UDK 547.913.450

DEPOSITIONS INSIDE OIL PIPELINES

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Abstract: *The composition of oil deposits in pipelines during oil pumping was investigated. In the experiments, they applied atomic adsorption, chromatography-mass spectrometry, gamma spectrometry. It was found that 20% of the deposits are paraffins, resins and heavy fractions of oil, and 80% are asphaltenes and mechanical impurities. It is established that the content of polyaromatic hydrocarbons and radionuclides is within the permissible limit, and heavy metals exceed the permissible limit up to 1000 times. It is possible to use these data when dealing with the waste of oil transportation by pipelines.*

Keywords: *paraffins, resins, oil deposits, radionuclides, heavy metals*

INTRODUCTION. During operation, there is a gradual decrease in the throughput capacity of pipelines due to: the accumulation of paraffin deposits, an increase in the roughness of the pipe walls as a result of their internal corrosion and the accumulation of corrosion products and mechanical impurities, as well as the accumulation of water in low places of pipelines, and air locks in the upper points of pipelines. A decrease in throughput leads to a sharp decrease in the efficiency of pipelines, a significant increase in pumping costs. In order to maintain the capacity and prevent the accumulation of water and internal deposits, as well as to prepare the section of the oil pipeline for in-pipe inspection and repeated testing, the internal cavity of the main oil pipeline must be cleaned by passing cleaning devices. Foreign objects remain in the cavity of the oil pipeline due to poor cleaning during construction and commissioning. Water and gas accumulate in the cavity of the oil pipeline due to incomplete removal during testing and commissioning of the oil pipeline. Water accumulation also occurs due to its release from the transported oil. Paraffin deposits are a multicomponent hydrocarbon mixture consisting of solid methane hydrocarbons. The formation of deposits is the result of two processes: the fixation of particles on the walls of pipes and their detachment by the flow of liquid. Depending on the intensity of one or the other process, paraffinization, erosion, or a state of dynamic equilibrium may occur. Paraffin deposits lead to a reduced throughput of the oil pipeline. To maintain throughput, preventive measures and cleaning of the oil pipeline from deposits should be carried out [1].Accumulation of deposits in pipelines leads to a decrease in the throughput capacity of oil pipelines and an increase in pressure during operation, which can lead to a pipeline rupture. The fight against oil deposits involves research in two directions: prevention of deposit formation and removal of formed ones. Thermal, chemical and mechanical methods of removing oil deposits are used. This problem has not yet been solved. These deposits change their composition, differ in their physicochemical and mechanical properties. Various methods and technologies are known for preventing the formation of oil deposits and their removal inside oil pipelines [2, 3]. But due to the lack of information on the composition and properties of oil deposits, the management of these wastes is problematic, since the most effective solvents are needed to select. A detailed study of the composition and properties of deposits is required to develop proposals for reducing these deposits and managing these wastes. Such studies are available on the example of Kazakh and Russian oils [4, 5], but there are no such studies for Azerbaijani oils. It is also necessary to consider the possibilities of their utilization - their use as additives to fuel oil, to building materials, in the manufacture of lubricating compositions [6]. If the composition of the waste or what is dangerous in it is known, their use becomes rational. The article presents the results of studying the structural-group composition of oil deposits, the presence of radionuclides, metals, and polycyclic aromatic hydrocarbons in them using a wide range of spectrometric methods.

METHODOLOGY

The studies were conducted using chromatograph mass spectrometry (GMS Trace DSQ – Thermo Electron, Finngan USA, 2005), atomic absorption (AAS Varian 220 FS), gamma spectrometry (CANBERRA gamma spectrometer, on a Ge detector, according to EPA 901.1), differential thermal (Perkin Elmer STA 600) and electron scanning (SEM-Sigma VP Carl Zeiss scanning microscope) methods.The deposit samples were obtained from the oil pipeline pumping station, where the deposits are cleaned by bonding. They are pre-dried in vacuum units and then prepared according to the requirements of standard methods used in spectrometric and microscopic instruments.

RESULTS AND DISCUSSION

Hydrocarbons in oil deposits were determined using mass spectrometric and chromatographic methods and the results are shown in Fig. 1.The main classes of compounds in oil deposits are paraffins, resins, asphaltenes, and mechanical impurities. Oil paraffins in deposits are alkane hydrocarbons C18-C36 and naphthenic hydrocarbons C30-C60.

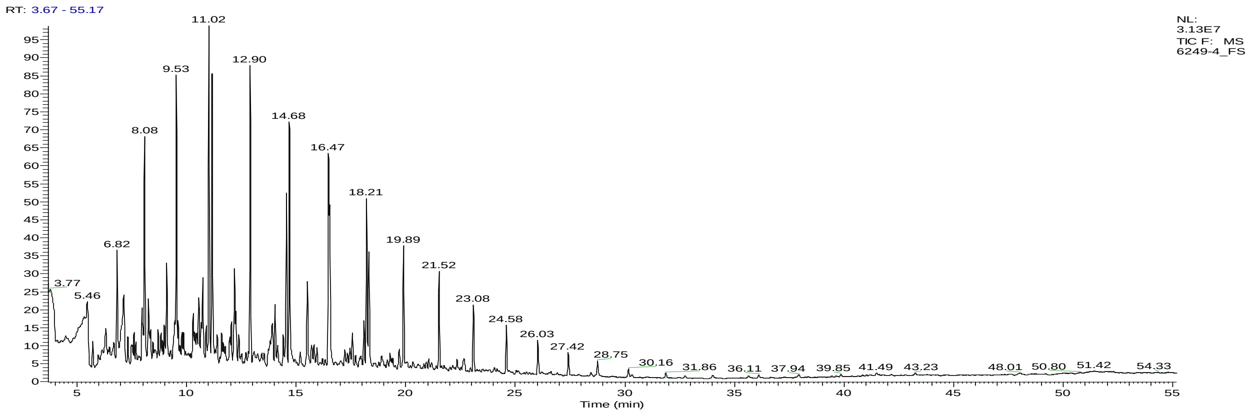

Fig. 1. Mass spectrum of hydrocarbons in oil deposits

The hydrocarbon composition of H_2O was determined using chromatograph mass spectrometry. It was found that 85% of the available C10-C40 hydrocarbons are C20-C40 hydrocarbons. In accordance with the obtained spectra, Table 1 shows the concentrations of hydrocarbons in the sediment.

Table 1

Values of hydrocarbon concentrations in H_2O (μg/g)

Categories and names of hydrocarbons	**Concentrations**	**Categories and names of hydrocarbons**	**Concentrations**
TPH(C10-C40) Total amount of carbohydrates	45155	C26	213.39
UCM (C10-C40) Number of non-separable carbohydrates	28319	C27	139.42
C10	55.58	C28	141.44
C11	268.40	C29	118.98
C12	441.37	C30	93.80
C13	611.55	C31	70.57
C14	708.04	C32	50.88
C15	860.78	C33	59.68
C16	810.28	C34	69.20
C17	816.84	C35	60.74
Пристан	652.58	C36	24.24

C18	708.55	C37	34.03
Фитан	484.77	C38	13.19
C19	740.84	C39	6.63
C20	562.81	C40	11.04
C21	400.08	Sum of n-Alkanes (C10-C40)	10346.62
C22	323.53	C17/ Pristana	1.25
C23	280.61	C18/ Fitan	1.46
C24	267.89	Pristana / Fitan	1.35
C25	244.89	C17/C18	1.15

As can be seen from the obtained experimental data, the total concentration of hydrocarbons in the HO is up to 50 mg/g, i.e. no more than 5%. The remaining 95% of HO are resins, asphaltenes and inorganic compounds. The molecular weight distribution of paraffin hydrocarbons contained in HO has been determined. As can be seen from Figure , paraffin hydrocarbons are represented by a homologous series of n-alkanes from C10 to C40, and this distribution has an extreme character with a maximum corresponding to hydrocarbons C14-C20. Similar results were obtained earlier [6-9] for Russian oils. The potential threat of environmental pollution is created by the formation of oil deposits with an increased content of natural radionuclides on process equipment [10].

Elemental analysis of HO was carried out on a scanning electron microscope (SEM), and the results are shown in Fig. 2. It is evident from the results that about half of the deposits are iron, but no information on its condition could be obtained. Apparently, the high iron content in the deposits is associated with corrosion processes in the pipeline.

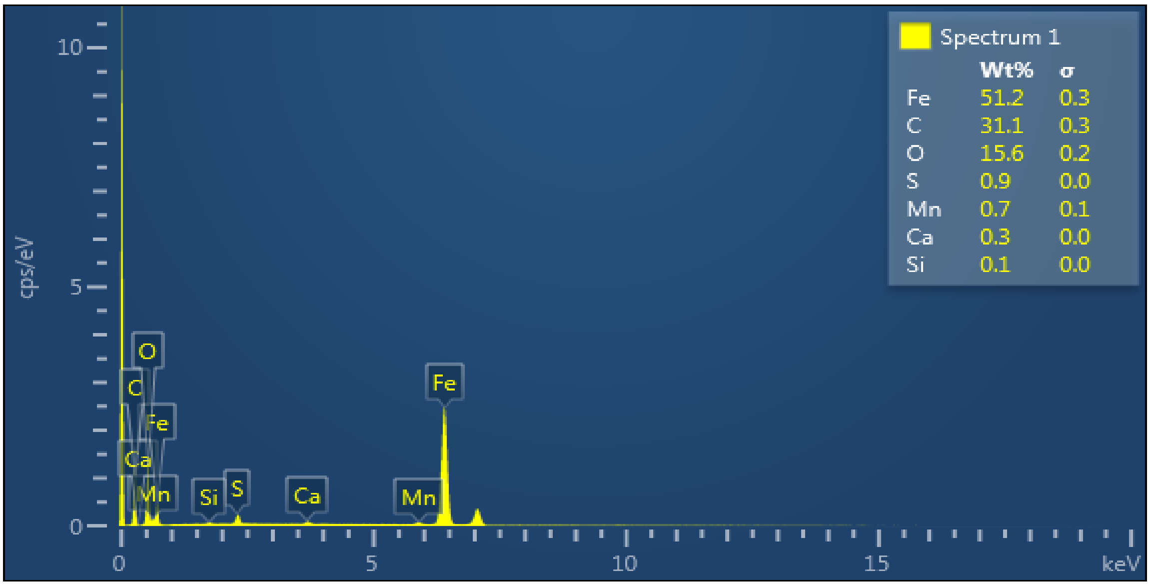

Fig. 2 Elemental composition of HO obtained by ESM.

Cleaning devices are used to clean the internal cavity of the oil pipeline from asphalt-resin, paraffin and dirt-paraffin deposits and to displace the product and foreign objects from the cavity of the oil pipeline. When choosing a cleaning device, it is necessary to take into account its technical characteristics and the characteristics of the oil pipeline. The method of cleaning by mechanical means (cleaning devices) has a number of disadvantages during operation, such as: frequent leaks in the cavity of the oil pipeline, which leads to the accumulation of paraffin; incomplete removal of mechanical impurities and water from the cavity of the oil pipeline. Also, the use of cleaning devices is impossible in pipe sections not equipped with chambers for starting and receiving cleaning and diagnostic tools. In addition, cleaning devices are less effective in oil pipelines with a variable cross-section[8-9].In the course of the studies, it was found that the chemical method of cleaning the internal cavity of oil pipelines is more effective and less expensive. When periodic cleanings are carried out by a chemical method, the corrosion inhibitor perfectly cleans the internal cavity of the oil pipeline and protects the pipe walls from corrosion. This method is effective for variable cross-section oil pipelines, since the reagent passes in the liquid flow through constrictions, bent sections, valves. In the economic part of the project, where cost estimates were made, it was revealed that the chemical cleaning method is more economical in comparison with the mechanical method, chemical cleaning of oil pipelines. Passing a chemical reagent together with cleaning devices allows achieving the required cleanliness of the internal surface of an oil pipeline with a variable cross-section. The chemical reagent effectively removes complex deposits, including such components as mechanical impurities, corrosion products, asphalt-resin-paraffin deposits and allows: to safely perform comprehensive repairs and restorationof the oil pipeline without the threat of environmental pollution that could occur when the oil pipeline is damaged;to preserve the oil pipeline while ensuring a non-corrosive state of the internal cavity during subsequent filling of the oil pipeline with nitrogen; During operation of oil pipelines, their throughput capacity gradually decreases due to: accumulation of paraffin deposits, increased roughness of pipe walls as a result of their internal corrosion and accumulation of corrosion products and mechanical impurities, as well as accumulation of water in low places of pipelines, and air locks in high points of pipelines. To maintain throughput, it is necessary to carry out preventive measures and clean the oil pipeline from deposits. When choosing a cleaning device, it is necessary to take into account its technical characteristics and the characteristics of the oil pipeline. The method of cleaning by mechanical means has a number of disadvantages during operation, such as: frequent leaks in the cavity of the oil pipeline, which leads to the accumulation of paraffin; incomplete removal of mechanical impurities and water from the cavity of the oil pipeline. If the use of cleaning devices is impossible in sections of the oil pipeline that are not equipped in this way, gel cleaning systems are used. The chemical method of cleaning the internal cavity of oil pipelines is more effective for oil pipelines with variable cross-sections. The chemical reagent effectively removes complex deposits, including such components as mechanical impurities, corrosion products, asphalt-resin-paraffin deposits.

CONCLUSION

Only 20% of oil deposits are hydrocarbon components, the remaining 80% are mainly inorganic components and heat-resistant parts of oil.A comparative analysis of the concentrations of metals contained in deposits and in oil fractions shows that the metal content in HO exceeds the concentration of metals in oil fractions by tens and sometimes thousands of times. The development of waste disposal to ensure the environmental safety of oil and gas production processes and additional extraction of mineral raw materials is an urgent problem.

REFERENCES

1. Zadvorny, I. V. Improving the energy efficiency of oil and gas pipelines. Pipeline cleaning methods.// In world science: problems and innovations, 2018. No. 3, pp. 29-31.
2. Vasilevskaya A.A. Features of formation the asphalt, resin, and paraffin deposits and methods of fight against them.//Nauka-bez-granic. 2017, №5 (10), p. 162-167
3. Khasanova K.I., Dmitriyev M.E., Mastobayev B.N. Increase in efficiency of application of means and methods of fight against the asphalt, resin, and paraffin deposits in the course of oil transport on trunk pipelines.//"Transport and storage of oil products and hydrocarbonic raw materials". 2013, №3, p. 7-11.
4. Baybekova L.R. Features of composition and structure of oil deposits.//Technology of oil and gas. 2006, №6, p. 241-246.
5. Gerasimova N.N., Kovalenko E.U. Saturated and aromatic compounds of high-paraffinic oil and organic adjournment.//News of the Tomsk Polytechnic University. 2014, v. 324, №3, -p. 147-152.
6. Tursumuratov M.T., Bekbulatov Sh.X. Use of slimes in road construction // Bulletin of the National Engineering Academy of the Republic of Kazakhstan,2010, № 1, p. 108-115.
7. Ryzhnikova, E.A., & Krasnov, V.G. Analysis of methods for cleaning main pipelines. // In XXIII All-Russian student scientific and practical conference of Nizhnevartovsk State University, 2017, No. 2, p. 112.
8. Fetisov, V.S., & Khammatova, G.A. Control of paraffin deposits in oil pipelines by thermal method. // In Quality management in education and industry , 2020. P. (395- 399).
9. Romanyuk S.S., Migunov V.I. Concentration of natural radionuclides in case of oil and gas production.//ANRI. 2006. №3 (46), p. 45-50.
10. Karikov, K. V. Methods of cleaning the main oil pipeline, 2017. P. 318-329 6.
11. Chatkin, K. A. Application of cleaning devices for removing deposits from the internal cavity of main pipelines.// Tomsk: 2017. P. 65-78.
12. Gulieva N.K., Mustafayev I.I., Nabizade Z.O., Chichek F.A. Radiation-chemical transformations of oil deposits// Journal of Applied and Fundamental Research. 2022. V.2.p. 72.
13. Gulieva N.K., Mustafaev I.I., Sabzaliev AA, Garibov R.G. /Composition and Properties of Deposits Formed on the Internal Surface of Oil Pipelines//Journal of Applied Spectroscopy-2018. №85 (1), p.103-108.