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WASTEWATER EVAPORATOR POND ASSESSMENT OF «CASPI BITUM» LLP

Abstract. The dynamics and level of pollution of the wastewater evaporator pond of the bitumen plant were studied in 2018-2019. The chemical composition of the waste water (WW) pond was determined by 8 indicators. The average annual indicators of the studied harmful substances in the water exceeded the permissible level from 1.1 to 21.9 times. At the same time, exceeding standards were registered for substances of 3 and 4 hazard classes: total iron - up to 2.8 times, petroleum products - up to 1.7 times. The content of anionic surface active agents (SAA) in the evaporator pond with an average degree of oxidation was recorded in excess of the maximum permissible concentration (MPC) by 2.0 times, 2.13 times, and 2.32 times on average over the years at points 1, 2, and 3, respectively. The average values of biochemical oxigen demand/chemical oxigen demand (BOD_5/COD) for 2018-2019 were as follows for the studied points of the evaporator pond: at point 1 (water outlet) - 0.215, at point 2 (South-Eastern part) - 0.195, at point 3 in the area of the sand massif - 0.21, and under the condition of $BOD_5/COD<0.5$ it means that the WW is over by resistant to oxidation compounds. This requires accelerating the evaporation process. A heliotechnical system of translucent coverings has been developed and offered for intensifying the evaporation process and isolating harmful substances from contacts with the biosphere. This system is environmentally and economically feasible.

Keywords. Oil, bitumen, petroleum products, wastewater, hot climate, evaporation pond, dissolved oxygen deficiency, biochemical index.

Introduction. Oil from the Karazhanbas field is used for the production of road bitumen at the Caspi Bitum plant with a high content of water, sulfur (1.06% by weight), as well as mechanical impurities sand like. High water pollution occurs during the production process when oil is dewatered and desalted in electric desalting plants (EDP). The resulting water is characterized not only by increased mineralization, but also by a high content of BOD and COD. High values of the COD index cause the availability of resistant to oxidation organic compounds in the water.

In general, it leads to a high degree of wastewater pollution. Wastewater discharge from the bituminous plant into reservoirs was prohibited due to sanitary engineering conditions, and its recycling is not possible [1,2]. Therefore, evaporation pond was built at a distance of 5 km from the plant, in a natural depression of the area [3, 4]. Wide formations of chemical compounds and elements accumulate in the reservoir and are practically not isolated from contacts with the biosphere. Thus, the surface of the areal evaporator of oil-polluted waters can evaporate hydrocarbon vapors of oil as well as other volatile chemical compounds and pollute the air and soil of populated areas [2]. Therefore, it is necessary to develop technical means to accelerate the evaporation process within a closed volume using Solar Energy in a dry and hot climate. The developed Solar System allows preventing the evaporation of harmful substances from the pond surface and intensifying the process of wastewater evaporation in a closed volume.

Work objective. Analysis of the evaporator pond condition and offer development for evaporation intensification and prevention of vapor emissions of chemical compounds and harmful gases evaporating with water vapors of wastewater.

Research material and methods. The presented material was obtained during field studies of the evaporator pond condition during 2018-2019.

The evaporation pond of the wastewater plant of the Joint Venture Caspi Bitum LLP was chosen as the study object. Heat treatment and discharge treatment are performed at the first stage of cleaning in the HTDT workshop of the bituminous plant. Standard treated wastewater is fed to treatment facilities, mixed with sewage and re-treated at the stage 2, which were on the balance sheet of Mangistau Industrial Park LLP.

Fractured tertiary and quaternary marls are water-bearing materials, with heavy clays serving as the underlying layer (water barrier) at a depth of 8-15 m. So, we selected 3 points for wastewater drawing from the pond based on the results of field research. These points are intended to reflect the characteristics we are studying for the selected sections of the evaporator pond.

The watershed slope to the North and North-East of the evaporator pond is composed of clay marl and shell limestone. The outlet (discharge) of treated WW into the pond is conducted using an asbestos-cement pipe with a diameter of 500 mm, with a stone head wall.

Research methods. Visual inspection of the pond condition and the surrounding area was carried out in the areas of each point, at point T1 (water outlet) in the North-Western part of the pond, and at point T2 (Eastern part of the pond), as well as at point T3 (sand massif in the South-West). The water temperature, pH and oxygen content were measured at the water sample sites. Water sample was carried out in accordance with GOST R 51592-2000. Storage of WW samples was carried out in accordance with the requirements of GOST 17.1.5.01-80. The pH of water was determined using a portable Hanna pH meter [5, 6].

Chemical analyses of water samples in the terms of dry residue, suspended solids, COD, BOD, ASAA, total iron, as well as petroleum products were carried out in the accredited testing laboratory of Tandem Eco LLP in Aktau. In the laboratory, the content of suspended solids in wastewater was determined according to GOST 26449.1-85, COD according to ST RK 1322-2005, BOD according to ST RK ISO5815-1-2010, ASAA according to ST RK 1983-2010, iron content according to GOST 26449.1-85, petroleum products according to GOST 26449.1-85 [7].

Statistical processing of work results; Standard methods of variation statistics were used. The data obtained in the studies are presented in the form of (mean ± sd) median (range) - the average ± standard deviation.

Research results, discussion and suggestions. The main principle of assessing the level of evaporator pond effect on the environment is to compare the value of hydro-chemical indicators of water with the standard values (MPC).

The results of hydro-chemical analysis of water are shown in Table 1 (concentrations exceeding the MPC are put in bold type).

The water temperature in the WW evaporator pond in the fall of 2018 (October 9) was 14.3°C at an outdoor temperature of 23°C at 11.00 am in the daytime.

The content of dissolved oxygen in the pond, at points 1 (water outlet) and at point 3, in the sand massif was in the range of 4.3-4.8 mgO_2/dm^3, at point 2 (South-East), the indicator was 4.5 mgO_2/dm^3. In the summer of 2019 (July 27), the indicators of dissolved oxygen (DO) in water are recorded below the indicators of 2018.

Thus, its content in water was 3.8 mgO_2/dm^3, 4.1 mgO_2/dm^3, and 4.3 mgO_2/dm^3 for the study points, respectively. The results of the 2018-2019 analyses show that there is a dissolved oxygen deficiency in the pond. It is known that the solubility of oxygen in oil-containing effluents is quite high. Also, the dissolved oxygen deficiency is associated with a hot climate.

Water **salinity** in the reservoir is quite high and amounted to 12.3 g/l in the fall of 2018, and in the summer of 2019 the indicator was higher and amounted to 13.7 g/l. The water in the evaporator pond is classified as salty. The predominant anions are chlorides and sulfates.

Water salinity ratio is related to the mineralization of underground water equal to 22.6 g/l.

Hydrogen (pH) index. The water in the evaporator pond of JV Caspi Bitum LLP has an alkaline reaction. The maximum pH values in the range of 9.21 (summer 2019) and 8.93 (summer 2019) during the research period were recorded in the area of wastewater discharge (point 1), in the North-Western part of the evaporator pond, (point 2) on the Eastern part of the pond, respectively. The alkaline reaction remains almost until winter in the hot climate of the Mangistau region. The minimum pH value, in the range of

7.33 (fall 2018), is marked at point 3, in the area of the sand massif. Also, when the pH decreases, the rate of clarification of wastewater increases (at pH = 7-8, clarification of 50-65%), due to the effect of subsidence of suspended matter particles in the bottom sediments [7].

The dry residue is mainly determined by the content of chlorides and sulfates in the water.

Therefore, the dry residue index is also usually high at high concentrations of these elements in water. There are overages of the MPC of the total salinity (dry residue) at point 2 (Summer 2019) and point 3 (Summer 2019), according to the results of the analyses. So, the dry residue at point 2 was 1617 mg/dm^3 (1.62 MPC) and 1559 mg/dm^3 (1.56 MPC) at point 3. Minimum values of the dry residue were registered at point 1(water outlet) in the fall of 2018 in the range of 1327 mg/dm^3 (1.33 MPC). This is due to the high level of fall Eastern and South-Eastern winds with a return of 19% and 18%, respectively, of the wastewater entering the pond in the direction of point 2.

Table 1 – The content of pollutants in the WW of wastewater treatment plant (WWTP) sump mg/dm^3

Index	MPC*	Point No. of water sampling from the evaporator pond					
		No. 1		No. 2		No. 3	
		Fall 2018	Summer 2019	Fall 2018	Summer 2019	Fall 2018	Summer 2019
pH	6,5-8,5	8,13±0,04	9,21±0,05	7,33±0,05	8,11±0,03	8,69±0,04	8,93±0,05
Dry residue, mg/dm^3	1000	1327±0,04	1419±0,03	1583±0,03	1617±0,03	1482±0,03	1559±0,03
Suspended solids, mg/dm^3	10,75	26,3±0,07	19,5±0,03	17,5±0,05	17,3±0,07	18,6±0,04	18,7±0,07
COD, mgO_2/dm^3	30	302,3±0,06	379,1±0,03	274,1±0,05	311,0±0,04	288,3±0,05	292,0±0,05
BOD_5, mgO_2/dm^3	3,0	96,3±0,04	38,5±0,03	83,0±0,06	35,5±0,05	91,4±0,03	33,7±0,05
ASAA, mg/dm^3	0,2	0,33±0,05	0,47±0,04	0,41±0,06	0,44±0,03	0,45±0,05	0,48±0,05
Fe total, mg/dm^3	0,3	0,84±0,04	0,51±0,05	0,62±0,03	0,55±0,04	0,77±0,06	0,63±0,03
Petroleum products	0,1	0,12±0,04	0,17±0,06	0,09±0,04	0,11±0,05	0,07±0,04	0,09±0,03

Suspended solids of wastewater samples: The highest content of suspended solids in the fall of 2018 was recorded at point 1 (water outlet) with an overage limit of 2.44 times (26.3 mg/dm^3). In the summer of 2019, the index of suspended solids decreased to 19.5 mg/dm^3 at the same point 1 and amounted to 1.81 MPC. The content of suspended solids was lower, but also exceeded the permissible norms in the most remote places from the waste water discharge, points 2 and 3. The index of suspended solids for both fall 2018 and summer 2019 was almost the same at the 2nd point, that is17.5 mg/dm^3 and 17.3 mg/dm^3. The overage was 1.63 and 1.61 MPC, respectively. The content of suspended solids in the sand massif at point 3 was recorded in the range of 18.6 mg/dm^3 in the fall of 2018, and 18.7 mg/dm^3 in the summer of 2019, with an average of 1.73 times higher than the MPC. At the same time, the increase of water turbidity in the pond can also be mainly due to the release of carbonates from the Khazar clay marls that form the bottom of the pond and the oxidation of iron compounds Fe2+ with air oxygen, as well as a result of violation of the regime of wastewater intake [8].

COD – is the quantity of O_2 in mg per liter of wastewater that is required for the oxidation of all organic and inorganic substances contained in 1 liter of WW.

According to the results of analyses, the COD index at point 1 (water outlet) in the fall of 2018 was 302.3 mgO_2/dm^3 (10.1 MPC), while the COD content in the summer of 2019 increased to 379.1 mgO_2/dm^3 (12.6 MPC). The COD index for point 2 in the fall of 2018 was 274.1 mgO_2/dm^3 (9.1 MPC), and in the summer of 2019, 311.0 mgO_2/dm^3 (10.4 MPC). The overage of the MPC for COD at point 3 was 9.6 MPC, with a COD content of 288.3 mgO_2/dm^3 (fall 2018), and (9.7 MPC) with a COD value of 292.0 mgO_2/dm^3 (summer 2019). High COD values cause the availability of resistance to oxidation of organic compounds in the water of the evaporator pond [5, 9].

BOD_5. Biological oxygen demand is an index of oxygen consumption for the oxidation of harmful impurities in the WW under exposure to microorganisms.

It should be noted that when determining the BOD_5 index for 5 days (in 1 liter of WW) from the pond, the oxidation of 67% of readily oxidizing organic substances was recorded at an average air temperature of 23°C. The BOD_5 value at point 1 in the fall of 2018 was 96.3 mgO_2/dm^3 with overage the MPC by 32.1 times, but the results of analysis of water samples in the summer of 2019 showed a sharp decrease in the BOD_5 value to 38.5 mgO_2/dm^3 (12.3 MPC). Overage of BOD_5 at point 3 is almost shown

at the same range: 91.4 mgO_2/dm^3 by 30.5 times (fall 2018) with a sharp decrease to 33.7 mgO_2/dm^3 (11.2 MPC) in the summer of 2019. The index arranged by the years of BOD_5 at point 2 was lower than at points 1 and 3, but exceeded the established standard by 27.7 times (fall 2018), but in the summer of 2019 this index fell sharply to 11.8 MPC. There is a sharp increase in the value of BOD_5 in fall. In summer, on the contrary, the BOD_5 index decreases very sharply, while its decrease usually occurs in anaerobic conditions with an oxygen deficiency. This is due to both the deposition of suspended solids and their anaerobic decomposition in bottom sediments, which leads to a decrease in the BOD_5 value in the summer [7, 9]. The data obtained as a result of research on the actual content of HS in the wastewater of the evaporator pond are shown in figure 1.

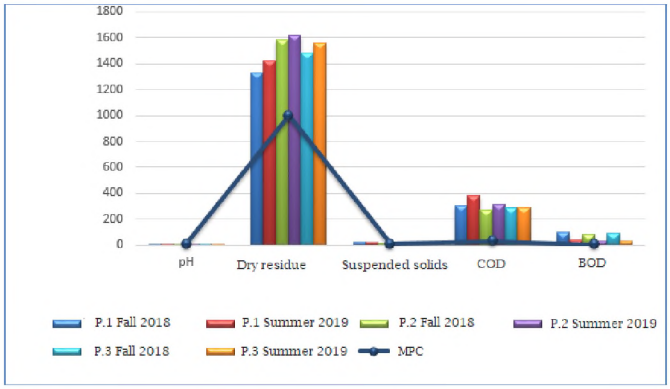

Figure 1 – Content of pollutants in the evaporator pond

ASAA: A significant part of the anthropogenic load that falls on the evaporation pond or other similar reservoirs is made up of WW containing ASAA [10].

These compounds belong to the toxicologically limiting sign of harm. They are formed like sodium salts, mainly when desalting oil on electric desalting plants (EDP). The highest concentration of ASAA in the water of the evaporator pond was found at point 3 (sand massif) in the summer of 2019 with an excess (2.4 MPC) at a value of 0.48 mg/dm^3. The index in the fall of last year at this point was lower by 0.13 mg/dm^3. The concentration of anionic surface active agents at point 1 in the fall of 2018 was 1.65 MPC with a value of 0.33 mg/dm^3. The concentration of ASAA exceeded the MPC by 2.35 times at 0.47 mg/dm^3 at the same point in the summer of 2019. The ASAA content in the South-West of the pond at the point was in the range of 0.41 mg/dm^3 (2.05 MPC); and 0.44 mg/dm^3 (2.2 MPC) for the fall of 2018, and for the summer of 2019, respectively.

Iron total Fe_{total} (Totality Fe^{2+} and Fe^{3+}). In water containing oxygen, Fe^{2+} easily converts to Fe^{3+} and is precipitated as a hydroxide. Fe^{2+} is unstable in an alkaline condition. Separate determination of dissolved and undissolved iron, as well as Fe^{2+} and Fe^{3+} does not give accurate results. Therefore, we determined the total iron Fe_{total} [11].

Maximum Fe_{total} concentrations exceeding the MPC were recorded in the fall of 2018, at points 1 and 3, in the range of 0.84 mg/dm^3 (2.8 MPC), and 0.77 mg/dm^3 (2.6 MPC). At the same time, the iron indexes for these points 1 and 3, in the summer of 2019, were lower values of 0.51 mg/dm^3 (1.7 MPC) and 0.63 mg/dm^3 (2.1 MPC), respectively. The Fe_{total} index for the sand massif at point 2 in the fall of 2018 was 0.62 mg/dm^3 (2.15 MPC) and was slightly higher than in the summer of 2019, at 0.55 mg/dm^3 (1.83 MPC). The decrease of the Fe_{total} index, in the summer of 2019, is due to the fact that the value of the hydrogen index pH>9 (9.21) at point 1 in the summer period, and points 2 and 3 to 9 (8.11) and (8.93), which allows characterizing the pond wastewater as alkaline. In General, the decrease of the Fe_{total} index is due to the availability of an oxidizer in the pond water in the form of chlorine.

Petroleum products (PP): The PP content was recorded at point 1 of the bituminous plant's wastewater discharge into the pond in the fall of 2018 at just over 1.2 MPC (0.12 mg/dm^3). At the same time, this index increased to 1.7 MPC (0.17 mg/dm^3). The PP content was lower than the MPC at point 2 in the fall of 2018, but in the summer of 2019 there was a slight increase (1.1 MPC). Their content is lower in the area of the sand massif.

The petroleum products load poses a danger to the environment in terms of their harmful effects, which are in the 2nd place after the radioactive contamination.

The active solar energy system has been developed and offered to prevent the evaporation of harmful substances from the water surface of the evaporator pond.

The transparent plastic coverings arranged in the deepest part of the evaporator pond will speed up the process of evaporation of wastewater, and prevent "emissions" of hydrocarbon vapors and sulfur-containing compounds [12, 13, 14].

The average concentrations of ASAA, Fe_{total} and petroleum products in the WW pond during the research period are shown in figure 2.

We will determine the biochemical index based on the data obtained in the research. This index reflects the BOD_5/COD ratio and it is always less than 1. The value of this index allows us to estimate the possibility of biological purification (table 2).

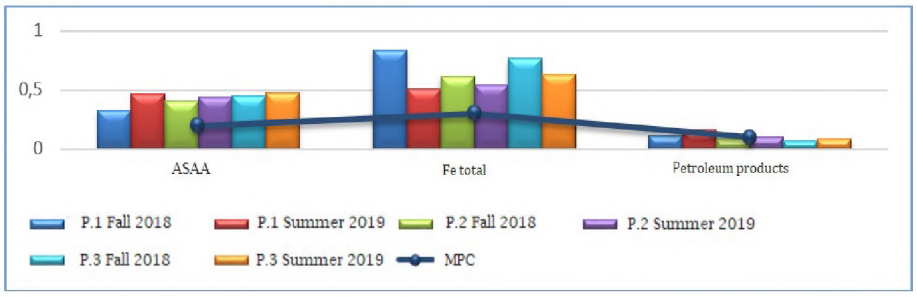

Figure 2 – Concentration of ASAA, Fe_{total} and petroleum products in the evaporator pond

Table 2 – Values of the BOD_5/COD ratio in the WW of the evaporator pond

Index	MPC*	Point No. of water sampling from the evaporator pond					
		No. 1		No. 2		No. 3	
		Fall 2018	Summer 2019	Fall 2018	Summer 2019	Fall 2018	Summer 2019
BOD_5, mgO_2/dm^3	3,0	96,3±0,04	38,5±0,03	83,0±0,06	35,5±0,05	91,4±0,03	33,7±0,05
COD, mgO_2/dm^3	30	302,3±0,06	379,1±0,03	274,1±0,05	311,0±0,04	288,3±0,05	292,0±0,05
BOD_5/COD ratio	-	0,32±0,05	0,10±0,04	0,30±0,03	0,09±0,06	0,31±0,05	0,11±0,04
COD/BOD_5 ratio	-	3,14±0,04	9,84±0,05	3,20±0,03	9,76±0,05	3,15±0,06	8,66±0,05

It can be seen from the data in table 2 that the values of the BOD_5/COD ratio are less than 0.5, which indicates that the water in the evaporator pond is saturated with resistant to oxidation compounds. However, it is known that industrial effluents are usually characterized by values of the biochemical index from 0.05 to 0.3. As for the COD/BOD_5 ratio, it is clear that in the summer period its values are 3 times higher than in the fall period. It is known that this ratio increases to 3.5 in industrial wastewater mixed with a significant quantity of sewage effluents, since it can reach up to 10 in the effluents of some industries.

Conclusion. An environmental assessment of the condition of the wastewater evaporator pond at the JV CaspiBitum LLP plant revealed the level of its pollution. It was found that the level of pollution in the pond water is V, and the waste water is dirty. According to the COD standard, the water is very dirty which corresponds to the VI level of pollution. According to the BOD_5 index, water pollution by organic compounds in the evaporator pond is also very dirty.

The values of the BOD_5/COD ratio in all studied points of the evaporator pond in the period 2018-2019 were less than 0.5. The water in the evaporator pond is supersaturated with resistant to oxidation compounds according to the standards for BOD_5/COD<0.5. On the other hand, it is known that the value of this biochemical index for industrial wastewater is characterized by values from 0.05 to 0.3.

It is necessary to create a closed solar energy system made of translucent PVC film coverings in order to speed up the process of evaporation of wastewater and prevent air pollution from harmful substances that evaporate with water vapor (figure 3).

Figure 3 – Overview of the developed solar energy system made of translucent coverings for intensifying the evaporation of wastewater and trapping harmful substances

It will enable you to reduce the level of air and soil pollution, speed up the evaporation process, and use polluted water purified by distillation in the irrigation system of urban trees and shrubs in conditions of water deficiency.

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«CASPI BITUM» ЖШС АҒЫНДЫ СУ БУЛАНДЫРҒЫШ ТОҒАНЫНЫҢ ЖАЙ-КҮЙІН БАҒАЛАУ

Аннотация. Мұнай өңдеу кәсіпорындарының, атап айтқанда, жол битумдарын өндіретін зауыттағы ағынды судың негізгі уытты және қауіпті ластаушы көзі – мұнай өнімдері. Бұл ағынды судың (АС) құрамы әртүрлі және мұнайдың сапасы өңдеу технологиясы, сондай-ақ оларды тазарту дәрежесімен анықталады. «Caspi Bitum» зауытында жол битумдарын өндіру үшін Қаражанбас кен орнының құрамында су, күкірт (массаның 1,06%) жоғары, сондай-ақ құм түріндегі механикалық қоспа бар мұнай пайдаланылады. Өндіріс процесінде судың қатты ластануы мұнайды сусыздандыру және тұзсыздандыру кезінде, электр тұзсыздандыру қондырғыларында жүреді. Бұл жағдайда пайда болған су минералданудың жоғарылауы әрі сонымен қатар ОБҚ және ОХҚ жоғары құрамы негізінде сипатталады. ОХҚ индикаторының жоғары мәні суда күрделі тотығатын органикалық қосылыстардың болатынын анықтайды. Бұл жалпы ағынды суды жоғары деңгейде ластайды. Санитариялық-техникалық шарттар бойынша битум зауытының ағынды суын су айдындарына ағызуға тыйым салынды, ал оларды қайта пайдаланудың мүмкіндігі болмады. Осыған байланысты зауыттан 5 км қашықтықта, ауданның табиғи ойпатында буландырғыш тоған салынды. Алдын ала тазартылған ағынды суды ағызуға арналған осы түрдегі жер сыйымдылығы, әдетте, Маңғыстау облысына жататын булану деңгейі жоғары аудандарда орналасады. Химиялық қосылыстар мен элементтердің кең бірлестіктері су қоймасында жиналады және іс жүзінде биосферамен байланыстан оқшауланбайды. Осылайша мұнай көмірсутектерінің және басқа ұшпа химиялық қосылыстар буы мұнаймен ластанған судың ареалды буландырғыш бетінен буланып, атмосфералық ауа мен елдімекендер топырағын ластауы мүмкін. Осыған байланысты құрғақ және ыстық климат жағдайларында күн энергиясы арқылы тұйық көлемде булану процесін жеделдететін техникалық құралдарды әзірлеу қажет.

2018-2019 жылдардағы зерттеулер битум зауытының ағынды суының буландырғыш тоғанының ластану динамикасы мен деңгейін зерттеді. Тоғанның ағынды суының химиялық құрамы 8 көрсеткіш бойынша анықталды. Әрбір нүкте ауданында тоғанның солтүстік-батыс бөлігіндегі Т1 (су жіберу) нүктесінде және Т2 нүктесінде (тоғанның шығыс бөлігі), сондай-ақ Т3 нүктесінде (оңтүстік-батыстағы құмды алқап) тоған күйін, іргелес жердің жай-күйін көзбен шолып қарау жүзеге асырылды. Су сынамаларын алу орындарында оның температурасы, pH және оттегінің мөлшері өлшенді. Су сынамаларын алу МемСТ Р 51592-2000 сәйкес жүргізілді. Ағынды су сынамаларын сақтау МемСТ 17.1.5.01-80 талаптарына сәйкес жүргізілді. Судың pH-ын анықтау Hanna портативті pH-метрі арқылы жүргізілді. Вариациялық статистиканың стандартты әдістері қолданылды. Буландырғыш тоғанның қоршаған ортаға әсер ету деңгейін бағалаудың негізгі қағидаты судың гидрохимиялық көрсеткіштерінің шамасын нормативтік мәнмен (ШРК) салыстырудан тұрады. Суда зерттелген зиянды заттардың орташа көрсеткіштері рұқсат етілген деңгейден 1,1-ден 21,9 есе асып түсті. Бұл ретте қауіптіліктің 3 және 4 сыныптарындағы заттар үшін нормативтердің: жалпы темір 2,8 есеге дейін, мұнай өнімдері 1,7 есеге дейін артады. Тотығудың орташа дәрежесі бар буландырғыш тоғандағы анионды баз мөлшері ШРК-дан 2,0 есе, 2,13 есе және 1, 2, 3 нүктелерінде жыл бойынша орташа есеппен 2,32 есе асып түседі. 2018-2019 жылдардағы орташа, буландырғыш тоғанның зерттелген нүктелері үшін $ОБҚ_5$/ОХҚ қатынасы келесі мәнді құрады: 1 нүктесінде (су шығару) – 0,215, 2 нүктесінде (оңтүстік-шығыс бөлігі) – 0,195, құм массивінің 3 нүктесінде – 0,21 және $ОБҚ_5$/ОХҚ<0,5 жағдайында – күрделі қышқылданатын қосылыстармен қанықтыруды білдіреді. «Caspi Bitum» БК ЖШС зауытының сарқынды су буландырғыш тоғанының жай-күйін экологиялық бағалау оның ластану деңгейін анықтауға мүмкіндік берді.

Тоған суындағы еріген оттегінің мөлшері бойынша ластану деңгейі V, ал ағынды судың лас екендігі анықталды. ОХҚ нормативі бойынша су өте лас, бұл ластанудың VI деңгейіне сәйкес келеді. $ОБҚ_5$ көрсеткіші бойынша су органикалық қосылыстармен ластанады, буландырғыш тоғандағы су да өте лас. ОХҚ мен ОБҚ мәнінің арасындағы арақатынас сарқынды суды тазартудың неғұрлым экологиялық қауіпсіз схемаларын, технологиялары мен әзірлемелерін дайындауу үшін қолданылатын ағынды судың іргелі сипаттамаларының бірі болып саналады, оларды су объектілеріне

төгуге тыйым салынады және қайта пайдаланудың мүмкіндігі жоқ. Бұл булану процесін тездетуді қажет етеді. Зиянды заттардың булану процесін қарқындату және биосферамен байланыстан оқшаулау үшін экологиялық және экономикалық тұрғыдан тұтас көрінетін мөлдір жабынның гелиотехникалық жүйесі әзірленді және ұсынылады. Бұл атмосфералық ауа мен топырақтың ластану деңгейін азайтуға, булану процесін жылдамдатуға, су тапшылығы жағдайында қалалық ағаштар мен бұталарды суару жүйесінде дистилляция арқылы тазартылған ластанған суды пайдалануға мүмкіндік береді. Әзірленген гелиожүйе тоған бетінен зиянды заттардың булануына жол бермейді және ағынды судың жабық көлемде ағынды судың булану процесін күшейтеді.

Түйін сөздер: мұнай, битум, мұнай өнімдері, ағынды су, ыстық климат, буландырғыш тоған, еріген оттегінің жетіспеушілігі, биохимиялық көрсеткіш.

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ОЦЕНКА СОСТОЯНИЯ ПРУДА-ИСПАРИТЕЛЯ СТОЧНЫХ ВОД ТОО «CASPI BITUM»

Аннотация. Основным токсичным и опасным загрязняющим веществом сточных вод предприятий переработки нефти, в частности завода по производству дорожных битумов, являются нефтепродукты. Состав этих сточных вод (СВ) разнообразен и определяется качеством нефти и технологией ее переработки, а также от степени их очистки. Для производства дорожных битумов на заводе «Caspi Bitum» используется нефть месторождения Каражанбас, с высоким содержанием воды, серы (1,06% масс), а также и механических примесей в виде песка. В процессе производства сильное загрязнение воды происходит при обезвоживании и обессоливании нефти, на электрообессоливающих установках (ЭЛОУ). Образуемая при этом вода характеризуется не только повышенной минерализацией но и высоким содержанием БПК и ХПК. Высокие значения показателя ХПК обуславливают наличие в воде трудно окисляемых органических соединений. Это, обуславливает высокую степень загрязненности сточных вод в целом. По санитарно-техническим условиям сброс сточных вод битумного завода в водоемы был запрещен а повторное их использование невозможно [2]. В этой связи, на удалении 5 км от завода, в естественном понижении местности был устроен пруд-испаритель [3,4]. Земляные емкости такого типа для сброса предварительно очищенных стоков, обычно устраиваются в районах с высокой испаряемостью к которым относится Мангистауская область. Широкие ассоциации химических соединений и элементов накапливаются в водоеме и практически не изолированы от контактов с биосферой. Таким образом. с поверхности площадного испарителя нефтезагрязненных вод могут испаряться пары углеводородов нефти также и другие летучие химические соединения и загрязнять атмосферный воздух и почву населенных мест [2]. В этой связи необходима разработка технических средств для ускорения процесса испарения, в пределах замкнутого объема с использованием энергии Солнца в условиях сухого и жаркого климата.

Исследованиями 2018-2019 гг., изучена динамика и уровень загрязнения пруда-испарителя сточных вод битумного завода. Химический состав сточных вод (СВ) пруда определялся по 8 показателям. В районах каждой точки, в точке Т1 (водовыпуск) в северо-западной части пруда, и в точке Т2 (восточная часть пруда) а также в точке Т3 (песчаный массив на юго-западе), был осуществлен визуальный осмотр состояния пруда, прилегающей местности. В местах отбора проб воды, измеряли ее температуру, pH и содержание кислорода. Отбор проб воды проводился в соответствии с ГОСТ Р 51592-2000. Хранение проб СВ проводились в соответствии с требованиями ГОСТ 17.1.5.01-80. Определение pH воды проводили с помощью портативного pH-метра Hanna.

Использованы стандартные методы вариационной статистики. Основной принцип оценки уровня влияния пруда-испарителя на окружающую среду, состоит в сопоставлении величины гидрохимических показателей воды с нормативными значениями (ПДК). Средние по годам показатели изученных вредных веществ в воде превышали допустимый уровень от 1,1 до 21,9 раза. При этом, для веществ 3 и 4 классов опасности регистрировали превышения нормативов: железа общего – до 2,8 раза, нефтепродуктов – до 1,7 раза. Содержание анионных ПАВ в пруде-испарителе со средней степенью окисления зафиксировано с превышением ПДК в 2,0 раза, 2,13 раза и 2,32 раза в среднем по годам в точках 1, 2, 3 соответственно. Средние за 2018-2019 гг, сооотношения $БПК_5$/ХПК, для исследованных точек пруда-испарителя, составили следующие значения: в точке 1 (водовыпуск) – 0,215, в точке 2 (юго-восточная часть) – 0,195, в точке 3 в районе песчаного массива – 0,21 и при условии $БПК_5$/ХПК<0,5 – это означает перенасыщение СВ труднооокисляемыми соединениями. Экологическая оценка состояния пруда-испарителя сточных вод завода ТОО СП «Caspi Bitum» позволила выявить уровень его загрязненности.

Установлено, что по содержанию в воде пруда растворенного кислорода, уровень загрязненности – V, а сточные воды грязные. По нормативу ХПК – вода очень грязная, что соответствует VI уровню загрязненности. По показателю $БПК_5$ загрязнения воды органическими соединениями, вода в пруде-испарителе также очень грязная. Соотношение между значениями ХПК и БПК является одной из основополагающих характеристик стоков, по которым ведется разработка наиболее экологически безопасных схем, технологий и разработок очистки сточных вод, сброс которых в водоемы запрещен а повторное использование невозможно. Это требует ускорения процесса испарения. Для интенсификации процесса испарения и изоляции вредных веществ от контактов с биосферой разработана и предлагается гелиотехническая система из светопрозрачных покрытий, которая экологически и экономически целесоообразна. Это даст возможность, уменьшить уровень загрязнение атмосферного воздуха и почв ускорить процесс испарения, использовать очищенную за счет дистилляции загрязненную воду в системе полива городских деревьев и кустарников в условиях дефицита вод. Разработанная гелиосистема позволяет предотвратить испарение вредных веществ с поверхности пруда и интенсифицировать процесс испарения сточных вод в замкнутом объеме.

Ключевые слова: нефть, битум, нефтепродукты, сточные воды, жаркий климат, пруд-испаритель, дефицит растворенного кислорода, биохимический показатель.

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