requirements the equipment installed at the wells is meant to prevent blowouts of oil and gas and the offloading line used to transferring oil to tankers is equipped with an emergency shutdown system that can be activated instantly. There is a special round-the-clock monitoring system consisting over 60 detectors tracing the changes in its operation. As it was mentioned, safety issues are an overriding priority for the companies dealing with the Arctic offshore petroleum production. Taking account of both international best practice and the requirement of Russian legislation, there was developed a detailed plan for the prevention and control of potential oil spills. Regular emergency training and response drilling are undertaken in the area where the rig is located to ensure maximum team skills and knowledge in the event of any emergency both offshore at or near the platform or onshore to protect coastal strip.

In conclusion, offshore petroleum production in the Arctic demands both technological innovation and safety assurance. It is necessary to use robust equipment able to work in extreme weather conditions without a chance to make mistakes. That is one of the reasons why Arctic offshore fields are developed quite slowly. Petroleum companies must be sure they reach the required level of technology and have enough amount of resources to deal with yet dangerous but promising area for the industry. Prirazlomnaya oil field is the first step in Arctic development, which is a great opportunity to get experience and improve offshore production technology even more.

References

1. Andrey Dmitriev, Dmitriy Khudyakov, Evgeniy Popok, Timur Akhmetshin, 'Technological complex of Prirazlomnaya offshore ice-resistant fixed platform', Tomsk (2014)
2. 'Prirazlomnaya Oilfield', Offshore Technology. Accessed on 30.03.2017: http://www.offshore-technology.com
3. 'Prirazlomnoye', Gazprom-neft. Accessed on: 25.03.2017: http://www.gazprom-neft.com

OILS PROPERTIES BASED ON FOURIER TRANSFORM INFRARED SPECTROSCOPY IN ARCTIC WESTERN SIBERIA

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Immense hydrocarbon reserves are associated with the Russian Arctic, but theirs production and transportation are a difficult engineering task. Russia takes the leading position in the number of the northern oil and gas fields among all Arctic states; in addition, the oils within the territory are characterized by low viscosity. This fact attracts the oil companies and the government to begin exploration and development of the Russian Arctic.

Even within the Arctic region, each oil is unique in terms of composition and physical-chemical properties, which requires an individual approach when choosing a rational method of production, transportation and processing of hydrocarbons. The methods of FTIR spectroscopy and GC-MS are the most sensitive and informative methods to investigate organic and inorganic compounds structure. Therefore, the goal of this study is to investigate the application of infrared spectroscopy for the analysis of crude oils within the Russian Arctic.

FTIR spectroscopy is based on the absorption, reflection and dispersion of infrared energy as it passes through a substance. This method is multifunctional, because it can work with liquids and solid bodies, and it became common in the water analysis. FTIR spectroscopy investigates the spectrum which either is passed through sample or is reflected from the sample surface. There are several methods of spectroscopy such as attenuated total reflection (ATR) spectroscopy, specular reflection, glancing reflection, and diffuse reflection. In this paper we investigated the crude oil samples by ATR spectroscopy, because the main advantages of this method are the ability to study non transparent samples and the relative ease of analysis.

Two n-hexane fractions of Novoportovskoe and Salymskoe oil fields were selected as the objects. The n-hexane fractions were analyzed with a Nicolet iZ10 Spectrometer in the range of 650-4000cm^{-1}. FTIR spectra were interpreted based on literature data. Identification of the hydrocarbon groups was performed by on the basis of relevant books and articles.

Currently FTIR spectroscopy is a widely accepted method in the multicenter studying of the petroleum composition of different fields. The morphological composition of oils and theirs components are determined according to intensity of the characteristic absorption bands of FTIR spectra with the help of a general baseline on a fixed range 1850 and 650 cm^{-1}. To determine the hydrocarbon and morphological composition changes of unrecovered oils which are extracted from petroliferous rocks, spectral ratios are used. They are ratio of absorption bands optical densities at frequencies of 1710, 1600, 1380 and 720 cm^{-1}.

For more detailed research of the component composition, gas chromatography-mass spectrometry was used. It is the method to analyze mixtures of organic and inorganic matters, as well as to determine the residual amounts of substances in liquid volume. The mixture of components is segregated based on the first technology; identification of assaying and structure of matter is by a second one. As a whole, this method provides a quantitative and qualitative analysis of all components of complex mixtures, including concentration that is in tenths and hundredths of a percent's dole.

According to the physical and chemical properties, the Salymskoe field's oil, which is characterized by low density, is light. Novoportovskoe field's oil is heavy crude. Both oils are of low viscosity. In Novoportovskoe field's oil there are a lot of alkanes and cyclic hydrocarbons content than in Salymskoe oil. Salymskoe oil is enriched with aromatic hydrocarbons.

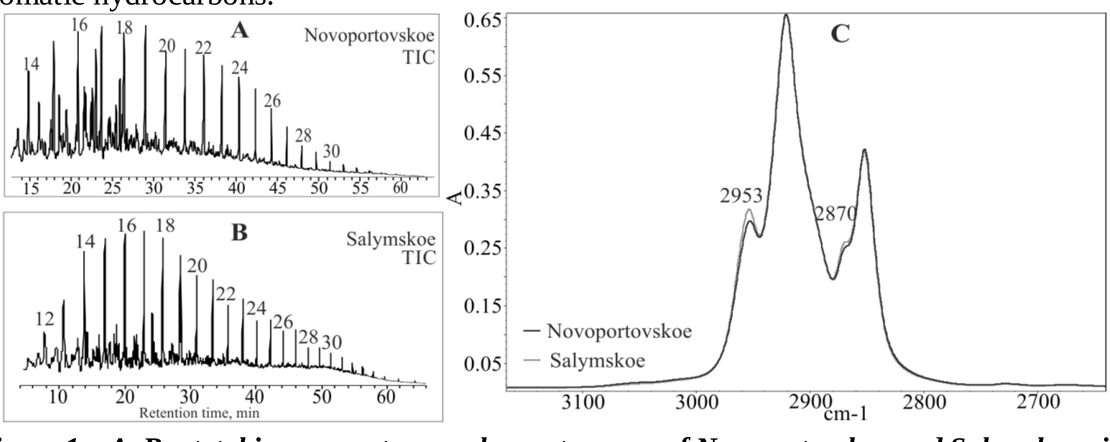

Figure 1 – A, B – total ion current mass-chromatograms of Novoportovskoe and Salymskoe oils; C – absorbance spectrum of the oils in the ranges 2620 – 3160 cm^{-1}

Within n-alkanes of Novoportovskoe field’s oil, which is characterized by a higher viscosity, C_{15}-C_{22} homologues predominate (Fig. 1 A). The n-alkanes distribution pattern of Salymskoe oil is characterized by a narrow peak in the area of C_{15}-C_{18} homologues (Fig. 1 B). This distinction can be indicated by FTIR spectroscopy of the oils in the ranges 2953 and 2870 cm^{-1}, since the ranges 2975-2950 and 2885-2860 cm^{-1} (Fig. 1) are designated -CH_3 groups in molecules. In Salymskoe field greater absorption wavelength in these ranges indicates higher abundant of -CH_3 bonds that was the result of higher content of the low-molecular weight n-alkanes in the mixture.

Based on FTIR spectroscopy the difference in the wave absorption in aromatic structures diapason is revealed. Figure 2 A shows that in the ranges 822 and 811, 751 and 744 cm^{-1} the wave absorption of Novoportovskoe oil is higher than in Salymskoe oil. This diapason characterizes the occurrence of aromatic rings mono-, di-, tri- methyl substitution.

GC-MS indicates that in the Novoportovskoe oil’s distribution of mono-methyl-substituted alkyl benzenes is characterized by the greater content of methyl- substituted alkyl benzenes than in Salymskoe ones (Fig. 2B, C). The wave absorption formation in the ranges 822 and 811, 751 and 744 cm^{-1} could be due to the predominance of various aromatic ring substitutions.

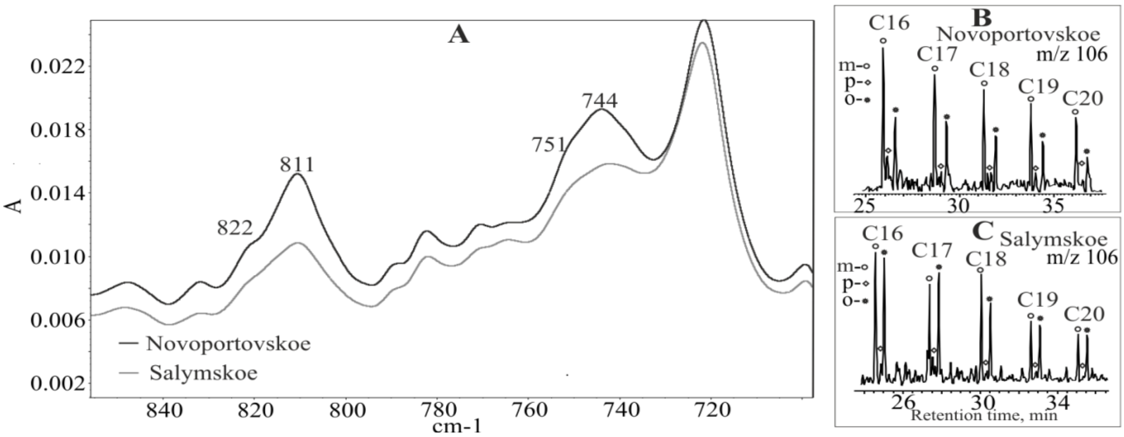

Figure 2 – A – absorbance spectrum of Novoportovskoe and Salymskoe oils in the ranges 700 – 855 cm^{-1}; B – distribution patterns m/z 106 of the oils

FTIR spectroscopy is high-sensitivity and relatively simple method of oils’ analysis. This method can determine the qualitative presence of various chemical bonds. In case of the Russian Arctic FTIR spectroscopy can be applied to identify the main group of compounds in the mixture and the nature of the aromatic ring substitution and the nature of the n-alkanes distribution.

References

1. Krasnoyarova N A. Efficient Use of Viscous and Heavy Oils of Russian Arctic Region, 2015.
2. Vlachos N. Applications of Fourier transform-infrared spectroscopy to edible oils (Analytica Chimica Acta 573), 2006 pp. 459-465.
3. Othmer K. Encyclopedia of Chemical Technology, fifths ed (Wiley Blackwell), 2007
4. Siesler H W, Ozaki Y, Kawata S, Heise H M. Near-infrared spectroscopy: principles, instruments, applications, 2008.
5. Niessen W M, Tinke A P. Liquid chromatography-mass spectrometry General principles and instrumentation (Journal of Chromatography A703(1-2)), 2000pp. 37-57.