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THE QUALITY RESEARCH OF WASTEWATER TREATMENT OF DOLYNA OIL DISTRICTS OF IVANO-FRANKIVSK REGION

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Purpose. To make analyze of quality of wastewater that is directly used in Dolyna oil district. ***Methodology.*** The article deals with the research of quality of wastewater treatment and is based on the data processing concentrations of pollutants during last 5 years. We have justified the relevance of environmental studies of water quality that is discharged into natural water objects. We have considered basic methods of wastewater treatment that are used in Dolyna oil district. We have depicted process of return water drainage from oil and gas enterprise into natural water objects. ***Results.*** We have presented characteristic of efficiency of the methods in the petroleum industry. As a next step, we have analyzed dynamics of changes of major pollutants in wastewater during 2011-2015. Moreover, we have conducted the comparison of the values of the studied chemicals that are entering into rivers Turianka, Sadzhava, Luschava with the maximum allowable concentrations of pollutants to water fishery purposes. ***Originality.*** We have given the proposals for improving of the quality of wastewater that is discharged into water objects Dolina district of Ivano-Frankivsk region. ***Practical value.*** This research is the basis for the development of monitoring programs, forecasting the environmental situation of the district and improvement of treatment plants. The results of the study should be used in Dolina oil district. *References 4, figures 24.*

Keywords: wastewater, pollutants, methods of treatment, petroleum industry, chemicals

ДОСЛІДЖЕННЯ ЯКОСТІ ОЧИСТКИ СТІЧНИХ ВОД У ДОЛИНСЬКОМУ НАФТОПРОМИСЛОВОМУ РАЙОНІ ІВАНО-ФРАНКІВСЬКОЇ ОБЛАСТІ

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Дослідження якості очистки стічних вод базувалось на обробці даних концентрацій забруднюючих речовин за останніх 5 років. Обгрунтовано актуальність екологічних досліджень якості води, що скидають у природні водні об'єкти. Розглянуто основні методи та технологію очищення стічних вод, що використовуються в Долинському нафтопромисловому районі. Зображено процес водовідведення стічних вод нафтогазового підприємства у природні водойми. Проведено характеристику ефективності використання описаних методів у нафтогазовій промисловості. Проаналізовано динаміку змін основних забруднюючих речовин в стічних водах протягом 2011-2015 рр. Проведено співставлення значень досліджуваних хімічних речовин, що надходять у річки Тур'янка, Саджава, Лущава з гранично допустимими концентраціями забруднюючих речовин для водойм рибогосподарського призначення. Наведені пропозиції щодо підвищення якості очистки стічних вод, що відводяться у водні об'єкти Долинського району Івано-Франківської області. Це дослідження є основою для розвитку програм моніторингу, прогнозування екологічної ситуації району та удосконалення очисних споруд. Результати дослідження можуть бути використані в Долинському нафтопромисловому районі.

Ключові слова: стічні води, забруднюючі речовини, методи очистки, нафтова промисловість, хімікати

PROBLEM STATEMENT. Oil and gas complex has a negative impact on all components of the environment. However, contamination of surface waters within the influence of oil and gas companies is attracted considerable attention. In the course of their activity a lot of water for various process needs are consumed, and thus increases and water pollution. Existing technologies and equipment for water purification are usually outdated and ineffective, resulting not provide the required level of wastewater treatment because of particular relevance is the question of improving the efficiency of wastewater treatment oil and gas companies.

Every year scientists record the increasing degradation of natural watercourses due to discharge of inadequately treated or untreated wastewater industry. Today various methods relating to water purification and used in the oil and gas sector are developed. The method of water treatment depends on the degree of contamination and the presence of hazardous substances. Works of scientists are dedicated to study of water treatment of pollutants: V.V. Goncharuk, O.Y. Ivanenko, N.S. Vishnevskyi, V.A. Krasinko, L.A. Kulskyi, V.I. Alekseyeva, V.P. Leonov, A.A. Popov, L.A. Borzakova, M.V. Korchemlyuk, L.M. Arkhypova [1,2].

The purpose is the analyzing quality of wastewater that is directly used in Dolyna oil district.

EXPERIMENTAL PART AND RESULTS OBTAINED. To achieve this goal we need to perform the following tasks:

– conduct characterization technology for return water to the oil and gas production company;

– to determine the effectiveness of methods of sewage treatment;

– analyzed the dynamics of change in the content of main pollutants in wastewater during 2011-2015.

Dolyna oil district is located in the Ivano-Frankivsk region, has oil, condensate and associated gas processing and pumping them to consumers. The main technological stations are served by auxiliary departments, which are used in the clean water and divert the river opposite in the rivers Turianka, Luschava and Sadzhava [3].

Dolyna oil district there are 4 issues of wastewater, which are used 2 methods of wastewater treatment, such as mechanical and biological treatment. Buildings for wastewater treatment are arranged so that the water runs consistently. The most difficult and large suspended solids are initially detained in buildings for mechanical treatment and then a lot of insoluble contaminants are separated accorgingly. On issue 1 (r.Turianka) is mechanical cleaning at wastewater treatment plants design capacity for storm wastewater 20 l / s, for washing cars - 10 l / s. This issue is formed from industrial, household and rain treated wastewaters №1,3 convoy shop technological transport. The composition of the unit includes car wash, workshop. With car washing convoy №3 return water are dumped on two bellhop reinforced septic tank with overflow (20 * 8 m) deep 9 m. Then after cleaning reverse water are served in the collector system of wells and access to the river Turianka. Clean the tank is held twice a year. Requirements to water river Turianka are taken as reservoirs communal water. Scheme of return water drainage in the r. Turianka (issue №1) is shown in Figure 1.

On issue 2 (r. Sadzhava) it is also used a mechanical method of cleaning at wastewater treatment plants design capacity 9,32m^3/day, 3400 m^3/year.

Issue №2 is formed by a convoy return water №5, which blocks from tractor's park pass mechanical cleaning sump and then are discharged into a sewer system gravity-flowing wells septic tanks with overflow into the river Sadzhava. Because the issue of return water is carried outside the settlement, requirements for river water Sadzhava are taken as a water reservoir fishery. Scheme of return water drainage in the r. Sadzhava is shown in Fig. 2.

On issue 3 (p. Luschava) it is performed biological treatment to a treatment plant design capacity 4,3 m^3/day, 1600 m^3/year. Issue №3 (Fig. 3) is formed of domestic wastewaters administrative building, industrial fuel and water from rain water. The water from the fuel is discharged into the storm sewage bypassing biological treatment (sand-gravel filter), the intermediate wells connected to the treated household wastewater and further are discharged into the river Luschava.

Economic and domestic wastewater purification is carried out at treatment plants, which consist of reinforced concrete septic tank, well dosing, sand-gravel filter, contact reservoir.

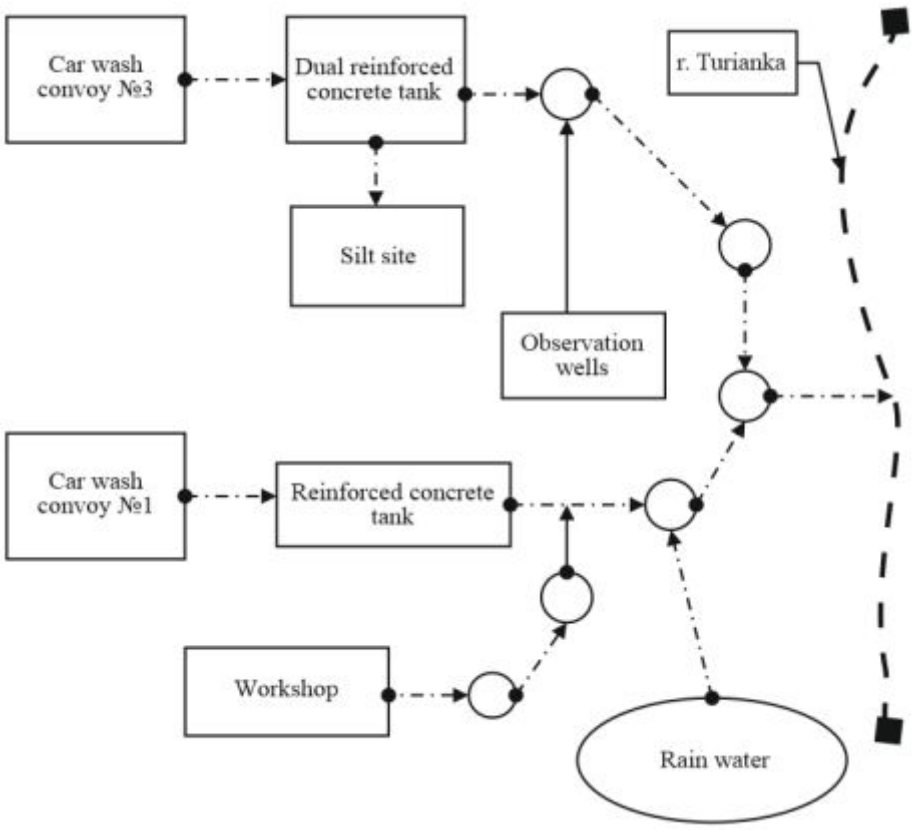


Figure 1 – Sheme of return water drainage from convoy №1 and №3 of workshop of technological transport of Dolyna oil district

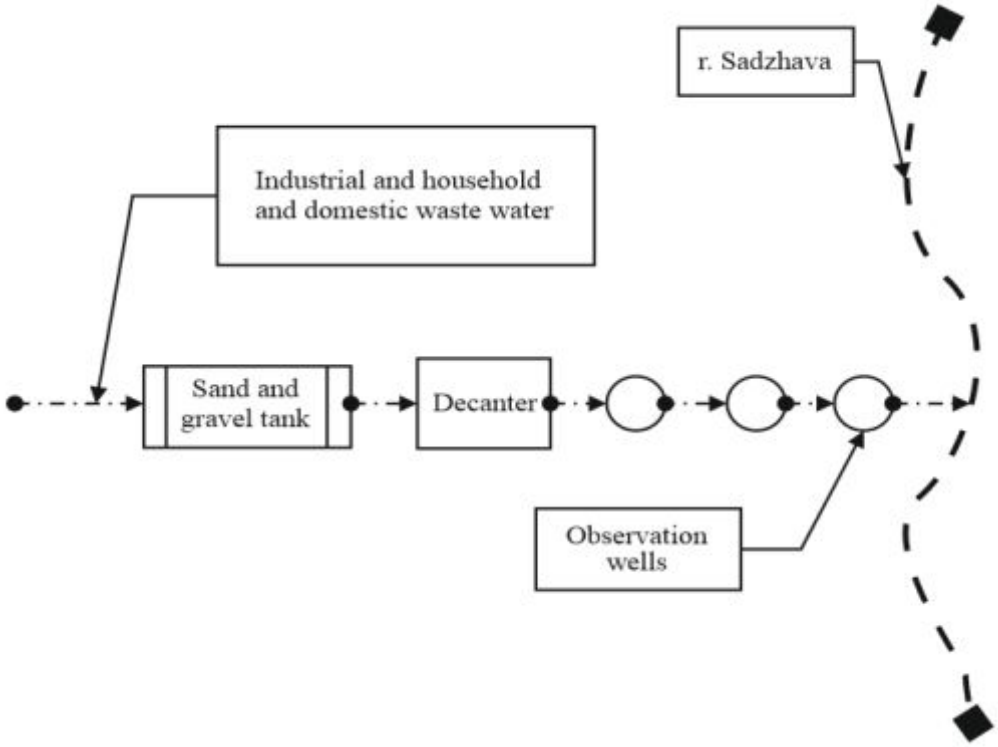
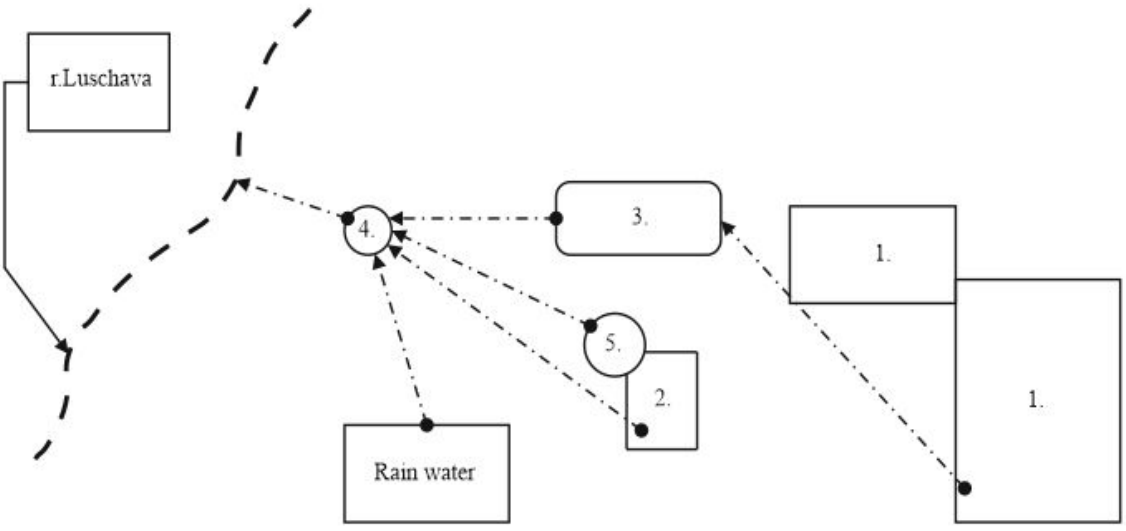


Figure 2 – Sheme of return water drainage from convoy №5 of Dolyna oil district



Legend:
1. administrative building
2.fuel building
3.treatment plants of domestic wastewater and rainwater
4.contact tank
5.building for chlorination

Figure 3 – Sheme of return water drainage of administrative building of Dolyna oil district

On issue 4 (r.Turianka) there are used biological cleaning to a treatment plant design capacity of 12,5 m^3/day, 1600 m^3/year and for mechanical cleaning of rain sewage 30 l / c. Issue №4 is formed of household rainwater and return water base logistics. Wastewater is purified in septic tanks and then is sent to the tank and filtered for sand and gravel filter.

The biological treatment is such technology on the company:

Economic - domestic wastewater produced in the process of life coming into the reception tank. Wastewater from the reservoir is served on septic tanks (slop camera - 6 pcs.) for pre-treatment, which is both light sewage and long term storage sediment. Organic part of sediment within 6-12 months, depending on the temperature is in the septic tank. Scheme of return water drainage in the r. Turianka (issue №4) is shown in Figure 4.

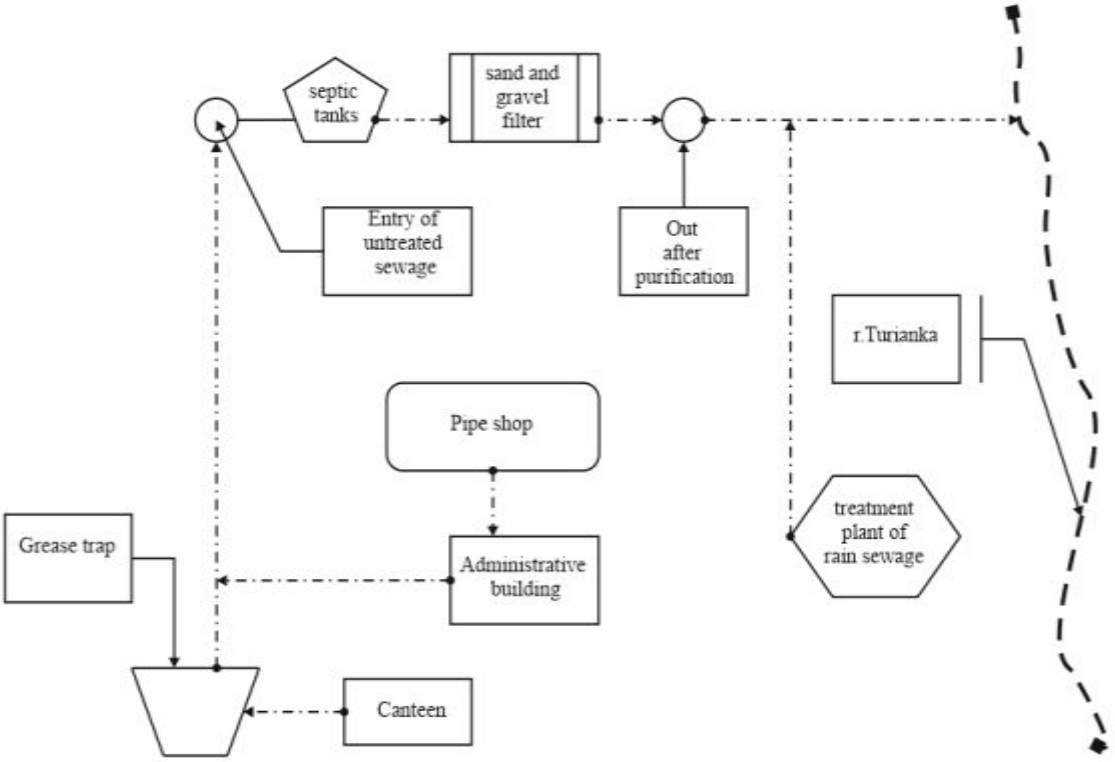


Figure 4 – Sheme of return water drainage of base material and technical support of Dolyna oil district

Wastewater is in septic tanks for two to three days. Septic tanks can reduce suspended solids content to 70-75% and BSC5 30-35%. Illuminated water from septic tanks are entered the sand and gravel filters.

Sand and gravel filters are arranged in waterproof soil in a pit with sloping walls. Pit is filled with filter material, which is laid irrigation and drainage network output. In this case, the distance between the irrigation and drainage pipes is 1-1,5 m vertically, and between the irrigation pipes in the plan – 0,5-1,0 m. Large and medium-grained sand is used as the filter material, is filling height - 0,8 m.

The air in the sand and gravel filters are supplied by irrigation and drainage system for ventilation pipes with a diameter of 100 mm, are derived 0,5 m above ground level.

Rain water is generated due to falling precipitation. A survey of the existing network of rain (storm) sewer and places cleaning and drainage of rain sewage at the plant showed that the total area of roofs and asphalt-concrete pavements, which is arranged rain (storm) drainage is – 1,1 hectares [4].

Rain sewage pass mechanical cleaning on the local treatment plant design capacity of 1,5 l / s.

The local treatment facilities are:

– sump;

– water filter.

After cleaning rain water sewage common with purified household water reverse are dumped in the river Turianka.

The presence of anthropogenic pollution of water bodies is determined by a high content of water pollution and changes in chemical composition. The main factor of the contamination of the natural water is treatment plant of poor performance of oil and gas companies. Poor performance treatment facilities of oil and gas company.

The dynamics of a greater concentration of most pollutants for 2011-2015 years are shown to assess the efficiency of mechanical and biological purification methods return water Dolyna oil district on four issues.

The quality assessment of surface water is carried out compared with the maximum allowable concentrations of pollutants to water fishery purposes.

Value BOD5 wastewater discharged into r.Turianka (issue 1), ranging 4,5-11,5 mgO_2/dm^3, that in 1,5-3,8 times higher than standard BOD5 (MPC is 3 mgO_2/dm^3). Wastewater discharged into r.Sadzhava (issue 2), varies from 5,6-17 mgO_2/dm^3 and in 1,9-5,7 times higher than the MPC. Maximum BOD5 for the period 2011-2015years is recorded in II quarter 2015 year (17 mgO_2/dm^3), which is associated with the receipt to the river polluted wastewater "Uniplyt."

The fluctuation of values BOD5 is observed on issue 3 within 6,6-17,5 mgO_2/dm^3 . Only case of exceeding the maximum MPC of 19,2 times was reported in the I quarter of 2011 year.

Value BOD5 wastewater that is discharged in r. Turianka (issue 4) ranges 3,2-8,4 mgO_2/dm^3 in 1,1-2,8 times higher than MPC. Dynamics of changes of major pollutants in wastewater during 2011-2015 is shown in Fig. 5-24.

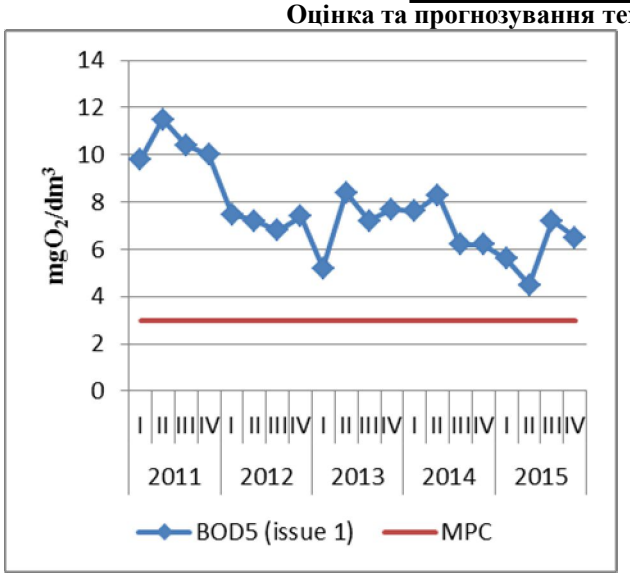


Figure 5 – Dynamics in changes of concentration BOD5 on issue №1 during 2011-2015

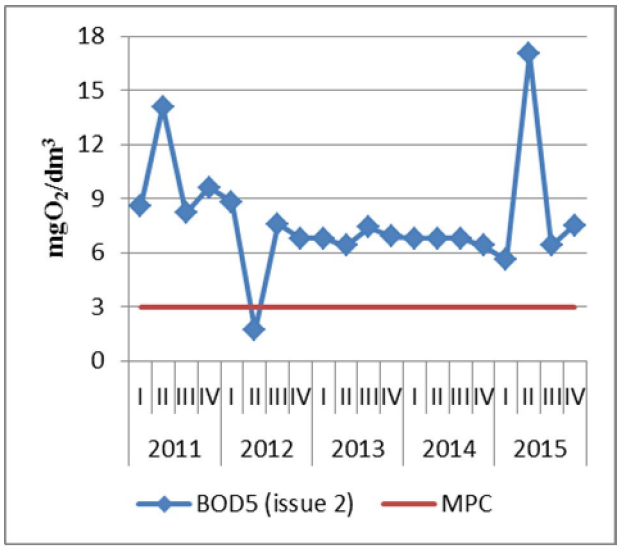


Figure 6 – Dynamics in changes of concentration BOD5 on issue №2 during 2011-2015

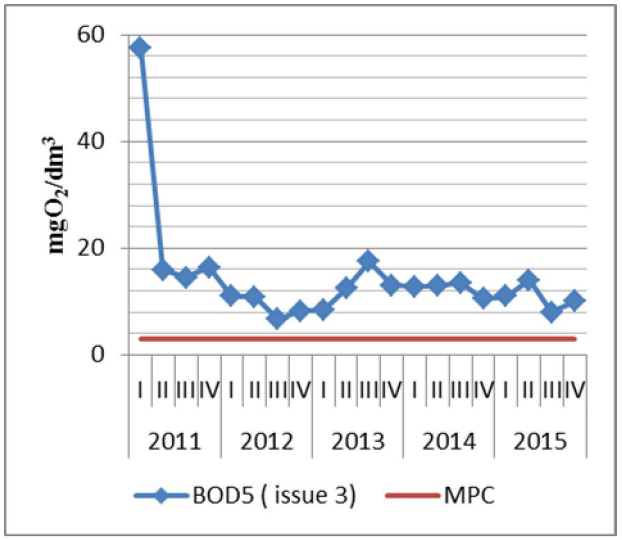


Figure 7 – Dynamics in changes of concentration BOD5 on issue №3 during 2011-2015

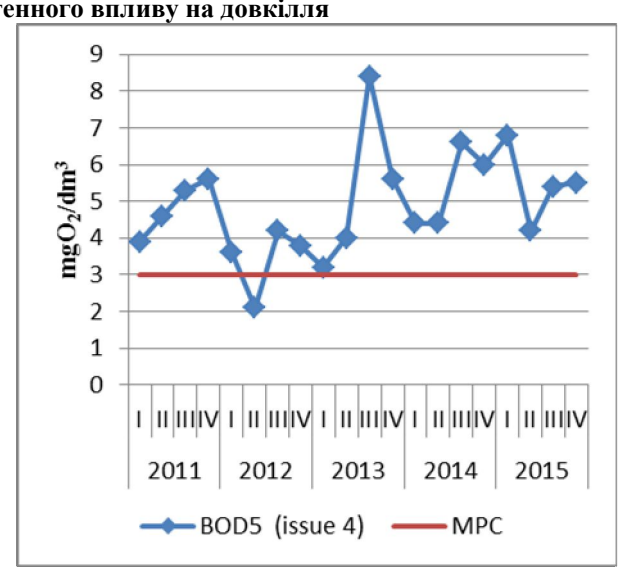


Figure 8 – Dynamics in changes of concentration BOD5 on issue №4 during 2011-2015

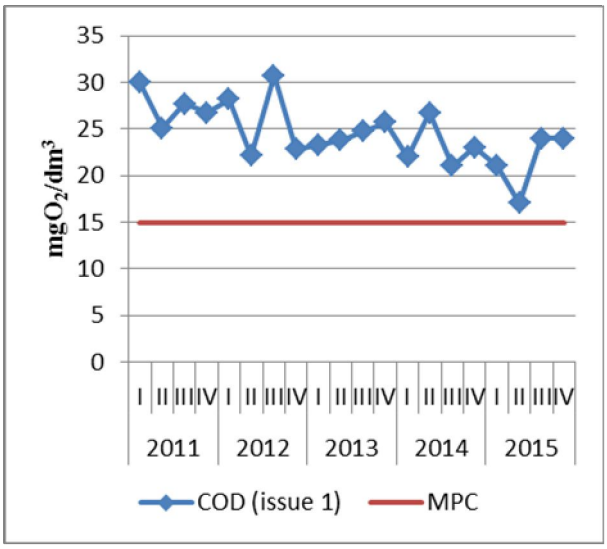


Figure 9 – Dynamics in changes of concentration COD on issue №1 during 2011-2015

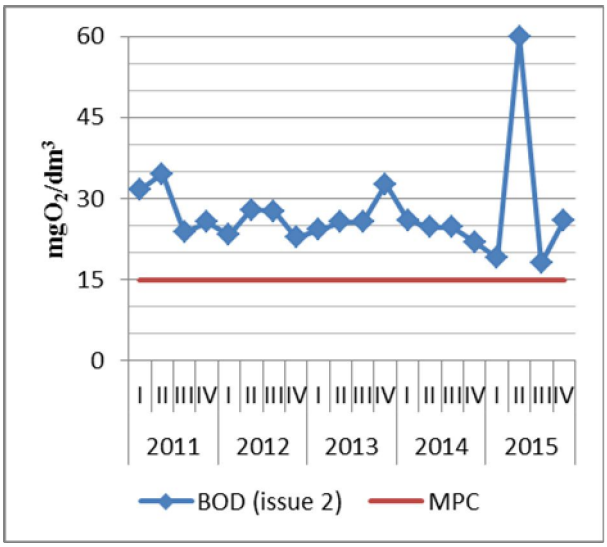


Figure 10 – Dynamics in changes of concentration COD on issue №2 during 2011-2015

The content of COD in waste water Dolyna oil district exceeds the permitted limit on all four issues, while MPC – 15 mgO_2/dm^3.

COD values during 2011-2015 years are varied widely:

– 17-30,7 mgO_2/dm^3 (issue 1), in 1,1-2,05 times higher than standard (MPC is 15 mgO_2/dm^3);

– 18-60 mgO_2/dm^3 (issue 2), which in 1,2-4 times higher than MPC. Maximum values COD is recorded in II quarter 2015 year;

– 26-152,4 mgO_2/dm^3 (issue 3), which is 10,2 times higher than 1,7- MPC;

– 18-41,9 mgO_2/dm^3 (issue 4), in 1,2-2,8 times higher than the MPC.

Excess COD indicates the flow of surface water discharges of organic matter from wastewater.

Earnings of ammonium salt surface waters due to discharges of waste water runoff from agricultural land containing ammonium fertilizer. The presence of ammonium salt biochemical processes is associated with degradation of proteins, deamination of amino acids.

The content of ammonium salt in wastewater ranges:

– 0,2-0,92 mg/dm^3 (issue 1) in the MPC 0,5 mg/dm^3. There were only 4 cases of slight - excess of MAC in 1,12-1,84 times in 2011 and 2013 years;

– 0,08-2,97 mg/dm^3 (issue 2). Excess regulation was found in 2012 (5 times), 2013 (3 times), 2014 (1,7 times). The concentration of ammonium salt reaching a peak in 2015, that exceed the MPC in 5,9 times;

– 4,27-66,23 mg/dm^3 (issue 3 in r.Luschava) that 8,54-132,46 times higher than the MPC. The content of ammonium salt reaches its peak in I quarter 2014 (132,45 mg/dm^3 which indicates the maximum contamination 2011-2015 years;

– exceeding the MPC in 1,14-3,2 times. The maximum concentration of ammonium salt was observed in the I quarter of 2014.

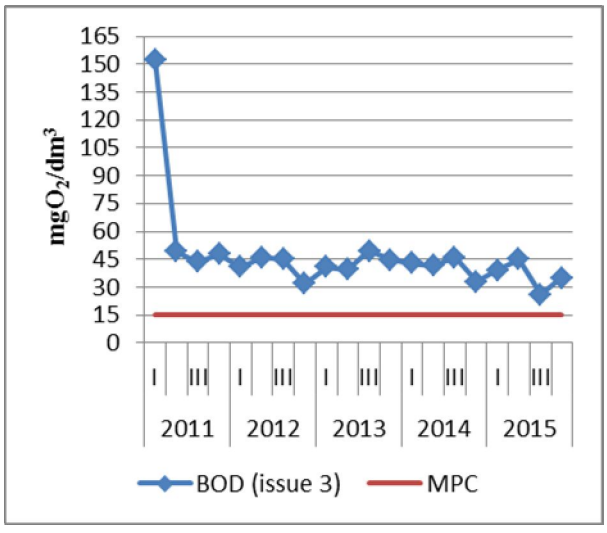


Figure 11 – Dynamics in changes of concentration COD on issue №3 during 2011-2015

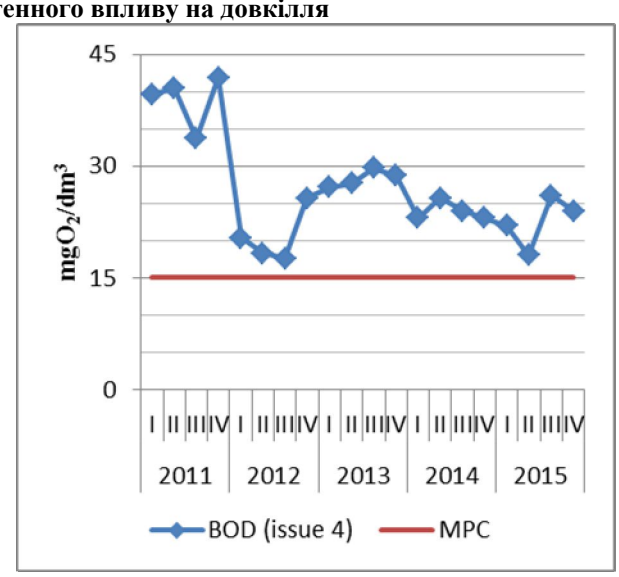


Figure 12 – Dynamics in changes of concentration COD on issue №4 during 2011-2015

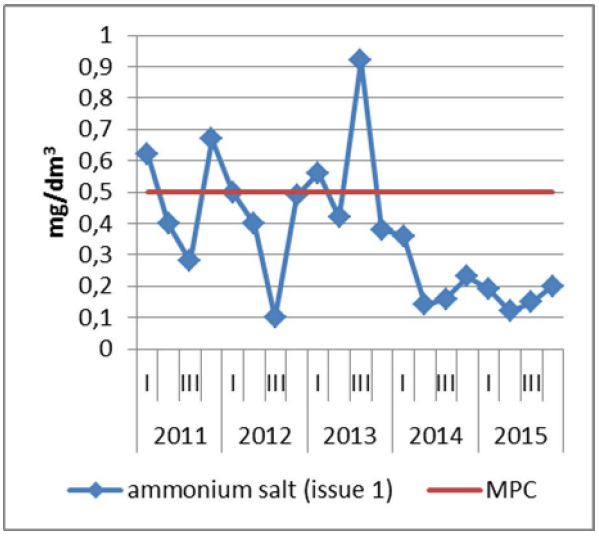


Figure 13 – Dynamics in changes of concentration of ammonium salt on issue №1 during 2011-2015

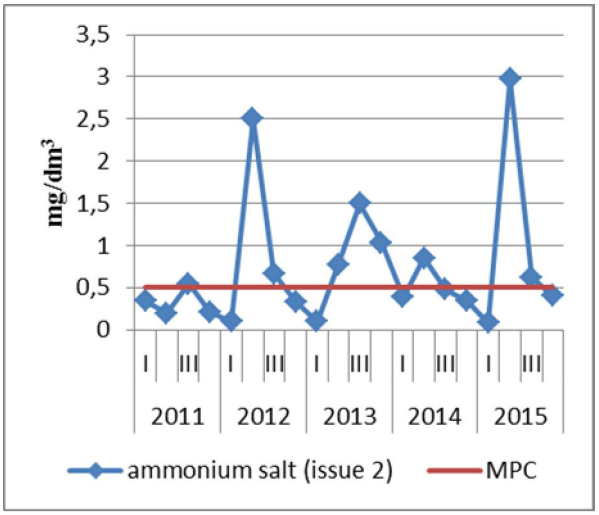


Figure 14 – Dynamics in changes of concentration of ammonium salt on issue №2 during 2011-2015

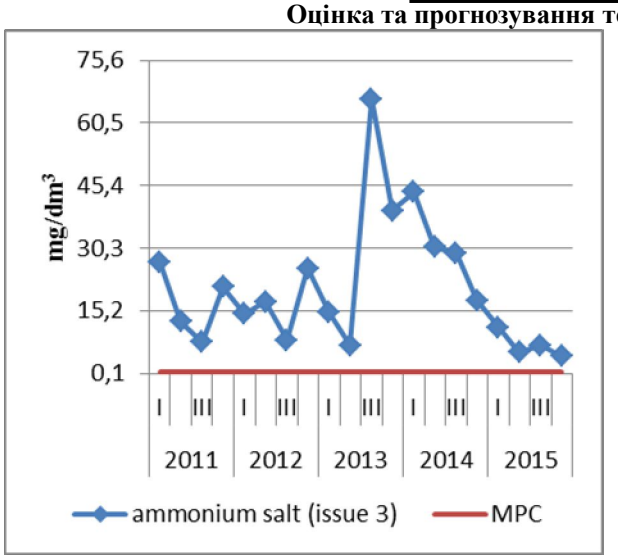


Figure 15 – Dynamics in changes of concentration of ammonium salt on issue №3 during 2011-2015

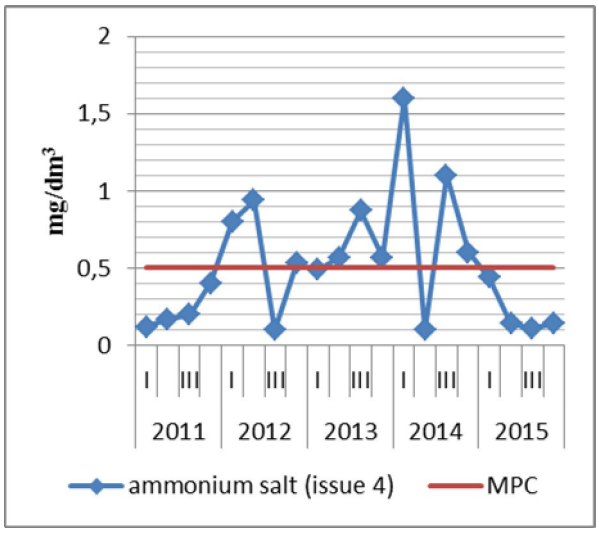


Figure 16 – Dynamics in changes of concentration of ammonium salt on issue №4 during 2011-2015

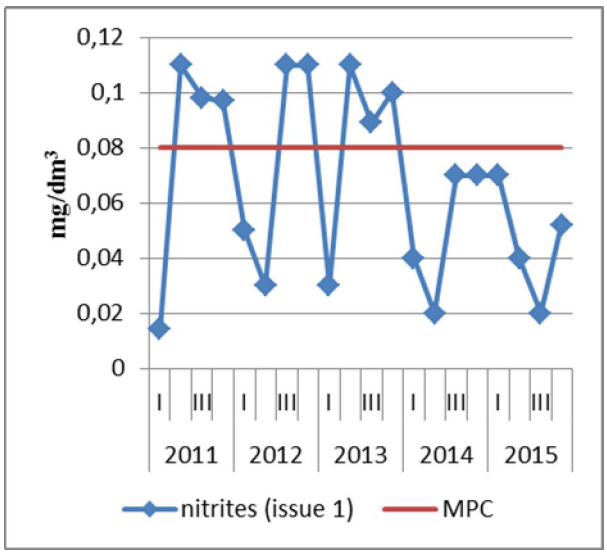


Figure 17 – Dynamics in changes of concentration of nitrites on issue №1 during 2011-2015

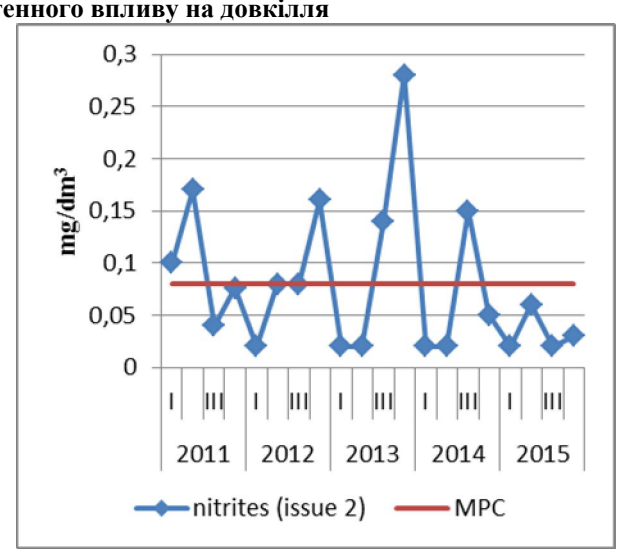


Figure 18 – Dynamics in changes of concentration of nitrites on issue №2 during 2011-2015

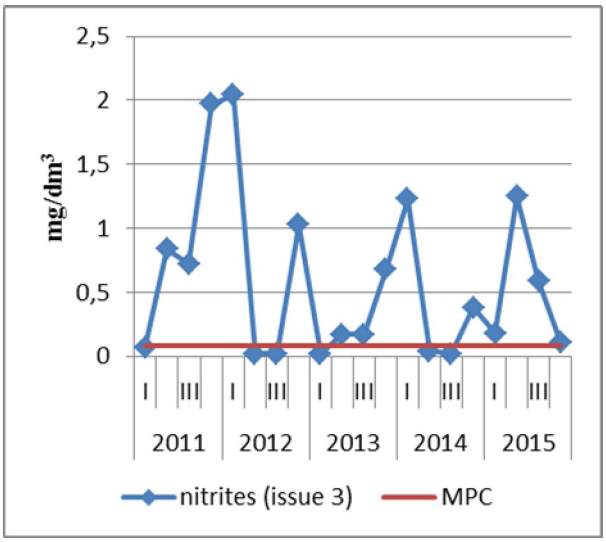


Figure 19 – Dynamics in changes of concentration of nitrites on issue №3 during 2011-2015

Nitrite is an intermediate form of bacterial processes in the chain oxidation of ammonium to nitrite. Nitrates enter the surface water when using nitrite as a corrosion inhibitor in water treatment process water.

Exceeding MPC standards for nitrates in 1,1-1,4 times (issue 1) was observed in II-III quarter of 2011, III-IV quarter of 2012, II-IV quarters of 2013. The content of nitrites in 2014-2015 was characterized by stability without exceeding the norm MPC.

The concentration of nitrites wastewater is discharged into the river Sadzhava (issue 2), exceeding the MPC in 1,75-3,5 times during 2011-2014. Significant improvement of ecological situation on the content of nitrite was observed in 2015.

The content of nitrite (issue 3) ranges 0,11-2,4 mg/dm^3, that 1,4 – 25,5 times higher than the MPC.

The concentration of nitrite for the production of 4 varies 0,11-0,34 mg/dm^3, that 1,4-4,25 times higher than that standard.

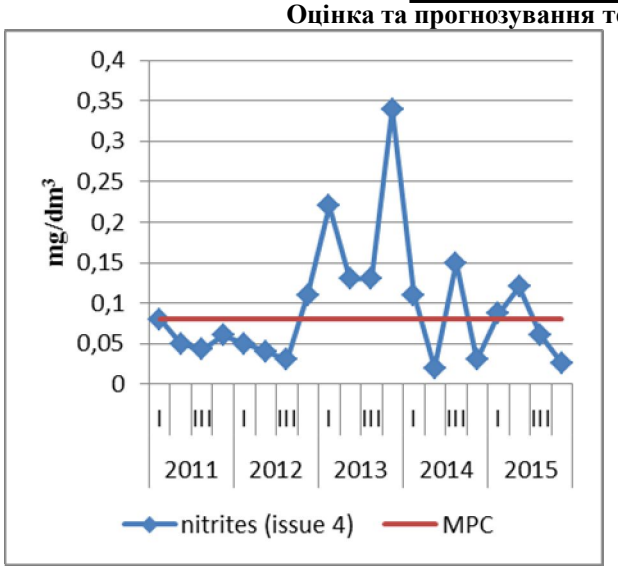


Figure 20 – Dynamics in changes of concentration of nitrites on issue №4 during 2011-2015

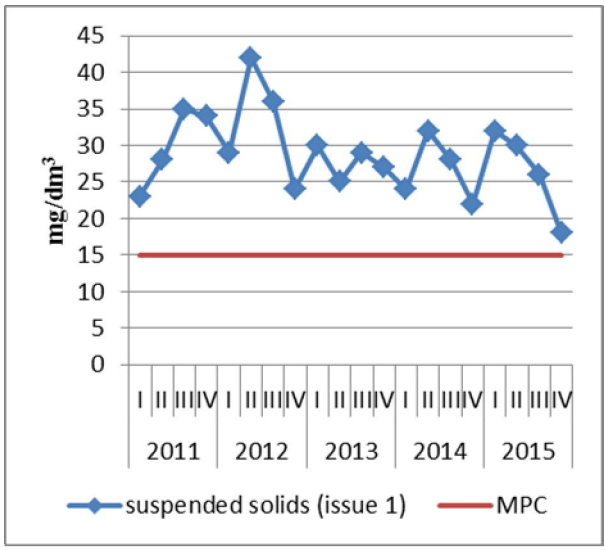


Figure 21 – Dynamics in changes of concentration of suspended solids on issue №1 during 2011-2015

Higher concentrations of nitrite in wastewater indicates the strengthening of decomposition of organic matter in a more slow oxidation.

Value of suspended solids during 2011-2015 was varied widely:

– 18-42 mg/dm^3 (issue 1), in 1,2-2,8 times higher than the MPC;

– 20-35 mg/dm^3 (issue 2) in 1,3-2,3 times the standard MPC;

– 16-24 mg/dm^3 (issue 3), in 1,06-1,6 times higher than the MPC;

– 16-23 mg/dm^3 (issue 4), in 1,06-1,53 times higher than the MPC.

Increasing of the concentration of suspended solids caused by seasonal factors, clouding sediments, sewage discharges.

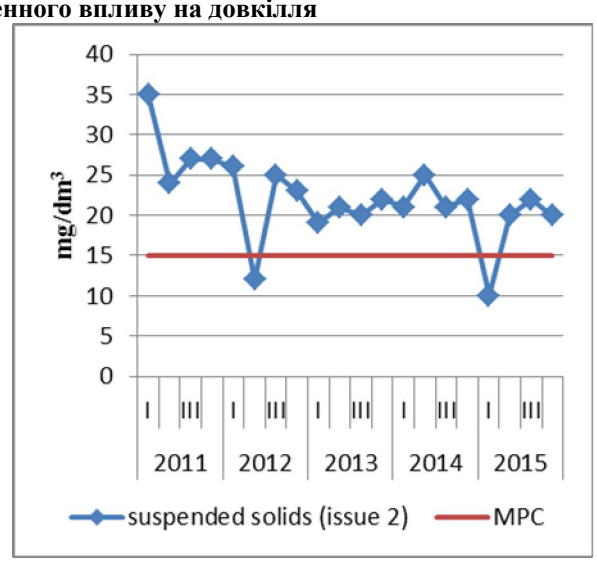


Figure 22 – Dynamics in changes of concentration of suspended solids on issue №2 during 2011-2015

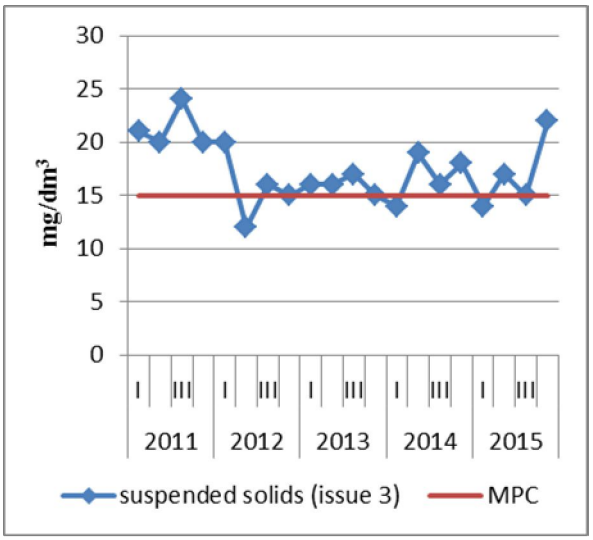


Figure 23 – Dynamics in changes of concentration of suspended solids on issue №3 during 2011-2015

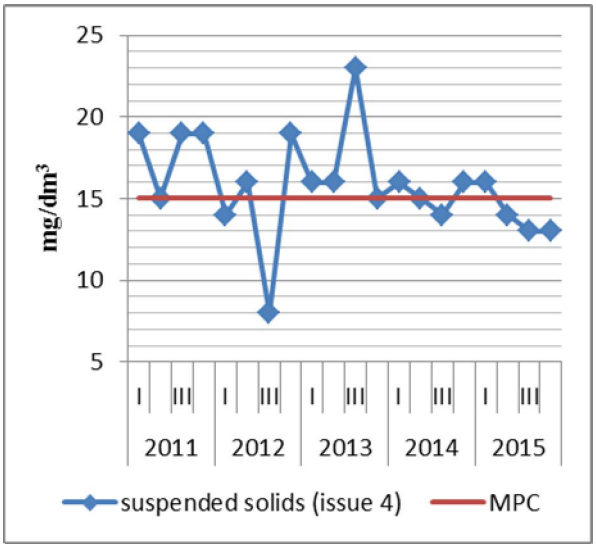


Figure 24 – Dynamics in changes of concentration of suspended solids on issue №4 during 2011-2015

Results of the research that consider the efficiency of wastewater treatment using a mechanical and biological treatment method in the enterprise is not sufficient, and, hence, we have low productivity treatment plants.

Therefore, it is recommended to improve existing methods of water treatment and efficient use of new cost-effective methods of wastewater treatment, to improve the environmental situation of water objects within the influence of the oil and gas industry.

CONCLUSIONS. Technology characterization and purification methods return water used directly in oil and gas production enterprise of Dolyna oil district was held. The dynamics of changes is analyzed and excess of such pollutants as BOD5, COD, ammonium salt, nitrites and suspended solids are discharged into rivers Turianka, Sadzhava, Luschava are fixed. Proposals to improve the quality of wastewater that is discharged into water objects of Dolina district of Ivano-Frankivsk region are offered.

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ИССЛЕДОВАНИЕ КАЧЕСТВА ОЧИСТКИ СТОЧНЫХ ВОД ДОЛИНСКОГО НЕФТЕПРОМЫШЛЕННОГО РАЙОНА ИВАНО-ФРАНКОВСКОЙ ОБЛАСТИ

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Исследование качества очистки сточных вод базировалось на обработке данных концентраций загрязняющих веществ за последние 5 лет. Обоснована актуальность экологических исследований качества воды, сбрасываемых в природные водные объекты. Рассмотрены основные методы и технологии очистки сточных вод, используемых в Долинском нефтепромышленном районе. Изображен процесс водоотведения сточных вод нефтегазового предприятия в природные водоемы. Проведено характеристику эффективности использования описанных методов в нефтегазовой промышленности. Проанализирована динамика изменений основных загрязняющих веществ в сточных водах в течение 2011-2015 гг. Проведено сопоставление значений исследуемых химических веществ, поступающих в реки Тур’янка, Саджава, Лущава с предельно допустимыми концентрациями загрязняющих веществ для водоемов рыбохозяйственного назначения.. Приведены предложения по повышению качества очистки сточных вод, отводимых в водные объекты Долинского района Ивано-Франковской области. Это исследование является основой для развития программ мониторинга, прогнозирования экологической ситуации района и усовершенствование очистных сооружений. Результаты исследования могут быть использованы в Долинском нефтепромышленном районе.

Ключевые слова: сточные воды, загрязняющие вещества, методы очистки, нефтяная промышленность, химикаты