t) - f_2(Ca^{2+}) - f_3(K) + f_4(P) \qquad (6\text{-}32)$$

Where:
f_1 (t), f_2 (Ca^{2+}),f_3 (K), f_4 (P) are the values depending on temperature, calcium

concentration, alkalinity, total salt content in water, determined by the graph in Figure H-6.1.

Note: To assess the corrosion effect of water on reinforced concrete structures, it must be in accordance with standards on design to protect against corrosion for house and building structure.

6.203. It must treat water stability when saturation index is greater than +0.5 in 8-10 months per year, or the saturation index is negative than three months per year.

6.204. For water treated with inorganic alum (sulphate aluminum, iron chloride ...) when calculating the saturation index, it needs to take into account the reduction of pH and alkalinity of water due to the addition of alum.

Water alkalinity after mixed with alum K_1 (mgdl/l) shall be determined by the formula:

$$K_1 = K_0 - \frac{Dp}{e} \qquad (6\text{-}33)$$

Where;

K_0 – The alkalinity of source water before mixed with alum (in mgdl/l)

Dp – Alum dose calculated according to unhydrated products (mg/l)

e – Equivalent of unhydrated alum, taken as given in Clause 6.15 (mg.mgdl). Free carbonic acid in water after alum mixture shall be calculated by the formula:

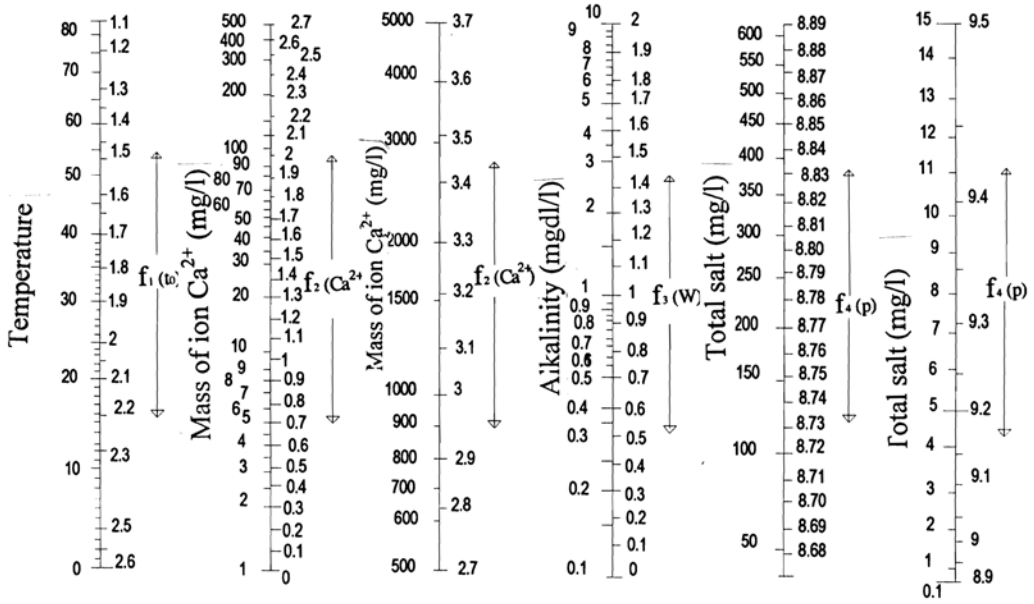
$$(CO_2) = (CO_2)_o + 44 \frac{D_p}{e} \text{ (mg/l)} \qquad (6\text{-}34)$$

Where:

$(CO_2)_o$ - carbonic acid concentration in source water before mixed with alum (in mg/l)

pH index of water after mixed with alum must be defined by monograph in Figure H – 62 according to alkalinity and carbonic acid content after mixed with alum.

Figure H-6.: The graph to determine the pH index of water saturated with calcium carbonate to equilibrium.



6.205. If saturated index is positive, in order to prevent depositing sediment of calcium carbonate in the pipeline, we should treat water by Sulfuric acid or Chlohydric acid or Hexametaphosphate or Tripolyphosphate Sodium. When treat stably by Phosphate for water using for eating and drinking, remaining redundant chemicals cannot exceed 2.5 mg/litre. When treat water only using for production demand, amount of Hexametaphosphate or Tripolyphosphate Sodium is taken as 2-4 mg/litre.

Amount of acid D_{ax} (mg/l), calculated on products in the market, must calculating according to formula:

$$D_{ax} = a \,.\, K.\, e_1.\, \frac{100}{C_K} \qquad (6.35)$$

Where:

a – coefficient defined according to the graph at Fig. H-6.3

K- Alkaline level of water before treating stably

e_1- Equivalent amount of acid (mg/mgdl). For Sulfuric acid e_1=49; for Chlohydric acid e_1=36.5)

C_K- Content of active element in trademark acid (%)

6.206. When saturated index has negative value, in order to create protection layer by carbonate at internal face of pipe wall, should alkalify or eliminate carbonic acid by ventilating on wind fan frame combining to eliminate iron in water.

Alkaline amount put more into water for water come to stable statement (j=0) must define according to one of formulas at table 6.20.

Where:

K – Alkaline level of water before treating stably (mgdl/l)

pHo- pH level of water before treating stably

D_k- Dosage of alkaline element (mgdl/l)

In order to transfer D_k in to weight unit of technical products (mg/l) must use formula:

$$D_K = D_K \,.\, e_2 \,.\, \frac{100}{C_K} \qquad (6\text{-}36)$$

Where:

e_2 – Equivalent amount of active elements in alkaline mg/mgdl. For lime counting on CaO =28.

C_K- Content of active element in technical products (%) Dosage of Soda counting on Na_2CO_3 (mg/l) must take equal to 3-3.5 times, bigger than dosage of lime counting on CaO (mg/l).

Table 6.20

Features of water	Formula for defining dosage of alkaline
J<O, $pH_o < pH_s < 8.4$	D_K = b.K here b – according to graph of fig. H-6.4
J<O; $pH_o < 8.4 < pH_s$	$D_k = (\chi + \xi + \chi.\xi)$ K here χ and ξ - according to graph

	of fig. H-6.5

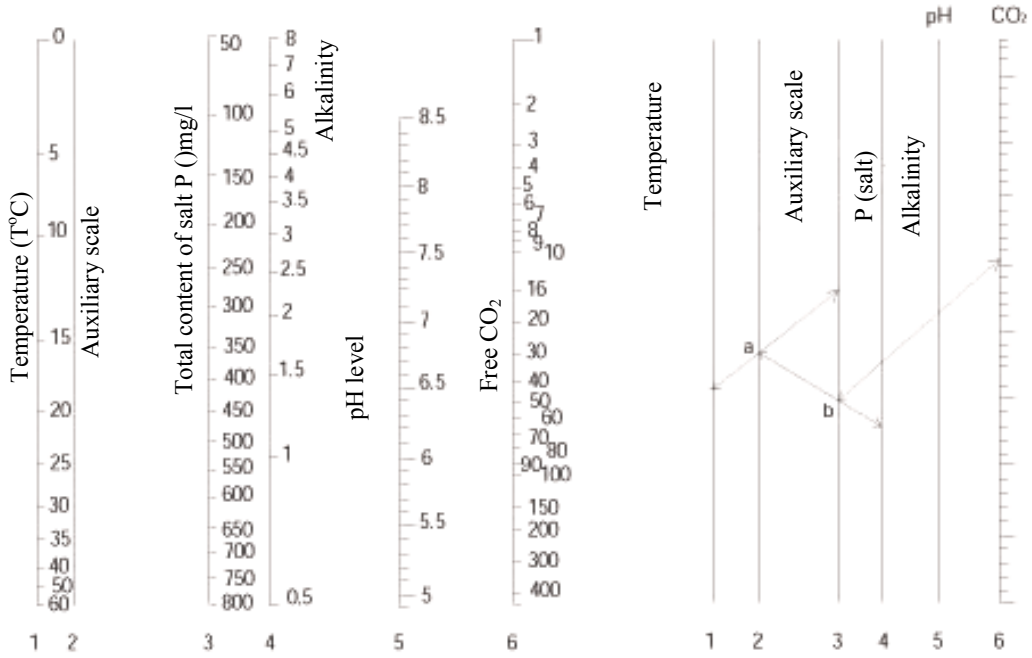


Fig. 6 - 2

Mathematiccal graph to define pH or concentration of carbonate acid in natural water

Application diagram

Connect t^o to salt content, cut auxiliary scale at point a. Connect point a to calculated alkalinity, cut salt scale at point b. Connect point b to existing CO_2, find out pH.

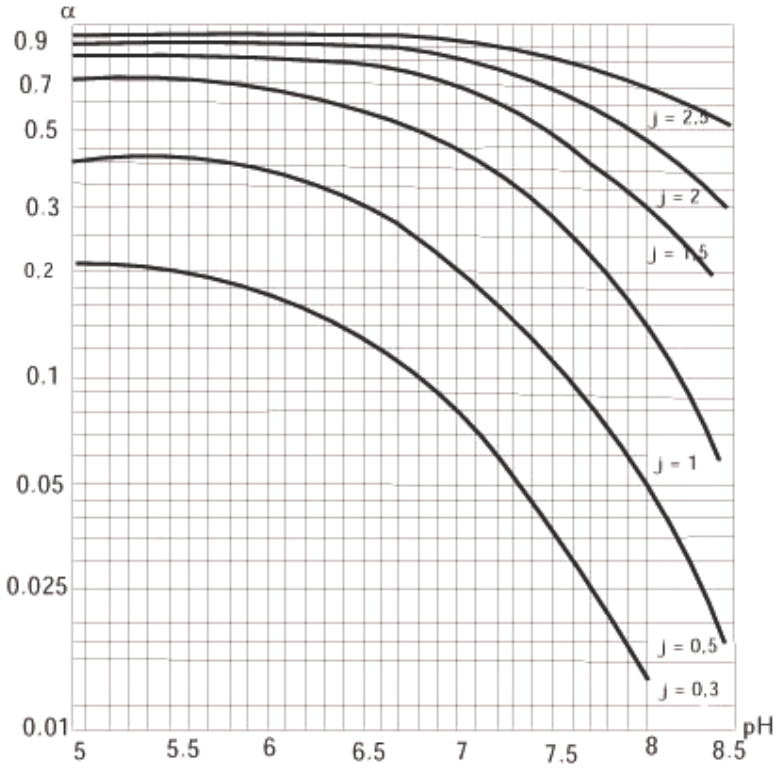


Fig. 6 – 3
Graph for defining coefficient when calculating acid dosage

6.207. When treat water stably, must anticipate probability of putting alkali substance into mixing tank, in front of and behind filtering tank , before mix chlorine the second turn. When putting alkali substance into front of and behind filtering tank must ensure purity of alkali substance and solution. Making up solution of lime and soda must be according to instruction at article 6.33-6.40.

Notes: Allow putting alkali substance in front of mixing tank and in front of filtering tank in cases of not making bad the effects of purifying water (in particular is reducing the effects of color treatment).

6.208. In order to treat water stably, must use lime and soda.

If dosage D_K counted according to the formula of Table 6.20 is bigger than d_K (mgdl/l) counted according to formula:

$$d_K = 0.7 \left[\frac{(CO_2)}{22} + K \right] \qquad (6\text{-}37)$$

then except for lime with content d_K (mgdl/l) must put more soda one amount D_x counted according to formula:

$$D_x = (D_K - d_K) \,.\, 100 \text{ (mg/l)} \qquad (6\text{-}38)$$

6.209. Eliminating carbonic acid to let water be stable must carry out on air eliminating frame with wood setting or plastic pipes. Water's pH level on eliminating frame must define according to graph of fig. H-6.2. Simultaneously, water's alkalinity must be taken as the alkalinity of source water after eliminating CO_2 air down to the 8-10mg/l.

Irrigating intensity on wood setting air eliminating frame must take as 40 $m^3/m^2.h$. Air flow is 20 m^3 for 1 m^3 of water.

6.210. Water treating method for protecting pipe from corrosion by creating one protecting layer of Carbonate Calcium or use Polyphosphate noted in Annex 8.

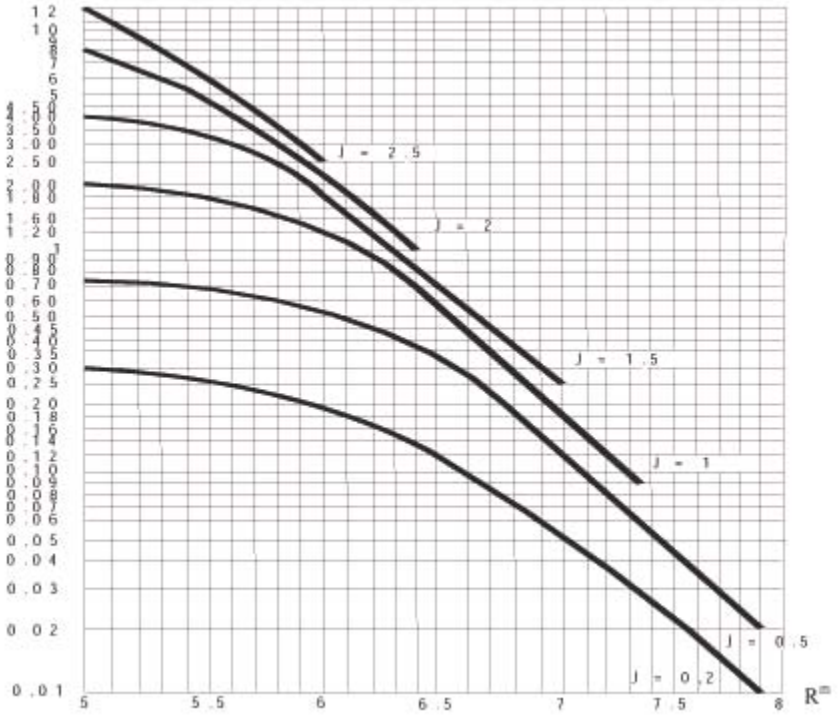


Fig. H-6.4
Diagram for defining coefficient β according to alkali concentration when pHo < pHs < 8.4.

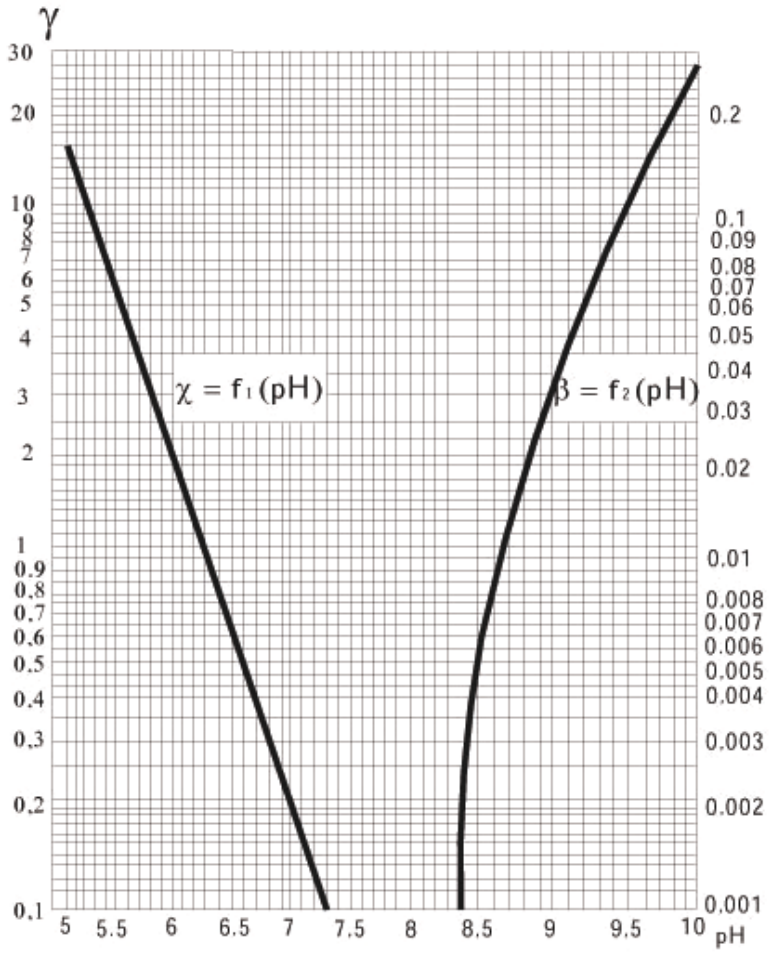


Fig. H-6.5
Diagram for defining coefficient χ and ξ according to alkali concentration when pHo < 8.4 < pHs

FLUORIDIZATION

6.211. It is necessary to make up more fluorine into water supplying for living, eating and drinking in case fluorine content in water lower than 0.5 mg/l. Put fluorine containing chemicals into water in front of filtering tank, contact filtering tank or behind general treatment works before antisepsis. Necessity for having to put more fluorine into water in each specific case is decided by the prophylactic and hygiene organ.

6.212. In order to fluoridize, can use following chemicals: Silicon Fluoride Sodium, Fluoride Sodium, Silicon Fluoride Ammonium

6.213. Dosage of chemical D_f (g/m^3) is defined according to formula:

$$D_f = [ma - (F^-)] \frac{100}{K} \cdot \frac{100}{C_f} \qquad (6\text{-}39)$$

Where:

m: Depending coefficient on putting fluorine into water for treatment. When put fluorine into behind purification works m=1; when put fluorine in front of filtering tank or contact filtering tank m=1.1.

a: Necessary content of fluorine in treating water g/m^3 depending on climate condition and alter according to season taken from 0.7-1.2 g/m^3 (small value taken for summer and hot climate zone).

K: Fluorine content in purified chemicals counted as % for Silicon Fluoride

Sodium K =60; Fluoride Sodium K =45; Silicon Fluoride Ammonium K = 64.

F^-: Flourine content in source water g/m^3

C_f: Purified chemical content in technical products %

6.214. When use Silicon Fluoride Sodium, need apply technological diagram of diluting for non-saturated solution in consuming barrels or saturated chemical solution in saturated dissolving equipments.

When use Fluoride Sodium or Silicon Fluoride Ammonium, need apply technological diagram of diluting for non-saturated solution in consuming barrels

Note: Allow to use technological diagram for quantifying dry chemical.

6.215. Capacity of saturated dissolving equipment q_c counted as l/h (according to saturated solution of chemical) defined according to formula:

$$q_c = \frac{D_f . Q}{np} \qquad (6.40)$$

Where:

Q - Treated water flow m^3/h

n - Number of saturated dissolving equipments

p – Dissolved level of Silicon Fluoride Sodium (g/l) at temperature 20°C p = 7.3 g/l; 40°C p =10.3 g/l. When defining the volume of saturated dissolving equipment, staying time of solution in the equipment taken not smaller than 5 hours. Going up speed of water flow in the equipment is not bigger than 0.1mm/s.

6.216. Chemical solution concentration when mix into saturated solution in consuming barrel is taken as:

- For Silicon Fluoride Sodium: 2.5%

- For Silicon Fluoride Ammonium: 7%

Use mechanical stirring or compressed air to stir and mix solution. Compressed air intensity is taken as 8-10 l/s.m^2.

Calculating consuming barrel according to instruction of article 6.21 and 6.24

6.217. Chemical solution of containing fluorine must be deposited two hours before putting into using.

6.218. When use Silicon Fluoride Sodium and Silicon Fluoride Ammonium, it is necessary to have anti-corrosive method for barrels, pipelines and quantifying equipments.

6.219. Must preserve chemicals of containing fluorine in the tanks manufactured at the factories and put the tanks into the storage. Calculating storages and number of tanks must be according to the instructions in article 6.326.

6.220. The house putting Fluorine quantifying equipment and the storage for putting fluorine must be separated from other manufacturing houses. The places which can cause dust must put partial air attracting pumps.

6.221. When use chemicals of containing fluorine, because of their toxicity, it is necessary to have methods of general protection and protecting for operating workers.

ELIMINATING FLUORINE IN WATER

6.222. When use method of filtering water through active aluminum oxide to eliminate Fluorine, sediment content of water before putting into filtering tank cannot exceed 8mg/l and total salt content cannot be bigger than 1000 mg/l.

6.223. Choosing absorbing material is pellet with diameter 2-3 mm, volume weight 0.5 ton/m^3.

6.224. Height of absorbing material in pressure filtering tank is taken as follows: when

Fluorine in water up to 5 mg/l takes 2 m; from 8-10 mg/l take 3 m. In opened filtering tank take 2m when Fluorine in water up to 5 mg/l and 2.5 m when Fluorine content in water 8-10 mg/l.

6.225. Height of pressure filtering tank is defined as plus height of absorbing material layer with free space interval on the surface of this layer. Height of the free space interval is taken not smaller than 60% of thickness of absorbing layer.

6.226. In filtering tank s, use distribution system of washing water and collection filtered water by pipe frame made of stainless material or use filter cover with interstice. When use distribution system with interstice (pipe or cover of filter) must put one layer of quartz sand with thickness 150mm and pellet diameter 2-4mm under the absorbing layer.

6.227. Normal filtration speed is taken not bigger than 6 m/h; filtration speed when working strengthenly is not bigger than 8m/h.

6.228. Filtering tank works in initial time for filtered water with Fluorine content from 0.1 – 0.3 mg/l and then fluorine content in filtered water is increased gradually.

6.229. Must stop filtering tank to reconstitute when fluorine content in water filtered through the tank is maximum makes fluorine content in general collecting pipe lead to consumer up to 1 mg/l.

Working time of filtering tank between two times of reconstituting T calculated by hours defined according to formula:

$$T = \frac{F.H.K}{q(C_o - \frac{Ck}{3})} \qquad (6\text{-}41)$$

Where:

F- Area of filtering tank , m^2

H- Height of absorbing layer, m

K – Absorbing capacity of absorbing material calculated according to Fluorine taken as 900-1000g/m^3.

C_0 – Fluorine content in source water, g/m^3

C_k- Fluorine content in filter water at the end of filter cycle taken as 1.5 g/m^3.

6.230. Before reconstitute, must turn up absorbing material layer by water with intensity 4-6 l/s.m^2; turning-up time 15-20 minutes.

6.231. Reconstitute for absorbing material by Sulfate Aluminum with concentration 1-1.5% calculating on $Al_2(SO_4)_3$. Reconstituted solution let go through the absorbing layer from top to bottom with speed 2-2.5m/h.

Note: 70-80% the first volume of reconstituted solution discharging; the remaining part of volume (approximate 25% volume of reconstituted solution) is reused to reconstitute attracting material. In this case start to reconstitute by recovered solution.

6.232. Consuming amount of Sulfate Aluminum counting $Al_2(SO_4)_3$ is taken 40-50 grammes for 1gramme Fluorine eliminated out of water.

6.233. After reconstituting, must clean the layer of attracting material by water flow from the bottom up to with intensity 4-5 l/s. m^2. Consuming water amount for cleaning attracting material layer is 10 m^3 for 1 m^3 attracting material layer.

ELIMINATING IRON AND MANGANESE

6.234. Must eliminate Iron in water supplying for living, eating and drinking when Iron in water source bigger than 0.3 mg/l and eliminate manganese when its content is

bigger than 0.2mg/l.

Notes:

1- In special case there is agreement ỏof epidemic prevention organ when Iron content in the source of underground water is 0.5 mg/l may be unnecessary to eliminate Iron.

Necessary level to eliminate Iron in water supplying to technical demands must be stipulated by water quality requirement of each kind need to manufacture.

2- Method for eliminating Mn please see Annex 10

6.235. Eliminating Iron in surface water is necessary to carry out simultaneously with making water clearly and eliminating colour. Components of works in this case are similar to works for making clear and eliminating colour of water. Calculation and composition of works must follow instructions in article 6.9 – 6.17.

6.236. Choosing method of eliminating Iron in underground water, choosing calculated parameters and dosage of chemicals must be carried out on the base of researched technological results carried out directly at water supplying source.

6.237. Can eliminate Iron in underground water by filtering water through Cationic filter tank. In this case must ensure not omit Oxygen and other Oxygenated substances into the water before putting it into Cationic filter tank. Cationic filter tankể reduce Iron content in water till 0.5mg/l as long as if all Iron in water are both existing in form of bivalent ion and must pay attention Cationic filter tank not able to eliminate Iron existing in glue form of Hydroxide Iron and organic Iron compounds.

6.238. Can apply one of following methods to eliminate Iron:

a) Ventilating simply and then purifying (only need take oxygen of the air into water for oxygenating Iron, no need eliminating CO_2 to raise pH level of water).

b) Ventilating for taking Oxygen and eliminating CO_2 to raise pH level of water, depositing or filter of touching, purifying.

c) Ventilating for taking Oxygen and eliminating CO_2 , after that through touching filter pool with filter material layer with activity of catalysis for eliminating iron and mangan, and then purify.

d) Alkalifying water by lime is combined with ventilating, deposit and then purify.

e) Flocculating by alum (with or without Chlorinating in advance to break organic Iron compounds) deposit to pure and then filter.

g) Through Cationic filter tank. Using method of alkalifying by lime and method of filter through Cationic filter tank are useful when must soften water simultaneously with eliminating Iron.

6.239. In order to design Iron eliminating station, it's necessary to have following datum:

a) Effective capacity of station, m^3/day

b) Requirement for water quality after eliminating Iron

c) Chemical analysis sheet for treating water must have following sufficient index: turbidity; coloured level; whole hardness and carbonate hardness; alkalinity; pH level; oxygenated level; Total Iron content and content of bivalent Iron ion, trivalent Iron ion; Content of chloride and sulfate ion.

d) Result of eliminating Iron at site by methods stated in article 6.246.

6.240. If test to eliminating Iron according to points a, b, c noted in article 6.246 is not met, choosing method of eliminating Iron must be carried out by comparison the cost of different test methods for eliminating Iron (alkalify, flocculating,

chlorinate, Cationic) to choose the most economic project.

6.241. When it is lack of documents about test result of eliminating Iron at site, to choose method of Iron eliminating method for stage of making report on feasibility study, can base on following norms:

When underground water has bivalent Iron content not bigger than 10 mg/l; coloured level of water measured directly when pump water out of well is not over 15°; oxygenated level is not over [0.15 (Fe^{2+}) + 5] mg/l O_2 ; NH_4 < 1 mg/l; total Iron content is not over content of bivalent Iron ion and trivalent Iron ion to 0.3mg/l; pH level of water after eliminating Iron ≥ 6,8; alkalinity of water is bigger than $(1+\frac{Fe^{2+}}{28})$ mgdl/l, we use simple ventilating method.

6.242. If alkalinity of underground water is bigger than limited numeric value $(1+\frac{Fe^{2+}}{28})$ mgdl/l; pH level of water after hydrolyzing Iron with numeric value < 6.8, we can apply method of ventilating and eliminating CO_2 to increase pH level of underground.

When ventilating forcedly in barrel with blower can reduce 85-90% amount of CO_2.

When ventilating on natural contacting frame can eliminate 75-80% amount of CO_2 in water.

When ventilating by direct spraying on surface of water (spraying height is not lower than 1m, irrigating intensity is not bigger than 10 m^3/m^2.h). Can eliminate 30-35% amount of CO_2 in water.

6.243. Calculating numeric value pH of water after ventilating and hydrolyzing Iron is carried out as follow:

According to given numeric value of alkalinity and pH of water (note in analyzing sheet), look up diagram Fig. H-6.2 to find out free CO_2 content in source water before ventilating. After that plus a supplement amount of CO_2 created by Iron hydrolysis into this free amount of CO_2. Each 1mg/l hydrolyzed Iron creates out 1.6mg/l CO_2 and reduces alkalinity of water as amount 0.036 mgdl/l.

When can calculate new content of CO_2 and alkalinity of water, according to diagram, find pH numeric value of water after hydrolyzing Iron. If pH of water after hydrolyzing is ≥ 6.8 and alkalinity > 1 mgdl/l, then apply simple ventilating method.

If can not do simple ventilating method and after minus 80% amount of CO_2, find out pH > 6.8 and alkalinity > 1 mgdl/l, then apply method of ventilating on natural touching frames to eliminate CO_2.

If ventilating on natural touching frames is not met and after minus 90% amount of CO_2, find out numeric value of pH > 6.8 and alkalinity > 1 mgdl/l, then apply forced ventilating method by barrel of blower. Necessary touching area in ventilating frame is defined by calculating according to principle of eliminating CO_2 in water.

6.244. If norms of source water quality noted in article 6.249 are ensured but pH of water after ventilating and eliminating CO_2 with numeric value is still < 6.8; alkalinity reduces < 1mgdl/l, then in front of the purifying pool must prepare to let water go through the touching filter tank which there is filtration material layer as catalyst of Iron eliminating inside (sand coated by one layer of Oxide Mangan) or kinds of natural Piroluzit ore, after that through purifying pool.

6.245. When airy methods are not get result, must apply methods of using chemical to eliminate Iron.

a) Use strongly oxygenated substances such as Chlorine or Potassium

Permanganate. In order to eliminate 1mg/l Iron, consume 0.70 mg/l Chlorine and alkalinity reduce 0.018 mgdl/l. In order to eliminate 1 mg/l Iron necessary to eliminate, consume 1 mg/l $KMnO_4$.

b) When alkalifying by lime water, dosage of lime is defined according to following formula:

$$D_v = 28\left(\frac{Fe^{2+}}{28} + \frac{CO_2}{22}\right) mg/l \qquad (6\text{-}42)$$

Where:

- Fe^{2+} is bivalent Iron amount in underground water, mg/l

- CO_2 is free CO_2 amount in water source, mg/l.

6.246. Composition of works which eliminates Iron by ventilating method include of:

1- Ventilating works (simple ventilating, natural ventilating on touching frames, and obligatory ventilating by barrel with blower).

2- Depositing pool or touching filter tank

3- Purifying pool

Parameters for calculating ventilation works as follows:

a) Simple ventilating: can spray directly on face of filter tank, irrigation intensity is not bigger than 10 m^3/m^2.h. The height from water level to holes of spraying pipe frame is not less than 0.6m or can let water spill through guiding gutter into filter tank. The spilling height from water level of lower section to spilling top is not lower than 0.5-0.6m

Spilling intensity 10 m^3/1m length of gutter edge. When use pressure filter tank must put the air in front of touching filter tank or in front of filter tank by compressing air pump or Ejector. Amount of air necessary to put into water takes 2 litres for 1 gram Iron necessary to eliminate. Behind the place where put the air into must place mixing tank to mix the air with water regularly. Mixing tank is cylindrical or spherical; inside place bulkheads to change movement direction of mixture water – air. Mixing tank has volume for water stay there not lower 1 minute.

b) Natural ventilating frame has touching material is coal slag coke or pebbles with average diameter 30-40mm or plastic pip D25-50 arranged perpendicularly into square 25x25 or 50x50; this layer overlaps other layer so that squares do not coincide.

Touching material is poured into layers with height 30-40cm. This layer is separated other layer 0.8m. Number of touching material layer is consequently the height of raining frame taking according to calculation from requirement of eliminating CO_2 in water. Raining intensity 10-15 m^3/m^2.h.

Raining frame includes of: distribution gutters are serrated ones. Axial distance between sub-gutters is 30cm. Axial distance of serra is 35mm. Depth of serra is 25mm. If use the distributing floor made of steel, drilling hole with diameter 5mm. Number of holes are according to calculation so that thickness of water layer on the floor is 5-7cm, ensure to distribute regularly on the whole are. If use pipe frame, drilling holes on the pipe are usually from 5-10mm. Calculation of pipe frame is same as calculation of pipe platform of distributing cleaning water in filter tank. Water spreading floor is placed at 0.6m under the distribution gutter made of 20cm wide plank placed separately 10cm with each other or by a half tree of bamboo with edges arranged separately 5cm with each other. Under the water spreading floor there are floors for pouring touching layers of air elimination, final

is water collecting floor by concrete. Equipment of raining frame includes of water pipe up to distribution gutter, speed is 0.8-1.2m/s. Pipes putting water from water spreading frame down touching depositing pool with speed 1.5m/s. Clear water pipe for cleaning D=50mm, sediment discharging pipe D = 100-200 mm.

c) Blower barrel: inside touching material or use wood plank with 200mm width, 10mm thickness placed separately 50mm with each other in to one layer, this layer is perpendicular to other layer and apart from each other by supporting frames of wood wall with section 50x50mm, or use plastic pipe arranged into layers perpendicular together and the edges of plastic pipes are apart 50mm from the other. The mass of touching material is defined according to calculation and requirement of eliminating CO_2.

The height of touching layer in blower barrek can be taken preliminarily according to alkalinity as follows:

Alkalinity in source water 2 mgdl/l, takes H = 1.5 m

2-4 mgdl/l, takes H = 2.0 m

4-6 mgdl/l, takes H = 2.5 m

6-8 mgdl/l, takes H = 3.0 m

Plane area is chosen according to irrigation intensity 40-50 $m^3/m^2.h$.

Air amount which blows into taken 10 m^3 for 1 m^3 water, blower pressure is taken preliminarily from 100-150 mm water column.

Equipment for blower barrel includes of water pipe up to distribution pipe frame, water pipe down to touching deposit pool, blower pipe, sediment depositing pipe when clean the touching material layer.

Distribution pipe frame uses for big hindrance distribution system or distribution floor made of steel with drilling holes.

The height from top of material layer to holes center of distribution pipe system is taken not less than 0.8m; under the floor for pouring touching material there is water collecting compartment to lead to touching deposit pool. In this compartment taken according to diameter of blower pipe, but not smaller than 0.5m

6.247. Volume of touching deposit pool to complete process of oxygenation and hydrolysis for Iron in water after go through ventilating frame depends on pH of water after ventilating, taken according to table 6.21.

In touching deposit pool need design bulkheads of guiding flow to ensure to be able to use the whole volume, does not create into dead water zone in the pool.

Table 6.21

pH	6.5	6.6	6.7	6.8	6.9	7.0	7.5	8
Necessary touching time (minutes)	60	45	30	25	20	15	10	5

6.248. Instead of touching deposit pool in diagram of using air compressor, air attracting ejector and pressure filter tank, can place touching filter tank.

Touching filtration area is defined according to formula:

$$F_{tx} = \frac{Q_n}{20} \quad m^2 \qquad (6\text{-}43)$$

Where:

Q_n – Capacity of Iron eliminating station, m^3/hr

20- Touching filtration speed 20 m/hr

6.249. In case water after ventilating has numeric value pH < 6,8; alkalinity < 1 mgdl/l which alkalifying by lime is difficult and uneconomic, then before put into purify pool must let water go through touching filter tank with filter material of black sand (sand is coated one layer of Oxide Mangan on the surface), pellet size 1-3mm. Process of culturing coating layer for Oxide Mangan on the surface of sand pellet see Annex 9.

6.250. Touching filter tank (opened or pressure) with quartz sand or black sand, pellet size 1.5-2mm. Filtration material layer thickness is 2.5m. Use big hindrance distribution system with buffering pebble layer. Wash touching filter tank by water flow from bottom up to with intensity 20 $l/s.m^2$. Scour wind with intensity 25 $l/s.m^2$ before. When calculating time of a cycle for washing touching filter tank, taking sediment containing level of material layer as 5 kg $Fe(OH)_3$ for 1 m^3 sand.

6.251. Structure of filter tank for eliminating Iron is similar to filter tank for purifying and eliminating colour. Properties of filtration material layer and filtration speed when ventilating for eliminating CO_2 and when eliminating Iron by chemical chosen according to item 6.11 article 6.103.

When ventilating simply, filtration speed and properties of filtration material layer is chosen according to table 6.22

Table 6.22

Properties of filtration material layer when use simple ventilating method					Calculating filtration speed (m/h)	
Minimum diameter (mm)	Maximum pellet diameter (mm)	Effective diameter (mm)	Un-identical coefficient	Height of filtration sand layer (mm)	When operating normally	When working reinforcedly
0.8	1.8	0.9-1	1.3-1.7	1000	7	10
1.0	2	1.2-1.3	1.3-1.7	1200	10	12

6.252. In order to extend working cycle of filter tank, we must increase deposit containing level of filtration material layer. When eliminating Iron, we can use filter tank with two layers. Lower layer is quartz sand, upper layer is antrazite coal. Properties of filtration layers and filtration speed of two-layer filter tank are chosen according to table 6.11 article 6.103.

6.253. Composition of Iron eliminating station works with using chemical as follows:

1. Equipment for diluting solution and quantifying chemical

2. Work of ventilating and mixing chemicals with water

3. Horizontal, vertical deposit pool or purifying deposit pool with suspending sediment layer

4. Filter tank.

6.254. Choosing chemical and their dosage to eliminate Iron must base on result of Iron eliminating test at site. Part of dissolving and quantifying chemical is designed same as stations of purifying and eliminating colour.

6.255. If need eliminate Iron in source of surface water (rivers, lakes, etc.), we apply process of using chemical. When design chemical house, we must calculate probability of putting following chemicals into water:

1) Aluminum alum with dosage counted on $Al_2(SO_4)_3$ taken suitably to instructions at article 6.11 depend on coloured level and turbidity of source water.
2) Lime (CaO) with dosage D_v mg/l counted on CaO defined by formula:

$$D_v = 28\left(\frac{CO_2}{22} + \frac{Fe^{2+}}{28} + \frac{D_p}{e_1}\right) \quad (6\text{-}44)$$

Where:

CO_2 - Free CO_2 content in source water, mg/l

Fe^{2+} - Bivalent Fe content in source water, mg/l

D_p - Alum dosage, mg/l (counted on dry product)

e_1 – Equivalent weight of alum (unhydrated), mg/l
3) Chlorine or Chloride Lime $Ca(OCl)_2$
Dosage of Chlorine or Chloride Lime (counted according to active Chlorine) defined according to formula:

$$C_{cl} = 2.25\ [O_2] \quad (6\text{-}45)$$

$[O_2]$: Oxygenated level of source water mg/l
Note: Chemical amount counting on the above formulas using for stage of feasible project. Until technical design stage need have precision datum attain from technological study process of eliminating Iron at site.

6.256. Station of eliminating Iron by Cationic includes of Cationic filter tank with filtration material as Cation exchanging substance. In order to avoid increasing Iron content in water, the wall of deposit pool and filter tank must be coated one stainless layer. Attracting and distributing system are made by plastic.

6.257. Filtration speed in Cationic pool is taken as 25m/hr. Thickness of Cation exchanging layer is taken as 2.5m. Reconstituting frequency of filter tank is defined by hardness of water need to soften and Iron content in water before and after treatment process.

6.258. Reconstituting Cationic filter tank by solution NaCl with concentration 5%. Need have to estimate each period (after 15-20 times of reconstituting) of washing Cationic filter tank by acid solution before reconstituting by salt for eating.

SOFTEN WATER

6.259. In order to soften water, need use following methods:
To eliminate hardness of carbonate, use Lime, Hydro Cationic.
To eliminate hardness of Carbonate and Non-Carbonate, use method of softening by Lime-Soda. Softening by Sodium Cationic or Hydro Sodium Cationic.
Note: In this chapter do not research treatment for water supplying to boiler.

6.260. To soften underground water, should use Cationic method. For surface water, if simultaneously request to soften water absolutely, and then use serial Cationic method.

6.261. In order to supply to demands of living or eating and drinking, amount of water necessary to soften q_m counted by percentage in comparison with total amount of water defined according to formula:

$$q_m = \frac{Co - C1}{Co - C2} x100 \quad (6\text{-}46)$$

Where:

Co – Whole hardness of source water (mgdl/l)

C1- Whole hardness of water put into network (mgdl/l)

C2- Hardness of softened water (mgdl/l)

AREAS OF CARBONATE HARDNESS AND SOFTENING WATER BY LIME-SODA

6.262. In composition of works for eliminating Carbonate hardness and softening by Lime-Soda must include of chemical house, mixing tank, deposit tank and equipments for treating and stabilizing water.

6.263. When eliminating Carbonate hardness, the remaining hardness of water can be bigger than Non-Carbonate hardness is 0.4-0.8 mgdl/l; and alkalinity from 0.8-1.2 mgdl/l. When softening by Lime-Soda, the remaining hardness is lower 0.5-1 mgdl/l and alkalinity 0.8-1.2 mgdl/l. Taking lower limit when water temperature from 35-40 ^{o}C.

6.264. When testing Carbonate hardness and softening by Lime-Soda must use Lime at milky lime. When amount of Lime which use daily is less than 0.25 ton (counting on CaO), it is allowed to put Lime into water in form of saturated lime solution made up from saturated equipments.

6.265. To eliminate Carbonate hardness with dosage of Lime Dv counted according to CaO, need define according to formula:

a) When the rate between Calcium concentration and Carbonate hardness in water $\left(\frac{Ca^{2+}}{20}\right) > C_o$, then:

$$D_v = 28\left(\frac{CO_2}{22} + C_K + \frac{D_K}{e_K} + 0.3\right) \qquad (6\text{-}47)$$

b) When the rate between Calcium concentration and Carbonate hardness in water $\left(\frac{Ca^{2+}}{20}\right) > C_o$, then:

$$D_v = 28\left(\frac{CO_2}{22} + 2C_C - \frac{Ca^{2+}}{20} + \frac{D_K}{e_K} + 0.5\right) \qquad (6\text{-}48)$$

Where:

(CO_2) – is concentration of free Carbonic acid in water, mg/l.

(Ca^{2+}) – concentration of Calcium in water, mg/l

C_c- Carbonate hardness of water, mgdl/l

D_k – Dosage of flocculants $FeCl_3$ or $FeSO_4$ (counting on dry product), mg/l

e_k- Equivalent amount of active substance in flocculants. For $FeCl_3$- 54; $FeSO_4$ - 76.

6.266. Dosage of Lime and Soda when softening by Lime-Soda, need define according to formula:

Dosage of lime counted by mg/l (counting on CaO)

$$\S_v = 28\left(\frac{CO_2}{22} + C_C + \frac{Mg^{2+}}{12} + \frac{D_K}{e_K} + 0.5\right) \qquad (6\text{-}49)$$

Soda dosage in mg/l (by Na_2CO_3)

$$D = 53\left(C_{kc} + \frac{\frac{D_K}{e_K} + 1}{}\right) \qquad (6\text{-}50)$$

Where:

(Mg^{2+}) – Magnesium content in water, mg/l

C_{KC} – Non-Carbonate hardness of water, mgdl/l

Remaining signals see at article 6.265.

6.267. When softening water by Lime or Soda, flocculants which must use is Iron (III) Chloride or Iron (II) Sulfate.

Dosage of flocculants (mg/l) D_K counted according to dry products $FeCl_3$ và $FeSO_4$ taken from 25-35 mg/l and defined precisely in management.

6.268. When eliminating Carbonate hardness or softening water without containing suspending sediment by Lime-Soda (underground or surface water) deposited preliminarily to separate Calcium Carbonate sediment, need use whirling reaction tank in case:

When eliminating Carbonate hardness, if $\frac{(Ca^{2+})}{20} > C_C$ and when softening water by Lime-Soda if Magnesium content in source water is not exceed 15mg/l and oxygenating level is not bigger than 10 mg/lO_2. In finally, let water be really pure, must let water go through filtration tank.

6.269. When calculating whirling reaction tank, must take speed of water into the reaction tank as 0.8-1m/s. Oblique angle of bottom peak is 15-20°; Going up speed of water counting at horizontal section with collecting part is 4-6 mm/s. Touching material of whirling reaction tank must use quartz sand or stone powder with pellet size 0.2-0.3 mm. Quantity 10 kg per 1 m^3 tank capacity. Lime must be put into the below part of tank under the form of solution or milk. When treating water in whirling reaction tank, cannot use flocculants.

Note: When $\frac{(Ca^{2+})}{20} < C_C$. Eliminating Carbonate hardness must be carried out in deposit pool. Behind deposit pool is filter tank.

6.270. In case cannot use whirling reaction pool because there are lots of Magnesium and water polluted by suspending sediment, must use deposit pool which has suspending sediment layer inside to separate sediment create out when softening water.

Counting and structure of clear deposit pool need be according to articles 6.86 to 6.96 and according to following regulations:

Distribution coefficient Kpp in formula 6-16 and 6-17 is 0.7-0.8.

Speed of water going up clear deposit zone V_{lt} is 1.3-1.6 mm/s when Magnesium hardness is smaller than 25% and 0.8 mm/s when Magnesium hardness is bigger than 25% the whole hardness. Water after going through deposit pool with suspending sediment content not bigger than 15mg/l.

Height of clear deposit zone is 2-2.5m.

6.271. Distributing water on area of clear deposit pool must use guiding pipes let water go from top to down, ensure cleaning easily Carbonate Calcium remain in the pipe. Area for each serving pipe cannot exceeds 10 m^2.

Speed of water running down in the pipe cannot exceed 0.7m/s. Speed of water running through interstice created between lower edge of down pipe and oblique wall of clear deposit pool must take equal to 0.6-0.7 m/s.

6.272. If composition of the pipe system on clear deposit pool does not ensure to eliminate bubble of air, the upper part of down pipe must have air discharging compartment according to instruction at article 6.60.

6.273. Maximum concentration of suspending sediment in water going into deposit pool (Cmg/l) need define according to formula 6-52, 6-53 with counting more sediment

amount M created by agglomerating substances.

When softening by Lime-Soda, M = $1.6D_k$. When test Carbonate hardness M=,07 D_k . Sediment pressing time T, when water has Magnesium hardness smaller than 25% the whole hardness taken as 3-4 hours. When water has bigger Magnesium hardness, then takes as T=5-7 hours.

Average concentration of suspending substances in sediment layer of sediment pressing compartment (Stb) takes according to table 6.8 of the article 6.68.

6.274. Pressure loss in suspending sediment layer taken in range 5-10 cm for each metre of sediment depending on amount of sediment contained in water and sediment created when soften (takes upper limit when sediment amount is big and Calcium Carbonate sediment is the main).

6.275. Filter tank for purifying water after going through whirling reaction pool or clear deposit pool must be one way filter tank. Filtration material is sand with pellet size 0.5-1.2 mm or two-layer filter tank. Filter tank must install washing equipment on the surface. Design of filter tank must follow articles 6.101-6.124.

METHOD OF SOFTENING BY SODIUM CATIONIC

6.276. In order to soften underground water and surface water with suspending substance not over 5-8 mg/l and coloured level not over 15 TCU, need use Sodium Cationic method. When use Sodium Cationic, water's alkalinity does not change.

6.277. When use Sodium Cationic method of one degree, hardness of water can reduce to 0.03-0.05mgdl/l, and when use two degrees, then its hardness reduces to 0.01 mgdl/l.

6.278. Actionic amount W_{CT} (m^3) put into one degree filter tank, need define according to formula:

$$W_{CT} = \frac{24.q.C_{tp}}{n.E_{Iv}^{Na}} \qquad (6\text{-}51)$$

Where:

q - Softened water flow, m^3/h

Ctp – Whole hardness of source water, (gdl/l)

E_{Iv}^{Na} - Exchanging capacity of Cationic when softened by Sodium Cationic, (gdl/m^3)

n – Reconstituting number of each filter tank per day, takes from 1-3.

6.279. Exchanging capacity of Cationic when softening by Sodium Cationic E_{Iv}^{Na}, counted by gdl/m^3, need define according to formula:

$$E_{Iv}^{Na} = \alpha_e \beta_{Na} C_{Na}.E_{ht} - 0.5qy.C_{tp} \qquad (6\text{-}52)$$

Where:

a_e: Coefficient of performance which reconstitutes with counting to reconstitute un-entirely, takes according to table 6.23.

b_{Na}: Coefficient counting to the reducing level of Cationic exchanging capacity for Ca^{2+} and Mg^{2+} due to Na^+ is kept one part, takes according to table 6.24.

C_{Na}: Concentration of Na in underground water, gdl/m^3. $C_{Na} = \frac{(Na^+)}{23}$

E_{ht}: Whole exchanging capacity of Cationic exchanging plastic (gdl/m^3), defining according exwork datum

Qy: Flow of water unit for washing Cationic, counted by m^3 cho $1m^3$ Cationic, takes as 4-6.

C_{tp} whole hardness of source water, counting as gdl/m^3.

Table 6.23

Amount of salt for eating to reconstitute Cationic, counting as g for 1gdl exchanging capacity	100	150	200	250	300
Coefficient of performance of reconstituting Cationic a_e	0.62	0.74	0.81	0.86	0.9

Table 6.24

$\frac{C_{Na}}{C_{tp}}$	0.01	0.05	0.1	0.5	1	5	10
b_{Na}	0.93	0.88	0.83	0.7	0.65	0.54	0.5

6.280. Area of one degree Cationic filter tank F_{ct} (m^2) need define according to formula:

$$F_{ct} = \frac{W_{CT}}{H} \qquad (6\text{-}53)$$

Where:

W_{CT}- Define according to formula 6-54

H- Height of Cationic layer in filter tank, takes 2-2,5 m (big numeric value use for water with bigger hardness than 10 mgdl/l).

6.281. Filtration speed through Cationic for one degree pressure filter tank at normal working condition can not over following limit:

- When the whole hardness of water reaches to 5 mgdl/l: 25 m/h
- When the whole hardness of water from 5 to 10 mgdl/l: 15 m/h
- When the whole hardness of water from 10 to 15 mgdl/l: 10 m/h

Note: Allow increase filtration speed more 10m/h in comparison with the above standard when stop filter tank to reconstitute or repair in short time.

6.282. Number of operating Cationic filter tanks must take not smaller than 2. Number of reversed pool: 1.

6.283. Pressure loss in Cationic filter tank must define by total loss in pipes of filter tank, in distribution system and in Cationic.

Total of pressure loss takes according to table 6.25.

Table 6.25

Filtration speed m/h	Total pressure loss in Cationic filter tank, m	
	Cationic layer height: 2m; pellet size 0.8-1.2 mm	Cationic layer height: 2.5m; pellet size 0.8-1.2 mm
5	4.0	4.5
10	5.0	5.5
15	5.5	6.0
20	6.0	6.5
25	7.0	7.5

6.284. ter layer on Cationic surface must take 2.5-3 m, filtration speed cannot be bigger than 15 m/h.

6.285. Water intensity for cultivating Cationic, need take as 4 l/s.m^2 when Cationic ellet size is 0.5-1.1 mm and 5 l/s.m^2 when Cationic pellet size is 0.8-1.2 mm. Cultivating time takes 20-30 minutes. Supplying water for cultivating Cationic counted according to articles 6.115 and 6.116.

6.286. Reconstitute Cationic filter tank by salt for eating. Amount of salt for eating P (kg) for one time reconstituting one degree Cationic filter tank need define according to formula:

$$P = \frac{f.HE_{Iv}^{Na}.a}{1000} \qquad (6\text{-}54)$$

Where:

f- Area of one filter tank (m^2)

H – Cationic layer height in filter tank (m)

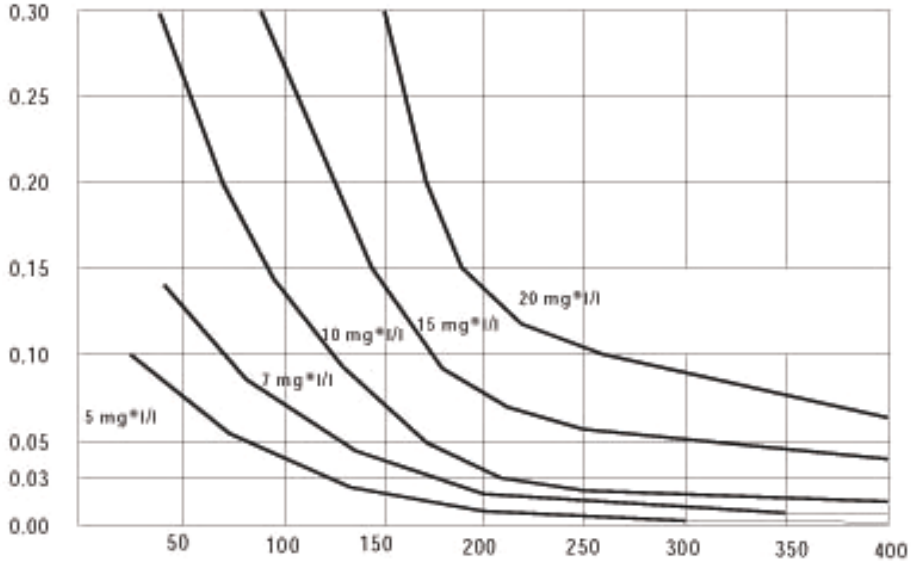
E_{IV}^{Na} - Cation exchanging capacity of Cationic plastic gdl/m^3 takes according to 6.279.

a- Amount of salt using for 1 gdl of working exchanging capacity, takes as 120-150 g/gdl for one degree filter tank in two-degree working diagram and 150-200 g/gdl in one degree working diagram. Hardness of softened water with different dosages is showed on figure H-6.6

Concentration of reconstituted solution when hardness of softened water is 0.2 mgdl/l, takes 2-5%.

When hardness of softened water is smaller than 0.05 mgdl/l, must reconstitute each turn. Firstly, solution 2%, approximately 1.2 m^3 solutions get 1 m^3 Cationic. After that remaining amount of salt made up into solution 5%-8%.

Filtration speed of salt solution through Cationic, takes 3-4 m/h.



Consuming salt amount counted by gam for 1 gdl of absorbed cations Ca^{++}; Mg^{++}

Fig. H-6.6. Diagram for defining hardness of water softened by Sodium Cationic

6.287. After reconstituting, need wash Cationic by water which has not been softened until Chloride amount in filtration water is approximately Chloride amount in washing water. Speed of water going through filter tank when washing takes as 6-8m/h.
Unit flow of washing water takes 5-6 m^3 for 1m^3 Cationic

6.288. The second degree Sodium Cationic filter tank must count according to instruction at articles 6.278- 6.308 with Cationic layer height is 1.5m. Filtration speed is not exceed 40m/h. Unit salt amount using for reconstituting Cationic takes 300-400g/ for 1 gdl hardness to have to eliminate. Pressure loss in the pool is 13-15m. Washing the second degree filter tank by filtered water of the first degree filter tank. Concentration of reconstituted solution takes as 8-12%.
When counting the second degree filter tank, hardness of water which runs into the pool takes as 0.1 mgdl/l.
Inon exchanging capacity of Cationic substance is taken according to documents of Manufacturer.

METHOD OF SOFTENING WATER BY HYDRO SODIUM CATIONIC

6.289. Method of Hydro Sodium Cationic is used to eliminate Cations (Mg and Ca) in water, simultaneously reduce alkalinity of water. Use this method to treat underground water and surface water with suspending substance content not over 5-8 mg/l and coloured level not bigger than 15 TCU.
Process of softening water must be carried out according to following diagrams:
Arranging Hydro Sodium Cationic filter tanks works in parallel allows to get softening water with hardness ≤ 0.1 mgdl/l and remaining alkalinity not over 0.4 mgdl/l. In this case, total content of Sulfate and Chloride in source water cannot

be bigger than 4 mgdl/l and Sodium cannot be bigger than 2 mgdl/l.

Arranging Hydro-Sodium Cationic filter tanks works in series when reconstituting unabsolutely allows getting absolute softening water and redundant alkalinity ≤ 0.7 mgdl/l.

Depending on softening level for arranging one or two degree Hydro-Sodium Cationic filter tank.

Note: Allow not put bivalent Sodium Cationic filter tank if it is un-necessary to soften absolutely or maintain pH of water in a determined limit.

6.290. Rate of water flow put into Hydro Cationic and Sodium Cationic filter tank when softening according to parallel diagram of Hydro-Sodium Cationic need define according to formula:

- Water flow put into Hydro Cationic filter tank:

$$q_{ht}^{H} = q_{ht}\frac{K-a}{A+K}\ (m^3/h) \qquad (6\text{-}55)$$

- Water flow put into Sodium Cationic filter tank:

$$q_{ht}^{Na} = q_{ht} - q_{ht}^{H}\ (m^3/h) \qquad (6\text{-}56)$$

Where:

q_{ht} – Effective capacity of Hydro-Sodium Cationic, m^3/h

q_{ht}^{Na} và q_{ht}^{H} - Effective capacity of Sodium Cationic and Hydro Cationic filtration, m^3/h.

K – Alkalinity of source water, mgdl/l

a- Necessary alkalinity of water after softening, mgdl/l

A- Total content of Anion of strong acid which exists in softening water (Sulfate, Chloride, Nitrate), mgdl/l.

Note:

1- Hydro Cationic filtration can be used as Sodium Cationic filter tank, therefore need to have to estimated the capability of reconstituting two, three Hydro Cationic pools by solution of salt for eating.

2- Calculating of filter tank and pipe must be according to two plans:

+ The first plan: Counting with maximum loading of Hydro Cationic filter tank, the maximum alkalinity K of water and minimum content of strong acid Anion (A).

+ The second plan: Counting with maximum loading of Sodium Cationic filter tank, the minimum alkalinity of water and maximum content of strong acid Anions.

6.291. Cationic volume W_H (m^3) in Hydro Cationic filter tank need to define according to formula:

$$W_H = \frac{24.q_{ht}^{H}(Co + C_{Na})}{n.E_{Lv}^{H}} \qquad (6\text{-}57)$$

Cationic volume W_{Na} (m^3) in Sodium Cationic filtration need to define according to formula:

$$W_{Na} = \frac{24.q_{ht}^{Na}.Co}{n.E_{lv}^{Na}} \qquad (6\text{-}58)$$

Where:

Co – Whole hardness of source water, gdl/m^3

n- Number of reconstituting filter tank per one day according to instruction at article 6.278.

E_{lv}^{H} - Exchanging capacity of Hydro Cationic, gdl/m^3.

E_{lv}^{Na} - Exchanging capacity of Sodium Cationic, gdl/m^3.

C_{Na} – Concentration of Sodium in water (gdl/m^3) is defined according to instruction at article 6.288.

6.292. Exchanging capacity E_{lv}^{H} gdl/m^3 of Hydro Cationic must define according to formula:

$$E_{lv}^{H} = a_H . E_{tp} - 0.5 q_{lv} . C_K \qquad (6\text{-}59)$$

Where:

a_H – Coefficient of performance reconstituting of Hydro Cationic, depending on unit flow of consuming acid and taken according to table 6.26.

C_K- Total content of Cations of Calcium, Magnesium, Sodium and Potassium (gdl/m^3).

q_{lv} – Unit flow of Cationic washing water after reconstituting, taken as 4-5 m^3 for 1 m^3 Cationic in the filter tank.

E_{tp} – Exchanging capacity of Cationic is according to ex-works datum in neuter environment gdl/m^3. In order to calculate E_{tp} when there is no ex-work datum must take according to instruction at article 6.279.

Table 6.26

Unit flow of acid sulfuric to reconstitute Cationic (g/gdl)	50	100	150	200
Coefficient of performance reconstituting Hydro Cationic α_H	0.68	0.85	0.91	0.92

6.293. Filter tank areas of Hydro Cationic and Sodium Cationic F_H (m^2) and F_{Na} (m^2) are defined according to formula:

$$F_H = \frac{W_H}{H}; \qquad F_{Na} = \frac{W_{Na}}{H} \qquad (6\text{-}60)$$

Where: H – Height of Cationic in filter tank taken according to instruction at article 6.280.

6.294. Calculation and structure of distribution in filter tank must take according to 6.109 and 6.113.

6.295. Pressure loss in Hydro Cationic filter tank, cultivating intensity and filtration speed need take according to articles 6.281; 6.283 and 6.285.

6.296. Number of Hydro Cationic and Sodium Cationic filter tank for one station cannot be fewer than 2 if the station operates all day and night. Take one spare Hydro Cationic filter tank if number of filtration stations is fewer than 6 and take two spare pools if number of filter tanks in the station is bigger than 6. Sodium Cationic filter tanks do not need spare pool but must prepare capability of using spare Hydro Cationic filter tank to make Sodium Cationic pool according notation at article 6.290.

6.297. Reconstituting Hydro Cationic filter tank by solution of acid Sulfuric 1-1.5%. Allow to dilute acid Sulfuric to the above concentration by water taken directly

from filter tank.

Flow speed of acid sulfuric solution to reconstitute through Cationic layer which cannot be smaller than 10m/hr, after that wash Cationic by water which has not been softened from the top down with speed 10m/hr.

Washing process is finished when acidity of filtered water is equal to total concentration of Sulfate and Chloride in washing water. The first half of washing water for letting into neutral pool, then letting to rain-water drain, the remaining part is let into pool for cultivating Cationic.

Note: Allow to use Chlohydric acid to reconstitute Hydro Cationic.

6.298. Acid amount (kg) with concentration 100% which uses for one time of reconstituting Hydro Cationic must count according to formula:

$$P_H = \frac{f.HE_{lv}^{H}b}{1000} \qquad (6\text{-}61)$$

Where:

f- Area of one Hydro Cationic filter tank (m^2)

b- Acid amount to reconstitute Cationic (g/gdl) depends on hardness of softened water, defined according diagram of figure H-6.7

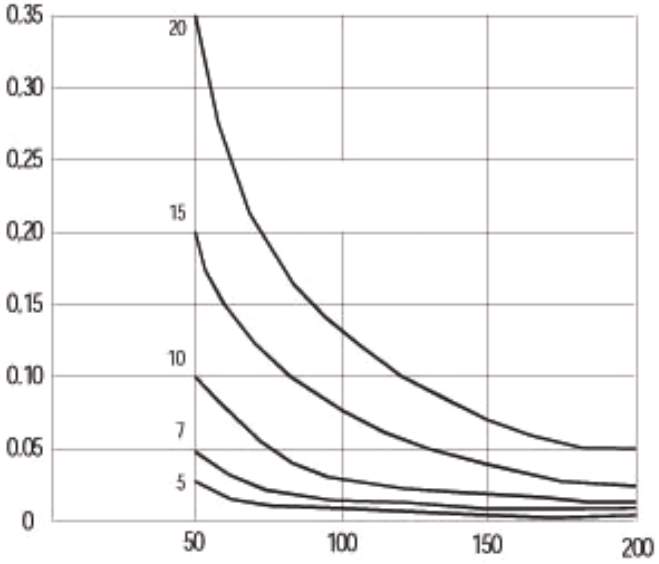


Fig. H-6.7 Diagram for defining hardness of water when soften by H-Cationic

Comsuming amount of H_2SO_4 counted by mg for 1 mgdl of Cations Ca^{++}, Mg^{++}, Na^{+} which were absorbed

6.299. Capacity of concentrated acid container and dilute acid solution tank (if not dilute directly in front of filter tank) must define from the condition of reconstituting one filter tank when number of Hydro Cationic filter tanks of the station is 4 and in order to reconstitute two pools when number of pools is up to 4.

6.300. Equipment and pipelines for quantifying and leading acid must design according to working safety norm when working with acid.

When using acid Sulfuric, equipments and conduits for it must use acid-resistant one.

6.301. Eliminate CO_2 in softened water by Hydro Cationic method or Hydro Sodium Cationic mixed method must carry out in air eliminating pools.

6.302. Horizontal section area of air eliminating pool must define according to irrigating for pool with piled wood floor is 40 m^3/h per 1 m^2 pool area.

6.303. Blower of gas eliminating pool must ensure to supply 20 m^3 air for 1 m^3 water putting into for eliminating gas. Define pressure of blower must base on resistance force of wood floor, resistance force is taken as 10mm water column for 1m height of wood floor. Other resistance forces are taken as 30-40mm water column.

6.304. Material layer height necessary to reduce content of CO_2 in water which was filtered through Cationic need to be defined according to table 6.27 depending on amount CO_2 (mg/l) of water for eliminating and is defined according to formula:

$$CO_2 = CO_2ng + 44K \qquad (6\text{-}62)$$

Where:

CO_2 ng- Free CO_2 amount of source water for eliminating (mg/l).

K – Alkalinity of source water mgdl/l.

6.305. When design the works of softening water by Hydro-Sodium Cationic filter tank putting in series and reconstitute un-absolutely for Hydro Cationic filter tanks, then taking following norms:

a) Harness of filtered water: C_L^H mgdl/l through Hydro Cationic pool is defined according to formula:

$$C_L^H = \left(Cl^-\right) + \left(SO_4^{2-}\right) + K_d - \left(Na^+\right) \qquad (6\text{-}63)$$

Where:

Cl^- and SO_4^{2-}: Content of Chloride and Sulfate in softened water (mgdl/l).

Kd: Remaining alkalinity of filtered water behind Hydro Cationic pool is equal to 0.7 -1.5 mgdl/l.

(Na^+): Na content in softened water (mgdl/l)

b) Acid amount for un-absolute reconstitution of Hydro Cationic filter tank is 50g to separate 1 gdl Carbonate hardness.

c) Exchanging capacity of Cationic in Hydro Cationic filter tank when reconstitute un-absolutely is:

- When alkalinity of source water is to 1.5 mgdl/l: 200gdl/m^3
- When alkalinity of source water is from 1.5 – 3 mgdl/l: 250gdl/m^3
- When alkalinity of source water is from 3 – 4 mgdl/l: 300gdl/m^3

Taleb 6.27

CO_2 content in water for eliminating gas, mg/l	Height of material layer in gas eliminating pool (Wood or plastic bar)
50	4
100	5.2
150	6
200	6.5
250	6.8
300	7

6.306. Water after going through Hydro Cationic filter tank (when reconstitute un-absolutely) must go through gas eliminating frame, after that go through Sodium Cationic filter tank designed according to instruction at articles 6.278-6.280

In this case, Ctp at formula (6-54) must take as C_{l}^{H} according to formula (6-66).

6.307. In order to prevent acid falling down Sodium Cationic filter tank in the stations where placing Hydro Sodium Cationic filter tank to work in series, when reconstitute Hydro Cationic filter tank with redundant dosage of acid, need put more pure water which has not be softened into filtered pool of Hydro Cationic pool right before gas eliminating pool.

6.308. Pipeline equipments and spare parts of water softening works with touching acid water or ferrous filtered water, includes of when Iron content is in standard, must be protected from corrosion or made of corrosion resistance materials.

DESALT AND ELIMINATING SALT IN WATER

6.309. Desalt for water with salt content under 2 g/l should use ion exchanging method. Water with salt content 2-10 g/l should use electrolysis method or filter through reverve osmosis membrane. Water with salt content bigger than 10 g/l must use method of distillation, freezing or filter through half-osmosis membrane.

Note: Desalting means reducing content of salt in water to the numeric value which meets requirement for water for eating and drinking. Desalting means reducing absolutely salt amount dissolved in water to the numeric value which meets requirement of manufacturing technology.

DESALT AND ELIMINATE SALT IN WATER BY ION EXCHANGING METHOD

6.310. Use ion exchanging method to desalt and eliminate salt when salt content in source water under 2000 mg/l, sediment content is not bigger than 8mg/l, coloured level of water is not bigger than 15TCU and oxygenated level $KMnO_4$ is not bigger than 7 mg/l O_2. When oxygenated level is bigger, must filter through active coal in advance.

6.311. Desalt by ion exchanging method need carry out according to one degree diagram. Filter in series of Hydro Cationic filter tank has ion exchanging capacity is weak alkali Anionic filter tank. Use this diagram need eliminate Carbonic gas out of water filtered through Cationic pool. Remaining salt content in water after having filtered through Ionic filter tanks need take as follows:

- When salt content in source water 2,000mg/l: Not bigger than 20 mg/l.
- When salt content in source water 1,500 mg/l: Not bigger than 15mg/l.
- Salt content required for water supplying demand of daily living, eating and

drinking is 400 mg/l; in that content of Chloride is not bigger than 250 mg/l and Sulfate is not bigger than 250 mg/l, can get by mixing one part of water filtered through Ionic filter tanks with content of remaining source water.

6.312. Eliminating salt in water simultaneously eliminating acid silic must be carried out according to two or three degree diagram. In composition of salt eliminating station according to two-degree diagram need prepare following works:

- First degree Hydro Cationic filter tank; filter tank of active coal to eliminate organic substance (if coloured level of water is bigger than 15 TCU and oxygenated level is bigger than 7 mg/l O_2); gas eliminating frame for eliminating Carbonic; first degree Anionic filter tank with filtration material of weak alkali Anionic.
- Second degree Hydro Cationic: second degree Anionic filter tank with filtration material of strong alkali Anionic for eliminating acid Silic and finally go through Hydro Sodium Cationic filter tanks.

6.313. Water after treating according to two-degree diagram contained amount of salt bigger than 0.5 mg/l and content of acid Silic cannot be bigger than 0.1 mg/l.

6.314. Three-degree salt eliminating diagram is used when total salt content in water after treating under 0.1 mg/l and acid Silic content under 0.05 mg/l. In that time change Hydro Sodium Cationic filter tank in two-degree diagram by filter tank with mixed material of Cationic and Anionic or by third degree Hydro Cationic filter tank and behind this filter tank is third degree Anionic filter tank with strong alkali Anionic.

6.315. Counting first degree Hydro Cationic filter tank must be according to instructions at items 6.291-6.300. Content of Cation Ca^{2+} and Mg^{2+} in water after filtering through first degree Hydro Cationic filter tank defined according to diagram of Fig. H-6.7. In that time, Na^{+} content is taken as two times of content of Cation Ca^{2+} and Mg^{2+}.

6.316. When choose adsorbing material to eliminate organic substance, for each detailed source of water must carried out according to research's result for technology of adsorbent substances.

6.317. For second and third degree Hydro Cationic filter tank, need take calculating parameters as follows: filtration speed 50-60 m/hr. Height of filtration material layer = 1.5m. Unit consuming amount for Sulfuric acid with concentration 100% - 100 gram for 1gdl absorbed Cation. Adsorbed capacity of ion exchanging substance is taken according to datum of manufacturer. Consuming water amount for washing Cationic: 10 m^3 for 1 m^3 Cationic.

6.318. Filtration area F of Anionic filter tank (m^2) must define according to formula:

$$F = \frac{Q}{nTVt} \qquad (6\text{-}64)$$

Where:

Q- Capacity of first degree Anionic filter tanks, m^3/day

n- Number of reconstitution for Anionic filter tank per day taken as 2-3 times.

T- Working time of each filter tank, between two times of reconstitution calculated according to formula:

$$T = \frac{24}{n} - t_1 - t_2 - t_3 \qquad (6\text{-}65)$$

- t_1- Time for cultivating Anionic = 0.25h
- t_2- Pumping time through alkali solution Anionic for reconstitution 1.5hr.
- t_3- Anionic washing time after reconstituting 3hr.

- Vt- Calculated filtration speed m/hr, taken not smaller than 4 and not bigger than 30.

Anionic volume in first degree filter tank W_1 m^3 is defined according to formula:

$$W_1 = \frac{QCo}{nElv} \qquad (6\text{-}66)$$

Where:

Co- Content of ions Sulfate and Chloride in source water mgdl/l.

Elv- Anionic exchanging capacity gdl/l taken according to the ex-factory documents.

6.319. In order to reconstitute first degree Anionic filter tank use Soda solution 4%. Unit consuming amount of Soda: 100g Na_2CO_3 for 1 gdl adsorbed Anion. At the stations of eliminating salt and acid Silic simultaneously, in second degree filter tanks, there are strong alkali Anionic which allow to reconstitute for first degree Anionic filter tanks by caustic solution reused after reconstituting for second degree Anionic filter tanks.
Must dilute Soda and caustic solution to reconstitute by water which went through Hydro Cationic filter tank.
Washing first degree Anionic filter tank after reconstituting by water filtered through Hydro Cationic filter tank with flow 10 m^3 for 1 m^3 Anionic.

6.320. Filtration material of second degree Anionic filter tank need use strong alkali Anionic with filtration layer thickness is 1.5 m. When calculating Anionic filter tank, its filtration speed need take as 15-25m/hr.

6.321. Acid Silic exchanging capacity of Anionic is taken according to the ex-work documents of the manufacturer.
For strong alkali Anionic, reconstitute by caustic solution with concentration 4%.

6.322. Unit consuming amount of caustic (NaOH) for reconstituting strong alkali Anionic taken from 120-140 kg for 1 m^3 Anionic.

6.323. Equipments, conduits and spare parts of salt eliminating station must design suitably to instructions at article 6.308.

6.324. Can eliminate salt by electrolysis method.

SPECIAL WATER TREATING METHOD

6.325. In order to eliminate Sulfur (H_2S) and Hydro Sulfide (HS^-) in water, need use following methods: Chlorination, ventilation, and then Chlorination, acidification, ventilation, agglomerating and filtration. Calculating equipments must carry out according to Annex 11.
In order to eliminate mixtures of acid Silic in water, need use following methods: agglomerating, filtrating water through adsorbent of Oxide Magnesium. Calculating equipments according to instruction at Annex 12.
In order to eliminate Oxygen dissolved in water, need use following methods: spraying water in vacuum. Associating Oxygen and reducing agent. Calculating equipments as instruction in Annex 13.

6.326. <u>Reducing Arsenic in water</u>

Oxygenating the whole amount of trivalent (III) Arsenic into pentavalent (V) Arsenic by strong oxidizing agent. After oxidizing process, can apply one of following methods to eliminate Arsenic.

- Agglomerating with ferrous salt and aluminum salt at pH =7 and then deposit and filtrating.
- Combine to process of softening water by lime and must ensure the whole flakes of sediment Magnesium precipitate and adsorb Arsenic settled and filtered out of water.
- Adsorbed Arsenic (V) by filtration method through active aluminum adsorbent material layer.

In any case also must carry out to test on testing model to be able to choose the most economic – technical process.

6.327. Eliminate ammonium

Can eliminate ammonium in water by physiochemical or biological method.

a- Physiochemical method:

- Use Chlorine to oxygenate NH_4^+ to one mutation point. This method is only applied when content of NH_4^+ and oxygenated level in water is small.
- Alkalify to put pH of water up to 11 in order to transfer the whole NH_4^+ into NH_3 gas and then ventilating and eliminating NH_3. This method is only applied when water has high ammonium content and simultaneously has to eliminate carbonate hardness of water by lime.
- Ion exchanging: Filter through Cationic pool. Reconstitute by salt for eating.

b- Biological method: biological treating process must carry out at conditions: water temperature > 12 ^oC; pH = 7-7.5; in water it is unable to have oxidizing agent; content of hydrocarbon and phosphate is enough to bring up bacteria Nitrosomonas and Nitrobactert. Must supply enough oxygen for biological treating process of transferring NH_4^+ into NO_3^- carry out absolutely. Type of material, composition of supplying and co-ordinating material to be environment for becteria's activity; rate of gas – water; dosage of chemicals putting into water; technological, technical parameters of works need be defined through experiment.

6.328. Eliminate Nitrate

Can carry out to eliminate Nitrate by biological or physiochemical method.

a- Physiochemical method: Eliminate Nitrate by ion exchanging method, electric osmosis separating and filtrating through reverse osmosis membrane. Ion exchanging method is usually applied in fact with following conditions:

- Water with sediment content < 1 mg/l.
- Content of SO_4^{2-} in water is low.

b- Eliminate Nitrate by biological method: kinetics of the process is very slow. Should only apply when water has big NO_3^- content or content of SO_4^{2-} in water is high.

CHEMICAL STORE AND FILTRATION MATERIAL

6.329. Chemical store must calculate to store chemical amount prepare for 30 days according to on the period of the most using chemicals.

Note:

1- When there is suitable reason, allow reducing the quantity of store but cannot be lower 15 days.

2- When there is central store (main store), then store quantity of cleaning station

allow counting at least 7 days.

6.330. Depending on type of chemicals, the store must be designed for dry or wet storing under the form of concentrated solution or products diluted with water.

6.331. Spare chemicals in dry form must contain in the hermetic store.

When define store area for containing alum, lime, the height of alum layer takes as 2 m, of lime layer takes as 1.5 m. If mechanize the height, can increase to 3.5 m for alum, 2.5 m for lime.

Polyacrylamid must be contained in barrel, the time is not over 6 months, simultaneously can not allow for coagulation.

Liquid glass (Silicate Sodium) must be contained in wooden of steel hermetic barrel.

Chemicals containing Chlorine must put into hermetic barrel.

6.332. When store wet alum in the pool, concentration of solution takes 15-20% counting according to dry product. No need to stir solution in the pool. Alum pool must put indoor, when there is suitable reason, permit putting outdoor. In each case must ensure to be tended and there is travel way around the wall of pool and must prepare method of resisting on the probability that solution infiltrates into the land. Pool capacity is counted on 2.2-2.5 m^3 for 1 tons lump alum at commodity form and 1.9-2.2 m^3 for 1 ton at pure form.

Number of pools cannot be below 4. When number of pools is to 10, must have one spare pool.

6.333. When can supply concentratively slaked lime or milky lime, must estimate wet store which includes of: containing pool, equipments for taking and transporting lime.

If supply lime at lump form or powder lime packed in hermetic bags, then can store at dry or wet form. If store at dry form, must design dry product store with machine of slaking and dissolving lime; if store at wet form, must have containing pool, equipments for taking, transporting and stirring to get milky lime.

When stirring by hydraulic, then pump capacity is defined on the base that circulate the whole amount of lime milk not below 8 times per hour, going-up speed of lime milk in the pool is not under 18m/hr.

Compressed air supplying system must calculate on article 6.22.

Allow to apply mechanical mixing method.

6.334. For booth with containing active coal, no have requirement of explosion resistance, and this booth is graded the third class of fire fighting level.

6.335. Store for Cationic and Anionic must calculate with quantity enough to contain for two Cationic filter tanks, for one weak alkali Anionic filter tank, for one strong alkali Anionic filter tank.

6.336. Chemicals store (except for Chlorine and Ammonia) must put near solution diluting booth.

6.337. Stores for spare acid, stores for consuming Chlorine and Ammonia must design according to specific regulations.

6.338. If store for consuming Chlorine is put in range of water factory, the Chlorine must be contained in bottles or pots. When daily using amount of Chlorine is over 1 ton, allow using big barrel made by manufacturer with capacity to 50 tons, simultaneously prohibit pouring Chlorine into bottles or pots at the water treating area.

6.339. Chlorine guiding pipe must be calculated as long as pressure reducing level exceeds 1.5-2kg/cm^2. Transport Chlorine at steam form from the store to using places by conduits with their length not over 300m.

6.340. Chloride lime must be contained in wooden barrel at specific store.

6.341. For eating salt, must have wet store. If daily using amount of salt is under 0.5 ton, allow using dry store with salt layer height not over 2m.
Capacity of wet store must calculate with condition of 1.5 m^3 for 1 ton salt. Containing tank can not be deep over 2m.

6.342. In case not ensure supply filtration material and gravel rightly according to required time, must design one specific store for storing, classifying, washing and transporting material to supplement and store in the period for big amendment.

6.343. Calculating store for filtration material and choosing equipment must base on from yearly requirement for supplement 10% filtration material quantity and one more storing amount for preventing troubles in order to replace for one filtration when number of filter tanks in the station is to 20 and for 2-3 filter tanks when number of filter tanks in bigger station.

6.344. When transporting filtration material by hydraulic method (ray pump or sand pump), then water flow is taken as 10 m^3 for 1 m^3 filtration material.
Diameter of conduits for transporting filtration material must define according to moving speed 1.5-2 m/s but not smaller than 50mm, turning places of pipe must bend regularly with bending diameter not smaller than 8-10 times of pipe diameter.

REUSE WASHING WATER

6.345. In order to reduce water amount using for demand of the only treatment station need reuse washing water of filter tank, touching filter tank and water part in the deposit pool when discharge out of deposit pool.

6.346. At the water treating station applying to diagram of settling and then filtrating must gather water for washing filter tank into one conditioning pool and then pump regularly into the beginning point of mixing tank.

6.347. In water treating stations which only use filter tank, then must cleaning washing water by settling tanks which operate cyclically. Settling time takes 1 hr, dosage of auxiliary agent for agglomerating (activating acid Silic or Polyacrylamid) take as smaller than dosage when treating water with coloured level and as bigger when treating opaque water.

6.348. Capacity of conditioning tank and numbers of settling compartment must be defined according to diagram of concentrating washing water into the tank and pump washing water into the works. If factory does not use Chlorinating before, then must disinfect washing water when reuse them. Volume of sediment compressing area is taken according to table 6.8, article 6.68.

6.349. In Ion eliminating stations, washing water is filtered before putting into settling tank made up alum, mixing regularly and then pumping into settling tank. Dosage of alum is defined according to testing result. Depositing time take not less than 3 hours. Defined numbers of settling compartment depend on number of filter tanks and cycles of washing filter tank. Volume of each defined compartment from water gather condition of one time washing, after settling must reuse purified water by pumping regularly into the beginning point of purifying work.
Volumn of sediment compressing compartment need define according to Iron content in source water and sediment concentration after compressing. Iron sediment has concentration after compressing is 35,000 g/m^3 when applying ventilating diagram and is 7000 g/m^3 when treating by chemicals.

6.350. In order to gather sand drifted out of filtration tank or touching filtration tank when washing, on system of gathering washing water must put sand settling tank, calculating settling tank takes according to instruction in standard of water

draining design.

6.351. Sediment from settling tank or pure tank with suspending sediment, sediment from system which reuses washing water must be put into the work for storing and condensation. Must use pump for pumping sediment into drying part or mud drying ground. Sediment speed in pipeline cannot be smaller than 0.9m/s.

AUXILIARY WORKS IN THE WATER TREATMENT STATION

6.352. It is necessary to have laboratory, repairing workshop and other serving works in the water treatment station. Standard area for each works takes according to capacity and local condition and can choose according to table 6.28.

Note:

1) Living houses and other public works such as: Administration, financial, plan, technical, club, refectory, temporary house, kindergarten, rest-room, etc. Depend on number of managing people to take according to the current design standards for civil architectural works.

2) In the city where there are many stations of water treatment, then laboratories and construction test at the most convenient station, but in each station must have at site testing room with area not smaller than 6 m^2.

3) If in the city there are many stations of water treatment, only need to build one mechanical workshop and common pipeline, in the station there is mechanical workshop and common pipeline, then no need build daily repairing workshop.

4) In case treatment stations has capacity smaller than 3,000 m^3/day are built near local medical organ, if the local medical organ can undertake water testing, then the station no need to build testing room.

6.353. Administration rooms, other rooms for activities should arrange outside of treatment station. In case it can not arrange at the outside, then should arrange indoor near the gate of station and apart from manufacturing area.

Table 6.28

Name of works	Area (m^2) of testing room and other auxiliary works for water treatment stations with capacity counted by m^3/day.				
	Under 3,000	3,000 to 10,000	10,000 to 50,000	50,000 to 100,000	100,000 to 300,000
Chemistry test room	30	30	40	40	2 rooms of 40 and 1 room of 20
Scale placing room	-	-	6	6	8
Microbe test room	20	20	20	30	2 rooms of 20
Room for culturing environment and researching aquatic beings	10	10	10	15	15
Room for storing tool, bottles and test chemicals	10	10	10	15	20
Centralized control room	Define according to design of centralized control and automation				
Shift watching room	8	10	15	20	25

Manager room	8	10	15	15	25
Repairing workshop	10	10	15	20	25
Mechanical and pipeline workshop	20	30	30-40	40	40-50
Guard room of gate and fence	8	10	10	15	20

ARRANGING ALTITUDE OF WORKS

6.354. Works must place according to natural sloping level of terrain with calculating pressure loss in the works, in connecting pipes and through measure instrumentations.

6.355. Numeric value of difference of water level in works and in connecting pipes must define according to detailed calculation to arrange preliminarily altitude of works, pressure loss can take as follows:

In the works:

Flow division tank: 0.3-0.5 m

In hydraulic mixing tank: 0.4-0.6 m

Mechanical mixing tank: 0.1-0.2 m

Drum-barrel net and microfilm 0.5-0.6 m

Rotary net: 0.1-0.2 m

In hydraulic flake creating tank: 0.4-0.5 m

In mechanical flake creating tank: 0.1-0.2 m

In settling tank: 0.4-0.6 m

In settling tank with suspending sediment: 0.7-0.8 m

In filter tank: 3-3.5 m

In touching filter tank: 2-2.5 m

In slow filter tank: 1.5-2 m

In connecting pipelines:

From water division tank to mixing tank: 0.2-0.3 m

From mixing tank to settling tank: 0.3-0.4 m

From mixing tank into touching filter tank: 0.5 m

From mixing tank into touching filter tank: 0.5-0.7m

From filter tanks to pure water containing pool: 0.5-1m

From filter tank or touching filter tank to pure water tank: 0.5m, pressure loss in measuring equipments at the point of water coming into and the point of water going out of the station, in equipments only measure flow of settling tank, settling tank in that has suspending sediment layer, filter tank and touching filter tank take from 0.2-0.3 m.

6.356. In the water treating station must design pipelines going around the treating works, prevent for case the station wrong, can transfer raw water to consuming source, or when there is any work in the treating line wrong can transfer water go around it to the next work. For the station with capacity under 10,000 m^3/day must estimate capability of stopping not bigger than 30% number of works. For the station with capacity of 10,000-100,000, not bigger than 20%.

6.357. The pipeline with or without pressure in the water treating stations and the pipeline with pressure placing in station area must use steel pipe or casting iron pipes.

6.358. Waste water with acid in Cationic stations or chemical house before discharging into containing lake must be neutralized.

6.359. Waste water of laboratories, managing houses, rest-room, etc. discharge into draining system of living waste water.

7. PUMPING STATION

7.1. In machine compartment of pump station can place group of machines with different purpose.

Note: In the pump station of living water is unallowed putting pump for toxic solution with bad odour, except for case of using pump supplying solution of creating foam for fire fighting.

7.2. Depend on safety level can divide the pump station into three types according to table 7.1

Table 7.1

Confidence degree of pump station	Properties of household using water
Type 1	Cannot stop supplying water; water supplying system specific for fire fighting and combined fire fighting system.
Type 2	Allow to stop supplying water in short time for operator open spare machine. When specific fire fighting system and combined fire fighting system has enough spare capacity of water for fire fighting and has enough necessary pressure. For pump station supplying water for resident area with size over 5,000 persons
Type 3	Allow to stop supplying water to overcome breakdown, but cannot be over 1 day. For specific fire fighting system and combined system has requirement of water for fire fighting to 20 l/s in resident area with size up to 5,000 persons. System of supplying living water for resident area up to 5,000 persons. Supplying water for irrigating plants and washing roads. Supplying water for auxiliary works of factory. When loading water by one unique pipeline.

Notes:

- For pump station with defined degree, safety degree of supplying electric power is also taken according to "Regulations of arrangement for electric equipments" article 12.1.
- Pump stations for fire fighting are designed according to Fire preventation and fighting standard (TCVN 2262-1995).
- Pump stations of supplying water for serving industry, design according to specific requirement of manufacturing.

7.3. Choosing pump type and number of operating machine group must base on calculation of simultaneous operation of pump station, conduits of factory and conditioning capacity, must base on daily and yearly water consuming diagram, fire fighting condition, optimal working rule of pump and operating stage of water supplying works.

When choose type of pump combination must ensure minimum redundant pressure value in all of working rule of pump station, allow using conditioning

capacity, adjusting number of rotary circles, change number and type of pump, whittle out ỏ change working wheel depend on modification of working condition in calculated period.

7.4. Combining between the first and second turn of pump station. In general, pumps for fire fighting, wind pumps and pumps for washing and filtrating should be arranged and combined in the second turn of pump station. Wind blower for eliminating iron is usually put near the forced iron eliminating barrel.

7.5. When design the stations need have to estimate capability of increasing of the station by replacing pumps with bigger capacity or equip more additional pumps.

7.6. Number of spare pump in water supplying stations (for pumps with same function) for one network or conduits chosen according to table 7.2.

Table 7.2

Number of operating machine team of one machine group	Number of spare machine team putting in the pump station		
	Confidence degree I	Confidence degree II	Confidence degree III
Up to 6	2	1	1
From 6 to 9	2	1	-
From 9 and over	2	2	-

Notes:

1) In some operating machine teams including of pump for fire fighting. Number of operating machine teams of one machine group, except for pump for fire fighting, cannot be lower than 2. In second and third degree pump station when there is the base which allows arranging one machine team.

2) When in one of machine group there are different properties, then the number of spare machine teams is taken according to machines with big capacity same as in table 7.2; for the machine with small capacity, allow putting spare pump in the store.

3) When pump station only has function of fire fighting or in living pump station with fire fighting system combine high pressure, then put more one spare machine team for fire fighting, not depend on number of operating machine team.

4) Allow not to put spare pump for fire fighting for resident area with fire fighting demand ≤ 20 l/s and for industrial enterprises with dangerous level for fire resistance type D and Z, for industrial building of fire fighting grade I and II, with inflammable roof, wall and partition wall.

5) In the first turn pump station build and combine to the receiving work with confidence grade II and III, with number of operating machine team is 4 and above, then number of spare machine team must reduce 1.

6) In the second degree pump stations, when number of pumps from 10 and above, allow let one of number spare machine in the store.

7) For pump station supplying water to resident area with population up to 5,000 persons, when there is electric power supply source, then allow putting pump for fire fighting with internal combustion motor.

8) For pump station of drilling well with using vertical axial pump or pump with sinking motor. When there is spare well (including of pump), then no need spare pump.

9) If pump station need supply water continuously, then for pumping filtered washing water, must put two washing pumps, one operating pump, one for spare.

7.7. Minimum width of traveling way between the protruding parts of pump, pipeline and motor cannot smaller than:

- Between machine teams that have voltage smaller than 1000V: 1m; have voltage over 500V: 1.2m.
- Between machine team and the wall of sunk pump station: 0.7m
- Other pump stations: 1m.
- Between air compressors: 1.5m
- Between machine teams and distribution panel: 2m
- Between movable parts of thermal engine: 1.2m
- Between the protruding parts and non-moving part of equipment 0.7m. For pump with electric motor smaller than 1000V and diameter of pushing pipe ≤100mm and permitted spare parts and equipments:
- Place machine team close the wall, there is no space between machine team and the wall, put two machine teams on the same platform but must have travel way around machine, with minimum width 0.7m. When defining size of machine compartment, need calculate area to mount and dismount pump.
- In order to reduce size of pump station on the plane, allow arranging machine with left and right rotary axis but working wheel can only move award one direction.

7.8. Covering structure for pump station should make firm by brick, concrete for protruding part out of the ground; underground part can be made by brick or concrete, depend on geological situation, hydrography geology and work size to design. When design pump station under underground water level or the highest water level of river and lake, then must have waterproof method for the bottom and the wall of pump station. Material layer of waterproof must be higher than the upper water level is 0.5m. Pump stations must both have method of draining water inside of the station by manual or mechanical. Face of pump platform must be higher than face of pump station foundation at least 0.2-0.3m.

7.9. Pumps axes should put according to regulation from automatic ignition condition (counting to the top of pump):
For containing tank:

- Counting from the highest water level of fire fighting capacity for a fire.
- Counting from medium water level of fire fighting capacity for two fires and above.
- Counting from spare water level for breakdown when that is not fire fighting.
- Counting medium water level when it is unnecessary to do fire fighting and use breakdown spare water amount.

For drilling well:

- Counting from moving water level when exploit with maximum flow.

For rivers, lakes:

- Counting from the lowest water level in rivers and lakes, depending on confidence degree of water taking works.

- When define height of pump axis must count to the permitted vacuum attracting height (counting from the lowest calculating water llevel) or necessary water column from attracting side according to manufacturer, as well as must count to pressure loss in the attracting pipeline, temperature condition and outside pressure.

Notes:

- In second and third degree allow arranging pump without automatic ignition, but must have method of igniting water for pump (take directly from general pushing pipe of one group pump, take directly from filter tank, use ignition water barrel putting in the pump station or use water tower, use vacuum pump).
- Foundation altitude of pump putting compartment of sinking pump stations should define from arrangement of pumps with big capacity or size.
- In the pump stations with the second confidence degree it is allowed putting the attracting head on the attracting pipeline with diameter up to 200mm.

When the pump station has bigger capacity, then must use vacuum pump and no need put the attracting head. Maximum water ignition time is 5 minutes on rule. For pump of fire fighting is 3 minutes. For pump with working uncontinuously (type 2, 3) is 10 minutes.

7.10. The height of pump putting compartment without lifting equipment takes at least 3m. If there is lifting equipment, then define according to calculating ensure the distance from the bottom of lifted object to the top of equipments putting below cannot be smaller than 0.5m.

7.11. In and out door size of pump station must be wide enough to move equipments and machineries in and out easily. Pump station need arranging many windows to take natural light and good ventilation. When necessary, can arrange man-made ventilated system to ensure temperature in pump station not bigger than 37^{o} – 40^{o}C.

7.12. Base on the most heavy weight of pump parts or electric motor, the pump station need be equipped following lifting equipments:

- When the weight from 0.2-0.5T: use movable three-claw post
- When the weight from 0.5-2.0T: use tackle with rail by manual or electric
- When the weight from 2.0-5.0T: use hanging type electric bridge
- When the weight bigger 5.0T: use electric bridge

7.13. When number of pump putting in the station bigger than 3 (includes of working pump and spare pump) if use general attracting pip, then number of attracting pipes cannot be less than 2 and should put two general pushing pipes. Morever, must ensure calculating water amount of the station, attracting pipe of pump need have minimum sloping level i=0.005 high toward to the pump. At the position of changing pipe diameter, need set taper oblique.

7.14. Choose diameter of pipe and spare parts must base on speed of running water in the pipe according to table 7.3.

Note: Allow to change speed not over 20% for pump to work suitably to requirement.

7.15. On the pushing pipeline of the pump must put cut-off valve and one way valve. Position of one way valve put between the pump and cut-off valve.

On the attracting pipeline, cut-off valve need put in case of automatic ignition pump or pumps connecting to general attracting pipe.

Table 7.3

Pipe diameter (mm)	Speed of running water in the pipe putting in the pump station (m/s)	
	Attracting pipe	Pushing pipe
Under 250	0.6 – 1.0	0.8 – 2.0
From 300–800	0.8 – 1.5	1.0 – 3.0
Bigger than 800	1.2 – 2.0	1.5 – 4.0

7.16. Arrange spare parts on pushing pipe and attracting pipe must ensure probability of any replacing or repairing for pumps, one-way valve as well as other spare parts but still can deliver 70% water flow to living demand for the first and second confidence pump station, and 50% flow for the third confidence pump station.

7.17. The pipeline inside of the pump station should be made of steel pipe with connecting flange and must put on pillow; if the pump station has small capacity allow using cast-iron pipe. Must paint to protect pipes and spare part in range of pump station before putting into using. Attracting and pushing pipelines of pump can put protrusively on the floor or in the gully with cover which can mount or dismount easily. Not allow putting pipe underground of the pump platform. When putting pipe in the gully, must have sloping level toward water collecting hole. Size of gully must be wide enough to be able to mount or dismount easily, usually take as follows:

- For the pipe with diameter up to 400mm, then the width B = d + 600mm
  Height of gully H = d + 400mm
- For the pipe with diameter from 400mm and above, then B = d + 800mm
  Height of gully H = d + 600mm
- At the positions putting the hooks of connecting knot, then the width of gully takes according to article 8.47

Where: d is diameter of pipe putting in the gully counted by mm.

When the pipe go through the wall if in the dry soil, then use oil dipping jute and cement mortar filling full of the hole; if in wet soil must have method of intercepting water, absolutely not let water infiltrate through the hole of pipe into the pump station.

7.18. Pumps must be equipped: pressure-gauge, air release valve, etc. Big pumps must be equipped vacuum meter. In pump station need arrange devices of measuring flow, pressure, signals of water level in relevant works, electric cabinet or circuit breaker, etc.

7.19. Must put pump so that vacuum attracting height cannot exceed the permitted attracting height of chosen pump, with calculating to pressure loss in attracting pipe, temperature condition, specific pressure of water steam and don't let make out phenomenon of wear propeller. For axial pump need have supporting pillar at the direction of attracting face, must follow instruction of manufacturer when the pump works.

7.20. The way into pump station must spray stones or make asphalted road.

7.21. The depth of machine putting compartment (from surface of ground to foundation) is defined according to specification. When arrange equipments in machine compartment under the working floor or balcony must have traveling path with height not smaller than 2.0m.

7.22. In sinking and half-sink pump station must have flood-resistant method for machine teams when there is a breakdown in machine compartment for pump with big capacity as well as for valves and pipelines by:

- Put engine higher than foundation of machine compartment 0.5m;
- Discharge to run itself amount of water into water draining-out system when terrain condition allows;
- Use pump to pump water from collecting hole.

When necessary, arrange water draining-out pump for breakdown with capacity counted with pumping time less than two hours and the depth of water layer on foundation face 0.5m.

7.23. In order to drain out the leak water, floor and trench in pump compartment must design to have sloping level to collecting hole. When water cannot run itself from collecting hole to the outside, then must arrange to pump leak water.

7.24. In sinking pump station working according to automatic rule, when the depth of machine compartment is from 20 m and above, as well as in the pump station there is person which operates usually when the depth from 15m and above must consider to put elevator.

7.25. Allow arranging pump station with other works of water supplying system but must separate by inflammable component and have doors direct to the outside.

7.26. Not allow building force-resistant wall of the second turn pump station and circulation pump station on the wall of containing pool and collecting pit.

7.27. In pump station (not depend on automatic level) must arrange hygienic area (toilet for men and ladies), shift handing-over room and wardrobe for operators. When pump station is apart below 50m from the managing area (kitchen, hygienic area), allow not arranging specific hygienic area.

In the pump station of the well no need to have to arrange hygienic area.

7.28. Operation of pump must follow the technical management process. If let pump work but the valves on the pipeline have been opened in advance must base on the base of calculation with counting to properties of pump and engine and the capability of crashing water in the pipeline.

7.29. The pump station with compartment size for putting machine as 6x9m and bigger must arrange pipeline for fire fighting inside with flow 2.5 l/s.

In addition, it is necessary to consider and arrange:

Two foam type portable fire extinguishers for electric motor with voltage up to 1000V

Four foam type portable fire extinguishers for internal combustion engine with capacity up to 300 horsepower.

When electric engine has voltage over 1000V or internal combustion engine with capacity over 300 horsepower must add more two CO_2 fire extinguishers, water containing tank with capacity 250 litres.

Notes:

- Fire fighting muzzle should connect to pushing pipe of pump
- In the pump station of the well does not require to have to arrange fire fighting pipeline

7.30. In the pump station with internal combustion engine allow placing fuel containing pool with quantity as follows: petrol 250 litres, mazut oil 500 litres.

Fuel containing pool is placed apart from machine compartment by inflammable wall with fire resistant limit not smaller than two hours.

HYDRO-PNEUMATIC EQUIPMENTS

7.31. Hydro-pneumatic equipment is applied in case pressure is unstable, need condition pressure instead of big water tank.
When pressure is stable to put hydro-pneumatic equipment, must have full bases of calculation.

7.32. Minimum pressure numeric value in the containing pot of hydro-pneumatic equipment has variant pressure, must ensure to calculate in the network when water level in the containing pot is at the lowest level.

7.33. In hydro-pneumatic equipment with variant pressure, allow putting one set of air compressor with electric supplying source or use the same compressed air system of factory as long as cannot stop supplying compressed air.

7.34. Minimum and maximum pressure P (at) as well as total capacity of containing pot V (m^3) in case variant pressure is defined according to formula:

$$Vn = (t \times qb)/4 \quad (7\text{-}1)$$

Where:

t – time of one cycle for closing and opening pump

qb – flow of pump (pump into the pot and into the network)
If qb is counted by m^3/h then:

$$Vn = qb/(4z) \quad (7\text{-}2)$$

Where z: permitted number of times for opening machine per hour (6-30 times)
Volumn of pressurizing pot:

$$Vk = Vn/f \quad (7\text{-}3)$$

Where f is pressurizing coefficient:

$$f = (P_1 - P_2)/P_1 \quad (7\text{-}4)$$

a) P_1: maximum absolute pressure in the network, equal to required max. pressure + pressure of atmosphere (bar).

b) P_2: minimum absolute pressure in the network, equal to min. pressure + pressure of atmosphere (bar).

7.35. In order to ensure pressure unchanged in the water containing pot, must put adjusted valve on gas guiding pipeline connecting water containing pot and compressed air pot.

7.36. Number of air compressors in hydro-pneumatic equipment, in case pressure is stable, not smaller than 2, in that one set for spare. Number of electric power sources is defined according to confidence degree of the work.

7.37. Containing pot of hydro-pneumatic equipment must be equipped discharging pipe, safety valve, pressure-gauge. Water containing pot and air containing pot must have measuring equipment by hydrostatic, float valve to prevent compressed air fall into the network and water run into air compressor.

7.38. It is necessary to have to automate the working process of hydro-pneumatic equipment.

7.39. Hydro-pneumatic equipment putting in the house must isolate to other room by fire-resistant wall and have window opening directly to the outside.

7.40. The distance from the upper face of containing pot to the ceiling cannot be smaller than 1m. The distance between containing pots and from the containing pot to the wall cannot be smaller than 0.5m.

7.41. Containing pot of hydro-pneumatic equipment is calculated according to technical standard of the pots working with pressure.

8. CONDUITS, PIPE NETWORK AND FACILITIES IN THE NETWORK

8.1. Number of pipeline for transporting water must take with counting to confidence of water supplying system and sequence of construction is usually smaller than 2. Conduit's diameter and connecting pipe must design so that when happens problem on any section of pipeline, water flow going through still ensure at least 70% living water amount and one part of necessary industrial water, at that time need consider to salvage capacity of containing tank and spare pumps. In case there is only one pipeline, it is necessary to prepare water with full capacity to ensure 70% calculated amount of living water, one part of industrial water is necessary when happen breakdown; in addition need have a reserve of water for fire fighting and prepare suitable method of fire fighting

8.2. Necessary time to overcome the breakdown of pipeline of the first degree water supplying system takes instruction at table 8.1. for the second and third degree water supplying system, the values in the table rise up respectively á 1.25 and 1.5 times.

Table 8.1

Pipe diameter (mm)	Necessary time to overcome the breakdown on the pipeline (h) according to the depth of putting pipe (m)	
	To 2.0 m	Over 2.0 m
< 400	8	12
From 400-1000	12	18
> 1000	18	24

Notes:

- Depend on material of pipe, pipeline and conditions of putting pipe, existence of road, means of transportation, means for overcoming breakdown, the above time can change but cannot take less than 6 hours.
- Allow increase time for overcoming breakdown as long as time of stopping supplying water and reducing level of flow do not over the limit stated in article 1.3.
- When it is necessary to disinfect the pipeline after overcoming the breakdown, the time stated in the table need to be increased more 12 hours.

8.3. Network of water supplying network must be hoop type network, cut-off network is only permitted to apply in following cases:

- Supply water to manufacturing when it is allowed to stop for amendment
- Supply water for daily living when the diameter is not bigger than 100mm
- Supply water for fire fighting when the length is not over 300m

Notes:

- At the resident point where there is population as 5,000 persons with water supplying standard for fire fighting as 10 l/s it is allowed to put cut-off network if the length not over 300m. But this must be permitted by fire fighting organ, simultaneously must have water store capacity for fire fighting.
- It is allowed to put cut-off network according to wave of construction before completing hoop type network according to the planning.

8.4. Conduits diameter is defined according to hydraulic calculating result for network of

transmissing, distributing water. Minimum diameter of water supplying network for daily living combined to fire fighting in resident areas and industrial factories not smaller than 100mm.

8.5. When one conduit on hoop type network, occurs breakdown, then the flow supplying to living of the network is permitted to reduce 30-50%. For the most useless point of using water is allowed to reduce < 75% of flow, as per free pressure not reduce over 5m. for water supplying system for manufacturing, the flow reduces, allow calculating according to the case which factory occurs breakdown. Total flow supplying to object of using water depends on number of pump supplying into the network but not reduce over 30%. When calculate the network in case occurs fire, then cannot include of the case which the network occurs breakdown.

8.6. Put distribution pipeline together with the main transmission pipeline with diameter ≥ 600mm, then the flow of distribution pipeline ≤ 20% total flow. If the main pipeline diameter < 600mm, putting more distribution pipeline together must have legitimate reason. When the pipe goes through the line with the road with surface wider ≥ 20m, allow putting separated two pipes in parallel.

8.7. Cannot connect directly water supplying network for living, eating & drinking with water supplying pipeline with quality different from living water. In necessary case must connect, then must have method of preventing from polluting living water (for example do two locks of water, the middle have discharging valve) and must be agreed by the medical organ.

8.8. On the pipeline and distribution pipe network, when necessary, must put following equipments:

a) Lock for dividing into section to repair

b) Gas attracting valve

c) Gas discharging valve

d) Valve and nozzle for discharging water

e) Lid putting into the pipeline when pipe diameter is bigger than 600mm

g) Equipment of decompression when appear phenomenon of crashing water.

h) Elastic joint

i) On the auto-flow pipeline with pressure must put energy consuming wells or other protecting equipments for the pipeline to work in permitted pressure limit.

8.9. Length of pipeline is separated to repair as following regulation:

- When there are two or many pipelines putting in parallel and there is any relation between the pipes which takes not over 5km.
- When there is a relation between the pipes, then take as the length of pipe section between connecting points.
- When there is only one pipeline with diameter < 600mm, then the length is not over 3km.

For distribution pipeline network, must ensure:

- Length of pipe section separated to repair cannot over 5 muzzles of fire fighting.
- Don’t stop supplying water to the places of using water where not allow interrupting supplying water.

8.10. Gas attracting valve can use two types: automatic and manual control. Automatic gas attracting and discharging valves put at the angle fracture high point of the pipeline according to the longitudinal measure and the upper part of repairing pipe section to eliminate the capability which creates into vacuum in the pipe with numeric value

higher than the calculated numeric value for chosen type of pipe, as well as in order to discharge gas out of the pipeline when agglomerated. When vacuum quantity is over the permitted value, then can use manual gas attracting and discharging valve putting at the upper part of each repairing pipe section and arranging in the wells of putting locking valve of dividing section for repairing.

8.11. Gas discharging valve must arrange at the place of putting gas attracting valve, as well as angle fracture points of the pipeline according to longitudinal measure.

Diameter of gas concentrating pipe section is taken as diameter of conduits, height 200-500mm depends on diameter of water pipe. Diameter of gas discharging valve need define according to calculation or take as 4% maximum calculated water flow on the pipeline, counting on gas volume at the condition of normal atmosphere pressure, preliminarily can take: d = 25mm for pipe with diameter ≤ 500mm; d = 50mm for diameter bigger than 500mm.

8.12. Pipelines and network must put at the sloping toward to the sediment discharging side with sloping level not smaller than 0.001. When terrain is flat, sloping level for putting pipes allows reducing to 0.0005.

8.13. Must put water discharge valve at the lowest point of each pipe section for repairing as well as places which regulated to clean the pipeline by the design before putting into using and during the process of management. Diameter of water discharging pipe and gas attracting valve must ensure that had discharged out of water in the pipe section which it serves with time not bigger than two hours.

Pipe and nozzle diameter of discharging water must ensure so that water flow speed in the pipe when cleaning not smaller than 1.1 times of maximum calculating speed of the pipeline. Using manual valve as sediment discharging valve.

Notes:

- When cleaning by air-water compressor, then moving speed of air-water mixture must not be smaller than 1.2 times of maximum calculated speed of pipeline.
- When cleaning by air-water compressor, then water flow is taken as 10-25% total mixing flow.

8.14. Washing water can discharge into raining sluice, gully and spout. If don't discharge by auto-running, can discharge into the attracting well and then use pump to attract out.

8.15. Fire fighting muzzles are arranged according to the road, distant not over 2.5m from the outer edge of roadway and distant not under 3.0m from the wall of building. Allow arranging fire fighting muzzles on the pavement.

Distance between fire fighting muzzles is defined according to calculation of fire fighting flow and properties of fire fighting muzzles. This distance must be suitable to requirement stated in the standard of fire fighting but not over 300m.

Pressure loss per 1m length of soft pipe for fire fighting is defined according to formula:

$$H = 0.00385q^2 \qquad (8\text{-}1)$$

Where: q is flow of fire fighting, l/s.

8.16. When design auto-running pipeline without pressure must build exploratory wells, if terrain is too sloping must build step shifting wells to reduce water flow speed and control water level in the pipe. Distance between exploratory wells is taken as follows:

- Pipe diameter < 700mm, the distance is not smaller than 200m.
- Pipe diameter from 700-1400mm, the distance is not smaller than 400m.

8.17. It is necessary to put elastic joint in following cases:

- Joints on the pipeline cannot be elastic according to the pipe axis when changing

temperature of water, air and soil.

- On the steel pipeline putting in tunnels or viaducts, the distance between elastic joints and motionless axes is defined according to calculation, with considering to composition of joint.
- On the pipeline putting on sunk soil foundation for welding steel pipe; putting under the ground at the places where have spare parts of casting iron.

In general, if need spare parts of casting iron protected to resist central drawing force by hard connecting the pipe to well's wall, build supporting pillar or coating on the pipe by jammed soil layer, then no need put elastic joint.

Must put movable joint (extension bowl, sleeve, etc.) in front of casting iron spare parts when pipeline puts under the rammed soil.

Movable joint and elastic joint of the pipeline putting under the soil must put in the inspection well.

8.18. Public nozzle of water must arrange with serving radius about 100m; when there is appropriate reason, serving radius can rise up. Around the place of putting public water nozzle, need build barring rib and must ensure to drain off water easily. Should design and combine to public water nozzle and fire fighting muzzle at the same place.

8.19. Choosing material and durability of pipe bases on calculation combining to hygienic condition, corrosion of soil, water, the working condition of pipe and requirement of water quality.

For working pipe with pressure, can use type of pipe: grey casting iron, steel, reinforced concrete, plastic, malleable casting iron, plastic pipe with reinforce glass fibre.

Grey casting iron pipe only should use when there is no non-metal pipe.

Steel pipe only should use when working pressure is high (over 8 kg/cm^2) or at the places:

- When the pipe goes through roads, railways, barricades, lagoon, lakes or rivers.
- The pipe putting on the viaduct, in the trench.
- When putting the pipe at the location which is difficult to build, sink land, land for mining exploitation, area with Kaster phenomenon

For reinforce concrete can use metal spare part.

Material of pipe in system of supplying living water must ensure the requirements stated in article 1.10.

8.20. It is necessary to have method to prevent the phenomenon of crashing water in cases:

- All or one group of pumps stop suddenly because of cutting off or breakdown of electric power;
- Switch-off one of operating pumps simultaneously before switch-off valve on the pushing pipe;
- Start pump when valve on the pushing pipe which opens readily;
- Open valve on the pipeline by mechanical;
- Close or open water collecting equipments suddenly.

In order to let the pipeline work safely, need calculate pressure increasing level because of phenomenon of crashing water and choosing method of protection.

8.21. Anticipating methods for hydraulic crashing water when closing pump suddenly:

- Put gas attracting valve on the pipeline;
- Put one-way valve with closing and opening controlled on the pushing pipe;

- Put valve or pot for eliminating crashing water on pushing pipeline;
- Discharge water through pump according to the contrary direction when pump rotates freely or stop completely;
- Arrange hydro-pneumatic pot or cooling tower for process of crashing water.

Note: In order to anticipate phenomenon of crashing water allow using: safety valve, decompression valve, discharging pipe into pushing pipe from attracting pipe, supplementing water into at the places where appears phenomenon of separating flow, using combination of pump with big rotary inertia.

8.22. Protect the pipeline from damage due to pressure increasing when closing valve by increasing time of closing valve. If this method is not ensured, then must increase more equipment (safety valve, gas discharging valve, pressurizing pot, etc.)

8.23. Normally water pipeline must put under the ground. If there is reason, allow putting pipeline protrudingly in the air, in the tunnel or put with other technical works in the same tunnel together (except for pipelines of flammable liquid and gas).

8.24. The pipeline putting on the soil foundation, must base on detailed geology and type of pipe to reinforce foundation.

- When putting directly on natural soil ground, then must keep intact composition of soil (stone pillar, flow sand, mud).

- If it is cobble, then must level and have buffering layer by mixing sand with thickness over 10cm. Can use soil but must ram carefully to reach to density 1.5T/m^3.

- When soil foundation is weak, must put the pipe on artificial foundation.

8.25. In case using steel pipe must have pipe protection method from corrosion at the both inside and outside. Need have datum of corrosion properties of soil, of water in the pipe, as well as corrosion capacity of conduits due to electric current spreading in the soil.

In order to prevent corrosion and subsidence of pipeline and distribute by steel pipe with diameter from 300mm and above, need apply protection method inside pipeline made of: coated a protecting isolation layer, not let water touch directly to pipe wall.

8.26. Determine the depth of burying pipe under the ground must base on the outside loading, durability of pipe, effect to outside temperature and other conditions; in normal, can take as follows:

- With diameter to 300mm, the depth of burying pipe is not smaller than 0.5m counting from the ground surface (road surface) to the pipe top.
- With diameter bigger 300mm, the depth of burying pipe is not smaller than 0.7m counting from the ground surface (road surface) to the pipe top.

Notes:

- When putting the pipe on pavement, then can reduce above numeric values but not smaller than 0.3m.
- When determine the depth of burying pipe, need consider to altitude of design face according to foundation leveling planning of urban and using capacity of pipeline before finishing work of foundation leveling.

8.27. Determine diameter of pipeline and distribution pipe of network on the base of economic and technical calculation. Simultaneously, need estimate the capacity which must stop some sections when necessary. Diameter of conduits, pipe combined to fire fighting in resident area and industrial factory cannot be smaller than 100mm; in agricultural resident area is not smaller than 75mm

8.28. Calculate pressure loss for types of pipes made of casting iron, steel, reinforce concrete, plastic, etc. imported according to Annex 14. In addition, can use current

hydraulic calculation sheet or ready setting diagrams in documents of other countries. For domestic types of pipes, then base on science research result. In general, pressure loss must increase 1-5% depend on detailed situation of each type of pipe.

8.29. When improve the pipeline and network must apply methods: (replacing, putting with new and old pipe, cleaning old pipe, etc.) to restore water guiding capacity of the pipeline. In special case it is allowed to take pressure loss in operating pipe sections and improve by pressure measured in fact.

8.30. When carry out economic, technological and hydraulic calculation of water distribution system, then base on features of system but must have enough to choose optimal plan.

Choosing cases is counted according to rule of working and combining of pump station, pipeline, network for distributing conditioning capacity of tower and containing pool basing on complex level and detailed requirement of water supplying system in each period:

- Maximum flow per hour in the day which uses water the most.
- Minimum flow per hour in the day which uses water the most.
- Maximum flow per hour with considering flow for fire fighting.

In case there is breakdown on some pipe sections but still ensure requirements stated in article 8.1 and 8.5.

8.31. Water supplying pipeline usually put in parallel with street and can put at the edge of street or the best is at pavement. Minimum distance according to plane from pipe's outer face to around works and pipelines, must define depending on pipe diameter, geological situation, work features and is usually not smaller than following regulations:

- To building foundation and work: 3m
- To descent base of railway: 5m
- To gully edge or base of sloping roof of road: 1.5-2.0m
- To the edge of rail way for tramcar: 1.5-2.0m
- To telephone line: 0.5m
- To high voltage electric line up to 35 KV: 1m
- To the outer face of raining water draining pipe, heat supplying pipe and product guiding pipe: 1.5m
- To electric lamp-post in the street: 1.5m.
- To the edge of high voltage electric post: 3.0m
- To the fence: 1.5m
- To the center of tree row: 1.5-2.0m

Note:

In the condition is narrow, arrangement is difficult but pipe diameter is small and lie at the higher place than foundation of work, can reduce the above regulations.

8.32. When living water supplying pipe is in parallel with waste water draining pipe and are at the same depth, then the distance according to plane between two wall of pipe cannot be smaller than 1.5m with pipe diameter up to 200mm and cannot smaller than 3,0m with pipe diameter bigger than 200mm. Together with the above condition but water supplying pipe is under waste water drain pipe, then the distance need to increase depending on difference about the depth of putting to decide.

8.33. When water supplying pipes intersect together or intersect other pipeline, then

minimum distance according to vertical direction is not smaller than 0.2m. In case living water supplying pipe go through water draining pipe, the pipe for leading solution with bad odour, then water supplying pipe must put higher than other pipes at least 0.4m. If water supplying pipe is under waste water draining pipe, the water pipe must have outer covering pipe, length of outer covering pipe counting from intersecting position is not smaller than 3m toward each direction, if putting pipe in the clay, and is not smaller than 10m if putting pipe in absorbing soil, and water draining pipe must use casting iron pipe.

If water supplying pipe intersects electric line and telephone line, then minimum distance between them according to vertical direction cannot be smaller than 0.5m

8.34. When the pipeline go through river, stream, etc. then can put on the bridge or at the bottom of river, stream and should use steel pipe. The pipe going through bridge can put in wooden boxes, concrete boxes or mounting into bridge under the hanging form and can calculate with flow speed up to 2.3-3.0m/s to reduce the loading of bridge. If burry at the bottom of river, then pipes number is not smaller than 2. The depth from river bottom to pipe top must have define according to washing-away condition of river-bed, in general cannot be smaller than 0.5m; when pipe is placed in the area where ships travel a lot, then cannot be smaller than 1m and must have method for preventing river-bed from washing away. Two sides of river must have testing well and signal pillar for ships traveling. Must estimate methods of washing for pipeline when necessary.

Design pipe through waterway with ships traveling must ratify waterway management organ.

Interval of water going through between siphons is not smaller than 1.5m.

Oblique level of siphons should take not bigger than 20^0 in comparison with horizontal direction.

8.35. Must avoid monumentally not let water supplying pipeline going through rubbish dumps, cemeteries. When the pipe going next these places, then must have a minimum distance from 10-20m (when the pipe is upper the underground water level, use small numeric value, when the pipe is lower the underground level, take big numeric value). In case must be mandatory to go through those places, then must carry out move graves, rubbish, simultaneously sterilize at site and use new soil filling into or must put protrudingly on the ground.

8.36. Surveying well in which arranges locking valve, spare parts, etc. can build by bricks or concrete. When build in higher underground water must have method of preventing water so that the bottom and wall of the well is higher than the highest underground water level 0.5m, the cover of surveying well can be made by reinforce concrete. If surveying well build right at the place vehicles traveling a lot, having big loading then the cover must have firm composition to avoid to breaking or replace by casting iron cover. Need have method for draining off raining water and leaking water from surveying well into draining system of raining water or neighbouring gully. If equipments of spare part putting in the well is too heavy, then must arrange supporting pillars, supporting at the end of pipe, joints and cross letter type of hermetic closing joint in order to estimate for developing water supplying.

8.37. When put many pipelines in parallel together, then the distance between outer edge of the pipe must ensure condition:

- Saving quantity of digging and filling.
- Installing and repairing advantageously depending on type of pipe.
- Suitable to geological and terrain condition.

  D < 250mm L ≥ 0.6m

  D từ 300- 600mm L ≥ 0.8m

D > 600mm L ≥ 1m

8.38. When put pipe in the tunnel, the distance between the outer edge of pipe and the wall of tunnel cannot be smaller than 0.2m. If there are spare parts on the pipeline, then this distance takes according to article 8.47.

8.39. The pipeline goes through railway, tramcar, route in general must put in inserted tube. When necessary, can put in the tunnel. In special case can put directly (use steel pipe and execute by opening type digging) but on the calculating base of ensuring safety and feature of the route (local traffic road, etc.).

Notes:

- Not allow to put the pipe in the walking tunnel or overpass.
- The pipeline in industrial area when pass over road allow not using wrapping tube but must use steel pipe.

8.40. In special case at the two ends of pipe section over the road must have checking well and blocking valve.

8.41. Distance from rails tie or road face to the top of pipe, wrapping tube or tunnel as following regulation:

- When execute by opened digging method – is not smaller than 1m.
- When execute by closed method such as click, horizontal drilling – is not smaller than 1.5m

8.42. Distance on the plane from the outer face of the wall of surveying well (at two section passing over the road) to the outermost rails of the wall of the surveying well (at two ends of section which go through the road) to the outermost railway axis or to the edge of pavement not smaller than 5m, to base of slopes not smaller than 3m.

8.43. Inner diameter of covered tube or inner size of tunnel stipulated as follows:

- When carry out opening execution, takes bigger than outside diameter of conduits 200mm.
- When execute by closed method, depending on diameter, length of pipe's section and safety condition in executing to define.
- When put the pipe in the tunnel, inner size of the tunnel must define according to executing and repairing condition.

Notes: Allow to put many pipes or many types of technical works in one wrapping pipe or one tunnel according to regulation of distance.

8.44. Putting pipe through railways running by electric power must have method of protecting pipe from corrosion caused by activating electric current.

8.45. Design the pipe going through railways must ratify railway managing organ.

8.46. At the turning-round positions according to the plane and vertical side must have pillow supporting joint in order to when appear force, the connecting joint can stand.

8.47. Define size of surveying well must ensure regulation of the distance from the well to spare parts as follows:

- Pipeline	D up to 300mm	a = 0.2m
	D from 300-600mm	a = 0.3-0.5m
	D over 600mm	a = 0.5-0.7m
- Flange	D up to 400mm	a = 0.2m
	D over 400mm	a = 0.4m
- Bowl	D up to 300mm	a = 0.4m
	D over 300mm	a = 0.5m

- From the bottom of the pipe to the bottom of surveying well

D up to 400mm	a = 0.15m
D over 400mm	a = 0.25m

When there is valve in surveying well, depend on type of valve, the distance from handle of valve to the wall of well must ensure operate advantageously.

Note: In case it is really necessary, the distance from the bowl to the wall of well allows being smaller than regulation.

8.48. In the well must have ladder for up and down, in special case allow using movable ladder. For big surveying wells must have working floor when necessary.

8.49. If surveying well is put in lawn area, then around the cover of surveying well must be laid gravel or macadam with width 1m sloping toward the outside, higer than soil ground 0.05m. If surveying well is put in unconstructed soil area, then the cover of surveying well must be higher than the ground's surface 0.2m.

8.50. When gas discharging valve is put in the surveying well, must arrange steam ventilating pipe.

9. STORING AND CONDITIONING CAPACITY

9.1. When define capacity of containing pool and water tower must depend on diagram of using water and pump in a day with maximum water using amount, simultaneously must consider to store water amount for fire fighting, used when it is wrong and use for the only water manufacturer, in addition when treating water for living demand must estimate necessary volume according to time of touching to disinfectant.

Capacity of conditioning water Wp, m^3 (containing pool, water tower, final tank of network, etc.) must define according to water consuming diagram, when there is not diagram, then define according to formula:

$$Wp = Q_{ng.max} [1 - K_H + (Kg - 1)(K_H/Kg)^{Kg/(Kg-1)}], \quad (9\text{-}1)$$

Where:

$Q_{ng.max}$ – Flow of the day with the biggest water using amount, m^3/day.

K_H – The rate between the flow at the maximum water supplying hour (supplying into conditioning capacity in water treatment stations, pump stations or supplying into network with conditioning tower) and the flow at the medium hour in the biggest water using day.

Kg – Hour unconditioning water using coefficient (take water from conditioning pool or pipes network with conditioning pool) is defined by the rate between maximum water taking hour and the medium hour flow in the biggest water using day.

Water amount taken out at max. hour for consuming objects has not conditioning capacity taken equal to biggest consuming hour. Water amount taken out by max. hour pump from conditioning pool to supply into network with conditioning tower is defined according to the biggest pump hour capacity of pump station.

Store capacity in water purifying stations need supplement more amount of water for washing filter tanks.

9.2. Conditioning water volume at industrial factories connecting to central water supplying system, must define on the base of water using diagram of each factory and water pumping diagram equivalent to working rule of the whole system.

9.3. Conditioning water volume in barrel of hydro-pneumatic equipment W (m^3) is defined according to formula:

$$W = \frac{Q}{4n} \quad (9\text{-}2)$$

Where:

Q – Rated capacity of one pump or capacity of the biggest pump in the group (m^3/h)

n – Number of opening the biggest pump in one hour.

9.4. Define water volume for fire fighting stored in the containing pool, tower, hydro-pneumatic barrel at resident points and industrial area must follow according to standard of fire preventing and fighting when design construction works.

9.5. When source water flow is not enough to supplement to volume of water for fire fighting according to the stipulated period, then it is allowed strengthening time of occupying fully the pool as long as create supplementary capacity ÄQ (m^3) defined according to formula:

$$ÄQ = \frac{Qx(K-1)}{K} \quad (9\text{-}3)$$

Where:

Q: Store water volume for fire fighting.

K: Rate of time for supplementing water amount fire fighting and required time.

9.6. If there is only one water pipeline leading into containing pool, then in containing pool must have store water amount for breakdown in period of amending pipeline, to ensure to supply water to:

- Manufacturing demand in the period happening breakdown.
- Living demand obtains 70% calculated water amount.
- Fire fighting during 2-3 hours when flow of fire fighting is up to 25 l/s depending on fire-resistant level of the house.

Notes:

- Amendment time of pipeline must take equivalent to instruction in article 8.2.
- Rehabilitating store water amount for breakdown is carried out by reducing water using standard or using store pump.
- Time of rehabilitating store water amount for breakdown is taken as 36-48 hours.
- Allow not considering to supplementary water amount for fire fighting when the length of pipeline is not bigger than 500m to resident area with population up to 5,000 persons, as well as to industrial and agricultural units with water flow for fire fighting not bigger than 40l/s.

9.7. The height of water tower or containing pool with pressure must define on the hydraulic calculating base to ensure to supply water in the useless cases. With the lowest level in the tower, ensure pressure of fire fighting on the network according to article 3.14 and 3.15.

9.8. Number of containing pools in one station of supplying water cannot be smaller than 2. In case, capacity of factory is small, there is method to supply water continuously, no need store water for fire fighting or only need contact to disinfectant, then allows designing one pool.

9.9. Containing pool can build by reinforce concrete or brick. Using which kind of material must depend on properties of pool, geological condition, execution, material statement at local and through economic-technical comparison to decide. In filling soil on the top of containing pool, the width should take about 200-300mm. Water tower can build by reinforce concrete, brick, metal, composite. Brick tower is applied when capacity and the height need salvage tower body to arrange auxiliary works of factory such as stores, workshops, offices, etc. in these auxiliary works cannot make out smokes, dust and toxic steam.

9.10. Containing pool of water for eating, drinking and living must ensure water circulate not over 48 hours and not smaller than 1 hour.

Note: When there is the base that the time of circulating water in the containing pool allows increasing 3-4 days. In that case, it is necessary to consider circulation pump of which capacity is defined from water circulating condition in containing pool not bigger than 48 hours, including of water amount put into from supplying source.

9.11. Containing pool, gourd and tower need be arranged: pipe for water into, pipe for water out or in-out combined water pipe, spilling pipe, exhausting pipe, ventilating equipment, surveying hole for up and down step or ladder for person up and down and transporting equipments.

Depend on function of containing pool to have better to consider and supplement:

- Water level measuring equipment, vacuum and pressure checking equipment;
- Radiating door with diameter 300mm (in the water containing pool not use for living, eating and drinking);
- Pipeline for washing pool (movable or fixed);
- Equipment for preventing water spilling out of the containing pool (automatic equipment or buoy valve on the pipeline for water into);
- Equipment of purifying air through steam pipes into the pool (in the containing pool using for living, eating and drinking)

9.12. The head of water pipeline into the pool and gourd and tower must flare mouth with horizontal mouth, funnel edge is higher than the biggest water level in the pool 50-100mm; or put water into the specific compartment, the upper edge of the compartment is higher than the biggest water level in the pool 50-100mm. When put the pipe through the wall of pool and gourd must put steel shield to avoid water infiltrate through the wall.

9.13. On the pipeline of water out, the pipe head putting in the pool need arrange reducing coupling.

The distance from attracting nozzle to the bottom, wall or pool navel should define according to calculating speed of water into the funnel mouth not bigger than the moving speed of the water at the entering section.

Horizontal edge of reducing coupling when putting on the bottom of the pool as well as the upper edge of pool navel should be higher than pool bottom > 50mm.

On the reducing coupling of water out or reducing navel need arrange chess grid type barring net sheet to eliminate whirlpools which withdraws gas into the pipe when water level in the pool or gourd goes down.

On the pipeline of water out (in-out pipe) to the outside of the pool need arrange equipment for tank truck and fire-engine taking water.

9.14. Spilling equipments need be calculated with flow as difference between the maximum amount of water into and the minimum amount of water out. Water layer of spilling mouth cannot be bigger than 100mm.

In containing pool and water tower, on spilling equipment need arrange hydraulic siphons to prevent insect from creeping through spilling pipe into the containing pool and gourd and tower.

9.15. Diameter of discharging pipe takes as 100-200 mm depending on capacity of containing pool and tower. The pool bottom need have sloping level not smaller than 0.005 toward discharging pipe.

9.16. Discharging pipe and spilling pipe can connect together (the heads of discharging pipe is not submerged):

- Spilling water and discharging water from the containing pool discharging into raining draining system of the area or to opening gullies with interrupted flow.

- When connect spilling pipe to opening gullies, need arrange barred net with intersection at the end of pipe.
- When there is not ability or discharging with unsuitable auto-running, should consider arranging the well to attract water by moving pump.

9.17. Attracting and discharging gas when water level in the pool changes, must put steam ventilating pipes, eliminate capability of creating vacuum over 80mm water column.

Space on the highest water level in the containing pool to the bottom of pool cover take from 200-300mm. Beam and pillow of plaiting slag with cover which can let be sunk, in that case need ensure ventilating between the holds of the pool cover.

9.18. Surveying hole need arrange near position of the pipe of water into, the pipe of water out, spilling pipe. Cover of the surveying hole in the containing pool used for living need have equipment to lock and mark signal. Surveying hole of the containing pool must be higher than the soil layer filling on the cover is not fewer than 0.2m.

Surveying holes in the containing pool using for living must ensure to be covered entirely.

9.19. The containing pool with pressure in fire fighting system of high pressure must be equipped automatic equipment, ensure to be able to switch off out of consuming network when start pumps for fire fighting.

9.20. In the containing pools of water supplying station, the lowest and highest water level of the equivalent capacities for fire fighting, breakdown, conditioning must have the same altitude.

When closing one pool, then in remaining pools must store not less than 50% water amount for fire fighting and store when occurs breakdown.

Equipments for the containing pool need ensure the capability of closing and opening independently for each pool.

In case no need store water for fire fighting and breakdown, allow arranging one containing pool.

9.21. Composition of valve pít at the pool cannot carry out hard connection to the pool.

9.22. Allow designing water tower with path or without path around gourd and tower depending on working rule of tower, capacity of gourd, climate condition and temperature of water source.

9.23. Allow using tower body to arrange auxiliary works of water supplying system; these auxiliary works cannot create out dust, smokes and toxic steam.

9.24. When do hard halve for pipe into the bottom of gourd, tower on the vertical pipeline must put elastic joint.

9.25. Water tower must be equipped specific lightning rod, when there is the same lightning equipments with other works.

9.26. Allow store water for fire fighting in special pool or opening pool for industrial enterprises and resident point.

9.27. Capacity of pool and lake containing water for fire fighting must define from flow and time of fire fighting.

Notes:

- Capacity of opening pool need be calculated with capability of evaporating water, the upper edge of the pool must be higher than the highest water level in the pool not less than 0.5m.
- Must have a advantage entering path to the pool, containing lake, collecting pit for fire-engine.
- At the places where arrange the pool and containing lake must follow

instructions according to the current regulation.

9.28. Number of pools or lakes of containing water for fire fighting cannot be smaller than 2, in that each pool (lake) must store 50% water amount using for fire fighting. The distance the pools or lakes of containing water for fire fighting takes according to article 9.29, or two lakes are adjacent.

9.29. The pools or lakes containing water for fire fighting must be arranged according to serving condition for the buildings with radius:

- 200m when there is automatic pump.
- 100-150m when arrange pump with engine (depending on type of pump).

In order increase serving radius, allow putting from containing pool (or lake) branches of cutting-off pipe has length not bigger than 200mm with counting to requirements of article 9.31.

The distance from water taking point of containing pool (or lake) to the buildings with fire-resistant capacity grade III, IV and V and to flammable material store not smaller than 30m, to the buildings have fire-resistant grade I and II not smaller than 10m

9.30. It is necessary to consider using of soft pipes for fire fighting with length to 250m to transfer water into the pools or lakes for fire fighting, If having agreement with organ of fire preventing and fighting, length of pipe can be to 500m.

9.31. If taking water from the containing pool or lakes by automatic pump or pump with motor is difficult, need consider arranging attracting holes with capacity 3-5 m^3. Diameter of connecting pipe of the pool or water lake with collection hole taken according to the condition which can load water amount calculating for fire fighting but is not smaller than 200mm. Must arrange barring valve on the pipeline of water into right in front of collection hole. Valve pin must be extended right under the surveying cover. Must arrange rubbish barring net on pipe nozzle at the side of lake.

9.32. For the pool or lake of containing water for fire fighting, should not arrange spilling pipe or exhausting pipe.

10. CLOSED WATER SUPPLYING

GENERAL INSTRUCTION

10.1. When study water supplying diagram must consider to general water circulation for the whole industrial factory or under the closed cycle for one stage, one workshop or specific equipment. Depending on purpose of using water, it must consider requirements of cleaning, freezing, treating for discharging water and reuse that water according to different necessary level.

10.2. Number of closed water supplying at the manufacturing units must define according to requirement of manufacturing technology, water using purpose, requirement of water quality, temperature, water pressure and the way of arranging water using points on the total plane of construction turn.

10.3. In order to reduce diameter and length of pipeline network, in the industrial factory need apply specific closed water supplying systems for the stages, workshops, specific equipments and try to put near the water using place.

10.4. Circulating water cannot corrode the pipe and heating exchanging equipment; cannot cause to biological settlement; settlement for impurities and mineral salt in the pipe and on the heating exchanging surface.

In order to get those requirements, need base on result of analyzing natural water quality supplemented more into the system; properties of discharging water; carbonate sediment and mechanical sediment; development of micro-organism; pipe

corrosion condition and heating exchanging equipment to have suitable method of treating additional water and circulating water.

10.5. Choosing composition, size of works and equipments for purifying, treating and freezing water must start from the biggest loading on those works.

BALANCING WATER IN THE SYSTEM

10.6. For closed water supplying system must set up water balancing; must count to water loss amount, water amount which need to discharge and water amount which need to add more into to compense water loss amount.

10.7. When setting water balancing, reduced water part includes of:

- Using water which cannot restore (water taken from water supplying system according to technology requirement), this lost water part taken according to technological calculation.
- Lost water due to vaporizing when freezing, Qbh m^3/hr counted according to formula:

$$Q_{bh} = K \,.\, \Delta t.\, Q_{ll} \qquad (10\text{-}1)$$

Where:

$\Delta t = t_1 - t_2$: Water temperature reducing level before and after freezing (freezing in lake, spraying frame or raining frame).

Q_{ll}: Circulated water flow, m^3/hr.

K: Coefficient counting to loss part when radiates heat due to evaporation.
For spraying frame and raining frame, K depends on air temperature, takes according to table 10.1.
For freezing lake and circulation settlement lake, K depends on temperature of water in the lake, taken according to table 10.2.
When cooling product in irrigation type heat exchanging equipment, lost water amount due to evaporation counted according to formula (10-1) must increase two times.
In spraying frame, raining frame, irrigation type heat exchanging equipment, lost water amount because of wind P_2 must take according to table 10.3.
Lost water in purifying works must be defined according to calculation of instruction at item 6.
Lost water because of infiltrating out of settlement lake and freezing lake is allowed to ignore if the lake has the water impervious bottom and surrounding bank. If lake only have the bottom impervious to water, and surrounding bank is hydrophilic, then must count according to hydrogeology surveying datum. For spraying pool and freezing pool, don't count absorbed water amount.
Water discharged out of system must define depending on circulation water quality and additional water depending on chosen water treating method.

Table 10.1

Atmosphere's temperature ^0C	0	10	20	30	40
K	0.001	0.0012	0.0014	0.0015	0.0016

Table 10.2

Temperature of water in the channel bed running into the lake ^{0}C	0	10	20	30	40
K	0.0007	0.0009	0.0011	0.0013	0.0015

Notes:

- For intermediary temperature, K is defined by interpolation method.
- Lost water because of water which evaporates naturally in the freezing lake must take according to standard of calculating water containing lake.

Table 10.3

Type of cooling work	Lost water because of wind P_2 counting on % amount of cooling water
Spraying lake with capacity up to 500 m^3/hr	2 – 3
Spraying lake with capacity over 500 m^3/hr	1.5 - 2
Opening spraying frame with shutter	1 – 1.5
Raining frame without shutter and irrigation type heat exchanging equipment.	0.5 – 1.0
- Spraying frame with blower.	0.2 – 0.5

Note: Small coefficient using for the work with big capacity or use for calculating and treating the cooling water for preventing from carbonate settlement.

REJECTING MECHANICAL IMPURITIES

10.8. When necessary, must reject mechanical impurities in circulation water and additional water.
Calculating and choosing the water purifying work must be according to instruction at Item 6.

10.9. Capability and intensity of forming mechanical sediment in containing compartment of spraying frame, in the pipeline and in the heat exchanging equipment must define on the base of management experiment of closed water supplying system with using water source given in area, or base on concentration, pellet composition of sediment in water to define.

10.10. In order to prevent and reject mechanical impurities in heat exchanging equipment, need arrange washing equipments and carry out the washing periodically. In necessary case, must treat circulation water partially.
Washing water polluted by mechanical impurities must discharge into the draining system of living or manufacturing water.

RESISTING WATER OF COLOR CONTAMINATION AND BIOLOGICAL SEDIMENT

10.11. In the water containing lake and in the cooling lake must use sulfate copper to resist water of color contamination (table 10.4).
Using Sulfate Copper in each case is also allowed by epidemic prevention organ and fish protection organ.

10.12. In order to prevent creatures develop in water collecting work and in the pipeline must use Chlorine or Sulfate Copper according to table 10.4. Or discharge out of water in the pipeline periodically, and then washing by hot water 45 - 50 ^{0}C and washing by mechanical. Can carry out color painting or take plastic to prevent the development of creatures.

10.13. In order to prevent bacterium and creature develop in the pipeline, must make up Chlorine into water. Dosage of Chlorine is taken according to table 10.4.

10.14. In order to prevent seaweed develop in the raining frame, spraying pool and heat exchanging equipment must treat cooling water periodically by Sulfate Copper solution (table 10.4).
Capacity of the pool for making up Sulfate Copper solution must define with solution concentration from 2 to 4% according to Copper ion.

10.15. In order to prevent creature develop in the raining frame, spraying pool and heat exchanging equipment (develop simultaneously with seaweed) must make up more Chlorine periodically before guiding water to the works. Further treating by Chlorine must carry out simultaneously or after treating by Sulfate Copper solution.

10.16. Equipment of making up Chlorine, pool of containing Chlorine or Sulfate Copper use for treating water in closed water supplying system must put in the same building (with insulated room) near the place guiding chemicals into water. The pools, network, pipe and equipments touching to solutions of Chlorine and Sulfate Copper must be made by material not corrosive.

Table 10.4

Effect of Chlorine or Sulfate Copper	Treating for cooling water					
	Chlorine			Sulfate Copper (Counting on Cu)		
	Dosage(mg/l)	Touching time	Number of times	Dosage (mg/lCu)	Touching time	Number of times
Prevent water of color contamination in the cooling lake (article 10.11)				0.1-0.5	According to experimental datum	2 days 1 time
Prevent microbe and creature develop in heat exchanging equipment and the pipeline (article 10.13)	Remaining odd dosage of Chlorine in equipment and the pipeline must be bigger than 1 mg/l after touching time of 30-40	40-60 minutes	2-6 times per day			

	minutes					
Prevent seaweed develop in raining frame, spraying pool and irrigating type heat exchanging equipment (article 10.16)				1-2	1hr	3-4 times in a month
Prevent creature, seaweed develop in raining frame, spraying frame and irrigation type heat exchanging equipment (article 10.17)	7-10	1 h	3-4 times in a month	1 – 2	1hr	3-4 times in a month

COOLING CIRCULATION WATER

10.17.	Type and work of cooling need base on: - Calculated water amount; - Calculating temperature of water cooled; - Temperature reducing level in the system and technology requirement for stabilizing the cooling effect; - Working rule of the cooling work (continuous or discontinuous); - Plane condition for arranging cooling work; properties of surrounding construction works; permitted noise level; effect of the wind make water shooting out to surrounding environment; - Chemical composition of additional water and circulation water.
10.18.	Range of using the water cooling work need choose according to table 10.5.

Table 10.5

Type of cooling work	Range of using the cooling work		
	Unit of loading heat amount (1000 kcal/m^2.h)	Reducing level of water temperature, ^oC	Difference between temperature of cooled water and temperature of atmosphere
Raining frame with fan	≥ 80÷100	3÷20	4÷5
Raining frame	60÷00	5÷15	8÷10

Spraying pool	5÷20	5÷10	10÷12
Cooling water pool	0.2÷4	5÷10	6÷8
Spraying outside	7÷15	5÷10	10÷12

11. SANITARY PROTECTION ZONE

GENERAL INSTRUCTION

11.1. When carry out new design or design of improving water supplying system must design hygiene protection zone.

11.2. Hygiene protection zone of water supplying work must include of: protection zone of water supplying source including of water gully; hygiene protection zone for water pipeline and construction zone of water treating work.

For water supplying source must design zone I and zone II; For collecting work and treating work must design zone I; For conduits must design zone II.

11.3. Hygiene protection zone must be designed on the base of following documents:

For source of surface water: documents of hygiene and hydrography;

For source of underground water: documents of hygiene and hydrogeology;

For water treating work: Documents of hygiene, engineering geology and hydrogeology.

11.4. Boundary of zone I of hygiene protection zone must be defined on the base with capability of expanding the construction area of treating work and putting conduits in the future.

11.5. In range of zone I of hygiene protection zone: prohibit constructing any work for man living, including of managing worker; prohibit discharging waste water, taking bath and washing clothes, fishing, grazing castles; prohibit using toxic chemicals, organ manure and kinds of mineral fertilizer to manure to trees.

11.6. Building constructed in zone I of hygiene protection zone must have water draining system. In there is not water draining system, then collecting compartment of water-closet must be water-proof and must put at the position where does not cause pollution when taking out the manure.

11.7. Zone I of hygiene protection zone must be leveled and organized to drain off surface water out of zone range.

11.8. Current houses, factories near the range of zone I of hygiene protection zone must have method of pollution resistance.

11.9. Zone I of water supplying source, of water treating work and area with gully in resident area must be insolated by fence and green trees according to articles 13.4 and 13.5.

Sideline of water surface of zone I must have marking buoy. On the collection nozzle putting in the water containing pool with ships traveling must put the buoy with lighting lamp.

On the frontier of hygiene protection zone of the water gully outside of resident area must have instruction signpost.

11.10. When design the water supplying works in zone I, hygiene protection zone must have method of resisting pollution through the collection work, the wall of well, cover and spilling pipe of containing pool and pump starting equipment.

11.11. On zone I of hygiene protection zone of water supplying source and treating work must organize usual patrol and protection or set alarm signal as well as other protection methods according to regulation at article 13.6.

11.12. When design zone II of hygiene protection zone of water supplying source must consider to following requirements:

- Factories, houses, resident areas must be constructed completely (has system of supplying water, draining dirty water and raining water, etc.) to protect the soil and water source from pollution;
- Waste water of manufacturing and living before discharging into water source in range of zone II of hygiene protection zone must be purified to ensure hygiene requirement;
- Prohibit pouring manure, rubbish, industrial waste, toxic chemical to pollute water source and pollute environment;
- When use the guiding channel and lake to be a water supplying source must clean seawees and mud settled at the bottom of channel, lake;
- Only allow using the finished products stipulated by epidemic prevention organ to eliminate seaweed in water.

11.13. It is necessary to organize the patrol and protection in zone II, hygiene protection zone of water supplying source and area of putting conduits and water guiding channel.

SOURCE OF SURFACE WATER

11.14. Depend on condition of hygiene, terrain, hydrography at the local to stipulate limit of zone I of hygiene protection zone of rivers and water guiding channel. It ensure following regulations:

- Distance from the collecting work toward the upper stream not smaller than 200m, toward the lower stream is not smaller than 100m.
- Distance from the river bank at the side with collecting work counting from the highest water level is not smaller than 100m.
- Distance from the opposite side of the collecting work is not smaller than 50m counting from the highest water level when the width through river is smaller than 100m and distant from the collecting work not smaller than 100m when the width of river is bigger than 100m.

11.15. Limit of zone I of hygiene protection zone of the lake which do as water supplying source need define according to condition of hygiene, terrain, hydrography, local climate and must ensure following requirements:

- According to surface of water, distant from collecting work toward each direction bigger than 100m;
- Distant from the bank of lake at the side with collecting work not smaller than 100m counting from the highest water level.

Note: For the collecting work in bay, then limit of zone I of the bay zone and area of surrounding land strip is not less than 100m.

11.16. When define the limit of zone II for river and channel to do water supplying source must count to the capability that water source is polluted by chemical dirty agent and must ensure following requirements:

- The upper stream, define according to time of water flow from the zone border to the collecting work from 3 to 5 days, depending on local condition when guarantee level of water flow is 95%;
- The lower stream, distant from the collecting work not smaller than 280m;

- The two banks, counting from the water divide line.

When river has phenomenon of rising up water or contrary flow, the distance at the lower stream of the work need define according to condition of hydrography and climate.

11.17. Limit of zone II of the lake which do as water supplying source must define according to the time water runs freely to the collecting work with the biggest speed with counting to the impact of the wind and raining water flow running into the collecting work in the time not smaller than 5 days.

11.18. Limit of zone II according to regulation of article 11.16 and 11.17 must ensure water quality at the water supplying source with the distance to the collecting work as follows:

- For circulated water source – 1 km toward the upper stream
- For non-circulated water source – 1km toward the both sides.

11.19. When design method of protecting surface water source at zone II must consider to hygiene condition of zone, condition of terrain, hydrogeology and must ensure following requirements:

- For the lake doing as water supplying source in the range of 300m counting from the highest water level, prohibit using toxic chemicals, organ and inorganic manure for trees, counting on the highest water level of the lake;
- Must stipulate places for people having bath, washing clothes and places for cattle drinking water;
- When there are ships traveling, must have methods of preventing polluting water source (ships must have tank for collecting waste water, rubbish, the the port must have rubbish bin, etc.)
- In the distance 500m from the highest water level cannot build breeding farm.

SOURCE OF UNDERGROUND WATER

11.20. Limit of zone I of hygiene protection zone for underground water source need stipulate according to protecting level of water containing layer, condition of terrain, hydrogeology and must be distant from the collecting work:

- Not smaller than 30m for water containing layer which is protected well;
- Not smaller than 50m for water containing layer without protecting or with protecting but not well.

Note: For the collecting work with small capacity putting at the position which is not effected by pollution, then distance from the collecting work to limit of zone I is allowed reducing to 15m.

11.21. Limit of zone II, must stipulate by calculation on the base of hygiene and hydrogeology condition. Simultaneously must count to replenish condition of water containing layer due to relating to surface water or other water containing layers.

If there is hydraulic relation of water containing layer to surface water (river, lakes, etc.), then area of supplementing water source for exploiting water containing layer must be in zone II of hygiene protection zone.

11.22. When design method of protecting the underground water source in zone II, must pay attention to following conditions:

Eliminate or improve exploiting wells not rightly according to specification and

the wells have defect;
When drilling new well or drilling for survey must be agreed by management organ of water source.

11.23. In the range of zone II of hygiene protection zone prohibit:
Build breeding facilities distant from boundary of zone I under 300m
Build cattles grazing field distant from boundary of zone I under 100m

LAND AREA FOR CONSTRUCTING THE TREATING WORK

11.24. Limit of hygiene protection zone of land area for constructing the treating work must count from protecting fence and be according to following regulations:

- Distant from the wall of containing pool, filter tank, touching settling pool of pump station at least 30m. Distant from the wall of other works (settling pool, house for activities, chemical store, Chlorine containing store, etc.) according to specific regulation. Distant from the base of water tower at least 10m.

Note: If the treating work put in area of industrial enterprise, then the above distance can reduce but not lower 10m.

11.25. Hygiene protection zone between treating station and industrial factories must be according to specific regulation of each kind of toxicity in manufacturing.
When on the treating station has Chlorine consuming store, hygiene distance to the house and public buildings must be not smaller than 300m.

WATER PIPELINE

11.26. Hygiene protection zone for water pipeline must take along the pipeline at the area which has not constructed with the width of the both two sides of the pipeline as follows:

- If there is underground water, then take 7m when pipe diameter is to 1000mm and 15m when pipe diameter is bigger than 1000mm;
- If there is underground water, then take out each side of the pipeline 20-25m, but it does not depend on pipe diameter.

For the case that the pipeline containing water is put in the area which have had construction, then the above distance allow to reduce.

11.27. Prohibit strictly putting the water pipeline go to the area of landslides, cemeteries, toxic industrial enterprises and breeding farm.

11.28. Latrines, muck pit, hole for rubbish putting distant from the water pipeline in range of 20m must move to other place.

12. ELECTRIC, AUTOMATED CONTROL AND CHECK INSTALLATIONS

GENERAL INSTRUCTION

12.1. Confidence degree of supplying electric power to the electric receiving works of water supplying system need follow “Norm of placing electric equipment” TCVN.
Confidence degree of supplying electric power to the pump station need take same as confidence degree of pump station (according to article 7.2 of this standard).

12.2. Voltage of engine need choose according to capacity, diagram of supplying using electric power, and type of engine need choose according to the condition of surrounding environment and properties of the house putting electric equipment.

12.3. Equipment of electric distribution, transformer and controlling cabinet need put in

the booths in machine compartment or next to the machine compartment with counting capability of expansion to increase their output. Allow putting electric distributing equipment and transformer at separated position.

12.4. Technology checking system need have:

- Means, tools for usual checking.
- Means for periodical checking (to correct and check operation of the work, etc.)

12.5. Checking technological parameters of water quality need be checked usually by measuring tool, analysis machine and by testing methods.

12.6. Control system of technological processes and size, automatic level for works need be chosen according to managing condition, economic – technical arguments as well as need counting to specific factors on social to decide.

WORKS FOR COLLECTING SURFACE AND UNDERGROUND WATER

12.7. In the work of collecting surface water need check dropping level of water level through barring gratings and net of barring rubbish, as well as need measure water level in collecting compartment and water level of rivers or flow.

12.8. In the work of collecting underground water need check flow of raw water pumped up from each well, water level in the well, in water concentrating pool as well as pressure of pumps.

12.9. For drilling well of collecting water at the deep course need automate switching-off pump when water level in the well lower the permitted value.

12.10. In the work of collecting underground water, controlling pump need be designed automation according to the moving water level in the well (in concentrating pool) or remote control from central control station.

PUMPING STATION

12.11. In pump station need check pressure in pressure pipeline, as well as water level in the containing pool, in the hole of attracting leak water, in vacuum bin; temperature at pump axis (if necessary); submerged level of water level in case occur breakdown. When capacity of machine team is equal to 100KW and above need carry out to check periodically performance of machine team with error not over 3%.

12.12. For pump stations with changed working rule need have part of adjusting pressure and flow to ensure consuming electrical energy at least. Adjustment can carry out according to degree by changing number of working pumps or change harmoniously number of rotary of pump or modifying by putting more inverters.

12.13. Electric driving part serving to adjustment need equip to one pump team belongs to the group from 2-3 working pump team.

Controlling inverter need be automated according to factual pressure on the network, water flow pump into the network and water level in the containing pool.

12.14. For pump teams with capacity from 250KW and above, should use synchronous electric motor, for machine teams with smaller capacity, should use short-circuit no synchronous motor. For machine teams which controls according to diagram of layer dividing circuit with using no synchronous motor of phase rotor.

12.15. For automated pump station, it is necessary to open spare pump team automatically when working pump switches off because of breakdown.

For pump station with remote control, switching-on spare pump team automatically need carry out for pump station with confidence degree type I.

12.16. For pump station with confidence degree I, need design to open pump teams automatically or open automatically intermittently when cannot open pumps at the same time because condition of supplying electricity.

12.17. If at the pump station with using vacuum tank to initiate water to pump, vacuum pump no need be automate according to water level of the tank.

12.18. At the water pumping stations need have a control for water level to not to refer to capacity for fire fighting and spare water capacity in the pool.

12.19. Pumps for fire fighting can remote control, simultaneous with giving order to open pump of fire fighting, need control not to let use store water of fire fighting and shut off the washing pump.

In high pressure system of fire fighting, simultaneous with giving order to open the pump of fire fighting need shut off all of other pumps, locking on the pushing pipeline to guide water to pressure water tower or pressure water containing pool.

12.20. Vacuum pump putting at the pump stations of the collecting well by siphons need be designed automatically according to the water level in the air containing tank putting on siphons pipe.

12.21. At the pump stations need automate the following auxiliary processes:

- Washing rotary net for barring rubbish according to the pre-fixed program (control time or according to the difference of water level).
- Pump for leak water according to water level in the collecting hole.
- Ventilating blower operates according to temperature of the air in room.

WATER TREATMENT STATION

12.22. At the water treatment station need check following technological parameter:

Water flow (source water, treated water, water for washing the filter tank, reusing water).

- Flow of reactant solution and air flow.
- Water level in the filter tank, mixing pool, bin for containing reactant and in other containers.
- Sediment level in the settling pool and purifying pool.
- Pressure loss in the filter tank (if necessary).
- Surplus Chlorine content or ozone.
- Concentration of reactant solution.
- pH level of source water and treated water.
- Other technological parameters request having direct checking and warrantee by equivalent technical means.

12.23. Need automate:

- Quantify flocculants (alum) and other chemicals.
- Disinfecting process by Chlorine, Ozone and chemicals of containing Chlorine.
- Process of filtrating and Fluoridizing by chemicals method.

When water amount putting into variant treatment, quantifying solution of reactant

need automate according to flow of treating water amount and reactant with unchanged concentration with on-site or remote adjusting this rate. If there is exact base, can automate according to the norm of source quality and reactant.

12.24. Filtrating speed need adjust according to water flow or water level in filter tank with making sure to distribute water regularly to filter tanks.

12.25. Need automate washing of filtration and touching filter tank (when number is bigger than 10). Letting filter tank stop working to wash need be according to water level, numeric value of water column in the filtrating layer or quality of filtrated water. Letting the touching filter tank stop working to wash need be according to numeric value of loss water column or according to the reducing level when adjusting valve opens to the maximum.

12.26. At the filter tank need automate air discharging out of the water supplying pipeline for washing and filtration.

12.27. Washing rotary net and net filtration equipment (microfilter) need automate according to the program or according to the reducing level of water level.

12.28. Pump for reactant solution need be controlled at site with switching-off automatically according to pre-fixed solution level in the tank.

12.29. At the water softening station by chemicals need automate quantifying reactant according to pH level and conductivity.

At the station of eliminating hardness of Carbonate and eliminating Carbonate need automate quantifying reactant (Lime, Soda, etc.) according to pH level and conductivity.

12.30. Reconstituting for filter tank of ion exchanging need be automated. Cationic filter tank: according to surplus hardness of water; For Anionic filter tank: according to conductivity of treated water.

NETWORK OF PIPELINE FOR GUIDING AND DISTRIBUTING WATER

12.31. On the water pipelines need arrange equipments to transfer signal of breakdown.

12.32. On the water distributing pipelines need put equipments to measure pressure and in necessary case, measure water flow at the checking points and inform those parameters by signal.

12.33. When necessary to have to adjust water flow, need arrange locking valves with remote controlling system on the network.

CAPACITY OF STORE WATER

12.34. In the containing pools or kinds of water container, water tank need arrange equipments for measuring water level and controlling them (in necessary case) to use for automatic system or transmit signal to pump station or control station.

CLOSED WATER SUPPLYING SYSTEM

12.35. For closed water supplying system, except for requirements stated at article 12.11, need check:

- Additional water flow.
- Water level in compartment of containing hot water and cooled water.
- Temperature of hot water and cooled water.
- Numeric value pH of cooled water.
- Surplus Chlorine concentration in cooled water.

- Salt concentration in hot water.

12.36. Controlling the closed water supplying station need carry out according to article 12.12 - 12.18.

12.37. Closing, opening pump of hot water need be automated according to water level in receiving compartment.

12.38. Control to pump additional water automatically to the closed water supplying system need carry out according to water level in the containing pool of cooling water.

12.39. For the cooling tower which includes of many units depend on temperature of cooling water need change number of working blowers by:

- For automating pump station: by automatic equipments.
- For other kind of pump station: by remote control equipment putting at control centre.

12.40. When treat to stabilize water, need automate quantifying for reactant as follows:

- Phosphate: according to additional water flow.
- Acid: according to given numeric value of pH.
- Sulfate and Chlorine: according to pre-fixed program.

CONTROL SYSTEM

12.41. In order to supply necessary amount of water to consuming households and quality of water requires need construct central control system for water guiding works.

12.42. Control system of technological processes are chosen as follows:

- Remote control: ensure to control and maintain the given working rule of the water guiding works on the base of using the means of checking, communicating, treating the feedback information.
- Automate: include of remote control system by constructing the means of technique to evaluate economic level, work quality and defining optimal operating rule of the work.

12.43. Mechanism of remote control station need be chosen according to one degree rule with unique control station. For the big water supplying system with a lot of the water collecting works at the areas far apart, then allow using two grades or lots of grades mechanism of remote control including of central control station and on-site control station. Necessity of that mechanism in each detailed case need have exact arguments.

12.44. Remote control need combine to automating partial or the whole controlled work. Volume of remote control working must minimize, but must be enough detailed information of the happening of technological process.

12.45. In the works without equipping fully the automating means and need have permanent staff to do the on-site control and checking, allow putting operating stations depending on the serving of remote control of those stations.

12.46. Remote control for the water supplying system need be ensured by telephone direct contact between control station with controlled works, with different serving and managing parts, regulating part of electric supplying, part of managing pipeline and fire fighting.

Control stations and works checked is located separately need be connected to administration contacting system by telephone.

Control station and checking works need equip the radiocasting system.

12.47. In control stations need arrange following rooms:

- Remote control room: to arrange the seats for control staffs, place the control panel, control diagram, means of feedback information, contact means.
- Machine room: to arrange remote control equipment, electric supplying equipment, contact equipments.
- Relax rooms for staffs.
- Repairing workshop for equipments.
- Room for battery and charging battery.

To arrange specialized technical equipments of automatic control system of technological processes, need supplement:

- Compartment of placing computer.
- Compartment for preparing and maintain material.
- Working compartment of staffs for programming and operating depending on composition of equipment block of control system, the rooms can arrange separately or unify together.

12.48. Control station of water supplying system need be arranged in area of constructing the water supplying works and put at the administrative building, at the filtration station, pump station or at the management building.

12.49. In remote control system need carry out the remote control for the following objects:

- The pump teams which are not automated and need have a direct interference of regulating person.
- The pump teams which are automated cannot stop working and need control again.
- The pump teams for fire fighting.
- Locks on the network and the pipeline used for change quickly the direction of flow.

12.50. In remote control, need move to the control center of measured datum, the main technological parameters of pumping water, distributing and treating water.

12.51. In the remote control system, need move the following signals:

- Working state of all remote control pump teams, and locks, as well as on-site control machineries or automatic control (to inform to regulating person).
- Stopping working of equipments because of breakdown.
- General alarm or damaged state of each work or the whole technological line.
- Specific and limited numeric value of technology parameters.
- Flooded station.
- Alarm (opening door) at the works not protected.
- Danger of fire.

13. REQUIREMENTS ON CONSTRUCTION SOLUTIONS, BUILDING AND WORK STRUCTURES.

TOTAL PLANE

13.1. Planning and constructing the works of water supplying system must be suitable to the requirements of general technology, instructions in the design standard on planning the industrial enterprises.

When the treatment works putting near the rivers and lakes, then the height of the ground must be higher than the wave top of the highest water level equivalent to calculated frequency in the rivers and lakes is 0.5m.

As for the first turn pump stations, attitude of the highest working floor must be higher than the wave top of the highest flood water level equivalent to calculated frequency is 0.5m.

13.2. When design the total plane of the treating area must have documents for surveying the underground works, hydrogeology document and the preliminary surveying documents of engineering geology in the plane of the treating area and their adjacent area if necessary.

13.3. Arranging stores of containing toxic chemicals such as Chlorine, Ammonia must be according to specific regulations.

Toxic chemicals when contain in the pressure tank must arrange apart from the water lake or the house and the other manufacturer bigger than 30m, when contain in the tank without pressure, then depend on the requirement of hygiene and fire fighting and must put at the end of main wind direction.

13.4. In every case, water supplying works must have covered fence. Structure and material to make the covered fence depend on the local condition.

13.5. In water treating area must plant green trees, the land part without construction must plant grass, the distance between green trees and the work must let trees' leaves not falling into the work and tree root not sabotage the underground works.

13.6. In the treating work must have protecting methods such as:

- Having covered fence;
- Far apart 50m must have signpost with marking prohibit area;
- Protecting lamp putting along the fences far apart together from 10 to 15 metres (depend on the output of tube)
- Telephone system.

SOLUTIONS FOR SPACE OF PLANE

13.7. Type and degree of fire-resistance of the house and the work depends on the confidence degree of supplying water take according to table 13.1.

Table 13.1

No.	Name of work	Confidence level of supplying water	Classification for the house and work	Fire-resistant level
1.	Collecting work	I II	I II	II III

		III	III	IV
2.	Pump station Confidence degree I Confidence degree II Confidence degree III	 I II III	 I II III	 I II III
3.	Water treating station (settle, filter, soften water, cooling water, eliminating iron, desalt)	II	II	II
4.	Chlorine making-up station	I	II	II
5.	Containing and conditioning pool From 1 to 2 pools with using for fire preventing, Bigger than 2 pools without for fire preventing,	I II	II II	Not define
6.	Surveying well on the network	III	II	Not define
7.	Water dam	III	II	II
8.	Pool for cooling circulation water Blower tower Cooling tower	 II II	 II II	 II-V II-V
9.	Spraying pool	II	II	Not define

13.8. When design the water treating station must pay attention to unify into block of the works with general technological line: chemicals house, purifying pool, filter tank, pump station, electric equipment, house for activities and auxiliary house, etc.

13.9. Stair for the underground parts of the pump station must have width at least 0.8m; sloping level is not smaller than 45^0. If the work has the length up to 12m, the sloping level of stair can take to 60^0. Width of stair to the valve control floor takes 0.6m sloping 60^0 and above. When the underground of pump station from 1.8m and above and the length (or diameter) of the station bigger than 18m must have at least 2 doors. The width of the doors at least is 1.2m.

13.10. In the pump stations must create the air convection current and fully natural light. If can not ensure, then must supplement by creating convection current of artificial air and artificial light.

Window of pump station must have protecting bars. The door must have the locks.

13.11. The containing pool has underground part putting the weak soil foundation, then on the ground surface must have partition wall toward the side of vehicles traveling. The distance from the partition wall to the wall of pool must be bigger than the buried depth of the pool.

Opening containing pool is higher than the ground surface up to 0.6m must have surrounding fence, not put opening pool near the road with lots of people and vehicles traveling.

COMPOSITION AND MATERIAL

13.12. The containing pool of reinforce concrete can design according to method of pouring at site, combining or half-combining.

13.13. The sink pump station by concrete, can design according to the opening-face digging method or dropping-down method depending on condition of terrain, engineering geology and hydrogeology.

13.14. Concrete mark of combining joint of stopping vein, of combining slit base vein must be higher than the concrete mark of the combining components or on-site casting concrete mark one grade.

13.15. Must have shiny coating insider for the water containing work to strengthen capacity of waterproof for the work.
The underground part of the water containing work must have shiny coating outside. As for land zone with underground water, except for shiny coating should have more ball layer coating outermost.
Inner or outer shiny coating layer need use cement mortar with yellow sand of high mark or pure cement.

13.16. For the water containing works and the works with requirement of high waterproof (pump station of raw water, clean water) if design by reinforce concrete must use concrete with mark 250 and above; if use concrete without reinforcement must use concrete with mark 200 and above.

13.17. Limit to the maximum the design for the works of containing water made of material of brick and stone. Especially, the works which bear pressure of water or with requirement of high waterproof. In case it is forced to have to design the water containing works made of brick, then use solid brick, mark 75 constructed by cement mark 75 and above.

13.18. Sloping roof of raw water pump station and sloping roof of the containing lakes must embank by stone or concrete plate.

13.19. Concrete layer with protecting reinforce of reinforce concrete structures belong to the works with chemicals must ensure at least is 30mm and above.

13.20. The well and valve pit on the pipeline built by brick, block stone or reinforced concrete.

13.21. The works placing subterranean under the ground partial or the whole must calculate, check and have a method of resisting pushing float which is caused by level of underground water or flood water. In case there is not an exact datum about the highest level of underground water or flood water, then the level of underground water or flood water takes same as foundation leveling core of the work. Need compose a layer of draining underground water under the bottom of subterranean placing works to drain off water during process of executing and amendment later.

13.22. Need have a method against hot for the containing pool: filling soil, planting grass or have other method. Thickness of filling soil layer at least is 20cm. In case need resist pushing float for the work, this filling soil layer can be thicker than calculated requirement.

13.23. The pipe going through the water containing works must be put in inserting pipe or make hard connection to the wall of the work.
Interstice between the inserted pipe and the pipe through the wall must be caulked hermetically by elastic and high waterproof material.
When the pipe going out of the wall must arrange the soft joining to protect pipe when appear phenomenon of irregular subsidence.

13.24. Reinforced steel used in the water containing works (including of steel putting for composition) must use steel with diameter 8mm and above and the distance between two steel bars cannot be bigger than 200mm.

13.25. Width of concrete layer for protecting reinforced steel for the water containing work and the works with requirement of high waterproof (pump station of raw water, pump station of clean water) must ensure:

- Bottom: 40mm
- Wall: 30mm

- Cover: 30mm
- Separated floor between the pools of stacking storey: 30mm

When design the water containing works, need arrange the vein of stopping executing and the vein of stopping executing combine to elastic interstice.

CALCULATION OF THE WORK

13.26. Load and over-load coefficient to calculate the work must be according to regulation in the loading design standard and impacts and according to table 13.2.

Table 13.2

Load and impact to the containing works	Over-load coefficient
1. Load and impact at the temporary and long-term a) Pressure of using water b) Pressure of underground water c) Effect of temperature	 1.1 1.1 1.2
2. Load and impact short temporary. a) Loading of machine which assembled and move to the block of sabotaged soil b) Pressure of water when eliminating	 1.3 (0.8) 1

Notes:

1) Loading caused by pressure on the wall and the bottom of the containing work takes as follow:

- Standard loading: equal to hydrostatic pressure of water; horizontal level of design water level.

- Calculating loading: equal to hydrostatic pressure of water; with over-load coefficient 1.1 but not over the water level to up to the wall top or spilling pipe.

2) Air temperature takes according to standard of construction climate datum.

3) On the roof of the containing work allow calculating temporary loading of kinds of light construction equipments.

4) Coefficient noting in the brackets applied in case the reducing of loading will have bad effect to working capacity of structure.

13.27. Calculating the containing work must carry out fully following cases:

- The work without containing water with surrounding of regular of irregular filling soil, underground water at the highest level with counting to active load distributing regularly or irregularly on the surface;
- The work with containing water, surrounding without filling soil;
- Force of pushing float caused by underground water at the highest level;
- The work has many compartments then must combine the compartment for containing and non-containing;

- Load arising during the executing process;
- Load of wind and other horizontal loadings if any.
- Calculating and checking fissure (caused by inner force and difference of temperature).

13.28. When construction works is in the area flooded or effected directly by the flood must calculate to the highest pressure of flooded water effects to the parts of the works

13.29. If the fissures on the work are only to 0.2mm, the work can be regarded as having not being fissured.

13.30. When design the water containing work must limit to the maximum the phenomenon of irregular subsidence and must meet requirements of arranging the technological line. For the water containing works (include of raw water pump station, collecting work, pure water pump station and works on the pipeline) the maximum permitted regular subsidence is 8cm.

CORROSION RESISTANCE FOR THE WORK

13.31. When design corrosion resistance for construction structure must follow the standard: Corrosion resistance for construction structure of house and work.

13.32. When design the work which bears the effect of electric current must have a method for electric corrosion resistance for component of reinforced concrete.

13.33. Parts of the structure must have the protecting layer for corrosion resistance. In case cannot carry out this problem, must increase the thickness of protecting layer for reinforced steel or increase the thickness and increase mark of outside mortar.

13.34. When design the liquid containing pool with unpermitted corrosion:

- Pillow the wall of the house on the wall of pool
- Place the pools stacking on together;
- Place the pipeline in the concrete layer of the bottom.

13.35. When reinforce foundation and other parts in the containing pool, cannot damage the protecting layer of corrosion resistance.

VENTILATING

13.36. In the station of quantifying Chlorine, must design the mechanical ventilating system which operates usually with atmosphere changing time is 6 times per 1 hour. This system must be controlled from the air analyzing machine and from pressing button fitting at the door.
Discharging air must be exhausted through the pipe putting higher than the top of the roof with the highest is 2m in area with radius 15m.
The air must be attracted with volume 50% from the lower zone and 20% from the upper zone of manufacturing compartment.

13.37. Ventilating system in the consuming Chlorine store must be mechanical ventilating system with number of air exchanging times 6 times per hour. In addition need have breakdown ventilating with number of additional air exchanging times 6 times per hour. This system must be controlled from the air analyzing machine. Simultaneously, the air analyzing machine must switch on sound and light signal to inform there is dangerous concentration of Chlorine in the store.
Waste air need to discharge through the pipe putting highly apart 15m from the

ground surface. Starting ventilating system need carrying out from the box of pressing button fitting at the door.

13.38. Ventilating for Ammonia quantifying house must be carried out through mechanical ventilating system with number of air exchanging times 6 times per hour. Wind discharging system must have spare blower at the same time of operating fan. Waste air is attracted from the upper zone; the pure air is put into the working area.

13.39. In the room putting Ozone making-up machine need design mechanic ventilating system with number of air exchanging times 6 times per hour. In addition, need have the breakdown ventilating system with number of supplementary air exchanging times 6times per hour. The wind discharging system must have spare blowers putting in parallel with operating blower. In the room putting machine need have air analyzing machine ensure switch off sound and light signal about having dangerous concentration of Ozone in the room.

13.40. In the room of making up Iron Chloride solution need design general ventilating system 6 air exchanging times per hour. In addition must design partial ventilating system from the cabinet for Iron Chloride bottles. Wind attracting speed at the operating holes of the cabinet must be not smaller than 0.5m/s.

13.41. In the room of making up Sodium Fluoride solution need design general ventilating system with 3 air exchanging times per hour. In addition need design partial ventilating system from the cabinet for Sodium Fluoride bottles and from the cabinet for cleaning the filtration parts of vacuum pump. Wind attracting speed at the operating hole must be not smaller than 0.5m/s.

14. ADDITIONAL REQUIREMENTS FOR WATER SUPPLY IN SPECIAL NATURAL CLIMATE CONDITION

SEISMIC AREA

14.1. When design the water supplying system at the seismic area with grade 7, 8, 9 need follow these regulations.

14.2. When design the water supplying works with confidence degree I, in the seismic area grade 8 and 9 need use two independent water supplying sources.

14.3. When use one source of supplying water with attracting nozzle at the different places, then water amount for fire fighting must be twice, simultaneously must add amount of necessary water to supply water for eating, drinking and living to the resident areas which having seism grade 9 in the time at least 12 hours and to the resident areas which having seism grade 8 in the time at least 8 hours.

Water amount need add for industrial areas takes according to diagram of breakdown.

14.4. In order to ensure the water supplying system operates safely need have following methods:

- Disperse the containing pools, put the containing pools at the areas opposite to the network;
- Replace water containing towers by the containing pools putting at the high point of construction area.
- Use the stations of increasing pressure for the water supplying works with flow 100m3/h;
- Use water supplying system with low pressure;
- Unify water supplying networks for eating, drinking – living, manufacturing,

fire fighting; supplying water which has not been purified but has been disinfected into the network of supplying water for eating, drinking – living after reaching an agreement with epidemic prevention organ.

14.5. Not allow unifying into block of pump station with other works except for collecting work.

14.6. The pump station putting deeply must place far apart from the containing pool and the pipeline at least 10m, the pipe putting through the wall of pump station must be covered by inserted tube.

14.7. The water containing works on the water treating station need classify into groups, must have at least two groups.

14.8. The water treating station must have round pipeline to supply water into the network. Must use a simple equipment of making up Chlorine to supply water into the network for eating, drinking and living.

14.9. Must design at least two containing pools. Each pool need connect to the network by specific design pipeline.

14.10. Don't permit halving hardly the pipeline in the wall and foundation of the house. Size of hole for the pipeline going through must ensure to have interstice at least 10cm. In case there is subsiding soil, the interstice is at least 20 cm high; must use elastic material to sealing the interstice.

The pipe placing through the wall of the containing work must be covered by inserted tube.

14.11. Must design soft joining at the following places:

- On the pipeline of water out, into the house and the work;
- At the place connecting to pump, water tank, well;
- At the place of vertical pipe of water tower connecting to horizontal pipelines;
- At the place which changes direction of putting the pipeline.

PIPELINE AND NETWORK OF SUPPLYING WATER

14.12. Need use following types of pipeline and conduits:

- Polyethylene pipe;
- Reinforced concrete pipe with working pressure up to 12kg/cm^2;

Allow using:

- Casting iron pipe and flexible casting iron pipe with working pressure up to 6kg/cm^2;
- Steel pipe with working pressure from 9kg/cm^2 and above.

14.13. Need have to use soft joints to connect reinforce concrete pipe, including of casting iron pipe.

14.14. The minimum depth for placing pipe, counting to the pipe top must be according to following regulation.

- Casting iron pipe and reinforced concrete pipe not smaller than 1m.
- Steel pipe: not define.

14.15. Must design two pipelines with horizontal connecting lines to change together to work. Number of horizontal connecting lines must define according to condition of appearing two places damaged on the pipeline. Simultaneously must ensure that can load 70% water amount for fire fighting and 70% water amount both for

eating, drinking – living and for industrial enterprises when these enterprises working according to diagram of breakdown.

Distributing network must design according to the hoop type circuit.

14.16. Should not put conduit and main pipelines in soil of saturated water (except for hard stone layer and big block of stone); in the filling soil layer with arbitrary humidity, and both in soil areas with tectonics destruction trace. In case must put the above pipeline in those layers of soil, then must use steel pipe.

STRUCTURE

14.17. Design the structure of buildings and works must follow standard for construction design at seismic area. Seismic grade of the building and work takes according to table 14.1.

Notes:

- Type of building and work of supplying water takes according to table 14.1.
- When design the containing work putting deeply. If seism exceed grade 7 must count with seismic impact.

Table 14.1

Type of building and work	Seismic grade of building and work when seismic grade on the construction area is		
	7	8	9
I	7	8	9
II	7	7	8
III	Without counting to seismic impact		

14.18. The containing work must be counted with simultaneous impact of soil loading; the own weight of structure, the weight of containing water and soil including of filling soil.

14.19. When define seismic loading of the work, in general value of seismic coefficient and oscillation form (βi; ηik) need take 1.5 for the containing work built underground and take 3 for the work built on the ground.

SUBSIDENT LAND AREA

14.20. Water supplying system for constructing at subsiding land area, must design according to design standard for foundation of building and work.

14.21. Building and work must arrange on the construction area ensure to drain raining water well.

Note: In case construction area is hillside, must design the surrounding channel on the hill to drain raining water.

14.22. Cannot construct the building and work on the bank of digging pit, on the bank of channel, gully and at the places which soil is easy to subside.

14.23. The distance from the containing work to types of building is defined as follows: In the soil area type I (the soil area type I is soil area which has not capability of subsidence because of the own weight), not smaller than 1.5 times thickness of the subsided soil layer; in the soil area type II (the soil area type I is the soil area which has capability of subsidence because of the own weight) have absorbent soil layer not smaller than 1.5 times thickness of subsiding soil layer, but not over 40m.

Note: Thickness of subsiding soil layer must count from natural soil surface of terrain.

14.24. In soil area type I; distance from the source causing usual subsidence to the place of constructing house and work allow not limit as long as can overcome subsidence statement absolutely.

14.25. In design drawings for the building and construction works at the subsiding area must ensure for the containing work and network closing hermetically; must have method for preventing absorbent into the soil; attracting and draining water at the leakage places.

14.26. The pipeline inside pump station and water filtration station, etc. must put on the floor surface. Can put the pipeline inside of un-absorbent gutter and drain water into private pit, from that water runs into checking well or into raining water draining system.

14.27. Public water nozzles must arrange at the lower places apart from the building and work a distance at least 10m.

14.28. For the soil area type I, the pipeline with pressure and running itself when design without subsidence of soil.

14.29. For soil area type II, when subsidence of soil is up to 20 cm, must ram carefully the foundation soil before putting the pipeline.

14.30. For soil area type II, when subsidence of soil is bigger than 20 cm, must put the pipe in the gully or in tunnel.

14.31. In order to observe leak water from the pipeline putting on the ground, need design checking well. The checking well can use checking well on the water supplying network. On the pipeline, the checking wells are put far apart together not over 250m. Can put discharging pipe in stead of checking well to discharge water into the depression when occurs breakdown but not let raining water submerge the pipeline.

On the auto-running pipeline, checking well put far apart together not over 200m.

14.32. When put water supplying pipeline in the ditch at the soil area type I, distance on horizontal direction counting from the outer face of pipe to the edge of buildings and works must take bigger than 5m; in the soil area type II take according to table 14.2.

Notes:

- In case there is have reinforcement method for subsiding soil, then not apply regulation in table 14.2.
- When water supplying pipeline with pressure over 6kg/cm^2, the above distance need take more 30%.
- In case cannot follow regulation in table 14.2; must put the pipeline in unabsorbent gutter; the gutter must have water discharging pipe for breakdown into the checking well.

Table 14.2

Thickness of subsident soil layer, m	Minimum distance (m) counting from the outer face of the pipe to the edge of building and work foundation in the soil area type II, when diameter of pipe is, mm			
	Up to 100	Over 100	Up to 300	Over 300
Up to 5	Same as soil without subsidence			

From 5 to 12	5	7.5		10
Over 12	7.5	10		15

14.33. The water pipeline and water supplying network, in front of spare part connecting to flange must compose moving joints put in the well.

14.34. In the soil area type I, design the well no need count to subsidence; in the soil area type II, soil foundation putting well must ram to 1m depth, the bottom and the wall under the pipeline must have unabsorbent composition. Surrounding soil of the well must make sloping 0.03 counting from the well mouth out.

14.35. The pipeline of water out, into the building must design according to design standard of inside water supplying.

14.36. Foundation of the containing work must be rammed with depth at least 1.5-2m. In volume of soil at rammed soil layer cannot be smaller than 1.6 T/m^3. Foundation of rammed soil must be wider size of the work toward each side at least 1.5m.

14.37. In the soil area type II, under the bottom of the work putting on rammed soil must have waterproof platform and composition of draining water into the checking well.

14.38. The water containing work which has bottom as contrary cone must have support pillar resting on foundation of unabsorbent reinforced concrete and have water draining composition into the checking well.

Note: For water supplying work with confidence degree III, when diameter is smaller than 10m, no need have water draining composition for breakdown.

14.39. For the water containing work with confidence degree I and II, constructed on the soil area type II, must follow subsidence and water leakage level of the work.

14.40. In the soil area type I; under foundation of the wall and column of building which put under the floor of pump station and the buildings with using water, under the containing pool must ram soil with depth 1.5-2m; the floor of the building with water must be made of unabsorbent material and have minimum sloping level 0.01 to drain off water into the collecting hole.

In the soil area type II, except for ramming soil, must make waterproof platform putting under the water containing work with water draining composition into the checking well.

14.41. Around the water cooling works should build unabsorbent pavement with sloping level 0.03 toward the collecting pool, width of pavement at least 5m, toward the direction of wind blowing the most strong and the width at least 10m. Under the pavement need ram soil carefully at the minimum depth 0.3m.

14.42. Under water tower must ram soil carefully according to regulation in article 14.36. In the soil area type II, foundation of water tower must be made of unifying block reinforced concrete platform with water draining composition into the checking well.

14.43. Around foundation of water tower, need have pavement paved by un-absorbent material, with sloping level 0.03 from water tower, the width of pavement must be bigger than footing of foundation pit 0.3 m but not over 3m.

EXPLOITING SOIL AREA – GENERAL REGULATION

14.44. When design the building and work, water pipeline and water supplying network must have protecting method to resist on the effects of mining exploitation.

14.45. Defining type of water containing work built at the exploiting soil area need base

on the economic-technical analyzing base and comparison between plans. In addition, must pay attention to size and shape of the containing work, properties of operation technology, amendment capacity, work restoration and other factors.

14.46. Cannot build the hermetic pools with capacity bigger than 6000m^3 on the exploiting soil area. In case it is imperative to have containing pool with big capacity, then need build some pools with smaller capacity.

Note: The containing pools for supplying water to manufacture don't define capacity of the pool.

14.47. Valve pits must be separated from the containing pool by deforming interstices.

14.48. On the exploiting soil area must design the containing works of reinforce concrete with shape of cylinder. In case there is exact reason, then allow designing the containing work with rectangle shape.

Must ensure to have easy travel path to the main parts of the containing work to carry out checking and repairing the work.

14.49. In the works of purifying and treating water (purifying pool, settling pool, filter tank, etc.) must have method to make flat the edge, gutter, gully after the work deforms. Gutters, gullies have submerged hole without requirement of making flat.

14.50. When design station of purifying and treating water, it need arrange particularly the main works, stations with small capacity, and then allow to unify the work into block.

14.51. In order to ensure station of purifying and treating water operate safely, each work need divide into block or unit.

14.52. Only allow designing horizontal settling pool in case there were methods of resisting the effect of exploitation (make interstice deforming, reinforce structure…)

14.53. The pipelines, gullies, gutters between the works in the station purifying and treating water must ensure to be able to displace and transpose.

14.54. In order to ensure deforming capacity of the pipeline in the pump station, air blowing station, station of purifying and treating water need use pillows of resting on joints, rolling pillows, sliding pillows.

14.55. Defining the bottom altitude and water level altitude in the containing work must ensure condition of water auto-running after the foundation is deformed.

14.56. Heavy equipments in the pump station, station of purifying and treating water must put on specific foundation without connecting to structure of the buildings. On the pipeline system in the station need put elastic conditioning pipe.

14.57. The pipeline, spare part putting in the pump station, air blowing station, station of purifying and treating water, in the valve pit of the containing work must use pipe and spare parts made of steel.

Notes: Allow using casting iron spare parts for the works with confidence degree II, III but install spare parts must install elastic joint.

14.58. The pipeline putting through the wall of the water containing work must have inserted tube and in front of the inserted tube must install elastic joint or insert by elastic material.

14.59. On the exploiting soil area can use all kinds of pipe but must count to factors of durability, using situation, deformation ability of hard joints as well as the base of economic – technical calculation.

14.60. Joints of pipe must use elastic material, rubber washers. Joints for welding steel pipe must have durability higher than metal durability of pipe.

14.61. On the underground steel pipeline must use steel spare parts. Only allow using casting iron spare parts in case there is composition of elastic joints.

14.62. The place putting air and water discharging valve on the pipeline must count to

subsidence of soil because of exploitation.

14.63. Must design two pipelines guiding water to consuming household. Allow supplying according to one pipeline but must construct the containing pool ensure containing enough amount of store water in order to supply in the time of overcoming breakdown.

14.64. Allow putting the pipelines in the same tunnel or gutter but must count to the deformation impact of ground surface caused by exploitation.

14.65. The pipe putting through rivers, channels, arroyos: the pipe must put more deeply than river bottom at least 0.5m and must have method of resisting erosion.

14.66. Structural methods to protect the underground steel pipe must base on the base of calculating durability and carry out following methods:

- Putting elastic joint to increase moving capacity of the pipe.
- Use material of few clinging to cover pipe a layer of 20 cm width.
- Raise force bearing capacity of pipe by using pipe with thick wall.

14.67. Pipeline protecting layer must define on the base of calculating results pipeline according to limited situation.

14.68. For steel pipe, limited statement is defined by force bearing capacity of pipeline on vertical direction ensure condition:

$m_a R_k \geq \Sigma\delta$; Where:

R_k – Calculated drawing-resistant force of the pipeline;

m_a – Working coefficient equal to 0.9

$\Sigma\delta$ - Total stress of vertical drawing in the calculated section of the pipeline caused by the effect of pressure in the pipe, temperature oscillation and effecting force of deformed soil during exploiting.

The effecting force of deformed soil on the pipeline is defined according to formula:

$$\delta_x = \frac{Q_o l}{\pi\delta}\left(1 - \cos\pi\frac{l_k}{l}\right) \quad (14\text{-}1)$$

Where:

δ - thickness of pipe wall, cm;

l – length of being drawn area in Munda, cm;

Q_0 – Intensity of effecting force of deformed soil, kg/cm^2;

l_k – Length of subsiding soil area for pipe in Munda drawing part, cm;

14.69. For casting iron pipe, reinforced concrete connecting to bowl or inserting, limited statement is defined by the maximum aperture of joints and still can keep intact hermetic level as long as:

$$\Delta \geq l_m\left(\varepsilon + \frac{D_u}{R_{min}}\right) \quad (14\text{-}2)$$

Where:

Δ ultimate aperture of joint;

ε horizontal deformation of ground surface in the calculating area;

D_u – Outside diameter of the pipe;

R_{min} Minimum arched radius of ground surface;

l_m – Distance between joints (length of pipe).

14.70. Distance between elastic joints l_c of underground steel pipe is defined according to formula:

$$l_c = \frac{\delta(m_o R_k - \sum\delta_k)}{Qo} \qquad (14\text{-}3)$$

Where: $\Sigma\delta_K$ total stress of vertical drawing caused by the impact of pressure inside the pipe, change temperature and bend elastically.

STRUCTURE

14.71. The containing works need design according to diagram of special deformation structure, hard structure diagram or mixed structure diagram.

14.72. Using typical design only allow when capacity is not exceed $500m^3$ and calculating deformation of the ground must be according to the relative horizontal deformation condition ε (1mm/m; and minimum arched radius R = 30km).

14.73. In order to create deformation capacity of the containing work and its parts must design the unabsorbent deformated interstices or using plastic soft structures.

14.74. Not allow the bottom of the containing work made of reinforced concrete with deformation structure putting lower than the underground water level.

14.75. For the containing pool counting on deformation diagram at few absorbent clay, need have water draining system.

14.76. In the soil foundation of the containing work according to the hard structure diagram, need have a buffering layer with 0.3 – 0.5m thickness, by gravel or macadam. In the soil foundation of the containing work according to deformation structure, need have a sand buffering layer with 0.15-0.2m thickness.

14.77. In necessary case, need design elastic conditioning gutters around the containing work or other methods to reduce or eliminate passive pressure of sliding soil in exploiting time.

14.78. Parts of the containing work must count according to design standard of structure of concrete and reinforced concrete.

14.79. Open containing pool (containing lake) must design according to deformation diagram with oblique wall and deformation interstice of horizontal cutting.

14.80. In exploiting area, can not use block stones, big block bricks to build the containing works.

14.81. For the containing pool with diameter bigger than 12m need use the roof with the form of parasol segment.

14.82. For the containing work counting according to hard and slim diagram must make of reinforced concrete which pours at site counting with basic and special loading.

14.83. In the containing pool of cylinder shape with roof although design according to mixed diagram need compose deformation areas between the wall of the pool and the bottom sheet, between bottom sheet and central concrete foundation and pillar. Between the edge of roof and the pool wall need compose sliding interstice which can move horizontally.

14.84. Types of purifying pool, vertical settling pool, mixed pool, alum pool, filter tank must design according to hard diagram.

14.85. Radian settling pool need design according to hard diagram or mixing diagram which has unchanged interstice between the bottom and mud raking machine.

ANNEX

Annex 1: Basic documents for studying water supplying diagram of the region

Annex 2: Evaluation for using water resources and choosing region to construct reservoir

Annex 3: Trial pump and monitor operation of the underground water collecting works

Annex 4: Methods of drilling wells for taking water

Annex 5: The requirements on filtrating tubes of water collecting wells

Annex 6: Standard of clean water quality used to design the water treating works supplying for eating, drinking and living.

Annex 7: Producing active Silicon acid

Annex 8: Methods of treating water to resist rust for the pipes

Annex 9: Produce black sand to do as catalyst when eliminate iron.

Annex 10: Methods of eliminating Manganese

Annex 11: Eliminate Sulfur Hydro in water

Annex 12: Eliminate Silicon acid diluted in water

Annex 13: Eliminate oxygen diluted in water

Annex 14: Hydraulic calculation for water supplying pipeline

ANNEX I

BASIC DOCUMENTS FOR STUDYING WATER SUPPLYING DIAGRAM OF THE REGION (AREA)

1. In order to use reasonably water resource in the water supplying diagrams of the region must be able to set up:

- Water supplying planning; it is one part of the region planning, and diagram of arranging manufacturing force of the region.
- Water supplying diagram of industrial areas to define the plan for constructing water supplying system and public water works the most economically and reasonably.

2. Water supplying planning and water supplying diagrams of industrial area where there is arrangement and development of industry, works for welfare and planning resident points must base on the datum of region planning, diagram of arrangement and development for industry, total plane and other documents.

3. Water supplying planning and water supplying diagrams combine to use synthetically and reasonably water resource with diagrams of developing irrigation and supplying water to agriculture, watering power and waterway traffic, fishing. There are general diagrams of using synthetic and preserving national resource which other specialized organ is set up.

4. In water supplying planning must have:

- Defining the current reserves of surface water and underground water, including of hot warer streams and using them.
- Defining the present statement of water supplying to resident points and industrial enterprises.
- Mapping out solutions of choosing water source and water supplying diagram with counting necessary method of protecting the fish source and hygiene of lakes.
- Establish the balance by water in the calculated period, simultaneously must put out the forecast of water quality in the future.
- Show on necessary methods to adjust again using of water.

5. In water supplying diagram to industrial areas need have to: do precisely datum on reserves of underground water and surface water, on statement of water supplying systems, on main construction industry, on consuming of underground water for calculated period of industry and resident, there is analysis for water supplying balance diagram to big enterprises with complex water using systems such as circulation and using purified waste water and waste water without being polluted.

For resident points and industrial enterprises water supplying diagrams are anticipated to have instruction of water collecting place and main pipeline; map structural diagram of collecting work, works of cleaning and treating water, damps, water reservoirs and water collecting lake, etc. with counting to combining to the water supplying works.

Define economic – technical norm of the water supplying lake; basic investment, cost of $1m^3$ water putting to the consuming place counting from water supplying source, contribution of water consuming household in construction, sequence and period of construction.

6. Consumed water part in water balance must ensure:

- Demand of water for living, manufacturing and service of the region,
- Water requirement for breeding fish,
- Water requirement for traffic; build wharfs; discharge water to ensure the depth for transport of ships,
- Protect normal water using condition of resident area and hygiene statement of the reservoir with counting to waste water which is pouring into and estimated to pour into,
- Discharge out of the reservoir to improve water quality because water is mineralizes or polluted by industrial waste water discharging into the reservoir,
- Water amount evaporating out of the reservoir when using the reservoir to make cooling.

Note: In case the households of consuming underground water at the lowerstream of the reservoir, then when calculate the reservoir, no need to count amount of underground water.

7. In calculating part for balancing surface water source, need have to know minimum amount of water, monthly average flow or daily average flow in the summer and winter, effective flow of the reservoir, water amount running into river of lowerstream of reservoir, useful numeric value of supplementary water amount is defined with counting to discharging amount of the reservoir according to the water compensation diagram. Underground water using for supplying water to living or industry is counted according to instruction at Item 4.

Polluted waste water after purifying can be reused for enterprises or for agriculture.

Exploiting reserves of underground water counting on grade A, B, C when analyse details of geological and hydrogeological conditions allow counting enough the reserves according to grade C_2.

ANNEX 2

EVALUATION FOR USING WATER RESOURCES AND CHOOSING REGION TO CONSTRUCT RESERVOIR

1. When evaluate using of water resources for purpose of supplying water need count to:

- Consuming rule and balancing water resource for purpose of using water with forecast for 15-20 years.
- Requirements for water quality put by consuming households.
- Properties of source water quality and capability of changing water quality.
- Properties of quality and number of silt, rubbish, movement of the mud and sand at the bottle and its stability.
- Capability of drought of water resource for rivers and lakes at mountainous region.
- Temperature of surface water according to months in year at different depths.
- Flooded months of rivers and streams.
- Reserves, supplementary conditions of underground water and reducing capability of reservoir due to changed natural condition, due to construction of reservoir and works of draining water, works of taking artificial water, etc.
- Quality and temperature of underground water
- Requirements of hygiene, requirements of organ on using and protecting water source, protecting fish, etc.
- Evaluation on economic and technical for conditions of using water from different water supplying sources.
- Capacity of making artificial damp and create out spare amount of underground water.

2. When evaluate reserves of surface water source to supply water, must ensure water flow which need have to supply and meet fully for consuming household at the lowerstream of the water collecting point such as: resident area; industrial enterprises; agricultural demand; demand of breeding fish; transporting demand of ships and other types of using water; simultaneously in order to requirements of protecting water supplying sources on hygiene.

3. In case the flow of remaining surface water under the collecting work is not enough, need estimate to adjust the natural flow in the limit of one hydrogeological year (adjust according to season) or take water from other surface water sources with abundant flow.

Note: Warrantee level for specific consuming households when current water flow in the reserves is not enough and increasing water amount is difficult or the cost is high which is decided according to the agreement with organ of using water and prophylactic hygiene.

4. Evaluating the reserves of underground water must bas on datum and surveying documents on hydrogeology.

5. When evaluate reserves need make clear the relationship of supplementing underground water source by surface water source.

6. Underground water reserves in necessary cases must be approved by authorities.

7. When design the reservoir need have to estimate and count to position of reserves is the most advantage for conditions of water quality and must pay attention of following problems:

- Change of water level rule.
- Size, area of flooded region and the region under the flooded water level.
- Phenomenon of sliding soil and washing away the bank.
- Change rule of underground water after putting water into the lake.

- Capacity of appearing floating things, masses of peat and properties on their quantity and quality.
- Temperature rule of water at the different depth.
- Height of the wave when have high winds.
- Change of chemical composition of water on the time in year according to observing documents during many years.
- Capacity or radiating and saturating toxic gas of water.
- Versatile process and change of opaque of water.
- Change of water quality because of effect of waste water.
- Chang of ecological environment of the reservoir (appearance of silt, water-plants and mosses, plants and beings in water).
- Change of hygiene statement.

4- Soil area of reserves, damp stem, type of damp, the work of discharging water must be chosen according to calculation with the most advantage condition of hygiene, construction, hydrogeology, engineering geology, terrain, hydro-meteorology. And we must count to requirements of design of public water works on the river such as:

- Estimate to clear lake-bed suitable to hygiene requirements. Engineering methods to protect territory from flood, and the bank is avoided reinforcing against.
- Time of arising the mud and in necessary case, estimate to wash the lake through discharging hole at the body of damp, gutter at the bottom or use the dredger to dredge, scoop soil.
- Methods of eliminating or reducing the development of water-plant and mosses, plants and reasons which making water color.

ANNEX 3

TRIAL PUMP AND MONITOR OPERATION OF THE UNDERGROUND WATER COLLECTING WORKS

1. To determine the flow of underground water collecting works whether it is consistent with the design or not, trial pump must be carried out once the construction completed.

2. The trial pump must be carried out with two times water level lower in well with flow as design flow and with flow higher than design flow 25-30%.

3. Total pumping time must reach 1-2 day and night each time down the well water level after the moving water level achieved a stable location and water thoroughly clear.

In case where underground water is not in stable state, pumping time must be enough to identify the laws of flow reduce when water level is stable or the law of water reduction when the flow is stable.
Note: When small sand washed up from the overlays around filtration tube and aquifer, should increase trial pumping time.

4. In the design of underground water collecting works, should prepare to install the network of monitoring wells or the water meter stations (for receiving underground spring water) to observe and monitor the water level, flow, temperature and quality of water. In this case, should use the exploitation wells and other water collecting works as designed which have been fully equipped with the necessary means of observation.

5. Structure of monitoring wells, their numbers and positions should be takes suitable with hydro-geological conditions in which the monitoring wells should be equipped with filtration tubes of diameter D89-D110mm.

6. The depth of monitoring wells should be taken under the following conditions:

For the aquifer without pressure, when the depth of exploitation wells below 15 meters, the filtration tube is taken as same as the depth of exploitation wells

For the aquifer without pressure, when the depth of exploitation wells over 15 meters, the upper top of working area of filtration tube must be located below the lowest moving water level from 2 to 3 meters.

For the aquifer with pressure, when the moving water level higher than insulation roof of the aquifer, the working area of the filtration tube must be installed at 1/3 above the aquifer, when the aquifer was partially dry, the top of working area of the filtration tube placed lower than the lowest moving water level in aquifer 2 - 3m.

For aquifers expected to exploit to end of static reserves, the top of working area of filtration tube must be placed below the lower level of the moving water from 2-3m at the end of the exploitation period of collecting works.

7. The depth of monitoring wells in the receiving works of deep well type, artesian well type and horizontal water receiving works should be taken by the depth to place the water collecting part of these works, while the top of the filtration tube of monitoring wells are placed lower than moving water level in the receiving works 2 - 3m.

8. In monitoring wells, water of upper level and the aquifer above the exploitation aquifer should be well isolated.

9. When necessary, should build wells to monitor the aquifers those are not exploited at the top.

10. To prevent the monitoring wells from closed, top of the filtration tube or supporting pipe caps must be sealed.

11. In the area of receiving works of surface water infiltration type from natural or artificial reservoirs, monitoring wells must be placed between the receiving works and flow of surface water, or lake, and in case of necessity, at the opposite bank of the lake. If any discovery where the underground water pollution (e.g. industrial waste water discharge site, lake water contains much of minerals, peat areas ...), between the pollution places and receiving works must build the additional monitoring wells.

ANNEX 4

METHODS OF DRILLING WELLS FOR TAKING WATER

1. When designing the water collecting works, method of drilling wells should be selected according to the hydro-geological conditions at site. The depth and diameter of well should be taken according to table PL-4.1.

2. In the unstable soft soil layer, should reinforce the wall of well from water receiving part to the mouth by tube.

3. To reinforce the wells, should use supporting tube made of steel which is overlap connecting or electric welding. When the initial diameter of well up to 426mm should use supporting tubes, for the well's diameter is larger than 426mm, should use steel tubes of electric welding, tube thickness 7 - 8mm for free tube lower by rotating drill and with tube thickness 10-12mm for tube lower by forced ramming drill.

4. To reinforce the well with the depth below 150m when using the method of rotary drill, and the depth below 70m when using the method of tower drill, allow to use non-metallic tube with cement coating on the tube wall.

5. Structure of wells using overlap tubes including orientation tubes, tubes for setting exploitation pumps, filtration tubes.

In the complex hydro-geological conditions, to prevent the aquifers and the soil layers with instable structure, which is easy to landslides and easy to be entrained with wash water, the structure of well must have auxiliary supporting tube.

6. Supporting tube columns for temporarily reinforcement to the drilling hole must be drawn up. The structures of the supporting tubes used as exploitation tubes, the free tube part must be drawn (overlap connecting) at the top up, the cutting edges in the top of the tube remaining in the wells must be higher than the lower bottom of the overlap tube inserted into a section not less than 3m while the depth of the well up to 50m, and not less than 5m while the well is deeper. Round slot between 2 overlap tubes must be coated by cement layer or inserted with washers.

7. The wells must be insulated to avoid contamination from the surface down to and from the aquifers those not to be in use by:

- Close or insert to the tube wall the natural or artificial clay layer.

- Insert cement outside the tube wall by means of putting cement liquid below the tube cap foil.

- Insert cement outside the tube wall by means of putting cement liquid to the estimated column of the design.

- Reinforcing the upper part of the well with two layers of wall tubes or by one layer of wall tube with insertion of cement outside the tube wall (to isolate the wells from being contaminated by surface water sources).

- When in the aquifers that going to be used or in the layers have hydraulic connection with used aquifers of corrosive nature, should have measures against leakage for wells or the tubes must be made of anti-corrosion materials.

Note: For insertion cement to the well, should use quick-linkage cement, marks not less than 400.

8. Should inspect the quality of the isolation of aquifers by pumping water out or draw water in when using the methods of ramming drill and compression of water under pressure when using rotating drill. Water used for quality testing of isolation between the aquifers must satisfy all hygiene requirements.

Table PL4-1

Drill method	Applied conditions
Rotary drill using clay fluid	Wells to be drilled in the favorable hydro-geological conditions, in the aquifers has been carefully studied in advance with reliable samples, and with consideration about flow reduction of the wells caused by clay fluid deposits to clog the soil layers. Should have electric logging after drilling.
Rotary drill using wash water or compressed air. Rotary drill using backwash	In the durable hard soil layers, the well having depth below 300m, diameter less than 1000mm and the majority of the soil layers without large boulders, when the depth of underground water distribution from the ground surface is 3m and more.
Ramming drill using cables	Wells placed in the soft soil layers with 100 - 150m depth (in hard rock layer, drilling up to > 150m depth is allowed)
Mixture (ramming drill and rotary drill)	Wells > 150m depth in the complex hydro-geological conditions, ramming drill through the aquifers and when the aquifers and no water layers containing no water are alternated. Rotary drill in the upper layers of aquifers intended for exploitation.
Reactive turbine	Wells with diameter > 1000mm and depth > 300m.

Note: When drilling through impermeable layer of clay with its depth is not great, allows for spring drill, clay and water used in drilling must satisfy hygiene requirements.

ANNEX 5

THE REQUIREMENTS ON FILTRATION TUBES OF WATER COLLECTING WELLS

1. Filtration tubes of water collecting wells must be selected according to the composition of the soil layer of aquifer and the depth of well, as per table PL-5.1.

2. While erosion water contains carbonic, H_2S, frames of filtration tubes must be made of stainless steel or other anti-rust materials with necessary durability.

3. Size of water receiving hole on filtration tube without pebble layer, should be selected under table PL-5.2.

4. Size of water receiving hole on the filtration tube with pebble layer, should be selected as average diameter of pebble particles in the adjacent layer to the filtration tube wall.

5. The hollowness of filtration tube has with round holes or slots must be ensured from 20-25%, filtration tube of winding steel frame or stamping steel sheet is not more than 30-60%.

6. In the pebble filtration tube, such pebble layer must use sands, pebbles, and mixture of sands and pebbles. The materials for pebble layer should be selected under the following expression:

$$\frac{D_{50}}{d_{50}} = 8 - 12$$

Where:

D_{50} diameter of pebble particle which other particles have smaller diameter consumes 50% of the pebble layer.

d_{50} particle diameter which other particles have smaller diameter consumes 50% of its soil layer containing water.

7. In the pebble filtration tubes, thickness of each pebble layer should be selected as follows:

- The filtration tube for pebble layer on the ground not less than 30mm.

- The filtration tube for support pebble layer created in drilling holes not less than 50mm.

8. Mechanical compositions of the materials formed by two or three layers of pebbles should be selected by the following expression:

$$\frac{D_1}{D_2} = 4 - 6$$

Where: D_1 and D_2 the average diameter of particles in the adjacent pebble & stone layers.

9. When choosing a pebble material layer for filtration tube made of hollow concrete or soft glazed terra-cotta must comply with the following rate:

$$\frac{D_{tb}}{D_{50}} = 10 - 16$$

D_{tb} average diameter of particles in filtration tubes (mm)

10. The inner diameter of filtration tube must be selected not less than 80-100mm.

Table PL-5.1

Aquifers	Types and structures of filtration tubes
The unstable haft stone soil layer, compacted pebble with size from 20-100mm over 50% by volume.	Filtration tube with boring holes or slots of filtration tube with frame structures.
Sand and pebble mixture, the size of the particles from 1-10mm. The particles with sizes from 1-5mm are over 50% by mass	Filtration tube with slits or holes, water collecting surface which is winding or steel sheet with stamping slots. Filtration tube, frame are stainless steel rods, outer is winding or pressed with stainless steel sheet.
Large sand, the particles have sizes from 1-2mm over 50% by mass.	Drilling filtration tubes for surface water collecting is winding, stamping steel sheet or pressing mesh with squares holes. Filtration tube, surface frame for water collecting are winding wire, steel sheet with stamping slots or steel mesh with square holes
Medium sand, the particles have sizes from 0.25 to 0.5 mm over 50% by mass	Filtration tube or frame for surface water collecting is smooth woven mesh (gold lame fiber) Filtration tube or frame wrapped a layer of pebbles (pebble filtration tube)
Small sand, the particles have sizes from 0.1 to 0.25 mm over 50% by mass	Filtration tube or frame covered 1 layer, 2 layers or 3 layers of sands or mixture of sands and pebbles. Filtration tube by hollow concrete or soft glazed terra-cotta

Notes:

- Steel filtration tube is allowed to be used for wells of any depth.

- Filtration tube made of soft glazed terra-cotta is used for monitoring wells, the wells set in layers of clay and sand mixture, inside the wells the clay fluid must be used when drilling, does not allow to be placed in water collecting wells containing iron.

- Filtration tubes made of wood, glass plastic, hollow concrete, soft glazed terra-cotta are allowed to be placed in the wells with depths below 100-150m.

- In the layers of large pebbles, instable stones, the depth of wells below 100 m, are allowed to use filtration tube with armored frame with stamping steel sheet with anti-rust surface.

- For the filtration tube must be covered square woven mesh made of gold lame or stainless steel, can be covered with plastic sheets with pressing slot.

Table PL-5.2

Type of filtration tubes	The hole sizes of filtration tube in mm	
	When heterogeneous coefficient of soil $\eta \leq 2$	When heterogeneous coefficient of soil $\eta > 2$
Round hole drilling	2.5-3 d_{50}	3-4 d_{50}
Slot drilling	1-1.25 d_{50}	1.5-2 d_{50}
Mesh wrap	1.5-2 d_{50} $\eta = \frac{d_{50}}{d_{10}}$	2-2.5 d_{50}

Where: D_{10}, D_{50}, D_{60} particle diameter in which the other particles with a smaller diameter consumes 10%, 50%, 60% in the soil layer (determined by the analysis diagram of particle components of the soil layer).

Note: The small size of the water receiving hole on the filtration tube for small particles and large size for large particles.

ANNEX 6

STANDARD OF CLEAR WATER QUALITY USED TO DESIGN THE WATER TREATING WORKS SUPPLYING FOR EATING, DRINKING AND LIVING

This standard is applied to design the water treating works supplying for eating, drinking and living.

A. As to physicochemical

No.	Factor	For urban water supplying system	For individual stations and in rural
1.	Opaque level, NTU	≤ 2	≤ 2
2.	Colored level, TCU	≤ 15	≤ 15
3.	Odour	Without smell, strange taste	Without smell, strange taste
4.	pH level	6.5 – 8.5	6.5 – 8.5
5.	Hardness, ^{o}dH	≤ 12	≤ 17
6.	Oxidizing level $KMnO_4$, mg/l	≤ 2	≤ 5
7.	Sulfur Hydro, mg/l	≤ 0.05	≤ 0.05
8.	Chloride, mg/l	≤ 250	≤ 250
9.	Nitrate, mg/l	≤ 50	≤ 50
10.	Nitric, mg/l	≤ 3	≤ 3
11.	Sulfate, mg/l	≤ 250	250
12.	Phosphate, mg/l	≤ 2.5	≤ 2.5
13.	Fluor, mg/l	0.7 -1.5	≤ 1.5
14.	Iodine, mg/l	0.005 – 0.007	≤ 0.007
15.	Ammonia, mg/l	≤ 1.5	≤ 1.5
16.	Calcium, mg/l	≤ 100	≤ 200
17.	Iron, mg/l	≤ 0.3	≤ 0.5
18.	Manganese, mg/l	≤ 0.2	≤ 0.5
19.	Copper, mg/l	≤ 2	≤ 2
20.	Zinc, mg/l	≤ 3	≤ 3
21.	Aluminum, mg/l	≤ 0.2	≤ 0.2
22.	Lead, mg/l	≤ 0.01	≤ 0.01
23.	Arsenic, mg/l	≤ 0.01	≤ 0.01
24.	Cadmium, mg/l	≤ 0.003	≤ 0.003
25.	Mercury, mg/l	≤ 0.001	≤ 0.001
26.	Chrome, mg/l	≤ 0.05	≤ 0.05
27.	Cyanide	≤ 0.07	≤ 0.07
28.	Concentration of odd Chlorine at the treating station or pressure increasing station	> 0.5 mg/l, but not bigger up to the level causing unpleasant odour	> 0.5 mg/l, but not bigger up to the level causing unpleasant odour
29.	Concentration of odd Chlorine at the end of network	> 0.5 mg/l, but not bigger up to the level causing unpleasant odour	> 0.5 mg/l, but not bigger up to the level causing unpleasant odour

Note: Other quality norms are not stated in this standard take according to current standard of water quality supplying for eating, drinking and living defined by Ministry of Health.

B. As to organism

1- In water it is not allowed to have kinds of organism which it is visible to the naked eye, there are not eggs of pathogenous parasitic worms and microorganism.
2- Total number of Coliform is equal to 0 in 100ml testing water.
3- E.Coliform or Fecal Coliform is equal to 0 in 100 ml testing water.

C. Management of water quality

1. Locations for taking testing water usually take at the treating station, containing pool, water tower and at the taps. Number of samples in one day at the water taking location is decided by epidemic prevention station combine to water factory. Method of sampling and analyzing for physicochemical and microorganism of water must follow the current National Standards.
2. Management unit of water manufacturing and business is responsible for ensure the water quality of eating, drinking and living. Local epidemic prevention station usually checks periodically. When there are unusual phenomena or the factors which do not ensure the required quality, the epidemic prevention station must combine to the management unit of water factory to stop supplying water and find out solution.
3. Individual water supplying station for one resident area or water supplying station of enterprise with combining water for eating, drinking and living, then the management unit of supplying water is responsible for ensuring water quality. Testing room of the unit which is responsible for testing water quality and propose the methods of protecting water source and water quality. Local epidemic prevention station checks periodically. The units which there are not a laboratories or rural water supplying stations, then the management unit need have to follow regulations and instructions of the local epidemic prevention station. Local epidemic prevention station shall check periodically.

ANNEX 7

PRODUCING ACTIVE SILICON ACID

Activate liquid glass solution with concentration 1.5-2.5% (counting on SiO_2) by alum solution with concentration 1.5-3.5% (counting on $Al_2(SO_4)_3$ must carry out in the continuous acting stations by mixing liquid glass solution with alum solution in the reaction bin, after that activate mixing solution which has just collected in the coincident equipment.

Must put chemical solution into the reaction bin to stir according to the rate: volume of liquid glass solution need be 0.5-1 volume of sulfate aluminum solution.

Operating concentration of chemical solutions and their volume rate need be defined in management process depend on quality of chemicals.

Station of producing active acid Silic must carry out the conditions:

- Consuming 3.5T liquid glass with content 28.5% SiO_2; modulus is not lower than 2.9 and 1.8 T aluminum alum with content 10% Oxide Aluminum Al_2O_3 to be able to collect 1 T activated acid Silic (concentration 100% counting according to SiO_2).
- Concentration of liquid glass solution 1.9% according to SiO_2.
- Capacity of quantifying pump and capacity of barrels for moving the solutions taking according to rate: 1:1.
- Stir the liquid glass solution with aluminum alum solution in the reaction bins with installing mechanical wings. Time of stirring solution is 1-2 minutes.
- Volume of coincident equipment is defined according to calculating staying time of collecting solution during 60 minutes and when compose coincident, must estimate capability of changing staying time of solution in the limit from 30 to 60 minutes.
- Dissolve liquid glass and stir it in the barrel by compressed air with intensity 3-5 l/cm^2.
- Need settle the operating solutions and collect them from the upper layer in working bins.
- When need have to transport activated glue, concentration off activated glue solution cannot over 0.5%. In necessary case of composing the storing barrel but time of preservation is not bigger than 12 hours. When put glue directly into mixing pool, then no need dilute them.
- Number of stations cannot be fewer than 2, number of reaction bin in each station is 2 (1 for working, 1 for storing). No need place stored station.

2. Activate liquid glass solution by Chlorine must carry out on the continuously operating stations when consuming amount according to calculation of actived acid Silic under 3-5kg/hr counting according to SiO_2 or in interrupted operating equipments when consuming amount is bigger.

Station for activating liquid glass solution by Chlorine operating according to cycle must use two Chlorine quantifying equipments (Chlorator), centrifugal pump and two barrels.

In working bin must count: prepare liquid glass solution with concentration 1.5% counting according to SiO_2. Circulate the solution through Ejector of Chlorator during 2 hours; dilute solution to the concentration 0.5% by SiO_2. Capacity of barrel W_A to activate liquid glass by Chlorine counting by m^3, defined according to formula:

$$W_A = \frac{D_a.q.T}{K}$$

Where:

D_a – Dosage of activated acid Silic counting by, g/m^3

q- Flow of treating water, m^3/h

T – Necessary time for producing activated acid Silic, hour (not smaller than 4 hours)

K – Concentration of activated acid Silic solution after diluting by water, g/m^3.

Barrel for activating must be hermetic and has ventilating pipe.

Use compressed air with intensity 3-5 l/cm^2 to prepare and stir solution.

Circulation centrifugal pump transfer liquid glass solution into Ejector of Chlorator equivalent to given flow must make out pressure not lower than 4-5 kg/cm^2 (40-50 metres column of water).

The pipeline and spare parts for transferring active acid Silic solution which is chlorinated must made of rust-resistant material.

Number of equipments for activating liquid glass by Chlorine putting in the station cannot be fewer than 2 (one for storing). Need have to estimate putting intermediate consuming barrel to transfer liquid glass into the equipment.

The house for putting Chlorator and acid Silic quantifying equipment must design according to requirements proposing for Chlorator.

ANNEX 8

METHODS OF TREATING WATER TO RESIST RUST FOR THE PIPEs

1. Resist rust for the pipe by the way which always keep Calcium Carbonate protecting film (or one layer of cement coating) on the inside surface of pipe wall which is not destroyed during transportation of water. In order to exclude CO_2 eroding factor which destroys the protecting layer, need put more alkali chemicals into water to keep the water stabilizing index I = pHo – pHs be always equal to 0 or have light positive value. However, dosage of alkali chemical putting into water cannot be so big that makes pH value of water after treating to supply for living is bigger than 8.5. Alkali chemical and dosage of alkali agent putting into for stabilizing water is counted according to Item 6.

2. Resist rust for casting iron and steel pipes of water conduits supplying for manufacturing can use phosphatized method. In that time dosage of Hexameta Phosphate Sodium hay Tripoly Phostphate Sodium must take as 15-25 mg/l (counting according to products in the market).

When put new section of pipe into the management, need have to soak the pipes fully by solution of Hexameta Phosphate Sodium or Tripoly Phosphate Sodium with concentration 200-250mg/l during 2-3 days and nights.

4. Prepare solution of Hexameta Phosphate Sodium or Tripoly Phosphate Sodium to treat and stabilize water need carry out in the barrels with protection of rust resisting. Concentration of working solution from 0.5-3% is counted according to technical product.

Diluting time in the barrel with mechanical stirring wings or using compressed air is 4 hours when temperature of water is 20°C and is 2 hours when temperature of water is 30°C.

ANNEX 9

PRODUCE BLACK SAND TO DO AS CATALYST WHEN ELIMINATE IRON

1. In order to intensify the effect of eliminating Iron in water, can use catalyst as black sand. Black sand is quartz sand coated by one layer of Manganese Oxide film on its surface.

2. Create one layer of Manganese Oxide on the surface of sand pellet by the way: Firstly, dip sand and stir them in solution of Manganese Chloride $MnCl_2$, after that stir them suspending in the solution of Potassium Permanganate $KMnO_4$ with concentration 1%.

Manufacturing process: sand is sorted out and washed putting into the stirring barrel with solution amount so that sand volume makes up 25% volume of barrel. Sand is stirred in mixing barrel containing solution of $MnCl_2$ with concentration 15% during the time from 1-2 minutes. After that remove solution of $MnCl_2$ out of stirring barrel and put into the storing barrel. After that pour the solution of $KMnO_4$ with concentration 1% into the stirring barrel. Sand is stirred regularly with this solution during time of three hours, after that leave this solution and dip sand one time again in solution of $MnCl_2$ 15% stirring regularly during 2 minutes, one time again put solution of $KMnO_4$ 1% into to stir sand regularly during 3 hours. Depend on the width of Manganese Oxide film which would like to have on the sand's surface so that repeat the above process from 1-5 times, the film is usually created regularly on the sand surface after 3 times of digging.

3. In manufacturing condition, can carry out cultivating the film of Manganese Oxide on the surface of sand pellet right in the filter tank. Stirring sand with solution of $KMnO_4$ 1% carried out by pumping and washing. The attracting pipe of pump connecting to the barrel for containing solution of $KMnO_4$. The solution is pumped through the sand filter tank and then running into the barrel. Use this way for each period necessary to reconstitute layer of MnO_2 film on the sand surface in the touching filter tank after the time interval of working with loosing ability of catalysis.

ANNEX 10

METHODS OF ELIMINATING MANGANESE

1. Must eliminate Manganese (Mn) of water for eating, drinking and living when Mn content in source water is bigger than 0.2 mg/l.

2. Choosing method of eliminating Mn as well as calculated parameters and dosage of chemical must be carried out on the base of experiment research result for finding technical line, carry out directly at water source.

3. Eliminating Mn in surface water is carried out simultaneously with process of purifying and eliminating colour. Part of calculating the works follow instructions at Item 6. Part of composing the work must be suitable to the both processes of purifying, eliminating colour and eliminating Mn.

4. Eliminating Mn in underground water: in case underground water includes of Mn and Fe, the must compare the economic effect between the plan of eliminating Fe and Mn simultaneously with the plan of eliminating Fe completely and then eliminating Mn.

If eliminating Fe, it is forced to use chemical (Iron is in the form of glue or has big content) then eliminating Fe and Mn will be carried out simultaneously.

Note: Process of oxidizing Mn(II) into Mn(III) and Mn(IV) by Oxygen of the air diluted in water happens verry slowly. When pH < 8, if not use chemical, oxidizing Mn^{2+} in fact does not happen or happens very slowly. When pH > 8.0, process of oxidizing Mn(II) into Mn(IV) by Oxygen of the air happens more quickly.

5. The Mn eliminating line is used and combined between the filter tank and methods of using chemicals for oxidizing Mn.

6. Can use one of following methods to eliminate Mn:

a) Make airy and then filter through Piroluzit, black sand.

b) Filter water by quartz sand after having used chemicals such as Chlorine, Chlodioxide, Ozone or KM_nO_4 to oxidize Mn.

c) Use Lime, Caustic or Soda, combine to alum and then settle and filter.

d) Filter through Cationic pool.

The line (a) can only carry out when pH of water after the airy process reach to value ≥ 8.5. When pH < 7, although having catalyst, oxidizing process Mn(II) by Oxygen of the air also does not occur. In this case must alkalify to raise pH of water.

The line (b) need pay attention: Time for transforming Mn(II) into Mn(III) and Mn(IV) when use Chlodioxide and Ozone at pH = 6.5-7 is 10-15 minutes.
When use Chlorine (also at the above pH) need 60-90 minutes.

The line (c): used when water source has requirement of softening by Lime or Soda or when combine to the process of eliminating simultaneously. The nature of phenomenon is when raise pH to 9-9.5, oxidizing Mn(II) by Oxygen in the air happens quickly and in water creates out flake of sediment $Mn(OH)_3$ and $Mn(OH)_4$, it plays roll of catalysis in the process of oxidizing Mn(II).

The line (d): Nature of this method is adsorbing process, exchanging, catalysis itself of ion Mn^{2+} happens on the surface of filtration material layer with coating absorbing film – catalysis itself Manganese Dioxide Hydrat $MnO_x.yH_2O$. This kind of filtration material must separate out of the process of eliminating Fe by two layer or two turn filter tank depending on total quantity Fe + Mn having in water and capacity of the works. Two layer filter tank only should use when total content Fe + Mn of underground water counting on formula $5Mn + 2Fe^{2+} \leq 5mg/l$ and output $Q< 100m^3/hr$. In case Fe exists at glue form and has big content, can separate the process of eliminating Fe at the settling pool and filter tank only has duty of eliminating Mn and one small part Fe remains after the pool settles. Eliminating Mn by this method can apply to both water source with $6.5 < pH < 7.5$. Water is at the balanced state of $CaCO_3$. Filtration cycle of Manganese filter tank should take about the interval $3 \text{ days} < t < 14$ days.

The line (e) is use few in the fact of manufacturing.

7. Composition of filter tank for eliminating Mn is chosen similar to filter tank used to purify, eliminate color as well as for eliminating Iron.

8. Dosage of chemical calculated for eliminating Mn as follow:

a. Dosage of Chlorine, Δn counting on mg/l.
- When in water there is no NH_4^+
$\Delta n = 1.3 [Mn^{2+}]$

- When in water there is NH_4^+
$\Delta x = 1.3 [Mn^{2+}] + (5\text{-}10)[NH_4^+]$

Note: If in water there is organ agent, then must count to expending Chlorine to oxidizing them.

b- Dosage of Chlodioxygen (mg/l)
$\Delta c = 1.35 [Mn^{2+}]$

c- Dosage of Ozone (mg/l)
$\Delta o = 1.45 [Mn^2]$

d- Dosage of $KMnO_4$ (mg/l)
$\Delta k = 2.06 [Mn^{2+}]$

e- Dosage of Lime or caustic or Soda putting into water: is enough for pH concentration of source water raise up to the numeric value 9-9.5.

9. When eliminate Mn by Chlorine, that pH of source water ≤ 7, the subsidizing pool must have time of keeping water is not less than 60.

10. When eliminate Mn by $KMnO_4$, the solution of $KMnO_4$ diluted at concentration 3%. Mixing and preserving solution by stainless steel barrels, or plastic barrels. Stirring and mixing solution by compressed air or mechanical equipment. Diluting $KMnO_4$ by hot water at temperature 50-60°C. Stirring time is 2-3 hours.

Flow of $KMnO_4$ is counted according to:

$$q = \frac{Q.D}{C.3600}$$

Where:
q – Flow of solution $KMnO_4$, l/s.
Q – Flow of treating station, m^3/h.
D – Dosage of $KMnO_4$ g/m^3.
C – Concentration of solution $KMnO_4$, g/l.

The point putting solution $KMnO_4$ into water must ensure that the transformation from pink color into brick yellow color is finished at the subsidizing pool or purifying pool. If there is the subsidizing pool, that process must finish before lead water into the filter tank. In case there is using of alum, then put solution $KMnO_4$ in to before putting alum into water.

ANNEX 11

ELIMINATE SULFUR HYDRO IN WATER

1. In order to eliminate Sulfur Hydro (H_2S) and Hydro Sulfide (HS^-) can use following methods: chlorinate, airy and then chlorinate, acidify, airy, flocculate and filter.

2. Chlorinate to eliminate Sulfur Hydro in water must carry out as follows:

a. Dosage: 2.1mg Chlorine for 1 mg Sulfur Hydro in water.

When define total quantity of Chlorine to treat must count to the quantity which requires more Chlorine to oxidizing other compounds in water.

When it is lack of this datum, dosage of additional Chlorine over necessary level to oxidizing Sulfur Hydro take equal to 2-3 mg/l.

When purify water according to this method shall create out the suspending agent (brimstone) and number (counting according to dry substance) by content of Sulfur Hydro containing in source water. When need eliminate brimstone in water must estimate to treat water by flocculation and filtration. Dosage of flocculants agent is defined by experiment.

b) Dosage of Chlorine 8.4mg for 1 mg/l Sulfur Hydro in water.

In the case occur the process of oxidizing Sulfur Hydro into Sulfite and shall not create out suspending substance (brimstone).

3. In order to reduce Chlorine amount, the water with pH smaller than 7.2, before Chlorinate must airy at opening form must take following parameters: load 15 m^3/m^2.h, the airy frame with pouring coke coal, slag, etc., large level 30-50mm, width of each layer 300-400mm; distance between layers 600mm.

When content of Sulfur Hydro in water is up to 5mg/l must have 3 layers; when content of Sulfur Hydro to 10 mg/l must have 5 layers. Room for putting the airy frame must be equipped blower with multiple of volume exchanging is 12 times.

Must design air testing tower when Carbonate hardness is smaller than 3 mgdl/l, the touching material uses the hoop of glazed terra-cotta 25x25x3mm or foamed wood. When Carbonate hardness is bigger than 3 mgdl/l, then use foamed wood.

Load on the air testing tower with touching material is hoop of glazed terra-cotta takes as 40 m^3/m^2.h; the height of glazed terra-cotta hoop layer is 2m when content of Sulfur Hydro is lower 10 mg/l, is equal to 3 m when content of Sulfur Hydro is to 20 mg/l. Flow of air is equal to 20 m^3 for 1 m^3 water.

The load in the air testing tower with piling wood takes as 30 m^3/m^2.h. Height of wood layer must be higher than height of glazed terra-cotta hoop layer 1m. Amount of air takes as 15 m^3 for 1 m^3 water.

By the airy way, if can reduce 20-30% amount of Sulfur Hydro in water, then saving Chlorine is appropriate.

4. When eliminate Sulfur Hydro in water according to method of acidifying, airying must estimate the following sequence of treatment:

- Acidifying by acid Sulfuric or acid Chlohydric still pH=5.5.
- Airying on the air eliminating tower.
- Chlorinate to oxygenate the remaining Sulfur Hydro after airying.
- Treat by flocculation and filtration to eliminate brimstone at the glue form created out during process of airying and Chlorinating.

Dosage of acid (mg/l) to reduce pH to 5.5 must define according to formula:

$$D_K = K.e.\frac{100}{c}$$

Where:

- K: Alkalinity of source water mgdl/l.
- e: Equivalent weight of acid.
- c: Content of acid Sulfuric, acid Chlohdric in technical acid %.

Dosage of Chlorine to oxidize the remaining Sulfur Hydro in water after airying takes as 4-5mg/l.

Water purified according to method of acidifying, airying, purifying must treat stably subsequently by alkalifying to eliminate corrosion.

ANNEX 12

ELLIMINATE SILICON ACID DILUTED IN WATER

1. Eliminate compounds of acid Silic in water is carried out by following methods:

a) In order to reduce content of SiO_3^{2-} to 3-5 mg/l then flocculate by Iron alum or Aluminum alum.

b) When alkalinity of water is under 2 mgdl/l, in order to reduce content of SiO_3^{2-} to 1-1.5 mg/l, then treating by Magnesite alkali. The treatment process must carry out at water temperature is over 35°C.

c) In order to reduce content of SiO_3^{2-} to 0.1-0.3 mg/l, then filter water through adsorbent Magnesium Oxide according to two degree diagram with making hot water and ensure when water is out of the filter tank with temperature not smaller than 40°C.

Note: Design to eliminate Silic and simultaneously desalt must be according to articles noted in Item 6.

2. When eliminate Silic in water by flocculation; dosage of $FeSO_4$, $FeCl_3$ or $Al_2(SO_4)_3$ must take as 15 mg for 1 mg SiO_3^{2-} and dilute more Lime with dosage enough to raise up pH after diluting to 7.8 to 8.3.

Calculated dosage of lime D (mg/l) (counting CaO) is defined according to formula:

$$Dv = 28\left(\frac{CO_2}{22} + \frac{Dp}{ep}\right)$$

Where:

Dp – Dosage of alum counting according to dry product (mg/l)

CO_2 – Content of acid Carbonite in source water (mg/l)

ep – Equivalent amount gram of alum (mg/mgdl)

Speed of water flow up to in the settling region of purifying pool must take as 0.9-1 mm/s with height of suspending sediment layer not smaller than 0.3m. Purified water amount in sediment separating compartment is equal to 10-25%. When necessary to reduce suspending substance in water down to under 15 mg/l, then must filter water.

3. When eliminate Silic in water, dosage of Magnesium Oxide or melt Dolomit Do (mg/l) must define according to formula:

$$Do = (SiO_3^{2-})12 - 1.7\,(Mg^{2+}).\,\frac{100}{C_{MgO}}$$

Where:

SiO_3^{2-}: Concentration of acid Silic in source water (mg/l)

Mg^{2+}: Content of Magnesium in source water (mg/l)

C_{MgO}: Content of magnesium MgO in Alkali Magesite or melt Dolomit (%).

Dosage of Lime counting on CaO, Dv(mg/l) when alkalinity of water is bigger than 2mgdl/l defined according to formula:

$$Dv = 28.\frac{CO_2}{22} + C_K + \frac{MG^{2+}}{12} + \frac{D_P}{ep} + 0.5 - \frac{D_o.C_{CaO}}{100}$$

Where:

CO_2 – Content of free CO_2 in source water (mg/l).

C_K – Carbonate hardness of source water (mgdl/l).

D_P – Weight of alum of Fe or $FeSO_4$ (mg/l).

ep – Equivalent amount gram of alum (mg/mgdl).

C_{CaO} – Content of CaO in Alkali Magnesite or melt Dolomit (%).

In order to calculate purifying pool must take following datum:
Speed of water flow up to in the settling region in the table 0.7-0.8 mm/s. Purifying water amount collecting in sediment separating compartment is equal to 30-40%. Height of suspending layer is 5.5-4.2m. Height of settling region is 2-2.3m.

4. When eliminate Silic by filtrating through adsorbent of Magnesium Oxide, the adsorbent need pile into the filter tank into layer with height 3.4-4m with pellet size 0.5-1.5mm.

The water before putting into the adsorbing filter tank, must eliminate Bicarbonate and free acid Carbonic. The water must be heated to ensure temperature of water after filtering is not lower than 40°C. Filtration speed takes smaller than 10m/s.

Must design the cultivating system for cultivating periodically th adsorbent in the filter tank by water flow going up from the bottom with intensity 3-4 $l/s.m^2$.

Adsorbent of Magnesium Oxide can not reconstitute. Silic containing amount of adsorbent takes as 10% of its weight. Weight of volume when pours into the heap is from 0.75-0.85g/cm^3.

ANNEX 13

ELIMINATE OXYGEN DILUTED IN WATER

1. Eliminate Oxygen diluted in water no need boil water as follows:

- Spray water in vacuum equivalent to the boiling-point of water at given temperature.
- Associate Soluble Oxygen with reducing agent Sodium Sulfite.

2. Associate soluble Oxygen with reducing agent must carry out in the mixing pool with hermetic mixing pool, counting with staying time of water in 5 minutes. In order to Oxygen eliminating process, need mix catalyst is Copper salt (1mg/lCu) or Cobalt (0.001mg/l Co) at the form of solution 0.01%. If want to eliminate 1 mg Oxygen must put into water 8.5mg Natri Sulfite. Chemicals are put into water at the form of solution 3-5%.

3. Oxygen eliminating tower with using vacuum must count with load of water is 50 $m^3/h.m^2$. Touching material can use glazed terra-cotta hoop 25x25x5mm. Volume of glazed terra-cotta hoop to reduce concentration of soluble Oxygen in water takes according to table of Annex 13.1.

Pressure in the air eliminating tower takes according to table of annex 13.2.

Table of annex 13.1

Oxygen content in source, mg/l	Volume of glazed terra-cotta hoop (m^3) counting for capacity 1m^3/h at different temperatures of water.				
	5°C	10°C	13°C	20°C	30°C
5	0.068	0.053	0.045	0.04	0.032
10	0.074	0.059	0.050	0.045	0.035
12	0.080	0.058	0.058	0.05	0.045

Table of annex 13.2

Temperature of water °C	15	20	30	40
Pressure in the air eliminating tower kg/cm^2	0.028	0.053	0.055	0.09

ANNEX 14

HYDRAULIC CALCULATION FOR WATER SUPPLYING PIPELINE

A. CALCULATING ACCORDING TO STANDARD OF THE RUSSIAN FEDERATION

1. Pressure loss in the pipeline of water transmission and distribution system caused by hydraulic resistance of pipe, joints as well as spare parts on the pipe.

2. Pressure loss per unit of pipes length (called as hydraulic sloping) including of joints resistance, is determined by the formula:

$$I = (ở/d) \times (v^2/2g) = (A_1/2g) \times [(Ao + C/v)^m /d^{m+1}] \times v^2$$

Where:

ở – Hydraulic resistance coefficient, defined according to formula:

$$ở = A_1(A_0 + B_0 d/Re)^m /d^m = A_1(A_0 + C/v)^m /d^m$$

d - Inside diameter of the pipe, m

v – Average speed of water flow in the pipe, m/s

g – Acceleration of gravity, m/s^2.

Re = vd/ớ - Numeric value of Renon; $B_0 = CRe/vd$

ớ - Kinetics viscous coefficient of the liquid, m^2/s

Value of exponent index m and coefficients A_0, A_1 and C for steel pipes, casting-iron pipes, reinforced pipes, plastic pipes and glass pipes takes according to table of annex 14.1.

3. When water is not treated stably or do not have the inside effective protectinglayer, hydraulic impedance of steel and casting iron pipe will increase fast. In that case, formula for defining the pressure loss in iron pipes, casting iron pipes is only used to calculate and check in case need analyse the working condition of water supplying system in the first stage of exploitation.

Iron pipes and casting iron pipes normally used have the inside protecting layer of cement, polymer or sand cement. In case there is not any protecting layer and water isn't treated stably, we need add coefficient (not smaller than 2) into the values Ao, C according to table PL 14.1 and K according to table PL 14.2. The above coefficient value must base on the loss incremental datum in the pipe working at similar condition.

Table PL 14.1.

No.	Type of pipe	m	A_0	$1000A_1$	1000 x $(A_1/2g)$	C
1	New steel pipe without the inside protecting layer or with the bitumen coating	0.226	1	15.9	0.810	0.684
2	New casting iron pipe without the inside protecting layer or with the bitumen coating	0.284	1	14.4	0.734	2.360

3	New steel pipe and old casting iron pipe without the inside protecting layer or with the bitumen coating	V<1.2 m/s	0.30	1	17.9	0.912	0.867
		V>1.2 m/s	0.30	1	21.0	1.070	0
4	Reinforced concrete pipe of vibration pressing		0.19	1	15.74	0.802	3.51
5	Centrifugal rotary reinforced concrete pipe		0.19	1	13.85	0.706	3.51
6	Steel pipe and casting iron pipe with the inside protecting layer of plastic or polymer cement, coating by centrifugal rotary method		0.19	1	11.0	0.561	3.51
7	Steel pipe and casting iron pipe with the inside protecting layer of sand cement, coating by centrifugal rotary method		0.19	1	13.85	0.706	3.51
8	Plastic pipe		0.226	0	13.44	0.685	1
9	Glass pipe		0.226	0	14.61	0.745	1

Note: Numeric value C is offered with ớ = $1.3x10^6$ m^2/s

These values are equivalent to the modern making technology.

If the guarantee values Ao, A1, C of the manufacturer are different ot the values given in the table of annex 14.1, they must be shown in the catalogue or the technical norms of manufacturing pipe.

4. Hydraulic impedance of joints need define according to the manual, hydraulic impedence of spare parts is given in the documents of manufacturer.

When there is insufficient datum about joints and spare parts installed on the pipeline, that partial pressure loss is allowed to get 10-20% in comparison the loss in length on the pipeline.

5. When carry out economic-technical calculation and hydraulic calculation for the network of transmissing and distributing water on the computer, pressure loss in the pipeline is defined according to formula:

$$H = i \times l = K \times q^n / d^p \times l, (m)$$

Where: q – Calculated flow, l/s
d – Calculated inside diameter of the pipe, m
i – Hydraulic sloping level
l – Length of pipe section

Numeric value of coefficient K and exponent coefficients n, p takes according to table PL 14.2.

Table PL14.2.

No.	Type of pipe	1000 K	p	n
1	New steel pipe without the inside protecting layer or with the bitumen coating.	1.790	5.1	1.9
2	New casting iron pipe without the inside protecting layer or with the bitumen coating.	1.790	5.1	1.9
3	Old steel and casting iron pipe without the inside protecting layer or with the bitumen coating.	1.735	5.3	2
4	Reinforced concrete pipe of vibration pressing	1.688	4.89	1.85
5	Centrifugal rotary reinforced concrete pipe	1.486	4.89	1.85
6	Steel pipe and casting iron pipe with the inside protecting layer of plastic or polymer cement, coating by centrifugal rotary method.	1.180	4.89	1.85
7	Steel pipe and casting iron pipe with the inside protecting layer of sand cement, coating by centrifugal rotary method.	1.486	4.89	1.85
8	Plastic pipe	1.052	4.774	1.774
9	Glass pipe	1.144	4.774	1.774

In addition, when carry out simple hydraulic calculation for the independent sections, can use hydraulic spreadsheet or diagrams given in advance, depend on size as well as material of pipe and other parameters.

B. CALCULATING ACCORDING TO STANDARD OF USA AND EU

Since ten years and up to now, a great number of theoretical equations and experimental formulas for calculating hydraulic loss has been used by USA as well as countries belongs to European Economic Development Community (EU). Almost of these formulas are evaluated that have the same origin from the Colebrook formula, their strong point is logistic and can apply to all kinds of liquid, however they also have weak point, that is its mathematics form relatively complete. Therefore, up to now, some experimental formulas are still used.

1) Darcy – Weisbach equation

$$J = \frac{\lambda V^2}{2gD}$$

2) Manning equation

$$V = \frac{1}{n} R^{2/3} J^{1/2}$$

Where:

$$J = 6.35(n - V)^2 D^{-4/3}$$

Average value of coefficient n for the different pipe materials:

- PVC-HDPE: 0.009 – 0.013

- Casting iron pipe with plating inside cement: 0.01 -0.013
- Casting iron pipe with inside is still harsh: 0.015
- Concrete pipe: 0.012 – 0.015
- Casting iron pipe: 0.012

3) Hazen – William formula

This is the most popular formula, particularly in USA and Japan. The pressure loss is function of coefficient C, modifies according to diameter of pipe and the state of inner face of pipe

$$J = 6.824\left(\frac{V}{C}\right)^{1.852} D^{-1.167}$$

Average value of coefficient C for the different pipe materials:

- PVC; HDPE: 140-150
- Casting iron pipe with plating inside cement: 135-150
- Casting iron pipe with inside is still harsh: 80-120
- Concrete pipe: 0.012 – 0.015
- Concrete pipe, casting iron pipe: 130-150

This formula is applied for all kinds of liquid and gas substances, at the place with tangled flow condition (Re > 2400), however do not apply to the conduit specialized to transmit gas with too big length.

4) Colebrook formula

$$\frac{1}{\sqrt{\lambda}} = -2\log_{10}\left[\frac{K}{3.71*D} + \frac{2.51}{\mathrm{Re}} * \frac{1}{\sqrt{\lambda}}\right]$$

Where:

$$J = \frac{\lambda V^2}{2gD}$$

Symbols of all parameters in the formulas stated above:

Symbol	Description	Dimensionality
J	Loss on length (m/m)	Non-dimensional
λ	Loss coefficient	Non-dimensional
D	Inner diameter (m)	Unit of length
V	Average speed at the studying section (m/s)	Unit of length/time
g	Gravity acceleration (m/s^2)	Unit of length/$(time)^2$
k	Equivalent roughness coefficient in Colebrook formula (m)	Unit of length
Re	Reynold numeric value	Non-dimensional
ν	Kinetics viscosity (m^2/s)	$(Unit\ of\ length)^2$/time
R	Hydraulic radius (m)	Unit of length
S	Wet section of pipe (m^2)	$(Unit\ of\ length)^2$
P	Wet circumference of pipe (m)	Unit of length
n	Roughness coefficient in Manning formula	Non-dimensional
C	Loss coefficient in Hazen-William formula	Non-dimensional