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Improvement Of the Process of Softening and Purification of Technical Water from Mechanical Mixtures

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Annotation: In the purification and softening of technical ways circulation water in our Republic and around the world taking into account the physicochemical-colloidal properties of water in purifying them from various metal ions mainly the separation of valuable chemical reagents and finely dispersed mechanical mixtures in water have been used. During the cooling or heating of raw materials of industrial water production enterprises, heat exchange increases the hydraulic resistance of process equipment as a result of cracking on the inner surface of the equipment, resulting in increased energy consumption, in addition to a decrease in heat and change of substances

In the purification and softening of technical ways circulation water in our Republic and around the world taking into account the physicochemical-colloidal properties of water in purifying them from various metal ions mainly the separation of valuable chemical reagents and finely dispersed mechanical mixtures in water have been used. During the cooling or heating of raw materials of industrial water production enterprises, heat exchange increases the hydraulic resistance of process equipment as a result of cracking on the inner surface of the equipment, resulting in increased energy consumption, in addition to a decrease in heat and change of substances. Therefore, one of the current problems is the softening of circulating technical waters and their purification from mechanical impurities [1].

In order to purify and soften the circulating technical water of the production enterprise from mechanical impurities, research work was provided on the project of the industrial technological system.

Principle of operation of the technological system is shown in Figure 1, which consists of: water is pumped to the clarifier (1) by means of a pump (7) in order to precipitate large dispersed solid particles in the gravitational field, the flow of untreated untreated water is rectified through the valve (14). The water, purified from large dispersed particles, then enters the filter (2) through the pump (8) to remove fine particles. To reduce (soften) the hardness of purified industrial water, it is sent to a container (3) filled with various chemical reagents and equipped with a stirrer and a pump (9).

Water, purified and softened from fine mixtures, is collected in a vessel (4) to cool the hydrocarbon feedstock. From here, the water through the pump (9) enters the heat exchanger (5), the water leaving the heat exchanger (5) is directed to the heat exchanger block (6) by means of the pump (19). Purified water leaving the heat exchanger block (6) is directed to the volume (5) through the pump (11), and the

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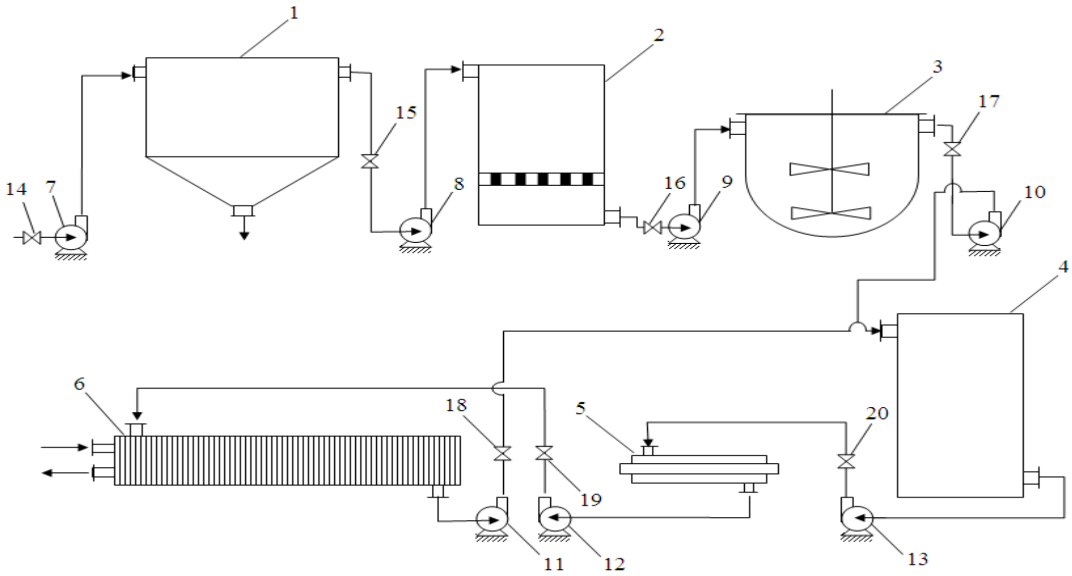

Figure 1. Technological line for purification and softening of circulating water from mechanical impurities: 1- tinder; 2-filter; 3- mixer; 4- container for purified water; 5- heat exchanger; 6- block of heat exchangers; 7-13 pumps; 14-20- gate valves.

water and the water circulates inside the system. Waste water flow leaving the heat exchanger block (6) is corrected by the valve (18) and directed back into the volume (5). The technological system is also equipped with instrumentation for setting the mode parameters

This technological line has been tested in the conditions of an Oil Refinery. The purpose of the tests is to purify the circulating water of an oil refinery from fine solid particles of mechanical mixtures and reduce its hardness.

The water sample was kept in the separator for 2 hours to remove large dispersed particles, during which time the large dispersed particles settled in the separator. The capacity of the purified water storage tank is 1500 m^3. When calculating the geometric dimensions of the technological line, all calculations were made with a margin of 15% in relation to the total volume of the device. The height of the purifier is usually not calculated and is taken equal to 2.5 ÷ 3.5 m [2]. According to this source, the sump was 3 m high, 5.5 m wide and 11 m long, and the total volume was 154.5 m^3. The dimensions of the filtration equipments are as follows: height - 12.5 m; width - 4.5 m; length - 4 m, total volume of the filtering apparatus 193 m^3.

During the tests of the proposed technological line in production conditions, shortcomings were identified, for which the following changes were made: In particular, the degree of tightness has been improved by sealing the sealant seals, the filter device, and the welds of the fluid transfer lines and the joints of the fasteners.

In the course of the study, the influence of various parameters of the production line on the process of purifying industrial water from solid mixtures and reducing hardness in industrial conditions was studied. In this case, the flow rate of water entering the reservoir varies in the range of 0.1 ÷ 1.0 m/s. During the experiments, the sedimentation rate of the fractions of solid particles was determined on the basis of table 1.

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Table 1
Effect of particle size on the settling rate of solids

№	Particle size, mkm	Settling rate, m/c, 10^3	Settling time, sec,	Solid particle concentration, %
1	< 500	9,46	0,0283	0,81
2	< 400	9,42	0,0282	1,22
3	< 300	9,35	0,0280	1,96
4	< 200	9,33	0,0280	2,12
5	< 100	9,28	0,0278	2,61
6	< 80	9,25	0,0277	2,98
7	< 60	9,18	0,0275	3,66
8	< 40	9,15	0,0274	4,02
9	< 20	8,46	0,0254	11,20
10	< 10	8,14	0,0244	14,60
11	up to 5	0,00043 No settling	$1{,}29\cdot10^{-6}$	54,82

The speed of movement of solid particles was determined by the following formula:

$$\omega = \frac{d^2 g(\rho_{sol.} - \rho_e)}{18\mu}\varepsilon F(\varepsilon) \qquad (1)$$

where, d^2 is the diameter of solid particles, *m*;
$\rho_{sol.}$ ва $\rho_{e.}$ – density of solid particles and medium, *kg/m³*;
μ - dynamic viscosity of the medium, *n·sec/m²*;
ε - volume fraction of liquid in suspension, *m³*.

According to the results of the experiment, the value of Fε, when solid spherical particles are ε <0.7, is determined by the following equation (2):

$$\Phi(\varepsilon) = 10^{-1{,}82(1-\varepsilon)} \qquad (2)$$

According to the results of the study, it was possible to reduce the hardness of circulating water in industrial conditions using various chemical reagents.

The total hardness of the investigated water of Kuimazor was 47 mg-eq/l. The effectiveness of the reagents was studied by exposing each reagent to 1 ton of water in varying proportions. The amount of the reagent was changed within 20-70 g. According to the research results, the most suitable reagent was 0.2% Na_3PO_4 and its consumption in industrial water in the amount of 100 g/t. As a result of the effect of this reagent on the circulating water, the total water hardness drops sharply from 47 mg-eq/l to 2.1 mg-eq/l. An increase in the amount of reagent added to water up to 200 g / t did not lead to a significant decrease in water hardness (table 2).

Table 2
The results of reducing the hardness of recycled water in an industrial environment

Na_3PO_4, g	Change in water hardness, mg-eq/l	Na_2HPO_4 + sulfonol, g	Change in water hardness, mg-eq/l	Na_2HPO_4, g	Change in water hardness, mg-eq/l	Na_3HPO_4 + sulfonol, g	Change in water hardness, mg-eq/l
70	8	70	7,4	70	28	70	18
80	6,5	80	6,1	80	22	80	16
100	2,2	100	2,9	100	17	100	15
200	2,1	200	2,7	100	15	100	13

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The technical parameters of the proposed technological system are shown in Table 3.

Table 3
Technical characteristics of the offered equipment

№	Characteristic	Purifier	Filter
1	Hydraulic resistance, Pa	2950	3300
2	Efficiency of water purification from mechanical impurities, %	20	99,9
3	Remaining concentration of fine dispersed solid particles in purified water, mg/m³	80,6	0,1
4	Work productivity, m³/day	154	193
5	Occupied area, m²	60,5	18

On the basis of provided research on production conditions, a horizontal clarifier for purification of recycled industrial water from coarse solid particles, as well as a filter apparatus for cleaning fine particles and a chemical reagent for normalizing the total hardness of purified industrial water - 0.1% Na_3PO_4 (100 g/t quantity) and the hardness of purified water is reduced to 2.1 mg-eq/l as a result of using this technological line.

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