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FTIR Transmission Spectra of Crude Oil of Some Absheron Peninsula Enterprises

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Abstract

Fourier Transform Infrared (FTIR) spectroscopy provides useful information about different chemical inclusions in crude oils. In particular, the presence or absence of hydrocarbon functional groups may be qualitatively determined. It is known that in the Republic of Azerbaijan there are 12 oil-gas production companies, including 8 owned by Azerbaijan and 4 owned by Joint Stock Companies. In most cases of oil spillage, it is desirable to have more than one analytical technique for detecting source of suspected spilled crude oil and its properties. In our previous publications, we reported results of the laser induced fluorescence and the Raman spectra analyses of crude oil samples taken from the 12 oil-gas production companies in Azerbaijan and discussed their distinctive features across observed spectra. In the present paper, we give results of the FTIR transmission spectra of crude oil samples taken from the 6 oil-gas production companies in the Republic of Azerbaijan.

Keywords: FTIR transmission, crude oil, optical spectroscopy, optical transmission, Absheron peninsula, Caspian Sea.

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Abşeron yarımadasının bəzi müəssisələrinin xam neft ötürmə FTİR spektrləri

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Xülasə

Fourier Transform İnfraqırmızı spektroskopiyası (FTİR) xam neftdəki müxtəlif kimyəvi daxilolmalar haqqında faydalı məlumatlar əldə etməyə imkan verir. Xüsusilə, karbohidrogenlərin funksional qruplarının olması və ya olmaması keyfiyyətcə müəyyən edilə bilər. Məlumdur ki, Azərbaycan Respublikasında 12 Neft-qaz çıxarma idarəsi fəaliyyət göstərir, o cümlədən 8-i Azərbaycana, 4-ü isə müştərək şirkətlərə məxsusdur. Neft dağılmaları ilə əlaqəli əksər hallarda, tökülən xam neftin təxmin edilən mənbəyini müəyyənləşdirmək üçün birdən çox analitik metodun olması məqsədə uyğundur. Əvvəlki məqalələrimizdə Azərbaycanın 12 Neft-qaz çıxarma şirkətindən götürülmüş lazerlə induksiyalı flüoresan və Raman xam neft spektrlərinin nəticələri və müşahidə olunan spektrlərin fərqli xüsusiyyətləri barədə məlumat vermişdik. Bu məqalədə, Azərbaycan Respublikasının 6 Neft-qaz istehsal edən şirkətlərindən alınan xam neftin udulması üzrə FTİR spektrlərinin nəticələrini təqdim edirik.

Açar sözlər: FTİR ötürülməsi, xam neft, optik spektroskopiya, optik ötürülmə, Abşeron yarımadası, Xəzər dənizi.

Фурье-спектры инфракрасного пропускания сырой нефти некоторых предприятий Апшеронского полуострова

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Аннотация

Инфракрасная спектроскопия с преобразованием Фурье (FTIR) позволяет получить полезную информацию о различных химических включениях в сырой нефти. В частности, можно качественно определить наличие или отсутствие функциональных групп карбогидрогенных углеводородов. В Азербайджанской Республике действуют 12 нефтегазодобывающих учреждений, в том числе 8 принадлежат Азербайджану, 4 – совместные компании. В большинстве случаев, связанных с разливами нефти, целесообразно иметь более одного аналитического метода для определения предполагаемого источника разлива сырой нефти и его свойств. В ранее опубликованных статьях мы привели результаты спектров флуоресценции и Рамановского рассеяния сырой нефти, полученной от 12 нефтегазодобывающих компаний Азербайджана, также были проанализированы характеристические особенности наблюдаемых спектров. В настоящей статье мы представляем результаты спектров инфракрасного поглощения сырой нефти, полученной от 6 нефтегазодобывающих компаний Азербайджанской Республики.

Ключевые слова: инфракрасное преобразование Фурье (FT-IR), сырая нефть, оптическая спектроскопия, пропускание сырой нефти, Апшеронский полуостров, Каспийское море.

Introduction

Crude oil is quite an interesting class of substances having wide practical applications. The complex nature of crude oil, leads in complex chemical-physical methods of analyses [1-10]. In our previously published paper, we described distinctive features of Raman scattering spectra of crude oils taken from 12 Oil-gas production companies of Absheron peninsula [10].

It is well known that there exist 4 different techniques (infrared (IR) spectroscopy, fluorescence (FL), gas chromatography and low temperature luminescence)) widely used to characterize crude oil spills on water and earth surfaces. These techniques are used not only to detect oil spills, but also to establish spills source. FL spectra and identification of spills sources have been successfully performed by KA-14 LIDAR, developed at National Aviation Academy (NAA) of Azerbaijan and the results were published [9]. Fourier Transform Infrared Transmission (FTIR) spectroscopy is also widely used for crude oil detection as well as its characterization [1, 4, 5, 6, 8].

The purpose of the work is to imagine the results of the first measurements of the IR transmission spectra of crude oils taken from 6 Oil and Gas Production Companies (*OGPC*) of Azerbaijan Republic. The results obtained are definitely necessary and useful for further creation of Data Bank of infrared transmission spectra of crude oils of Azerbaijan.

Analysis of scientific and technical literature on the topic. FTIR spectroscopy is considered as better technique for petroleum characterization [1, 4, 5, 6, 8]. In these papers the authors illustrated the use of FTIR spectroscopy for detailed analysis of the crude oils (including light, medium and heavy crude oils) as to know about their chemical composition, heteroatom content as well as source of these oils. An analysis of the literature shows that IR spectra of crude oils are observed in a wide range of the spectrum, including high-wavelength. This method is non-expensive, simple and rapid one-site technique that can be used for general compositional analysis and in the field of geochemistry of crude oils [1, 4, 5, 6].

The optical release IR spectrum of any oil can be roughly divided into 3 absorption bands: I - bands in the 3200 - 2600 cm^{-1} spectral range (high frequency IR area); II - bands in the 1800 - 1200 cm^{-1} area; III - bands in the spectral range of 900 - 650 cm^{-1} [5, 8]. The most intense in the IR spectra of crude oils are the absorption bands at 2920 cm^{-1} and 2860 cm^{-1} (valence oscillations of CH groups CH_2 and CH_3). In the same area, it is possible to detect the presence of water traces in the studied crude oil sample (characteristic absorption band at 3300 cm^{-1}) [5,8].

As it is mentioned above, several methods can be used to characterize the properties of crude oil, and they are selected according to the field of application. The vast majority of these methods are complex, time-consuming, expensive, these include the processes that are toxic solvents in large quantities and require a large number of samples. Most of these analyzes are carried out in the international standard methods and materials defined by the American Testing Society (ASTM) and the American Petroleum Institute (API) [8]. ASTM International and the API have collaborated to launch a petroleum standards collection to help customers throughout the oil and gas industry

access the standards they need in one convenient location.

IR spectroscopy appears to be a viable alternative due to its efficiency in freely placed crude oil on a surface soaked in soil or floating in water for detection, characterization and monitoring. IR data have been successfully used to study the chemical composition of oils in general [1, 4, 5, 6, 8] and to decipher some specific properties of crude oils, for example, their various fractions (saturated, aromatic compounds, resins and asphaltenes) . However, most of the models created to evaluate the characteristics of the oil according to spectral data are insufficient, and the variety of oil samples, which limits its volume, representativeness and reliability.

The aim of our present work is to use of FTIR spectroscopy for measurements of crude oils from different locations of Absheron peninsula and to establish their peculiarities. These data are useful for further creation of Data Bank of IR transmission spectra of Azerbaijanian crude oils. IR absorption spectra were measured using a *BRUKER IFS66 Fourier spectrometer* in the mid-IR region, in the spectral range of 500-7000 cm^{-1}. This spectrometer was available at the Institute of Spectroscopy of Russian Academy of Sciences. The spectral resolution was 5 cm^{-1}. A cuvette with silicon windows (thickness 1 mm) and a gap of 20 microns was used for measurements. All measurements were performed at room temperature. The transmission spectra of crude oils taken from 6 *OGPC*-nies of the Absheron peninsula are presented in Fig. 1-6 and frequency values are summarized in Table.

Table – Frequency values of IR transmission spectra of crude oils obtained from the final processing of spectra shown in Figures 1 to 6

Sample OGPC	**Peak No1 (a) cm^{-1}**	**Peak No2 (b) cm^{-1}**	**Peak No3 (c) cm^{-1}**	**Peak No4 (d) cm^{-1}**	**Peak No5 (e) cm^{-1}**	**Peak No6 (f) cm^{-1}**	**Peak No7 (j) cm^{-1}**	**Peak No8 (h) cm^{-1}**
Lokbatan-Buta (1)	970	1375	1480	1580	2850	2930	4350	5800
Tagiyev (2)	962	1360	1490	1580	2860	2950	4370	5850
28 May (3)	960	1400	1490	1585	2860	2950	4320	5900
Siyazan (4)	970	1400	1480	1585	2860	2950	4300	5900
Bibiheybat (5)	970	1350	1480	1585	2860	2950	4350	5850
Narimanov (6)	870	1350	1485	1580	2830	2950	4370	5850

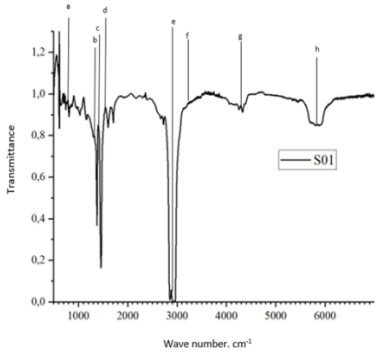

Figure 1 – IR transmission spectrum of crude oil of *Lokbatan-BUTA*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis- Wave number, cm^{-1}. Vertical axis- Transmittance, rel. units

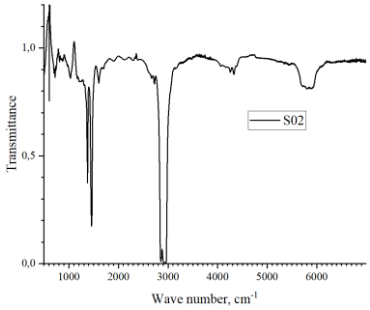

Figure 2 – IR transmission spectrum of crude oil of *Tagiev*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis- Wave number, cm^{-1}. Vertical axis- Transmittance, rel. units

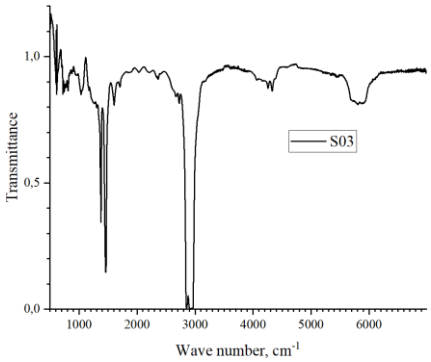

Figure 3 – IR transmission spectrum of crude oil of *28 May*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis - Wave number, cm^{-1}. Vertical axis - Transmittance, rel. units

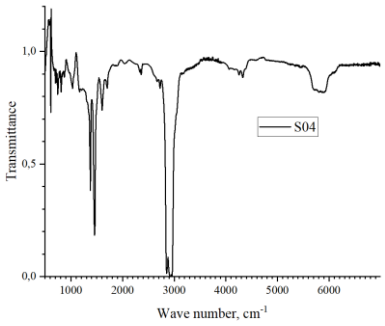

Figure 4 – IR transmission spectrum of crude oil of *Siyazan*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis- Wave number, cm^{-1}. Vertical axis- Transmittance, rel. units

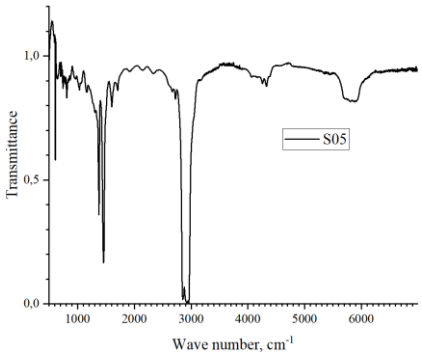

Figure 5 – IR transmission spectrum of crude oil of *Bibigeybat*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis- Wave number, cm^{-1}. Vertical axis- Transmittance, rel. units

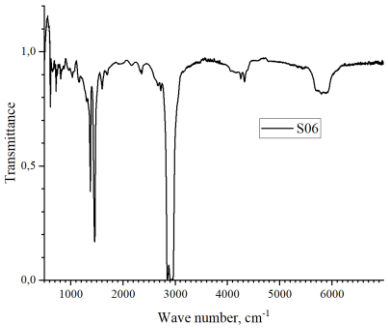

Figure 6 – IR transmission spectrum of crude oil of *Narimanov*`s *OGPC*. The measurements were carried out with *BRUKER IFS66 Fourier spectrometer*, which is available at the *Institute of Spectroscopy of Russian Academy of Sciences*. The spectral resolution was 5 cm^{-1}. Horizontal axis- Wave number, cm^{-1}. Vertical axis- Transmittance, rel. units

Conclusion

Frequency values of transmission spectra minimums (absorption maximums) shown in Figures 1 to 6 are summarized in Table.

What immediately catches the eye is that the absorption band near the frequencies of peaks (a), (b), (j) and (h) varies markedly from sample to sample both in intensity and, in some samples, in frequency.

Finally, it is worth noting that we plan to perform measurements of crude oils IR transmission spectra taken from rest 6 OGPC-nies with further creation of Data Bank of Transmission spectra of crude oils taken from Absheron peninsula of Azerbaijan Republic.

Conflict of interests

The authors declare there is no conflict of interests related to the publication of this article.

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