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Investigation Oil Bituminous Sands - Raw Materials for Energy

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Abstract

In Western Kazakhstan, there are huge reserves of oil Sands, containing in its composition natural bitumen, which can be used in various sectors of the economy. The widespread use of bitumen is due to their high technological, operational and economic performance. The composite materials were obtained by the reaction of lithification with modifying additives of oil-bitumen rocks with inorganic minerals at room temperature. IR-spectroscopy oil-bitumene rocks were carried. The separation of the organic part of the oil-bearing mine from the Munaily-Mola deposit of West Kazakhstan was carried out by the extraction method with the Soxlet apparatus. As a solvent, a mixture of 1: 4 alcohol-benzene is used. Three-and-four-layer filter cylinder cartridge (intravascular tube) was prepared from the filter paper without diameter of the neck diameter of the extraction nozzle. The tube was dried in a drying oven, and on the one hand it was wrapped in cotton, and measured. The tube is filled with fiber, cotton pellets, and again measured, the difference in mass is 0.01 g. The volume of oil-bitumene rocks No. 4 in the organic part is 12,66%, and the mineral part is 87,34%. At the same time, in oil-bitumene rocks No. 5, the share of government securities in the GS - 12.47%, mineral part - 87.53%.

Keywords: Oil-bitumen rocks 1, mechanism 2, IR-spectroscop 3.

1. Introduction

Use of natural bitumene in alternative function quality in energy is an alternative functure. In works [1, 2] it is shown that reduction of material and power expenses at development of oil and bitumen deposits is impossible without attraction of power saving up technologies. The work is devoted to determination of optimal modes of intensification of processes in porous environment by means of generation of acoustic vibrations with the help of jet equipment. These processes and technical means are the basis for the mospromising energy-saving technologies for the development of hard-to-recover oil reserves and the alternative to the latter - natural bitumen, namely: technologies of combined impact on productive formations. At the same time, the methods used are not in opposition to each other, but contribute to increasing the efficiency of each of them. One of the methods of such impact is thermal wave impact on formations - combination of wave impact with intraformer combustion... Theoretical research was carried out and the mechanism of thermal decomposition of asphaltenes, which are the products of primary processing of natural bitumens, was proposed [3]. Generalized chemical reactions are presented, the possibility of which is justified by the calculated Gibbs energy values (negative values at gasification temperature), which were determined taking into account the thermodynamic parameters of structural fragments, modeling substances that are part of asphaltenes. Ways of formation of components of generating gas are shown, on the basis of which kinetic and thermophysical parameters of gasification process can be defined. The paper [4] presents the results of the study of the composition of oilbituminous rocks of the Alimbai field, located in Zhylyoi district of Atyrau region to the north-east of the city of Kulsary (Western Kazakhstan). According to experts' estimates, natural bitumen reserves in the Republic of Kazakhstan amount to 1 billion tons, and oil-bituminous rocks - over 15-20 billion tons. The purpose of this work was to study the organic components of oil-bituminous rocks of this field as an additional source of fuel, energy and chemical resources. For the study were taken samples of oilbituminous rocks of different depths of occurrence. As shown by the results of analyses, the yield of the organic part of the field varies from 3.4 to 13.7% of the mass. Natural bitumen field Alimbai is characterized by a content of oils from 57.8% to 71.3% of the mass. due to the increase in the depth of occurrence of oil-bituminous rocks there is a decrease in molecular weight from 587 to 476 a.u. m. Thestate of development of heavy oil and natural bitumen deposits is shown in [5]. Due to the constant increase in demand for energy resources and the continuous decline in the production of light traditional oil, more attention is paid to the development of heavy high-viscosity oil fields and natural bitumen. However, their special properties, characterized by high viscosity and low mobility in

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combination with heterogeneous conditions of occurrence, complicate the process of their extraction. Despite the success of some of the impact methods, most developments continue to face low production levels, high capital investment and low payback on technology, as well as negative environmental impacts in their application. The paper reviews the main characteristics of heavy high-viscosity oil and natural bitumen, as well as the state of field development on a global scale. A wide overview of field development methods in Russia and abroad, based on hydrodynamic, thermal and chemical methods of reservoir stimulation, is presented... Natural bitumens of Tatarstan were studied in [6]. The physicochemical nature of natural bitumen and their rheological differences were studied in [7].Composition of natural bitumen compounds of Ashalchinskoye deposit were investigated in [8]. Modernization of bitumen in supercritical liquids was studied in [9], rheology and stability in [10], and abiotic oxidation of oil bitumen under natural conditions in [11]. Potential solutions to current environmental problems are defined along with renewable energy technologies in Turkey [12]. Colloidal state of bitumen is estimated in [13], and water leaching of bitumen and asphalt is given in [14]. The yield and properties of natural bitumen are described in [15-18]**.**

2. Material and method

Removal of the organic part of the oil-buried mine of the Western-Kazakhstan Munaily-Mola deposit was carried out by the method of extraction of the sextet apparatus. As a solvent, the alcohol-benzene mixture is used at a ratio of 1: 4.Three-and-four-layer filter cylinder cartridge (intravascular tube) was prepared from the filter paper without diameter of the neck diameter of the extraction nozzle. The tube was dried in a drying oven, and on the one hand it was wrapped in cotton, and measured. The tube is covered with fiber, cotton pellets are re-measured, the difference in mass is 0.01 g and is put on the extraction pad. The solvent was heated to boiling point of the solvent in the sand bath. In the freezer the vapor of the condensed solvent flows continuously on the nozzle. It dissolves hydrocarbons in the GS and extracts them from the excavation. After filling the extractor, the solvent is sieved into the flask through the tube. The organic separation is carried out until the color of the solvent in the extraction nozzle is removed. The nozzle (chuck) on the nozzle dries to a constant result at the dryer at a temperature of 50-600 °C. Oil-bitumine is separated by the organic part of the fossil and solvent dissolved in a simple manner. The mass of the organic part is found by the difference between the mass of the initial GS and the dried mineral part placed on the cartridge and by the measurement of the liquid fraction after the solvent is removed. The extraction results in the Soxlet apparatus are shown in Table 1.

As can be seen from the table 1, the organic part of the fossil oil No. 4 is 12,66%, and the mineral part is 87,24%. At the same time, in GS, the share of government securities in the GS - 12.47%, mineral part - 87.53%.

The hydroxylated extraction [19] method was carried out with the addition of sodium silicate and potassium hydroxide in a 6.3 weight ratio, corresponding to 80% and 20%. The data on the oil content of the mine is shown in Table 2.

As can be seen from the table 2, the bitumen separated by the water-alkaline extraction method number 4 is 10.75%, the mineral part is 89.25%, and the number 4 bitumen is 16.54%, the mineral part is 83.46%. The difference in data obtained by various extraction methods is explained by error in practice. Extraction with the solvent in the soxle apparatus is more precisely because separation of the organic and inorganic part of the excavation is practically carried out in full.

IR spectroscopy. For information about the processes by mixing oil-bitumene rocks with polymeric binders were held infrared spectroscopic studies of the respective samples. Infrared absorption spectra of bitumen, OBR and polymer compositions were obtained on an automatic dual-beam spectrometer UR-20 in the absorption interval of 400-4000 cm^{-1}.

3. Results and discussion

Information on the chemical changes in the oil obtained for the reception of liquid products, which has been investigated by IR spectroscopic studies, is collected.

It is evident from the spectra of the F-5 fraction (G-5 model, Figure 1) in pyrolysis products: 724.9 cm^{-1} - characteristic of alkanes characteristic (-CH2-) n - methylene groups. Also, the aromatic compounds with 1,3,5 substituent groups are 1376.5 cm^{-1}. CH3- is characterized by deformational oscillations of the methyl group. The Deformational oscillations are characterized 1642.6 cm^{-1} - CH_2- group.

1704.3 cm^{-1} is characterized by the carbonyl group -C = O. Absorption strips typical for 1302.9 cm^{-1} SO_2-group. In the spectrum γ C = 1376.5 cm^{-1} has a double bonded absorption band. It is characteristic for the wave vibrations of group 3418 cm^{-1} –OH group. The hydrogen bond in the molecule is characteristic of polyatom alcohols. 2924,2 cm^{-1}, 2953.1 cm^{-1} Asymmetrical wavelength oscillations = C-O-C are characterized by aromatic ether. For example, the group OCH_3.

If the spectrum of the fraction F-5 after the dry run was compared with the spectrum K-1 of the starting material, the water-alkaline extraction method, the absorption band - 2149.6 cm^{-1} did not exist in the spectrum of G-5, otherwise the new absorption band 2088.1 cm^{-1} emerged.

Also, K-1 type 1699,3, 1557,9, 1236,0; 1218,8; 1113,5 absorption peaks are missing in G-5 pattern, disappeared. G-5 is 1704.3; 1455,6; 1302.9 cm^{-1} new absorption strips were formed. 911.8 cm^{-1} band, 618.9; 537,5; 471,2; 426.9 cm^{-1} strips were removed. F-5 model is 561,8; 724.9 cm^{-1} strips were formed. During the dry injection of these OBR it is observed that the compounds that are incorporated into the chemical processes are subject to change.

Thus, IR-spectroscopic study of OBR indicates that in the liquid fraction F-5, carbonic group -C=O formed absorbing strips characteristic of SO2-sulfur compounds.

The volume of liquid product obtained as a result of dry oil injection of oil-bearing mine 5 is 5.5%.

As a result of the dry-discharge of oil-bearing salt from No. 5, liquid products, divided into two layers, were obtained: dark brown material with high content, smaller; bottom layer of light brown color, large amount of liquid. Qualitative analysis of gaseous products of thermal injection (potassium permanganate and bromine water reactions) revealed that unsaturated hydrocarbons exist.

It has also been shown that gaseous gases, as a result of the discharge, contain hydrogen gas (based on the specific sound that emerges in the gas mixture). It is easy to identify hydrogen for the No. 5 OBR, which can serve as an indirect indication of the large number of light fractions in the dried products.

Gaseous gases separated from No.5 OBR issue the blue-purple flame. The gaseous product density is determined by the formula ρ = m / υ. For the No. 5 OBR issue: ρ = 4.46 * 10-3 / 50.34 * 10-3 = 0.083 kg / m^3.

Thermal drying of oil-bearing fossils is a chemically complex process because OBR is subjected to varying degrees in various types of reactions resulting from several types of reactions that combine with multiple hydrocarbons and parallel processes. For example, breakdown of molecules with intermediate carbon atoms and the formation of molecules with low molecular weight. Formation of high molecular weight condensation and polymerization; dehydration, hydrogenation, and the like.

Their thermodynamic stability plays an important role in evaluating the possibility of hydrocarbons to change during dry injection. The molecule contains the number of carbon atoms in the lower thermodynamic stability for different classes of hydrocarbons in the following sequence: Paraffin> Naphtha> olefins> aromatic hydrocarbons.

However, because of the iso-isothermal-temperature dependence of different temperature dependence, the order of this row varies with the opposite:

The most stable paraffins, more stable naphthenes and aromatic hydrocarbons are the most common source of hydrocarbons from the OBR.

When paraffins are heated to 450-550 °C, their molecules are spun near the center of the chain, resulting in paraffins and molecules of ethylene hydrocarbons. For example:

$$C_{18}H_{38} \rightarrow C_9H_{20} + C_9H_{18}$$
$$C_9H_{20} \rightarrow C_5H_{12} + C_4H_8$$

For low molecular paraffins, dehydration and breakdown of the carbon chain are broken down by breaking:

$$C_5H_{12} \rightarrow C_5H_{10} + H_2$$
$$C_5H_{12} \rightarrow C_4H_8 + CH_4$$

4. Conclusions

1. Organic and mineral parts of oil-bituminous rocks No. 4 and No. 5 were investigated.
2. Introduction of natural bitumen were researched.
The mechanisms of pyrolysis of petroleum products were proposed.

References

1. Samburova L.I. Energy-saving technology of influence on the process of natural bitumen extraction // In the collection: Collection of selected works of the Annual XVIII International Internet Conference of Young Scientists and Students on Contemporary Problems of Mechanical Engineering (MIKMUS-2006), Ministry of Education and Science of the Russian Federation Russian Academy of Sciences Russian Foundation for Basic Research Institute of Mechanical Engineering named after V.I. Lomonosov. A.A. Blagonravov Russian Academy of Sciences. 2006. – P. 128-135.
2. Alekseev K., Sharifullin I., Garafutdinova G., Voythekh R., Umarov B., Khalikov N. Natural bitumens as an alternative fuel in the energy sector // In the collection: Young Researcher: Challenges and Perspectives. Collection of articles based on the CI international scientific-practical conference. Moscow, January 14-24, 2019. – P. 450-452.
3. Yermolaev D.V., Minhaleeva G.R. The mechanism of thermal positioning of asphaltens of natural bitumens // Bulletin of the Technological University. 2015. Vol. 18. No. 12. – P. 27-31.
4. Ishmukhamedova N.K., Karimov O.H. Composition of petroleum breed breeds of Alimbay deposit of the Republic of Kazakhstan // Electronic scientific journal "Oil and Gas Business". 2017. No. 5. – P. 6-19.
5. Gataullin R.N. Development of heavy oil and natural bitumen fields // Bulletin of the University of Technology. 2018. Vol. 21. No. 10. – P. 71-82.
6. Kemalov A.F., Kemalov R.A., Abdrafikova I.M., Gainullin V.I.
7. Study of natural bitumen of nagornoye deposit, troitskneft jsc (the republic of Tatarstan, Russian Federation) Asian Social Science. 2014. Vol. 11. No. 3. – P. 296-304.
8. Ratov A.N. Physicochemical nature of structure formation in high-viscosity crude oils and natural bitumens and their rheological differences // Petroleum Chemistry. 1996. V. 36. No. 3. - P. 191-206.
9. Antipenko V.R., Cheshkova T.V. Composition of compounds connected through essential and sulphide breedings in oils of natural bitumen of ashalchy deposit // News of Tomsk Polytechnic University. 2014. Vol. 324. No 3. – P. 16-21.
10. Scott D.S., Radlein D., Piskorz J., Majerski P., deBruijn T.J.W. Upgrading of bitumen in supercritical fluids // Fuel. 2001. Vol. 80. No. 8. – P. 1087-1099.
11. Gonzalez O., Muroz M.E., Santamaria A., Garcia-Morales M., Navarro F.J., Partal P. Rheology and stability of bitumen/eva blends // European Polymer Journal. 2004. Vol. 40. No. 10. – P. 2365-2372.
12. Charrié-Duhaut A., Lemoine S., Adam P., Albrecht P., Connan J. Abiotic oxidation of petroleum bitumens under natural conditions // Organic Geochemistry. 2000. Vol. 31. No. 10. – P. 977-1003.
13. Kaygusuz K., Kaygusuz A. Renewable energy and sustainable development in turkey // Renewable Energy. 2002. Vol. 25. No. 3. – P. 431-453.
14. Loeber L., Muller G., Morel J., Sutton O. Bitumen in colloid science: a chemical, structural and rheological approach // Fuel. 1998. Vol. 77. No. 13. – P. 1443-1450.
15. Brandt H.C.A., de Groot P.C. Aqueous leaching of polycyclic aromatic hydrocarbons from bitumen and asphalt // Water Research. 2001. Vol. 35. No. 17. – P. 4200-4207.
16. L.K. Nvizug-Bi Analysis of methods for the development of high-viscosity oil and natural bitumen deposits // Science. Equipment. Technologies (polytechnic messenger). 2018. No. 1. – P. 168-188.
17. L.K. Nvizug-Bi, O.V. Savenok, Nigeria Survey of Bitumen and Heavy Oil Field Development // Bulat Readings. 2018. Vol. 2. No.1. – P. 194-197.
18. Lapidus A.L., Kerimov V.Yu., Mustaev R.N. and others. Natural Bitumens: Physicochemical Properties and Production Technologies // Solid fuel chemistry, 2018, V.52. Issue 6. – P. 344-355.
19. Nivedya M.K., Ravindran P.K., Murali J. Experimental investigations and constitutive modeling of bitumen stabilize d mixtures // International Journal of engineering science, 2016. Vol. 102. – P. 36-54.
20. 19. Patent 648597 USSR, class. C 10 G 1/04, 1979. Meshcheryakov S.V., Toyganbaev E.A., Ospanova Zh.A., Pankratova N.A. Additive to the process of extraction of bitumen from bituminous rocks.

Appendix

Table 1.The composition of the mineral fibers identified by extraction method in the Soxlet apparatus.

No. OBR	OBR massa, g	Organic part		Mineral part	
		g	%	g	%
No. 4	150	19,13	12,66	130,87	87,24
No. 5	115,8	14,45	12,47	101,35	87,53

Table 2. Composition of the mineral fibers identified by the hydroelectric extraction method.

No. OBR	OBR massa, g	Organic part		Mineral part	
		g	%	g	%
No. 4	400	43	10,75	357	89,25
No. 5	400	66,14	16,54	333,86	83,46

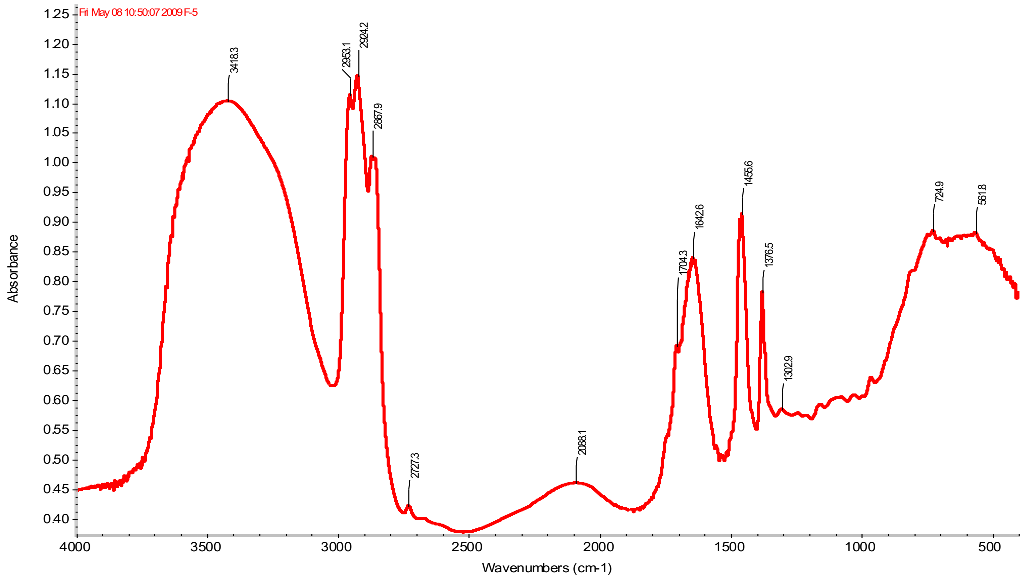

Fig. 1. IR spectra of the F-1 sample

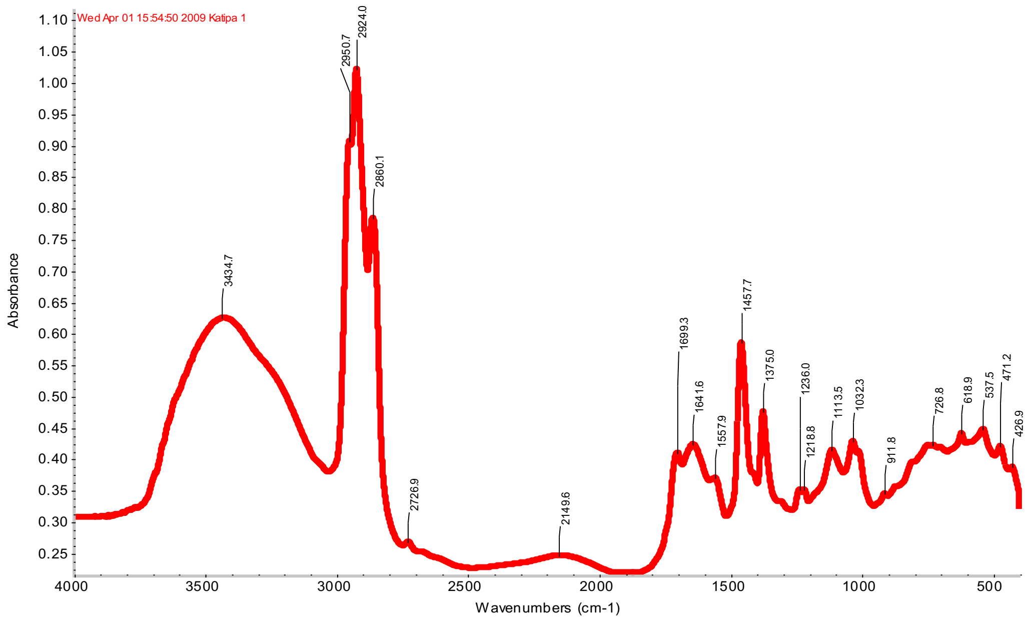

Fig. 2. IR spectra of the K-1 sample