International Journal of Future Generation Communication and Networking
Vol. 13, No. 3, (2020), pp. 3953–3960

Research Results of Softening and Reducing the Rigidity of Technical Waters

A.M.Xurmamatov[1], O.K.Ergashev[2], O.T.Mallabayev[2]

[1] Institute of General and Inorganic Chemistry, Academy of Sciences of the Republic of Uzbekistan, Tashkent,
E-mail: gafuri_19805@mail.ru

[2]Namangan Institute of Engineering and Technology, Namangan,
E-mail: oybek_0701@bk.ru

[2] Namangan Institute of Engineering and Technology, Namangan,
E-mail: o.mallabayev@mail.ru

Annotation:

The article presents the results of reducing the rigidity of the circulation water of an oil refinery with various reagents: a mixture of Na_3PO_4 + sulfonal; Na_2PO_4

Na_2PO_4 + sulfonal; $Ca(OH)_2$; Na_3PO_4 and the results of deep purification of circulating Kuimazar waters from coarse and fine solid particles of mechanical impurities. As well as the results on the influence of hydraulic resistance of sediment formed in the process of filtering contaminated water on the degree of purification.

Keywords: *technical water, hydraulic resistance, mechanical impurities, filtering apparatus, purification rate, solid particles.*

[1]

Introduction.

Water hardness is an undesirable phenomenon. On the inner walls of the heat exchange equipment, hard water forms scale with poor thermal conductivity, resulting in increased fuel consumption. In addition, scale contributes to the erosion (corrosion) of the walls of heat-exchange equipment. Water hardness can vary widely: soft water - 4 mg- Eq / l; medium hard water - 4 ÷ 8 mg-Eq / l; hard water - 8 ÷ 12 mEq. / L; water is very hard - over 12 mg-Eq / l [1,2]. At the Bukhara refinery (BuhNPez), Kuimazar waters are used for cooling oil and gas condensate raw materials, which are contaminated with coarse and fine particles of mechanical impurity and have a high hardness. The use of these waters for cooling hydrocarbon raw materials results in the formation of the internal surface of heat-exchanging equipment, wherein the hydraulic resistance of the apparatus is increased, and the heat-exchange and mass-exchange processes are degraded [3].

Regular preventive cleaning of heat-exchange equipment is the key to efficient and uninterrupted operation of heating and hot water supply systems. Any heat carrier, especially water, contains impurities. When heated, they accumulate on the walls of pipes and surfaces of other elements of the system.

If it is not removed in time, it is converted into persistent mineral deposits, which hinder the normal circulation of the heat carrier and significantly reduce the heat return. With layers as thick as 2 mm, the efficiency drops to 7%.

To compensate for the loss of heat during transportation, the fuel consumption must be increased up to 50% [4.5].

Studies have been carried out on the influence of various factors (reference content of mechanical impurities; reagent type and quantity; process temperature; design size of laboratory installation) on the efficiency of the reduction and purification of circulating water from mechanical impurities.

In order to determine the average concentration of fine and coarse particulates of mechanical impurities in the circulation water of the refinery, we have conducted a series of experiments. All experiments were conducted at ambient temperatures. During the experiments, 100 ml of

ISSN: 2233-7857 IJFGCN

contaminated water (brought from Kuimazar Lake) was taken for filtration in a laboratory filtration unit, after which the paper filter was dried in the furnace of the brand - SNOL 1,6.2,5.1/11-I2 for an hour at a temperature of 110 C, After that, the paper filter was cooled in the desiccator for 30 minutes, then weighed with an error of 0.0002 g using an electronic stamp weight - FA1004G.

Materials and methods.

The calculations for the determination of the particulates of mechanical impurities were calculated as the arithmetic mean of ten parallel tests. Experiments have shown that the total concentration of mechanical impurities in Kuimazar waters averaged 6.006%.

The mass fraction of mechanical impurities was calculated according to the known formula, %:

$$M = [(m_1 - m_2) / m_3] \cdot 100,$$

where, m_1 – filter cup mass after filtration, g; m_2 – Mass of clean filter cup, g; m_3 – mass of water canopy, r.

To soften and purify the circulating water from mechanical impurities, Kuimazar water was used. Each experiment was carried out with an initial hardness of the studied water of 47 mg-Eq / l; indications of water hardness according to the standard should not exceed the limit of 2 ÷ 3 mg-Eq / l. [6] The results of studies on softening the test water are given in table.1-5.

Table 1. The results of the hardness reduction of Kuimazar waters using the reagent Na_3PO_4 + sulfonal (water hardness 47 mg-Eq / l)

№	The mass of the investigated water, ml	Reagent concentration (Na_3PO_4 + sulfonal), mg	Water gesture, mg-eq. / l
1	10	0,01	30
2	10	0,03	20
3	10	0,04	15
4	10	0,05	6
5	10	0,07	5
6	10	0,09	3
7	10	0,1	3

Table 1 shows that when Na_3PO_4+sulfonal is added to the reagent by 10 ml, its rigidity was 30 mg-eq/l, and at the addition of 0.03 mg the water rigidity was reduced to 20 mg-eq. /l, the further addition of a reagent of 0.04 0.07 mg the hardness of the water under investigation is gradually reduced to within 15 5 mg-eq. /l, and with the addition of a reagent of 0.09 mg to 0.1 mg, the value remains unchanged, i.e. 3 mg-eq. /l. In the course of experiments to reduce the hardness of this water, the reagent Na_2PO_4 was also carried out (table.2).

Table 2. Results of reduction of hardness of Kuimazar waters with reagent $_2$ (water hardness 47 mg-eq/l)

№	The mass of the investigated water, ml	Reagent concentration (Na_2PO_4), mg	Hardness of water, mEq / L
1	10	0,01	31
2	10	0,03	24
3	10	0,05	22
4	10	0,07	21
5	10	0,08	20
6	10	0,1	18
7	10	0,2	18

When conducting experiments to reduce water hardness, the Na_2PO_4 reagent was added in the range of 0.01–0.2 mg per 10 ml of test water. The results show that the water hardness decreased from 31 mg-eq. /l to 18 mg-eq. /l. Experiments have also been carried out by the reagent Na_2PO_4+sulfonal (table.3).

ISSN: 2233-7857 IJFGCN

Table 3. Results of reduction of hardness of Kuimazar waters with reagent Na_2PO_4+sulfonal (water hardness 47 mg-eq/l)

№	Mass of water under investigation, ml	Reagent concentration (Na_2PO_4+ sulfonol), mg	Hardness of water, Mg-Eq / L
1	10	0,01	22
2	10	0,03	16
3	10	0,05	15
4	10	0,07	14
5	10	0,08	14
6	10	0,1	14
7	10	0,2	14

In order to reduce the hardness of the Kuymazar waters, the Na_2PO_4 + sulfonal reagent was added in the range of 0,01÷0,2 mg per 10 ml of the studied water; as a result, the water hardness was reduced from 22 mg-Eq / l to 14 mg-Eq / l, when the reagent is added from 0.07 to 0.2 mg, the water hardness indication remains unchanged, i.e. this indicator was 14 mg-Eq / L. We also conducted a series of experiments to reduce the hardness of water with $Ca(OH)_2$ reagent.

Table 4. The results of reducing the hardness of Kuimazar waters using the reagent $Ca(OH)_2$ (water hardness 47 mg-Eq / l)

№	The mass of the investigated water, ml	Reagent concentration (Ca(OH)2), mg	Hardness of water, Mg-Eq / L
1	10	0,01	35
2	10	0,03	40
3	10	0,05	42
4	10	0,07	45
5	10	0,08	50
6	10	0,1	50
7	10	0,2	50

Table 4 shows that when the reagent $Ca(OH)^2$ was added 0.01 mg per 10 ml water, the hardness was 35 mg-eq. /l, at the addition of 0.03 mg, the water hardness was 40 mg-eq. /l and at the addition of 0.05 mg, the water hardness was increased to 42 mg-eq. /L, further addition of reagent within 0,08÷0,2 mg of water hardness increased to 50 mg-eq. and remains unchanged. This is because the high calcium salt content (Ca ions) leads to increased water rigidity.

Table 5.Results of reduction of hardness of Kuimazar waters with reagents Na_3PO_4 (water hardness 47 mg-eq/l)

№	The mass of the investigated water, ml	Reagent concentration (Na_3PO_4), mg	Hardness of water, Mg-Eq / L
1	10	0,01	24
2	10	0,03	21
3	10	0,05	16
4	10	0,07	7
5	10	0,08	5
6	10	0,1	2
7	10	0,2	2

Table.5 shows that when a Na_3PO_4 reagent is added, the 0,01 mg water rigidity decreases to 24 mg-eq/l, and when a reagent is added to 0.03 mg its rigidity decreases to 21 mg-eq/l. Further additions of the reagent from 0.05 to 0.08 mg water rigidity decreases from 16 mg eq/l to 5 mg eq/l. With the addition of a reagent of 0.1 and 0.2 mg, the water rigidity decreases to 2 mg-eq/l, and this value does not change.

Results and discussion

Besides the mileage for the correct use of circulating waters, the design parameters of the installation are also affected. A cylindrical laboratory septic tank, in which coarse particulate matter is

ISSN: 2233-7857 IJFGCN

deposited in the laminar-mode gravitational field, was used to pre-treat circulation water from coarse particles of mechanical impurities. The geometric dimensions of the laboratory septic tank are: height - 0.2 m; length - 0.4 m; width - 0.3 m, i.e. the plant is designed to purify water of 0.024 m^3/h.The volumetric content of the liquid in the suspension was determined by [7]:

$$\varepsilon = \frac{V_{ж}}{V_{ж} + V_{тв}}, \quad (1)$$

where Vж is the volume of liquid in the suspension; Vтв is the volume of solids in the suspension.

When the suspension is precipitated, it is divided into two layers: the sludge and the lightening fluid (h-height of the lighted liquid). At the surface of deposition F m^2, the volume of the lightened liquid is hF $м^3$ [7]:

$$V = \frac{hF}{\tau} м^3/с, \quad (2)$$

where h is the height of the liquid layer, m; τ - deposition time, sec.
Necessary surface of sedimentation [7]:

$$F = \frac{V}{\omega_0} м^2 \quad (3)$$

The volume V of clarified liquid at its density ρж кg/$м^3$ is [7]:

$$V = \frac{G_{ж}}{\rho_{ж}},$$

Then we obtain:

$$F = \frac{G_{ж}}{\rho_{ж}\omega_0} \quad (4)$$

Where Gж – fluid volume, $м^3$; ρж – fluid density, кг/$м^3$; ω0 – smallest solids free deposition rate, м/c.

Accordingly, the deposition surface or cross-sectional area of the sump was determined by the equation [7]:

$$F = \frac{1{,}3G_c}{\rho_{ж}\omega_0}(1-\beta)м^2, \quad (5)$$

where Gc – amount of dry matter, $м^2$; β - ratio of the weight of dry matter in suspension and sediment $\beta = \frac{x_1}{x_2}$ (concentration of solid phase in water x_1 = 6,006 %, concentration of the condensed suspension x_2 = 15,1 %).

The particle deposition rate was calculated:

$$\omega о\tau = h. \quad (6)$$

The height of the industrial sump is usually not calculated, but taken equal to 2,5÷3,5 м [7].

The performance of the sump on the thickened suspension was determined [7]:

$$G_{сг.} \frac{G_{тв}}{x_2}. \quad (7)$$

Accordingly, the capacity of the clarifier for clarified liquid will be [7]:

$$Gж = Gc - Gсг.. \quad (8)$$

Sedimentation diameter of solid particles was determined from the data of sedimentometric analysis:

$$d_s = \sqrt{18 \cdot 10^7}\ \mu H/(\rho_1 - \rho_2)\, g\tau, \quad (9)$$

Where μ - dynamic viscosity of the medium, Па*с; ρ_1 – particle density, г/$см^3$; ρ_2 - density of the medium, g / cm^3;H – particle settling height, см; g – gravity acceleration, м/$с^2$; τ - settling time, c.

ISSN: 2233-7857 IJFGCN

A filtering apparatus (Figure 1) was installed in order to thoroughly purify the circulation of Kuimazar water from fine particles after preliminary gravitational purification. During filtration, the leachate moves through the draught layer and the filter bulkhead. In the sediment layer, the liquid moves through pores - capillary channels of variable section and different curvature [7,8]. If the filter area is equal to F m^2, then the amount of liquid V m^3 passing through the filter □ during time s is [7]: $V = \omega_0 F\tau = \Delta\rho F\tau \frac{d^2\Phi^2\varepsilon^3}{248(1-\varepsilon)^2\mu H}$

or

$$V = \frac{\Delta\rho F\tau}{R} \quad (10)$$

где $R = \frac{248(1-\varepsilon)^2\mu H}{d^2\Phi^2\varepsilon^3}$

As follows from this equation, the filter resistance R (н·сек/м^3) other things being equal, it shall be reduced with the increase of the voids content and the reduction of the viscosity of the leachate [7].

The R value was calculated from the draught resistance Roc. and the filter bulkhead Rпер. [7]:

$$R = R_{oc.} + R_{пер.} \quad (11)$$

Draught resistance proportional to its thickness δ [7]:

$$R_{oc.} = r\delta. \quad (12)$$

where r – proportionality coefficient called draught resistance. The fluid velocity through the layer was determined [7]:

$$\omega = \frac{V}{F\tau} = \frac{q}{\tau} = \frac{\Delta\rho}{R}\, м^3/м^2\cdot сек. \quad (13)$$

The sediment volume can be expressed by the filter area F by the thicknessδ of the sediment. If we denote by u the volume of sediment per 1 m^3 of filtrate, the volume of sediment deposited after the formation of V m^3 of the filtrate will be

$$F\delta = uV. \quad (14)$$

The thickness of the sediment layer is:

$$\delta = u\frac{V}{F} = uq. \quad (15)$$

$$q = \frac{V}{F}\, м^3/м^3. \quad (16)$$

The hydraulic resistance of the apparatus was determined by the known formula:

$$\Delta P = \frac{\xi\rho\omega^2}{2}.$$

We conducted a series of experiments on the influence of the resistance of the filter septum and the resistance of sediment depending on the volume of water passing in the filter septum. The geometric dimensions of the laboratory filtering unit: total height - H = 0.55 m; length - L = 0.30 m; width - B = 0.30 m.

A porous septum is installed in the middle of the filtering unit; pore sizes of the filtering septum are 0.1 mm. The resistance of the filter unit without a partition is 350 Pa, with a partition - 1830 Pa. The volume of the filtering unit is 0.0495 m^3.

The results of the studies are shown in table.6.

ISSN: 2233-7857 IJFGCN

Table 6. The effect of sediment resistance depending on the volume of water passing in the filter baffle

The change in the concentration of the suspension in the critical zone,%	The height of the thickened layer, m	Filtrate volume, m3	Hydraulic resistance, Pa	Degree of purification , %
10	0,01	2,601	2150	98,8
20	0,02	2,102	2340	99,01
30	0,03	1,506	2550	99,16
40	0,04	1,024	2905	99,24
50	0,05	0,586	3440	99,38

From table 6 it is seen that with an increase in the concentration of the suspension in the critical zone from 10% to 50%, the height of the thickened layer also increases from 0.01 m to 0.05 m, while the hydraulic resistance also increases in the range of 2150 ÷ 3440 Pa.

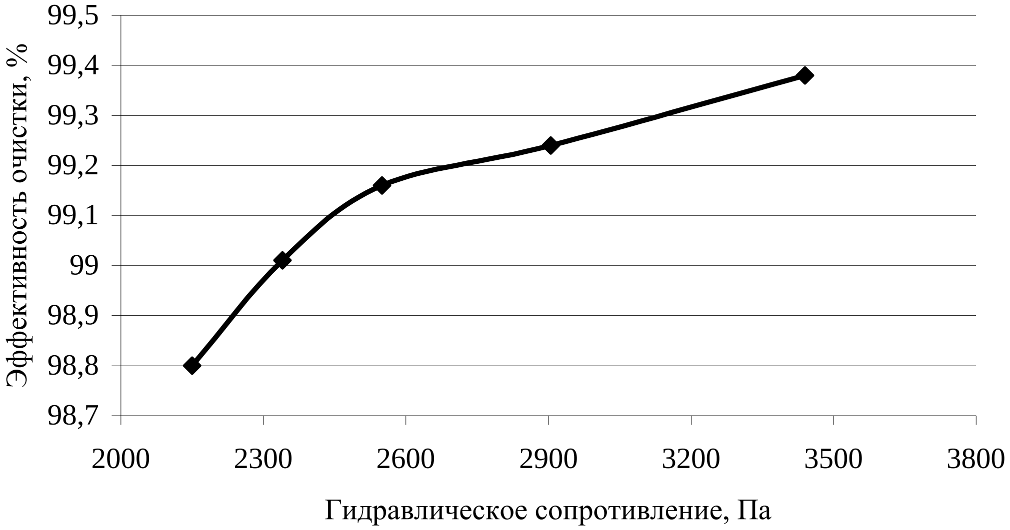

Figure. 1. The influence of the hydraulic resistance of the apparatus on the efficiency of water purification from mechanical impurities

With an increase in the hydraulic resistance of the filter apparatus by 2150 Pa, the degree of purification of the circulating water from fine particulate matter is reached up to 98.8%, and with a change in the hydraulic resistance of the apparatus to 2340 Pa, the cleaning efficiency is 99.01%. A further increase in the hydraulic resistance of the apparatus to 3440 Pa, the degree of purification also increases, i.e. this figure is 99.38%.

Conclusion

Thus, studies conducted to reduce the rigidity of the circulation water of a refinery show that the reagents are: a mixture of Na_3PO_4+ sulfonal; Na_2PO_4; Na_2PO_4+ sulfonal; $Ca(OH)_2$ is unsuitable for reducing the hardness of the circulating water, because the decrease in water hardness is not reached to the limit using these reagents. To reduce the hardness of circulating process water, it is advisable to use a reagent of 0.2% Na_3PO_4The experiments on filtering circulating water show that with an increase in the concentration of the solid layer on the filtering baffle from 10% to 50%, it leads to an increase in the hydraulic resistance of the apparatus within 2150–3440, in addition, the filtrate volume also decreases, and at the same time, the cleaning efficiency of the apparatus is achieved to limit standards, i.e. 99.38%. This is because for deep cleaning of circulating water from fine particulate solids of mechanical impurities, it is desirable to use filtering apparatus.

ISSN: 2233-7857 IJFGCN

REFERENCES

[1] A.G. Kulman. General chemistry. Ed. 2nd, rev. -M.: «Колос». - 1968. –S. 440.576 p.
[2] https://studbooks.net/2541686/tovarovedenie/stochnye_vody_ neftepere-rabatyvayuschih_zavodov.
[3] L.S.Alekseev, V.A.Gladkov. Improving the quality of soft waters. M., Stroyizdat, 1994
[4] http://roscontract71.ru/services/ochistka-teploobmennogo-oborudovaniya.
[5] http://www.postroj-dom.ru/vodosnabjenie/141-jostkost-umiagchenie-vody .html#list3.
[6] O'zDSt 540: 2010 State standard of Uzbekistan “Mineral drinking water, therapeutic, medicinal-table”. The publication is official. Tashkent. 2019.19.p
[7] A.N.Planovsky, V.M.Ramm, S.Z.Kagan. Processes and devices of chemical technology. Ed. –M .: Chemistry. -1968. -WITH. 249-250. 831 p.
[8] R.I.Ayukaev, V.Z.Meltzer. Production and use of filter materials for water treatment. L., 1985.128 p.
[9] В.Е. Егорушкин, Б.И. Цеплович. Основы гидравлики и теплотехники. Изд-во. –М.: Машиностроение. -1981. 260 с. –С. 193.]
[10] [В. И. Кудинов Основы нефтегазопромыслового дела. Изд-во. –М.: Ижевск. -2004. 720 с. –С. 401].
[11] [И.В. Мазырин. Смазочные устройства машин. Изд-во. –М.: МАШГИЗ. -1963. 246 с. –С.112.].
[И.В. Мазырин. Смазочные устройства машин. Изд-во. –М.: МАШГИЗ. -1963. 246 с. –С.112.].
[12]
[13] В.И.Калицун, Ю.Н.Ласков, Ю.В.Воронов, Е.В.Алексеев. Лабораторный практикум по водоотведению и очистке сточных вод. Учебное пособие для ВУЗов. –М.: Стройиздат, 2000. 272 с.–С. 101.
[14] С.В.Яковлев, Я.А.Карелин, А.И.Жуков, С.К.Колобанов. Канализация. Учебное пособие. Изд. пятое, перераб. и доп. –М.: Стройиздат, -1975. 576.с. –С.24-25.
[15] В.И.Кичигин. Агрегация загрязнений воды коагуляцией. Учебное пособие.–М.: АСВ, 1994. 100 с.–С. 56-57.
[16] С.В.Белов, Ф.А.Барбинов, А.Ф.Козьяков. и др. "Охрана окружающей среды", - М.: Высш. шк., 1991. – 339 с.С.56-70.
[17] Б.Н.Репин, С.С.Запорожец, В.Н.Ереснов и др.Водоснабжение и водоотведение. Наружные сети и сооружения: справочник. /под ред. Б. Н. Репина. – М.: Высш. шк., 1995. – 431 с. –С. 48-55
[18] А.Я.Николаев. Биологическая химия. –М.: Мед.информ.агентство. 1998, 494 с. –С. 328-329.
[19] С.В.Яковлев, С.В.Водоотведение и очистка сточных вод: учеб для вузов / С.В.Яковлев, Ю.В.Воронов. – М. : АСВ, 2002. – 704 с. –С. 408-409.
[20] Л.Д.Виноградова, Л.Н.Крюкова, "Контроль качества воды". Методические Указания, - Омск. -1997. – 38 с. –С.26-28.
[21] С.Л.Громов. Журнал "Теплоэнергетика" №11. -2006. -Раздел: Водоподготовка - Регенерация ионитов
[22] В.А.Скороходова. "Очистка сточных вод" Омск-1982. -360 с. –С.194-198.
[23] А.И.Жуков, И.Д.Монгайт, И.Д.Родзиллер. "Методы очистки производственных сточных вод", - М.: Химия, 1996. -345 с. –С.201-210
[24] Ю.А.Ершов, В.А.Попков и др. "Общая химия". "Биофизическая химия". "Химия биогенных элементов". Учеб. Для вузов - 2-е изд., М.: Высш. шк., 2000-560 с. – С.264-266.
[25] Водоснабжение и водоотведение. Наружные сети и сооружения. Справочник под ред. Б.Н.Репина. –М.: «Высшая школа», 1995. 431 с. –С. 139-140.
[26] А.М.Долгоносов. "Ионный обмен и ионная хроматография" –М.: Химия, 1993. -360 с. –С. 78-80.

ISSN: 2233-7857 IJFGCN

[27] Г.А.Чикин, О.Н.Мягков. "Ионообменные методы очистки веществ". Учебное пособие Воронеж: изд-во ВГУ, 1984. -372 с. –С. 300-312.
[28] А.И.Алексеев, М.Б.Середа, С.Юзвяк. Химия воды: Водные системы, классификация, вредные и токсичные вещества. -СПб.; Щецин: СЗТУ. -2001. 216 с. –С. 56-57
[29] М.Е.Беккер, Г.Н.Лиепиньш, Е.П.Райпулис. Биотехнология. –М.: ВО АГРОПРОМИЗДАТ. 1990. 334 с. –С. 221.
[30] В.Т.МазаевТ., Шлепнина Т.Г., Мандрыгин В.И. Контроль качества питьевой воды. -М.: Колос, 1999. 312 с. –С.69-70].
[31] Современные технологии и оборудование для обработки воды на водоочистных станциях : Сб.ст./НИИ коммун.водоснабжения и очистки воды; [Сост. и общ.ред. В.Л. Драгинского и др.]. - М.: НИИКВОВ, 1997. - 112,[1] с. : ил.; 21.

ISSN: 2233-7857 IJFGCN