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RESULTS OF EXPERIMENTS OF STUDYING THE COMPOSITION AND PURIFICATION OF TECHNICAL WATERS

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Annotation. The article presents the results of a study to determine the elementary composition of technical water formed by the gas processing plant. Some defined elements from the composition of process technical water include: Al, As, Ba, Bi, Ca, Cd, Co, Tl, Cr, Cu, Fe, In, K, Li, Mg, Zn, Mn, Mo, Na, Ni, Pb, Sb, Sr. Determination of the elementary composition of technical water is carried out by using the device ICPE-9000 Shimadzu. Moreover, the results of reducing the hardness of technical water are also presented and the most suitable reagent is determined. In order to reduce the hardness of technical water, reagents $Ca(OH)_2$, $Na(PO_4)_3$, Na_3PO_4, $Al_2(SO_4)_3$, Sulfonyl, $Na(PO_3)_n$, H_2O, NaF, $Al_2(SO_4)_3$, $18H_2O$, were used in the experiments.

Keywords: technical water, reagent, elementary composition, purification, mechanical impurities.

Introduction. The presence in the water of mechanical impurities of fine sand, clay, silt suspensions, particles of hydrotreating metals, organic compounds, cause increased turbidity and color of water. This causes breakdowns of valves, pumps and is unacceptable for most technological processes. Therefore, the removal of such pollutants is a paramount task in water purification [1-7].

Hardness is a parameter of water quality. Water hardness is one of the qualitative characteristics of water, which is caused by the presence in water of salts of two alkaline earth metals - calcium and magnesium. Hardness is important for assessing the quality of any used technical, drinking and water used for the needs of industrial enterprises with specified characteristics. The total hardness of water is determined by the sum of temporary and permanent hardness. Constant hardness of water - calcium and magnesium salts of hydrochloric, sulfuric nitric acids i.e. strong acids. Such hardness salts in water do not precipitate during boiling and do not crystallize in the form of scale. Temporary hardness of water is an indicator of the presence of calcium and magnesium carbonates and bicarbonates in water, which, when boiled and pH values are greater than 8.3, almost completely precipitate into a flocculent precipitate, crystallize in the form of scale or form a film on the water surface [8–13].

Methods. According to the method for determining the hardness of water in hydrochemistry, it is considered: 0-4 ml eq / l soft water; 4-8 ml eq/l of medium hardness water; 8-12 ml equiv/l hard water; more than 12 ml equiv/l very hard water. This applies to the assessment of the total mineralization of water, but for drinking water the maximum allowable concentrations are 0-7 ml eq / l. Specialists in the field of filtration conditionally divide the hardness of drinking water as follows: 0-1.5 ml eq / l - soft water; 1.5-2 ml-eq / l - optimal drinking water; 2-5 ml-eq/l - hard water; 5-7 ml-eq / l - superhard water; more than 7.0 ml-eq/l non-drinking water, outside the recommended values [14-17].

Results and Discussion. To determine the elemental composition of industrial water generated from the technological processes of gas processing plants, a series of experiments was carried out, the experiments were carried out using an ICPE-9000 Shimadzu instrument, Japan. The results of the analysis are shown in table.1.

Table.1.

The results of the analysis of industrial waters of a gas processing plant (ICPE-9000 Shimadzu)

Element name	Content, *mg/l*	Element name	Content, *mg/l*	Element name	Content, *mg/l*
Al	0.923	*Cr*	0.0461	*Mn*	0.0575
As	0.0870	*Cu*	<0,003	*Mo*	0.0170
Ba	0.0874	*Fe*	4.72	*Na*	248
Bi	<0,003	*In*	0.216	*Ni*	0.148
Ca	11.7	*K*	36.1	*Pb*	0.473
Cd	0.0621	*Li*	0.205	*Sb*	0.233
Co	0.0556	*Mg*	24.6	*Sr*	0.350
Tl	<0,003	*Zn*	0.0945		

Table 1 shows that in the composition of industrial waters the content of Al is 0.923 mg/l, As is 0.0870 mg/l, Ba is 0.0874 mg/l, Bi<0.003 mg/l, Ca is 11.7 mg/l, Cd is 0.0621 mg/l, Co-0.0556 mg/l, Tl<0.003 mg/l, Cr-0.0461 mg/l, Cu-<0.003 mg/l, Fe-4.72 mg/l, In-0.216 mg/l, K-36.1 mg/l, Li-0.205 mg/l, Mg-24.6 mg/l, Zn-0.0945 mg/l, Mn-0.0575 mg/l, Mo-0.0170 mg/l, Na-248 mg/l, Ni 0.148 mg/l l, Pb-0.473 mg/l, Sb-0.233 mg/l, Sr-0.350 mg/l, the largest indicator of Na is 248 mg/l, etc. this is explained by the fact that the purification of such industrial waters requires several steps and a large amount.

In order to determine the hardness of industrial water, a number of experiments were carried out, first, analyzes were carried out to determine the hardness of industrial water formed from Muborak Mining and Chemical Combine. Titration method i.e. using chemicals Trilon B, ammonia 25% aqueous and methyl orange, an analysis was carried out to determine the hardness of industrial water "Muborak" GPP.

To reduce the hardness of industrial waters, a number of chemical reagents were used: Ca(OH)2, Na(PO4)3, Na3PO4, Al2(SO4)3, Sulfanol, Na(PO3)n*H2O, NaF, Al2(SO4)3*18H2O, etc. (Table 2).

Table 2

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, *mg-eq/l*
1.	$Ca(OH)_2$	0,01 %	9
2.	$Ca(OH)_2$	0,02 %	9
3.	$Ca(OH)_2$	,0,03 %	10
4.	$Ca(OH)_2$	0,05 %	17

5.	$Ca(OH)_2$	0,07 %	17
6.	$Ca(OH)_2$	0,08 %	18

Table 2 shows that with an increase in the percentage of calcium hydroxide (Ca (OH) 2) from 0.01% to 0.08%, water hardness increases from 9 meq/l to 18 meq/l due to calcium . This is due to the fact that the hardness of water increases due to Ca.

In order to reduce the hardness of industrial water, sodium polyphosphate reagent (Na(PO4)3) was used.

Table 3

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, *mg-eq/l*
1.	$Na(PO_4)_3$	0,01 %	4
2.	$Na(PO_4)_3$	0,02 %	6
3.	$Na(PO_4)_3$	0,03 %	6
4.	$Na(PO_4)_3$	0,04 %	5
5.	$Na(PO_4)_3$	0,05 %	5
6.	$Na(PO_4)_3$	0,06 %	5
7.	$Na(PO_4)_3$	0,07 %	0 (turned blue)
8.	$Na(PO_4)_3$	0,08 %	0 (turned blue)

It can be seen from Table 3 that Na(PO4)3 was used in the ratio of 0.01%-0.08% to reduce the hardness of process water. With the use of 0.01% sodium polyphosphate, water hardness decreased from 13.6 *mg-eq/l* to 4 *mg-eq/l*. A further increase in the ratio of sodium polyphosphate to 0.07% - 0.08% water hardness was 0. This is due to the fact that with an increase in the concentration of sodium polyphosphate, water hardness gradually decreases.

The experiments were also carried out with the reagent sodium phosphate (Na3PO4).

Table 4

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, mg-eq/l
1.	Na_3PO_4	0,01 %	3
2.	Na_3PO_4	0,02 %	3
3.	Na_3PO_4	0,03 %	3
4.	Na_3PO_4	0,04 %	3
5.	Na_3PO_4	0,05 %	3
6.	Na_3PO_4	0,06 %	3
7.	Na_3PO_4	0,07 %	2
8.	Na_3PO_4	0,08 %	2
9.	Na_3PO_4	0,09 %	2

Table 4 shows that Na3PO4 was used in the ratio of 0.01%-0.09% to reduce the hardness of process water. With the use of 0.01% sodium phosphate, water hardness decreased from 13.6 *mg-eq/l* to 3 *mg-eq/l*. A further increase in the ratio of sodium polyphosphate to 0.07% -0.09% water hardness was 2. With an increase in the concentration of sodium phosphate, the water hardness decreased on average 2.

To reduce the hardness of process water, experiments were carried out with aluminum sulfate reagent Al2(SO4)3; 10 ml of process water were taken during each experiment to reduce hardness.

$$Al_2(SO_4)_3 + 6H_2O \rightarrow 2Al(OH)_3\downarrow + 3H_2SO_4$$
$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4\downarrow + 2H_2O + 2CO_2\uparrow.$$
$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4 + 6CO_2\uparrow.$$

Table 5

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, *mg-eq/l*
1.	$Al_2(SO_4)_3$	0,01	15
2.	$Al_2(SO_4)_3$	0,02	20
3.	$Al_2(SO_4)_3$	0,03	25
4.	$Al_2(SO_4)_3$	0,04	30
5.	$Al_2(SO_4)_3$	0,05	55
6.	$Al_2(SO_4)_3$	0,06	53
7.	$Al_2(SO_4)_3$	0,07	68
8.	$Al_2(SO_4)_3$	0,08	82
9.	$Al_2(SO_4)_3$	0,09	92
10.	$Al_2(SO_4)_3$	0,1	100

Table 5 shows that at a concentration of Al2(SO4)3 of 0.01%, the water hardness index was 15 mg-eq / l, with an increase in the concentration of Al2(SO4)3 reagent to 0.02%, the water hardness also increases in parallel to 20 *mg-eq/l*; Al2(SO4)3 is not suitable for softening industrial water.

Next, the reagent sulfanol was used.

Table 6

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, *mg-eq/l*
1.	Sulfonyl	0,2	4
2.	Sulfonyl	0,4	2
3.	Sulfonyl	0,6	1
4.	Sulfonyl	0,8	1
5.	Sulfonyl	1,0	1

Table 6 shows that when using sulfanol in a ratio of 0.2÷1.0 *mg-eq/l*, water hardness decreases within 4÷1 *mg-eq/l*.

In order to soften process waters, sodium polyphosphate Na(PO3)n*H2O was also used as a reagent.

Table 7

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, mg-eq/l
1.	$Na(PO_3)_n{*}H_2O$	0,003	0,15
2.	$Na(PO_3)_n{*}H_2O$	0,004	0,28
3.	$Na(PO_3)_n{*}H_2O$	0,006	0,36
4.	$Na(PO_3)_n{*}H_2O$	0,007	0,42
5.	$Na(PO_3)_n{*}H_2O$	0,009	0,63

At a Na(PO3)n*H2O concentration of 0.003%, the hardness of industrial water was 0.15 ml-eq/l, at 0.004% the water hardness was 0.28 ml-eq/l, at 0.007% the water hardness index changed to 0.42 ml-eq/l, and at 0.009% reagent water hardness increased to 0.63 ml-eq/l. This is explained by the fact that it is advisable to use 0.003% Na(PO3)n*H2O to reduce the hardness of industrial waters.

In the course of wholesales, NaF reagent was used to reduce the hardness of industrial waters.

Table 8

The results of reducing the hardness of industrial waters (initial hardness of industrial water - 13.6 mg-eq / l)

№	Reagent names	Reagent concentration, %	Water hardness, mg-eq/l
1.	NaF	0,01	1
2.	NaF	0,02	1
3.	NaF	0,03	1
4.	NaF	0,04	1
5.	NaF	0,05	1
6.	NaF	0,06	1
7.	NaF	0,07	1
8.	NaF	0,08	1
9.	NaF	0,1	1

Table 8 shows that with the sodium fluoride reagent, industrial water has acquired constant softness.

In the course of the experiments, a series of experiments was also carried out to reduce the hardness of technical water and the salt content in the composition of technical water from the Mubarek GPP was determined.

Table 9

The results of reducing the hardness of process water (initial hardness of industrial water - 13.6 mg-eq / l)

Reagent *Al2(SO4)3*18H2O, %*	Quantity *Ca, mg-eq/l*	Hardness, *mg-eq/l*	Hydrocarbonate, %	Sulfur content, %
0,01	8	12,5	-	-
0,05	**5**	**12**	**-**	**-**
0,1	6	12	-	-
1,0	11,5	40	-	-
2,0	17,7	60	-	-

From Table 9 it can be seen that in order to reduce the hardness of technical waters, the reagent Al2(SO4)3*18H2O was used with different ratios, i.e. from 0.01% to 2.0%. At a ratio of Al2(SO4)3*18H2O of 0.01%, water hardness decreased from 13.6 *mg-eq/l* to 12.5 *mg-eq/l*, and at a reagent concentration 0.05% water hardness was 12.

The experiments continued with FeSO4 reagent with different concentrations (from 0.01% to 0.2%). Table ... .. shows the results of reducing the hardness of industrial waters formed by the Mubarek GPP.

$$FeSO_4 + 2\,H_2O \rightarrow Fe(OH)_2 + H_2SO_4.$$
$$4\,Fe(OH)_2 + O_2 + 2\,H_2O \rightarrow 4\,Fe(OH)_3\downarrow.$$

$$4 FeSO_4 + 4 Ca(OH)_2 + 2 H_2O + O_2 = 4 Fe(OH)_3\downarrow + 4CaSO_4 .$$

Table 10

The results of reducing the hardness of process water

Reagent *FeSO4, %*	Quantity *Ca, mg-eq/l*	Hardness, *mg-eq/l*	Hydrocarbonat e, %	Sulfur content, %
0,01	-	-	-	-
0,05	**1,5**	**15**	**-**	**-**
0,1	11	12,5	-	-
1,0	iron	copper	-	-
2,0	iron	copper	-	-

Table 10 shows that the amount of Ca was 1.5 *mg-eq/l* at a FeSO4 reagent ratio of 0.05%, while the water hardness increased to 15 *mg-eq/l* from 13.56 *mg-eq/l*.

Experiments were also carried out with sodium phosphate and polyacrylamide (PAA) reagent.

Table 11

The results of reducing the hardness of process water

Na_3PO_4+($-CH_2CHCONH_2-)_n$	Quantity *Ca, mg-eq/l*	Hardness, *mg-eq/l*	Hydrocarbonat e, %	Sulfur content, %
0,15	-	12	-	-
1,5	-	4	-	-

The hardness of technical water decreased from 13.56 mg-eq/l to 12 mg-eq/l at a reagent ratio of Na3PO4+(-CH2CHCONH2-)n of 0.15%. The amount of Ca, bicarbonate and sulfur is absent (Table 11).

Conclusion. Thus, the experimental studies carried out to determine the elemental composition of technical waters of the formed gas processing plant indicate that it contains many elements of the periodic system, i.e. content of Al-0.923mg/l, As-0.0870mg/l, Ba-0.0874mg/l, Bi<0.003mg/l, etc., the highest concentration of Na is 248mg/l, this is because the purification such technical water requires several steps and a large amount. In addition, to reduce the hardness of industrial waters, a suitable reagent is sodium polyphosphate Na (PO3) n * H2O. At the same time, at a ratio of the reagent from 0.003 to 0.009 mg-eq/l, the indicator for the decrease in hardness ranged from 0.15 mg-eq/l to 0.63 mg-eq/l.

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C O N T E N T S

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

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