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SCIENTIFIC-TECHNICAL BASICS OF VISCOSITY REDUCTION OF THE KAZAKHSTANI OILS, WHICH PROVIDE A SIGNIFICANT INCREASE OF OIL RESERVOIRS

Abstract.
The aim of the work: Scientific-technical basics of viscosity reduction of the Kazakhstani oils, which provide an essential increase of oil reservoirs.

In modern economic conditions, the oil and gas industry of Kazakhstan continues to remain in the area of active growth, along with maintaining its high investment attractiveness.

The contrast of experimental results on the study of spectral responses to external pulse effects and theoretical developments on the types of equilibrium for interplanetary cycles allows us to draw the following conclusions:

1. Obtaining information on changes in the state of the interface between phases by measuring spectral responses provides the necessary potential for searching for cause-effect relationships in all ranges of external influences.
2. The change in the quantitative relationships in the "impact-response" system is suggested to be estimated by the formula of Smirnov A.P., which makes it possible to reflect three-stage processes in the whole variety of their manifestations.
3. It is shown that the state of water (supplier of hydrogen and oxygen) at the interface between phases affects the processes of synthesis and decomposition of hydrocarbons. The observed effect is of practical importance in the development of geotechnology to reduce viscosity under natural underground conditions.

Keywords: oil recovery, impact-response, spectral composition, interface, property management, natural occurrences.

One of the favorable factors for this is the development of the positive dynamics of the global oil and gas industry, which determines the expanded opportunities for sales of products in foreign markets and the liquidity availability, which is available for investment in exploration and extraction. Export volumes of hydrocarbons are growing. At the same time, Kazakhstan has great prospects with the expansion of production capacity of a number of existing fields; and the oil refining sector and the sale of petroleum products in order to increase the added value of products and more complete provision of the domestic market with petroleum products [1-3].

Nowadays the scale of oil and gas production has increased significantly and is being introduced into the development of a field with complex geological-physical conditions, the most important problem of increasing the completeness of oil extraction from the subsoil is being solved, since the average value of the oil recovery coefficient is 0.3-0.4 [4-9].

Thus, the formulation of the objectives of the extraction completeness from oil reservoirs, that have reached the economic limit of operation, becomes particularly relevant in the modern oil and gas industry. However, it becomes economically unprofitable to solve such problems with the help of modern methods of increasing oil recovery, since the scientific-technical basics of hydrocarbon synthesis (UW) in the conditions of natural occurrence are insufficiently worked out. Therefore, in order to create a new geo-technology it is necessary to change the scientific paradigm, which considers the oilfield as an unchanged statically natural formation conditioned by previous transformations, called the oilfield. This definition (place of birth) much more fully reflects the essence of the dynamic approach to solving the problem of increasing oil recovery, because it allows us to consider the conditions of occurrence as a functioning long-term reactor operating at a certain speed of hydrocarbon synthesis (UW). By pumping lighter components, certain conditions are created for the viscosity increase, which can be reduced by natural reactor hydrogenation with hydrogen, which is present in excess in formation water. Therefore, the main attention in our work is paid to the methods of water decomposition in reservoir conditions. If the conditions of hydrogenation in a natural reactor are provided, it will work at a set speed and chemical composition [10]. Since any process begins and is initiated by the state of the phase separation boundary, in this work the results of the experiments on the spectral composition studies of the responses to the external influence on the phase separation boundary for Kazakhstan UW are shown.

Methods of work conduction. The well-known postulate "all processes start and proceed at the interface of phases" was used in the physical modeling of the synthesis and decomposition of hydrocarbons. For this purpose an experimental module, consisting of an acting device (pulse signal generator) and a receiver in the form of a USB spectrometer in the kilohertz range, was created. In the natural reactor of the formulated module there is water with an oil slick, information about the state of which is brought to tungsten electrodes, which are located on the border of the "oil-water" phase. The electrodes are at a distance of 1/4 and 3/4 of the length of the measuring unit. Impact on the interface is carried out at the frequency of water decomposition (42.8 kHz).

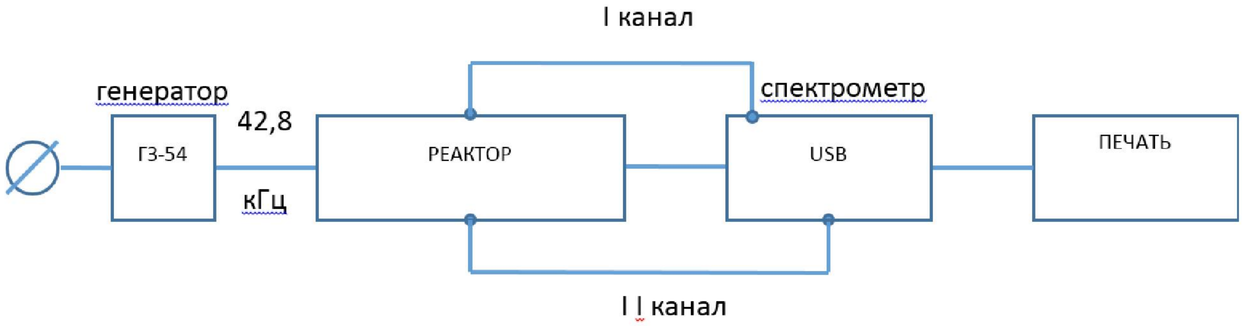
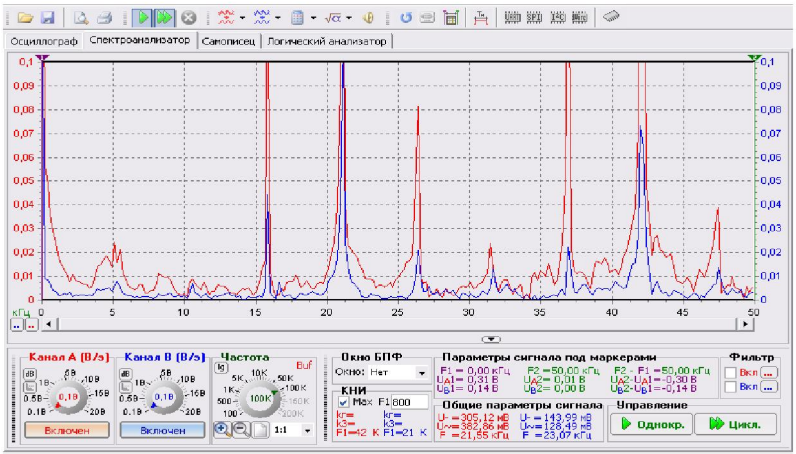


Figure 1 – Functional pattern of the experimental module. Experimental results

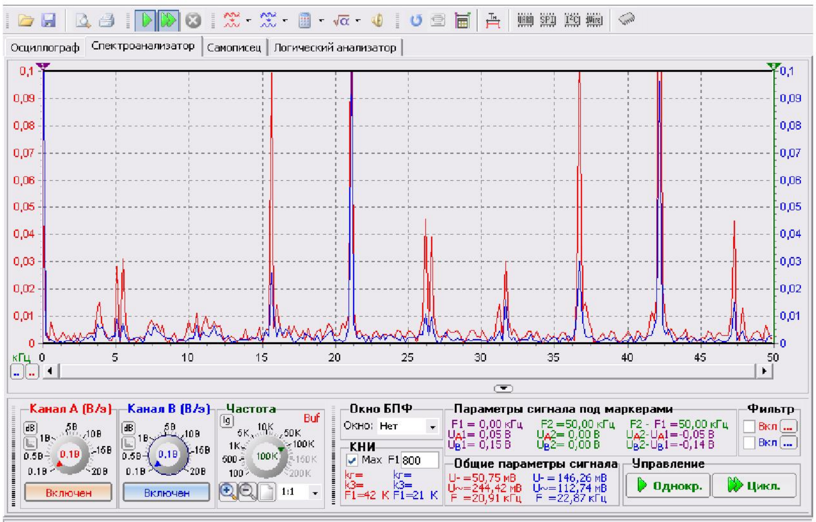
Akzhar. When applying impulses at a frequency of 42.8 kHz onto the oil slick of the Ak-zhar oilfield it can be noted that the amplitude values of the first channel are 2-3 times larger than the values of the second channel. At the same time, the spectral composition of the responses does not correspond to the positions of the harmonic series of the acting frequency (see figure 2a). So the response of the supplied frequency shifted to 1.3-1.5 kHz to the low frequencies for both channels. Proportional to the response rate (41.6 kHz) there is a response with a maximum of 21 kHz - which is the first harmonic of the response's fundamental frequency. After it there should theoretically be present the responses on the 2nd and 3rd harmonics of this frequency. They're not on the spectrogram. However, there are responses with large amplitudes at frequencies 36.5 and 16 kHz. In the high-frequency region there are responses (at) near 47 kHz. This is the spectral composition of the responses at the interface of the oil-water phases in the initial state.

At the same time, the harmonic series of the action supplied to the slick is easy to identify, since it corresponds to frequent decomposition of water, i.e. for water the characteristic frequencies are 42.8; 21.4; 10.7; 5.3; 2.6 kHz. The other responses (36.5; 16, etc.) correspondingly reflect the structural components of the oil slick.

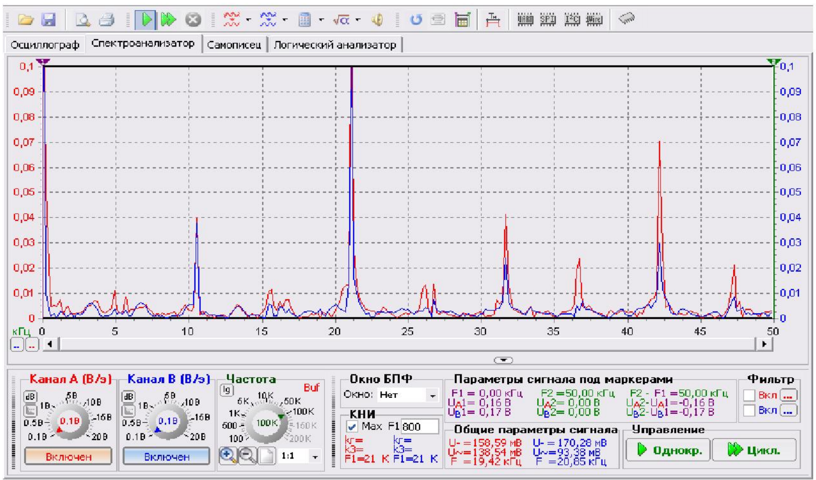
After 8 hours of exposure the appearance of the spectrogram has changed significantly (see figure 2b), indicating a change in the chemical composition of the interface. Firstly, the response at the fundamental frequency $\Delta f = 42{,}8 - 41{,}8 = 1kHz$ shifted towards lower frequencies by 1 kHz, i.e. less than in the original state, and secondly-there were new responses at frequencies 26; 26,5 and 5; 5,5, which have a doublet structure. The appearance of doublets is a sign of uneven reactions progression along the length of the experimental reactor.



a – Theinitialslick

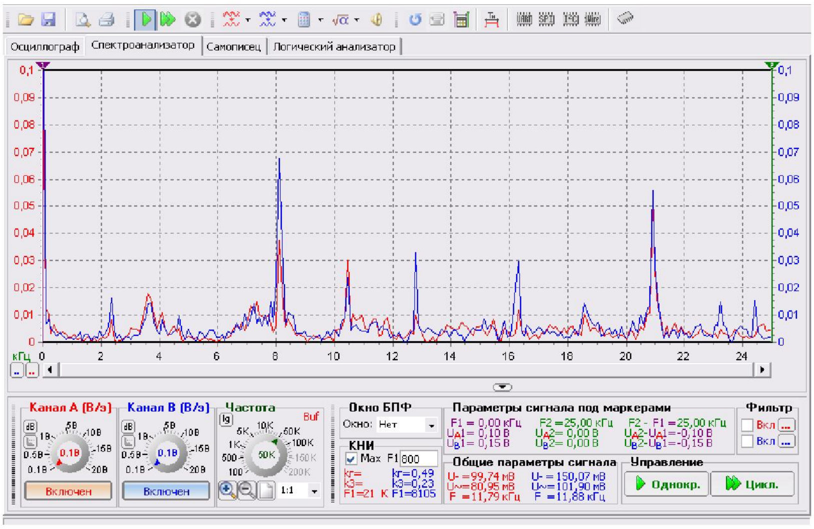


b – After exposure during 8 hours

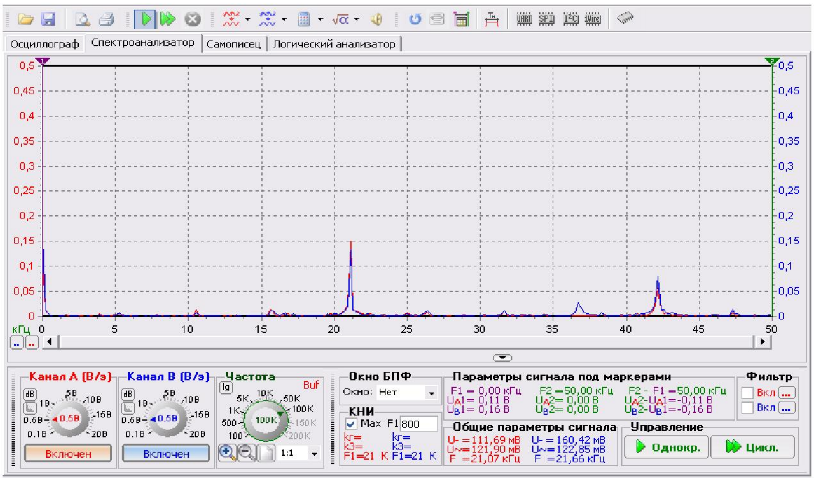


c – After 3 days of aging

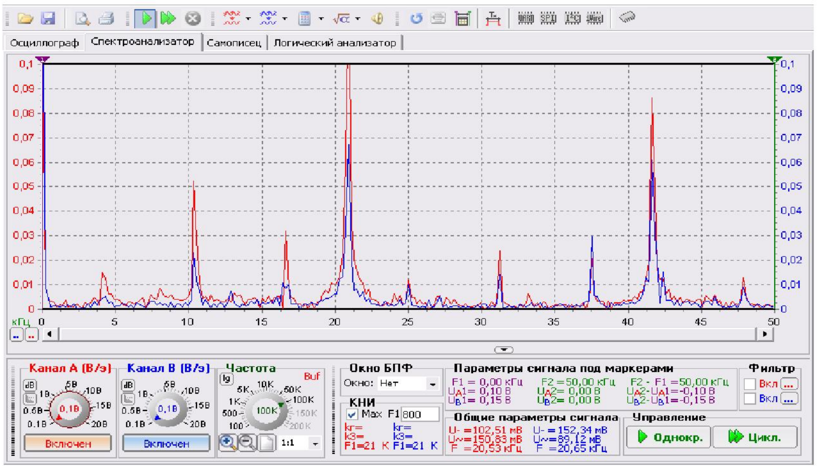
Figure 2 – The spectral composition of the boundary responses (Akzhar)



a – Theinitialstate



b – After exposure during 24 hours



c – After2 days of aging

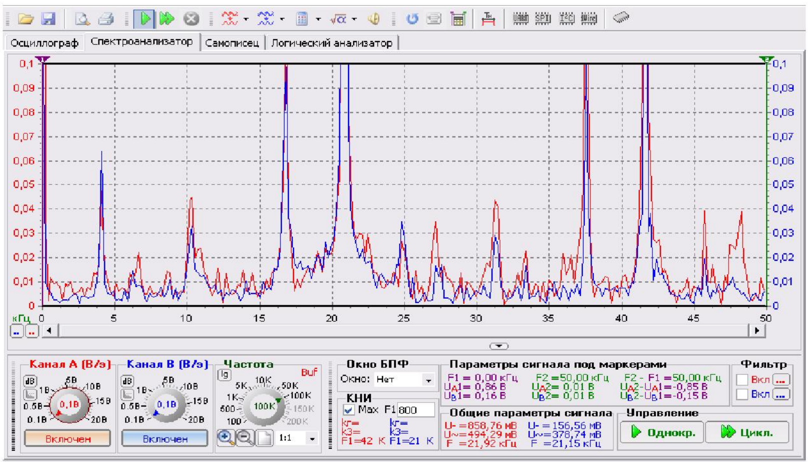
Figure 3 – The spectral composition of the “oil Karabulak – water” interface response

The spectrogram of the responses, taken after 3 days of aging, gives an idea about the stability of new structural components (see figure 2c). Here, the spectrogram has almost no displacement of the main frequency of the action, but the amplitude response value is half less of the first harmonic (21.2 kHz), which means that the response is dominated by larger elements of the structure that are no subject to any changes (to aging). On the 2nd and 3rd harmonics their numbers are less, but they correspond to a number of the fundamental frequency.

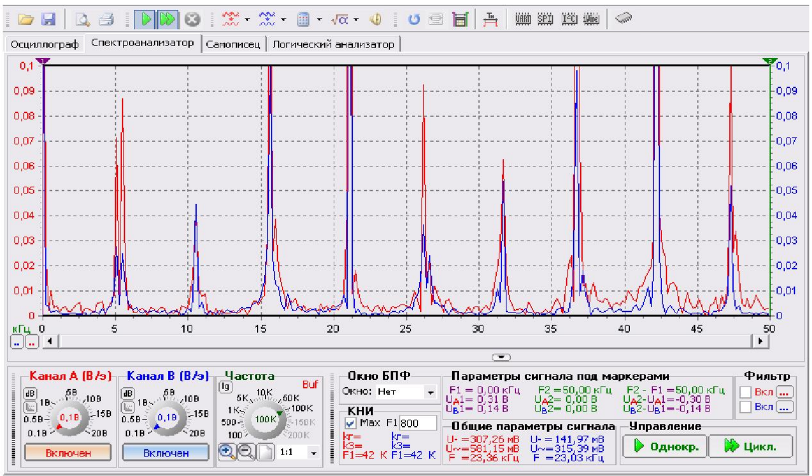
Thus, based on the obtained results, it can be concluded that under the influence of the water decomposition frequency on the interface new structural elements appear both from the synthesis of larger structures, on the basis of water, and also from the decomposition of hydrocarbon, which acquire a high-frequency response.

A similar study was given for a composition consisting of an oil slick from the Karabulak oilfield on the surface of tap water mineralization. In the initial state (figure 3a.) the spectrogram is similar to the response shown in figure 2. The main difference is the appearance of low-frequency responses near 22, 17, 14, 6 kHz, which can be considered as signs of the appearance of the structures of the main chemical composition of the researched oil.

After processing the composition during the day (figure 3b) the type of response spectrogram has changed significantly-the responses at low frequencies have disappeared. The response to 21 kHz has amplitude twice the amplitude of the original signal, which is the main sign of changes in the chemical



a – The initial state (reactor orientation: East-West)



b – After exposure during 24 hours (reactor orientation: North-South)

Figure 4 – The spectrogram of the response of the composition "oil Zhanatan - water"

composition of the phase boundary components in the direction of larger regular structures. In the course of aging (figure 3c.) these structures do not change their acquired peculiarities, i.e. the responses are stored at frequencies 37, 32, 21, 10.5 kHz. The main feature of this spectrogram is the absence of displacement at the frequency of exposure, which means full coverage of the acting signal of the entire volume of the reactor.

To understand the reaction from the diurnal rotation, spectrograms of responses were taken at different positions of the experimental modulus relative to the cardinal directions (see figure 4). In the initial state, when the reactor is located along the East-West direction, the response spectrogram has the same regularities that are inherent in the initial "oil-water" compositions for other oil fields, i.e. there are responses of the harmonic series of the acting frequency (42,8; 21; 10; 5). These responses characterize specific features of the formation of water structures, as they reflect the process of water decomposition (42,8 Puharich frequency [11]). To assess the impact of the change in the state of the oil surface from the Zhanatan field, one may consider frequencies of 37.5, 32, 16.5 kHz, the amplitudes of which are commensurable with the magnitude of the acting signal. These are signs of a resonant response. The basis for this assumption is the almost identical speed of propagation of mechanical (acoustic) waves in the water and oil environments [12, 13].

After an impact on the Puharich frequency during 24 hours (figure 4), with the orthogonally (N-S) changed orientation of the ditch, a unique spectrogram of the response was obtained in which the entire harmonic series for water and oil has doublet responses shifted 1- 2 kHz relative to the main signal. It should be noted that almost all responses have amplitude values commensurate with the response of the impact frequency. This experimental fact means that in the entire volume of the reactor, the processes of formation of both small (47 kHz) and larger structures occur in the most boundary composition. At the same time, a regular structured film becomes the master of specific formations, the state of which it can control. The observed effect of the occurrence of regularity of responses makes it possible to predict the results of external action on the change in the rate of HC synthesis under natural conditions.

Scope of application of results. For a comparative analysis of the qualitative features of the change in the state of the phase boundary during the course of the action, a table of the spectral composition of the responses for three oil fields was compiled: Akzhar, Zhanatan, Karabulak.

Spectral composition of responses for water and oil harmonics of the interface (Akzhar, Zhanatan, Karabulak)

Conditions of the experiment (oil field)	Amplitude of spectral response, B								
	Frequencies of the harmonic series of water, KHz				Frequencies of the harmonic series of oil, KHz				
	41,6	20,5	10,5	5	37	32	25	16	8
Ak-Zhar, initial condition of oil	0,22	0,15	–	0,02	0,1	0,02	0,08	0,1	–
Ak-Zhar, 8 hours of treatment	0,25	0,15	–	0,025	0,1	0,01	0,05	0,1	–
Ak-Zhar, aging 72 hours	0,02	0,15	0,04	0,01	0,02	0,04	–	0,1	–
Karabulak, initial condition of oil	–	0,05	0,03	–	–	–	–	0,03	0,07
Karabulak, 24 hours of treatment	0,1	0,15	–	–	<0,05	–	–	–	–
Karabulak, aging 48 hours	0,09	0,15	0,03	–	0,03	–	0,03	0,03	–
Zhanatan, initial condition of oil East-West	0,2	0,03	0,045	0,055	0,15	0,045	0,04	0,15	–
Zhanatan, 24 hours of treatment North-South	0,22	0,15	0,12	0,05	0,18	0,15	0,09	0,17	–

Tabular data indicate that during the treatment the amplitude of the responses varies, both for the components of the harmonics of the water series, and for the special frequencies of the oil film. In this case, the response of each oil field has specific features. Therefore, when developing software for properties management, it is necessary to take into account the individual characteristics of the oil field [14, 15].

In dynamical systems, whose potential for external influences exceeds the possibilities for the material to return to the previous type of equilibrium - the processes of melting, dissolution, chemical reactions, plastic deformation, etc., the transition to a new state takes place in stages, accompanied first by the destruction of weaker bonds, then by intermediate and most energy-intensive bonds.

The quantitative relations in the multistage process of the phase transition fit well in the equation of Smirnov A. P. [17]:

$$l_n\eta/(1-\eta)-l_n\eta_i/(1-\eta_i3)=\varepsilon_i((D-D_i)/D_i)^n .$$

This relationship establishes the link of the energy necessary for the transition to another state of the multiparticle system in the condition of a change in the fraction of particles in the excited state from η_i to η (the left side of the equation). The right-hand side of the equation of equilibrium characterizes the energy of the change in the measure of action on the system from Di to D (D can be temperature, magnetic field, pressure, frequency, density, velocity and other parameters changing under the action of external forces).

Analysis of the systemic bonds [17] in a solid, carried out for four levels of consideration, showed that the value of ε_i can be equal to 1, 10, 100, 1000 depending on the type of energy conversion during the interaction process. For example, in the process of decomposition of water by energy storage substances, three types of resonance interactions were identified, in which ε_i has values of 10, 100, 1000.

Thus, this equation can characterize several types of equilibrium in which the quantitative relations between the excited and unexcited elements of the structure are balanced by changing the physical properties of the substance. If this relationship has the force of law, then in already existing types of equilibrium, inter phase and intra-phase - these relationships must be satisfied. The left side of the equation gives a quantitative representation of the changes in the reacting system, and the right reflects all the varieties of responses to the external action mathematically described by the value of the power-law dependence of n. The physical meaning of this indicator reflects the change in properties in the A, 2D, 3D dimensions.

Experimentally observed values of the degree n:

$$n = 1; \qquad n = 1/2; \qquad n = 3/2.$$

An exponent n = 1 is characterized by changes in properties, which are described by linear relationships, for example, frequency, refractive index, diffusion, and others. We used this relation with n = 1 to determine the interaction frequency for environments moving with different velocities. The well-known formula of Krasilnikov V.A. [12] is a particular case of this law. In the matrices of systemic relationships that we have developed, the exponent equal to one is used for processes and states of level 1 of consideration.

The exponent n = 1/2 (square root) can be used for the second level of consideration (2D processes), where changes in states associated with the transformation of electromagnetic energy into mechanical one and vice versa prevail. In our case, these are processes and states of the second level of consideration (exponent relations).

Responses for 3D levels of consideration include processes associated with the impact of the dynamic effect of daily rotation of the planet, where the space-time parameters are determined by Kepler's third law [18-21].

Comparison of experimental results on the study of spectral responses to external impulse actions and theoretical developments based on the types of equilibrium for intraplanetary cycles allows us to draw the following conclusions:

1. Obtaining information on changes in the state of the interface between phases by measuring spectral responses provides the necessary potential for searching for cause-effect relationships in all ranges of external influences.

2. The change in the quantitative relationships in the "impact-response" system is suggested to be estimated by the formula of Smirnov A.P., which makes it possible to reflect three-stage processes in the whole variety of their manifestations.

3. It is shown that the state of water (supplier of hydrogen and oxygen) at the interface between phases affects the processes of synthesis and decomposition of hydrocarbons. The observed effect is of practical importance in the development of technology to reduce viscosity under natural underground conditions.

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ҚАБАТТЫҢ МҰНАЙ БЕРГІШТІГІН АЙТАРЛЫҚТАЙ АРТТЫРУ МАҚСАТЫНДА ҚАЗАҚСТАНДЫҚ МҰНАЙ ТҰТҚЫРЛЫҒЫН ТӨМЕНДЕТУДІҢ ҒЫЛЫМИ-ТЕХНИКАЛЫҚ НЕГІЗДЕРІ

Аннотация.

Жұмыстың мақсаты: Мұнай қабаттарының мұнай беругіштігін айтарлықтай арттыру мақсатында қазақстандық мұнайдың тұтқырлығын азайту үшін ғылыми-техникалық негізізде құру.

Қазіргі экономикалық жағдай барысында Қазақстанның мұнайгаз саласы оның жоғары инвестициялық тартымдылығын сақтай отырып, белсенді өсу аймағында болуды жалғастыруда.

Сыртқы импульстік әсер етуіге спектрлік жауап (жаңғырық)және теориялық әзірлемелер түрлері бойынша эксперименттік нәтижелерінсалыстыру барысында тепе-теңдік үшін планета ішілік зерделеу бойынша цикл мынадай қорытындылар жасауға мүмкіндік береді:

1. Қазақстандық мұнайдың тұтқырлығын азайту процесінпрограммалық қамтамасыз ету міндеті барысында, әр кенорнында әртүрлі болғандықтан, анықталған әсер етудің жауабының (жаңғырықтың) спектрлік құрамын зерттеу үшін физикалық үлгілеу жүргізу керек болды.

2. Спектрлік жауапты өлшеу жолымен фазаның бөліну шекарасының өзгеруі жайлы ақпарат алу – барлық сыртқы әсер ету диапазондарының себеп-салдарлық өзара байланысының қажетті қуатын іздеу болып табылады.

3. «Әсер ету-жауап алу» жүйесінде сандық қатынастардың өзгеруін үш стадиалық процестің көптүрлік пайда болуын көрсетуге мүмкіндік беретін А.П.Смирновтың формуласымен бағалау ұсынылды.

Түйін сөздер: мұнай бергіштік, әсерге жауап беру, спектрлік құрам, бөліну шекарасы, қасиеттерді басқару, тау жыныстарының табиғи орны.

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НАУЧНО-ТЕХНИЧЕСКИЕ ОСНОВЫ СНИЖЕНИЯ ВЯЗКОСТИ КАЗАХСТАНСКИХ НЕФТЕЙ, ОБЕСПЕЧИВАЮЩИХ СУЩЕСТВЕННОЕ ПОВЫШЕНИЕ НЕФТЕОТДАЧИ ПЛАСТОВ

Аннотация.

Цель работы: Разработка научно-технических основ снижения вязкости казахстанских нефтей, обеспечивающих существенное повышение нефтеотдачи пластов.

В современных экономических условиях нефтегазовая отрасль Казахстана продолжает находиться в зоне активного роста, наряду с сохранением ее высокой инвестиционной привлекательности.

Сопоставление экспериментальных результатов по изучению спектральных откликов на внешние импульсные воздействия и теоретических разработок по видам равновесия для внутрипланетных циклов позволяет сделать следующие выводы:

1. Получение информации об изменениях химического состава границы раздела фаз путем измерения спектральных откликов обеспечивает необходимый потенциал поиска причинно-следственных взаимосвязей во всех диапазонах внешних воздействий.

2. Изменение количественных соотношений в системе «воздействие-отклик» предложено оценивать по формуле Смирнова А.П., дающей возможность отражать трехстадийные процессы во всем многообразии их проявлений.

3. Показано, что состояние воды (поставщика водорода и кислорода) на границе раздела фаз влияет на процессы синтеза и разложения углеводородов. Обнаруженный эффект имеет практическое значение при разработке технологии снижения вязкости в условиях природного залегания.

Ключевые слова: нефтеотдача, воздействие-отклик, спектральный состав, граница раздела, управление свойствами, природные залегания.