Journal of Innovations in Business and Industry

Vol. 04, No. 01 (2026) 19-28, doi: 10.61552/JIBI.2026.01.003 - http://jibi.aspur.rs

REOPHYSICAL-CHEMICAL PROPERTIES AND BEHAVIOR OF A PHASE FROM CONTAINING WAX, ASPHALTENE, REZIN OF CRUDE OIL

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Received 17.10.2024.
Revised 18.01.2025.
Accepted 26.03.2025.

Keywords:

Crude oil, wax, asphaltenes, nanocolloids, fluid, anomalies.

Original research

A B S T R A C T

Modern views on a state problems are considered the wax, asphaltene, rezin of deposits (WARD) in the oil-field equipment and possible methods of her decision. In work, the major factors influencing on are listed formation of WARD. The special attention, is paid to a group chemical composition of initial raw materials and mutual influence of separate high-molecular components of oil on structurization in oil system at low temperatures. Influence of structural and group composition of oil on the formation mechanism, structure and WARD properties is, shown. The short list of the existing methods of prevention and removal of WARD from the oil-field equipment is given. The chemical methods connected with use of various additives, reagents and eliminators are in more detail considered. The short characteristic of the main classes of the chemicals used at a solution of the problem of prevention and removal of WARD is given. It is, shown that for the choice most ways of prevention and removal of deposits, effective from the chemical point of view organic substances receiving adequate idea of structure is necessary, properties and structure of initial oil and the formed deposits. Below the wax appearance temperature these aggregates evidently act as cementing species in extended networks of wax crystals. The optical absorption measurements revealed an increase of a vertical concentration gradient in the samples, heated to the above specific temperatures, which may be indicative of some phase separation in the studied crude oil.

1. INTRODUCTION

Development of oil industry of Russia at the present stage is characterized by decline in quality of a source of raw materials (Filimonova et al., 2019). In overall balance of the developed fields the fields which have entered a late stage of development prevail and, as a result, considerable deterioration in their structure, increase in a share of hardly removable reserves of oil, flood of layers and production of wells is observed. So at production paraffinic a crude oil serious problem, defiant complications in work of wells, the oil-field equipment and pipeline communications, education the wax, asphaltene, rezin of deposits (WARD) which formation leads to decline in production is system and overall performance of pump installations (Zhang et al., 2020). Formation of emulsions at an exit from a well together with the accompanying reservoir water strengthens draft education (Goroshko, 2003).

It is known that fight against WARD in processes of oil production is conducted on two to the directions: prevention (or prevention) deposits; removal already the

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created deposits. The choice of optimum ways of fight from asphalt pitch paraffin deposits and efficiency of various methods depends on many factors, in particulars, from a way of oil production, the thermobaric mode of a current, structure and properties of the got production. Despite a big variety of methods of fight against WARD, problem it is still far from permission and remains to one of the most important in domestic oil-extracting branch (Nurullayev, 2014).

The factors influencing formation of WARD.

Intensity of formation of ASPO in system of transport, collecting and preparation of oil is influenced by a number of factors, basic of which are:

- Pressure decrease in the field of a face and the violation of hydrodynamic balance of gas-liquid system connected with it;
- Intensive gas emission;
- Reduction of temperature in layer and a trunk of a well;
- Change of speed of the movement of gas-liquid mix and its separate components;
- Composition of hydrocarbons in each phase of mix;
- Ratio of volumes of phases (oil-water).

In the bottomhole zone of layer (BZL) the listed factors change continuously from the periphery to the central region in a well, and in the well from a face to the mouth therefore the quantity and nature of deposits aren't constants.

The place of allocation of WARD can be at various depth and depends on a well operating mode. Among the conditions promoting formation of deposits it is possible to call pressure decrease and temperatures, and also an oil gassing. It is known that the dissolving ability of oil in relation to paraffin decreases with fall of temperature and decontamination of oil. At the same time the temperature factor prevails.

Intensity of a thermolysis depends on a difference of temperatures of liquid and surrounding breeds at a certain depth, and also heat conductivity of ring space between lifting pipes and an operational column. Practice of oil production on crafts shows that the main sites of accumulation of WARD are borehole pumps, lifting columns in wells, discharge lines from wells, tanks of trade assembly points. Most intensively WARD are postponed on an internal surface of lifting pipes of wells. In discharge lines their education amplifies in winter time when air temperature becomes much lower than temperature of a gas-oil stream.

With growth of speed of the movement of oil intensity of deposits increases in the beginning that is explained with increase in turbulization of a stream and, therefore, increase in frequency of education and a separation of the bubbles from a surface of a pipe floating the weighed particles of paraffin and asphaltic substances. Besides, the moving stream breaks part of deposits from walls of pipes, than and it is possible to explain sharp decrease in deposits in the range of 0-50 m from the mouth, and also having big speeds of a current, it turns out more resistant to cooling what too slows down process of formation of WARD (Ibragimov et al. 1986).

The roughness of walls and existence in system of solid impurity promote also allocation from paraffin oil in a firm phase. Except the specified major factors on intensity of a parafinization pipelines at transportation of the flooded production of wells water content of production and size pH reservoir waters can exert impact, and influence of these factors is ambiguous and can be various for different fields.

Influence of a chemical composition of oil on process of formation of WARD.

WARD formed in different wells differ from each other on a chemical composition depending on group hydrocarbonic structure crude oil, got on these wells. But at all possible variety of structures for all deposits it is established that contents in them asphaltic and paraffin components will be the return: the more in WARD the share of asphalt of resinous substances, the less will contain paraffin that in turn will be defined by their ratio in oil. Such feature is caused by nature of mutual influence of the paraffin, pitches and asphaltene, which are in crude oil until their allocation in deposits.

WARD formed in different wells differ from each other on a chemical composition in As have shown pilot and practical studies before paraffin is emitted for surfaces of the borehole equipment, his crystals make transformation of the structures so that, connecting among themselves, will organize a continuous lattice like a wide tape. In such form adhesive properties of paraffin amplify many times over, and his ability to stick to firm surfaces considerably is intensified (Nurullayev et al., 2016).

2. LITERATURE REVIEW

However if oil contains rather large number of asphalten (4-5% and above), their depressor action affects. Asphaltene can to act as the germinal centers. Paraffin molecules participate in a sokristallization with alkils chains of asphaltene forming dot structure. That is formation of a continuous lattice doesn't happen. As a result of such process paraffin is redistributed between a set of the small centers and release of paraffin on a surface is significantly weakened (Mikhaylov et al., 2021).

Pitches, owing to the structure, on the contrary, promote creation of conditions for formation of tape units of paraffin crystals and their sticking to a surface and the presence interfere with impact of asphaltene on paraffin, neutralizing them. As well as asphaltene, pitches influence the size of temperature of saturation by oil paraffin, however nature of this influence opposite: with growth of their mass contents temperature of saturation increases in oil (if, for example, to increase presence of pitches from 12 to 32%, then temperature of saturation will increase from 22 ºC to 43 ºC).

Crude oil saturation temperature paraffin is in direct dependence on mass concentration of pitches and in the return from concentration of asphaltene (Schuler et al., 2020).

Therefore, process of a, education paraffin depends on a ratio asphaltene (A) and resinous (R) connections as a part of crude oil (Fakher et al., 2020).

With increase in the A/R parameter temperature of saturation will decrease – associates of asphaltene in crude oil are less stabilized because of a lack of the stabilizing components (pitches). As leads to reduction of temperature of saturation, process of crystallization of paraffin such crude oil is suppressed with associates, and adjournment of paraffin doesn't happen; at the A/R small values on the contrary, saturation temperature increases – asphaltene don't make impact on a paraffin education, paraffin is freely emitted from crude oil (Malozyomov et al., 2023).

Mechanism of formation of WARD.

The parafinization mechanism is understood as set of processes, leading to accumulation of a firm organic phase on an equipment surface (Struchkov & Rogachev, 2018). At the same time, formation of deposits can happen or due to coupling with a surface of already ready, formed in a stream particles of a firm phase, or due to emergence and growth of crystals directly on a surface equipment (Ibragimov, 2003).

The probability of fixing of particles of paraffin on an equipment surface in the conditions of the operating well is almost insignificant – the paraffin particle can be fixed on an equipment wall, but provided that originally she will get stuck on her purely mechanically (Pattnaik et al., 2012).

At transportation of oil on the pipeline the following processes proceed. Crude oil comes to the pipeline and contacts to the cooled metal surface (Hart, 2014). At the same time there is a gradient of temperatures directed perpendicular to the cooled surface to the center of a stream. Due to turbulization of a stream oil temperature in volume decreases. At the same time two processes in parallel proceed:

- Allocation of crystals of n-alkanes on a cold surface;
- Crystallization of n-alkanes in volume of crude oil.

Release of paraffin not in itself, but their adjournment on a surface of pipes and the equipment in the direction of a heat transfer is almost important. Such deposits are formed at observance of a number of conditions: existence in crude oil of high-molecular hydrocarbons, first of all metane row. Decrease in temperature of a stream to values at which there is a loss firm phase; existence of a substrate with the lowered temperature on which hydrocarbons crystallize and to which they are so strongly linked that a possibility of failure of deposits by a stream at the set technological mode it is practically excluded. By researches of the last years it is authentically established that direct link between the content of paraffin and intensity of his adjournment isn't present. Lack of such communication is caused, first of all, by essential distinction of structure solid hydrocarbons – paraffin, namely, distinction in ratios of aromatic, naphthenic and metane connections in high-molecular part hydrocarbons which at standard methods of research of crude oil isn't defined (Ismayilov et. al., 2015).

Meanwhile, it is proved that distinctions as a part of solid hydrocarbons generally and predetermine features of formation of paraffin deposits. The content of hydrocarbons with branched structures aromatic is higher, naphthenic and the izoalkans, the less strong appear paraffin deposits as connections of this kind possess the increased ability to keep crystal educations liquid weight (Nurullayev, 2015).

Hydrocarbons of a metane row – especially high-molecular paraffin, on the contrary are easily allocated from solution with formation of dense structures. It is clear, that friable and semi-fluid crystal deposits rather easily can be removed with a natural stream of liquid in use of wells, without causing any complications, and, on the contrary, the dense and strong deposits created generally from n-alkanes create serious complications for which elimination many means and work are spent (Nurullayev, 2016).

Structure and WARD properties.

WARD isn't simple mix of asphalten, pitches and paraffin, and represent the difficult structured system with a pronounced kernel from asphaalten and sorption solvatny a layer from oil pitches (SSE). The Asphaltene Resinous Substances (ARS) is represented by heterocyclic compounds of a complex hybrid structure which part are nitrogen, sulfur, oxygen and metals (Fe, Mg, V, Ni, Ca, Ti, Mo, Cu, Cr, etc.). To 98% of ARC makes aromatic and naphthenic structures (Kayumov et al., 2006).

3. METHODOLOGY

The framework of structure of molecules of pitches and asphaltene forms the hydrocarbonic skeleton making 70-90% of the gross weight of molecules. In a genetic connected number of hydrocarbons-pitch-asphalten the gradual tendency of impoverishment by hydrogen and enrichments by carbon is observed. The share of aromatic elements of structure increases, and degree of their condensed raises; the share decreases atoms of carbon in peripheral part; specific weight of atoms in the central kernel of molecules – polynuclear structure with strong prevalence of aromatic rings increases. Pitches and asphaltena differ also on the content of nitrogen and oxygen. In pitches oxygen, and in the asphaltene nitrogen generally concentrates.

Depending on the nature of oil and contents in it solid hydrocarbons, and also depending on the place of sampling the structure of deposits includes: paraffin – 9... 77%; pitches – 5... 30%; asphaltene – 0,5... 70%; connected crude oil to 60%; mechanical impurity – 1... 10%; water – from shares to several percent; sulfur – to 2%. Depending on the maintenance of organic components of WARD it is offered to subdivide into three classes:

1. asphaltens – P / (A + R) <1;
2. paraffin – P / (A + R>1;
3. mixed – P / (A + R) ~ 1,

where P, R and A - contents (% of masses.) paraffin, rezinss and asphaltene, respectively.

Usually under the term paraffin unites all hydrocarbonic part deposits. Though in this part n-paraffin (metane hydrocarbons, or alkanes with a direct chain), in it contains naphthenic (cyclanic) and aromatic hydrocarbons with long alkils chains in smaller quantity. Structure of paraffin hydrocarbons microcrystalline, naphthenic with long alkils radicals form macrocrystalline structure (Evdokimov et al., 2003).

The pitches which are a part of WARD are presented first of all by the neutral pitches emitted by means of silica gel and chloroform (four-chloride carbon). These are semi-fluid, sometimes semisolid dark brown or black color of substance. The relative density of pitches is from 0,99 to 1,08 g/cm^3. The molecular mass of pitches can reach 1200. They are well dissolved in all oil products and organic solvents, except for ethyl and methyl alcohols. On average pitches contain up to 15-17% of oxygen, sulfurs, nitrogen.

With increase of molecular mass of pitches the content of oxygen, sulfur and nitrogen decreases. A basis of structure of molecules of pitches is the flat condensed polycarbocyclic grid consisting mainly from benzene rings. This structural grid can contain naphthenic and heterocyclic rings (five and six-membered). The peripheral part of the condensed system of WARD pitches is replaced on hydrocarbonic radicals (aliphatic, cyclic and mixed). The nature and the number of these deputies strongly depends on properties of oil. Deputies can include functional groups (-OH, -SH, -NH_2, =CO, etc.). When heating to 260-350 °C of pitch begin to be condensed and turn into asphaltene.

With increase of concentration in pitch solution, on the one hand, slow down growth of crystals, and with another, – promote deformation of a surface of crystals and emergence on them the new centers of crystallization. Extent of manifestation of this or that tendency is defined by the nature of pitches and causes the corresponding form and the size of crystals of solid hydrocarbons (Evdokimov et al., 2007).

On modern representations of an asphaltene are the polycyclic aromatic strongly condensed structures with short aliphatic chains in the form of dark-brown amorphous powders. Density of asphaltene is slightly more than unit. In the asphaltene contains (% of masses.): 80... 86% of carbon, 7... 9% of hydrogen, to 9% of sulfur and oxygen, and to 1,5% of nitrogen. Asphaltene don't crystallize and can't be divided into individual components or narrow fractions. When heating higher than 300-400 ºC they don't melt, and decay, forming carbon and flying products. Asphaltene are the heaviest and polar components of crude oil. Asphaltene are very inclined to association, their particles of a polidispers and therefore molecular weight depending on a method of definition can fluctuate from 2000 to 4000 а.е.м. Asphalthen are considered as products of consolidation of pitches. The particle of asfalten represents itself a micelle which kernel consists of the high-molecular polycyclic condensed connections of mainly aromatic character, and the adsorptive layer is formed by low-molecular surface-active connections, including pitches and naphthenic acids which together with aliphatic components of oil, form a solvate cover of a micelle (Evdokimov et al., 2006).

Apparently, still nobody seriously thought that the properties of micellar colloids attributed to asphaltene carried them to a new class of disperse systems. Namely, the disperse systems consisting of the firm particles dispersed in a liquid phase are colloidal suspensions whereas systems in which the disperse phase is formed on reversible process an education micelle represent associative colloids. Associative, or micellar colloids, as a rule, have a rich phase variety: from the elementary isotropic micellar phases to elaborate supramolecular nanostructures.

As an example, in figure 1 the complex phase chart in coordinates temperature – concentration is shown (T-C) for nonionic surfactant – monododecsilt air of pentaethylene glycol ($C_{12}E_5$) in water. We will note that on the phase chart there are closed phase areas (the closed contours) corresponding to implementation so-called returnable phase transitions.

It is important for further discussion that the closed contours on the phase chart demonstrate existence in system of polymorphism; formation of these areas on the phase chart happens to stratifying transition participation (phase transition of the second sort) that is characteristic of existence in the associates directed not covalent (for example, hydrogen) communications.

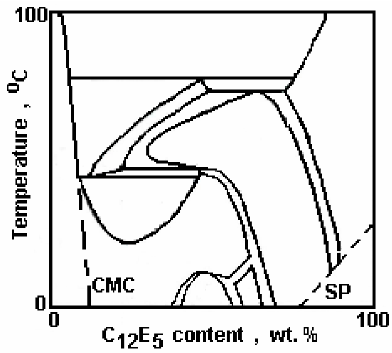


Figure 1. Complex T-with the phase chart of associative colloids in to binary system water-surfactant. Shaped critical borders – traditional curves of critical concentration a micelle of education (SMS) and solubilities (SP), (Strey et al., 1990)

Surprisingly, as after adoption of the concept of a micelle of education for nanoparticles of asphaltene, researchers of crude oil disperse systems still continued to adhere to outdated ideas of existence of only one critical concentration in surfactants solutions. As a result, no analogies to associative colloids (the difficult phase chart with a set of critical concentration (CC) and temperatures) still seriously were studied though, as

shown below, both the known experimental data and the last publications contain versatile information which will be coordinated that asphaltene on business, really are associative nanocolloids (Evdokimov et al., 2003).
Phase changes in asphaltene the containing systems can be revealed on the special points (isolated steps to figurative breaks, extrems, bends, etc.) on experimental dependences of various parameters of system on concentration and temperature. In figure 2 the example from our earlier published article about some temperature and concentration effects which are shown on dependences of steam is given -meters of rheological model of Gershelya-Balkli for sated with asphaltene crude oil.

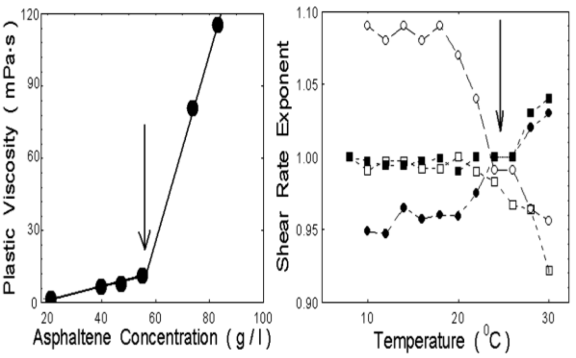


Figure 2. Identification of special/critical points on experimental dependences for creation of the phase chart of nanocolloids of asphaltene (Evdokimov et al., 2001)

The analysis of big data array has shown that (except for several obvious emissions) all special points revealed thus form clear phase boundary (critical lines) on the chart in T-C. Almost important ranges of temperatures and concentration on the phase chart are rather wide: before melting and thermal destruction / coking on temperature and from infinitely diluted oil solutions to firm asphaltene on concentration. For the last, decades research groups have published many data worldwide on identification of special points which lay down in various parts of the phase chart of asphaltene.
For example, our group studied concentration features in the diluted solutions with the maintenance of asphaltene from ~ 1 mg/l, to ~ 1 g/l at temperatures close to room. Other researchers studied temperature effects in the range of temperatures from 50 °C to ~ 400 °C for bitumens and allocated from in detail oil of asphaltene that is at concentration of asphaltene in system from ~ 140 g/l, to ~ 1200 g/l. It should be noted that not all obviously distinguishable on schedules and the charts "special points" have been noticed by authors of works, and not all noticed features were discussed. For example, when studying features of aggregation of asphaltene the method of low-angle dispersion of neutrons (SANS) has received dependences of radiuses of rotation of RG on concentration in solutions with the maintenance of asphaltene of 3,4-117 mg/l at temperatures from 8 °C to 73 °C. Authors of article have given rather competent and quality estimates to temperature and concentration effects, but haven't paid attention to obvious maxima of R_G at concentration ~ 5, ~ 20–22 and ~ 70 g/l. Moreover, evolution of original data in coordinates of R_G-T allows to notice special temperature in the range of 28-32 °C.
T-C the phase chart of asphaltene in oil.
The comparative analysis of all available information on special points the, containing environments still was carried out by nobody to asfaltena. In fig. 5 the phase chart of asfalten constructed by us for the first time in coordinates T-with generalizing is shown available data of various authors. Noted on the chart "special points" are received in the same way as it is described in the previous section. Apparently from drawing, it is already enough data which are available now to allocate on the chart well distinguishable, and the main thing, phase borders received by independent authors. However you shouldn't forget that still limited quantity of initial the statistical analysis doesn't allow to carry out information; therefore, all numerical values of critical parameters given below have to be perceived as the approximate sizes demanding further specifications so far (Hansen & Yu, 2001).

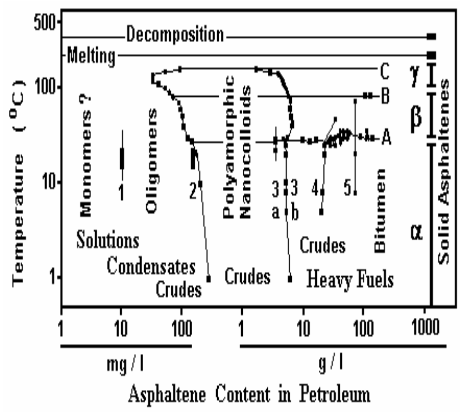


Figure 3. Complex T-C the phase chart of associative nanocolloids of asphaltene in crude oil constructed according to data available currently

Border of primary aggregation (the line 1 on figure 5). The first experimental data on primary aggregation of asphaltene at concentration of 7-10 mg/l were also US areas of a range, viscosity and a nuclear magnetic resonance relaxation are received in experiments on studying of light absorption in visible for solutions of firm asphaltene and natural crude oil in toluene. Accessory of this border has been recently confirmed to process of primary association of monomers of asphaltene with method of fluorescent spectroscopy (Mohammed et al., 2022).
Stratifying border (the line 2 in figure 3). This border (concentration of asphalten of 100-150 mg/l at 20 °C) has been received for solutions of firm asphalten and natural crude oil in experiments on studying of light absorption, a nuclear magnetic resonance relaxation, viscosity, speed of distribution of ultrasound in the environment and in other parameters. Well-known feature of the stratified (immiscible) systems is an existence of the closed phase area on the chart in T-page coordinates. If to look at the chart represented in figure 3, then it is visible that lines 2

and 3 tend to formation of the closed phase area. It is possible to call the lower and top borders of area which are also visible on the chart critical temperatures of dissolution (top – UCST, lower – LCST).

Borders of the former CC (the line 3a and 3b in figure 5). Special points" on dependences of various parameters at concentration of asphaltene ~ 1–10 g/l many researchers, and works in this range of concentration received the greatest number. At the specified concentration there are most considerable changes of practically all measured parameters. More detailed researches of the published data on CC show that actually critical concentration in this area two: 1–3 mg/l and 7–10 mg/l. As it was told above, many years these special points took for CC of asphaltene, by analogy with simple surfactant. When it has become clear, that the classical mechanism of a education micelle isn't peculiar to asphaltene, the new abbreviation – CNAC (critical concentration of formation of nanounits) has been entered. Borders of the former CC reflect phase changes not of primary systems consisting of molecules of asfalten, and secondary, more difficult systems of the nanocolloids which are already created on phase border of stratifying in figure 5. Moreover, at least, one of lines of the former CC can enter the closed contour limiting phase area stratifyings as it is noted above.

For an asphaltene of the containing fluid liquids, including natural oil, the interphase border (the line A in figure 3) – area of "special temperatures" 25–35 °C is most studied α-β. Transition to more dense (β) to a phase has been noticed on considerable reduction of volume of difficult units of asphaltene, on to decrease in a superficial tension and on increase in deposits from solutions of asphaltene. In addition to the stratifying transition discussed above, this border admits the top critical temperature of dissolution (UCST) as for bitumens, and for solutions of asphalten. Are rather less studied β-γ phase border (the line B in figure 3) and the upper γ-phase bound (the line C in figure 3). The last border can be also called the lower critical temperature of dissolution (LCCT) limiting the closed phase area of stratifying. These figure 3 show that the transitions controlled by temperature between α, β and γ phases are observed for all concentration of asphaltene from stratifying border to the right (line 2).

As an example, in figure 4 the schedule of dependence of viscosity on concentration of asphaltene (in logarithmic coordinates) for more is shown than to the 200-th crude oil the world of various geographical and geological origin. The continuous line in figure 6 has no special value and is drawn only visually to allocate obvious maxima of viscosity. For indisputable statistical confirmation of the discussed features, it is undoubtedly necessary still the bigger volume of data (especially in the range of low concentration of asphaltene); despite it, even crude data of figure 6 show accurate coincidence of anomalies of viscosity to all (except one) phase borders of nanocolloids of asphaltene from figure 3. The phase border which isn't getting here 1 corresponds to concentration of asphaltene in oil about 0,001 masses. %, while in the majority of databases all concentration less than 0,01 masses. % are classified as lack of asphaltene. We will note that figure 4 shows the actual absence in the nature mobile crude oil with the maintenance of asphaltene above phase border 5 which as it was already discussed, can be a natural limit of solubility asphaltene in natural the crude oils.

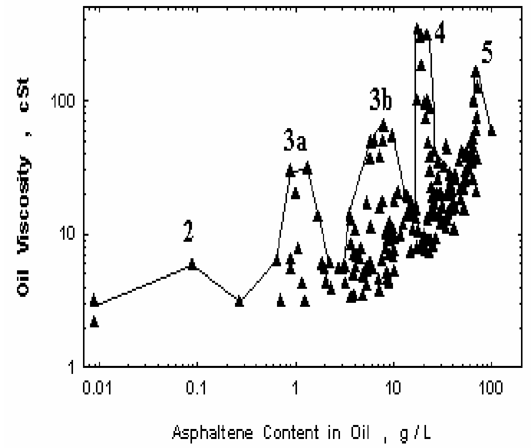


Figure 4. Difficult dependence of viscosity on the maintenance of asphaltene for crude oil got in different parts of the world.

The allocated maxima are numberedaccording to phase borders of asphaltene in figure 3. It is known that between viscosity and density of oil there is a close interrelation. Really, density crude oil of our database also show maxima at concentration of the asphaltene corresponding to phase borders of nanocolloids as shown in figure 7. Actually effects of nanophases of asphaltene are so steady and constant that easily are found, even in very the lists of properties of crude oil limited on volume. For example, on one of the websites devoted to problems of adjournment of asphaltene the table Content of rezins and asphaltene in various the crude oils is placed.

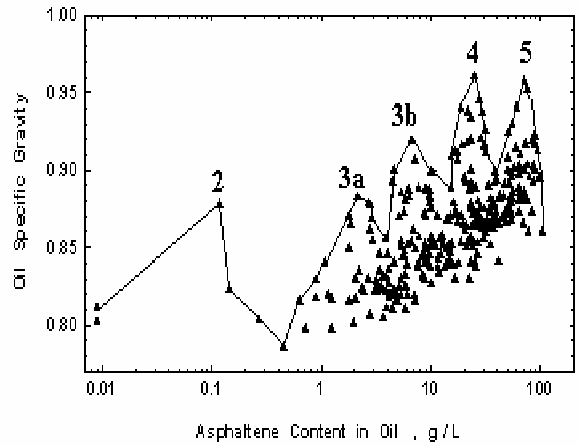


Figure 5. Difficult dependence of relative density on the maintenance of asphaltene for crude oils got in different parts of the world.

The allocated maxima are, numbered according to phase borders of asphaltene in figure 3.
Properties only are brought in the table 20 crude oils with the nonzero maintenance of the asphaltene got in different parts of the world (Canada, Venezuela, Mexico, the USA, Russia, Brazil, Iraq, France, Algeria). The schedule of dependence of relative density given on the website nefty from concentration of asphaltene is shown in figure 8. Comparison with more the substantial database (see figure 7) allows to refer splashes in relative density to the same phase borders asphaltene (the border 3b isn't visible in figure 8 because of small numbers of points in the necessary range of concentration).

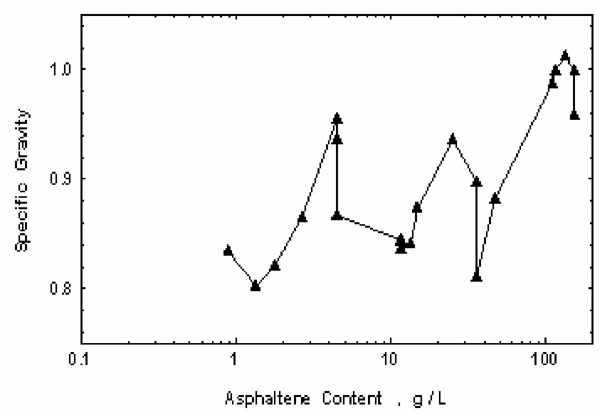


Figure 6. Difficult dependence of relative density on the maintenance of asphalten for the limited list of properties crude oil, got in different parts of the world

Our experiments have allowed to find noticeable changes of properties natural crude oil and upon transition through temperature phase border in figure 3 (Evdokimov et al., 2007).

4. RESEARCH RESULTS AND DISCUSSION

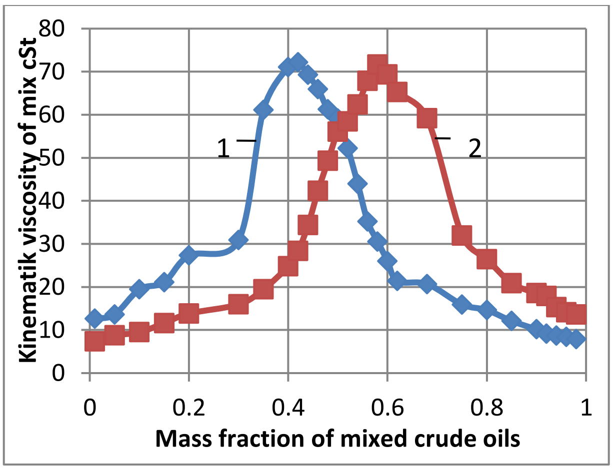
Researches of the last years have drawn a conclusion that nonlinear deviations of properties of mix the differently sortable crude oil from the existing models of ideal mixes most likely are caused by structural transformations of oil nanophases. At concentration of asphaltene in mix crude oil to the corresponding borders of nanophases perhaps emergence of undesirable manifestations of incompatibility.
Thus, the existing recommendation about technologies of mixing should add with the criteria taking into account interference as a part of separate components allowing to make a necessary assessment of "unacceptable", and also "optimum" concentration of asphaltene and other high-molecular chemical compounds in oil mixtures.
Various models of the considered processes existing now don't allow to predict changes of indicators of quality of examinees of oil mixtures with a sufficient accuracy, necessary for engineering calculations yet.

In work on the example of crude oil Azerbaijan it is established that besides loss of various rainfall, manifestation of "incompatibility" in oil mixtures can be expressed also in noticeable anomalies of quality indicators.
For the purpose of studying of interference of components as a part of mix various tests of crude oil and their mix have been investigated in vitro. According to the corresponding state standard specifications researches on definition of physical and chemical indicators "density", "viscosity", "hardening temperature", and "quantity of ballasts" of examinees of systems have been conducted.
In particular, physical and chemical indicators crude oil fields the Bulla (BCO) and Garachukhur (GCO) of Azerbaijan which have been used with a research objective their interaction at mixture are provided in the table. As are visible from the table, the qualities considered oil in parameters differ from each other.

Table: Physical and chemical indicators crude oils fields Bulla (BCO) and Garachukhur (GCO) of Azerbaijan.

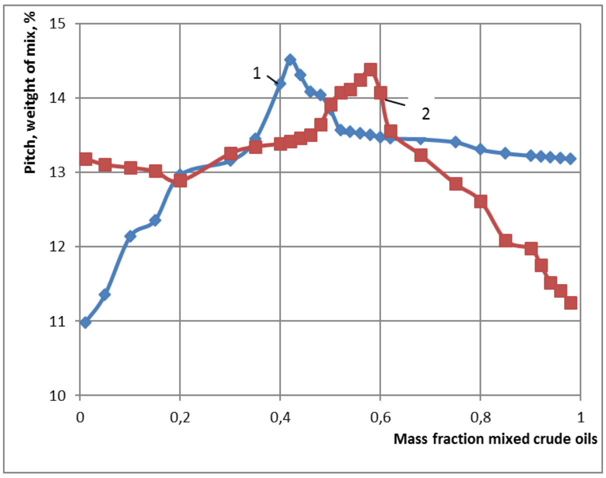
Physico-chemical parameters	Crude oil		Methods of carrying out analyses
	BCO	GCO	
Kinematic viscosity at 20 ^{0}C, cSt	15,76	6,41	GOST 33
Pitch, weight %	10,27	13,28	Hromotagrap.
Asphaltene, weight %	0,23	0,64	GOST 11858
Wax, weight %	13,34	2,53	GOST 11851

As a result of researches depending on ratios of components of mixture not additive properties of noted parameters have been found. In oil mixtures in some cases the effect of a sinergizm (figure 7÷10) was observed. In figure 7-10 a mass fraction of the mixed oil, i.e. from sequence of mixture of the GCO and BCO components are presented according to change of parameters of viscosity, content of pitches, asphaltene, wax.



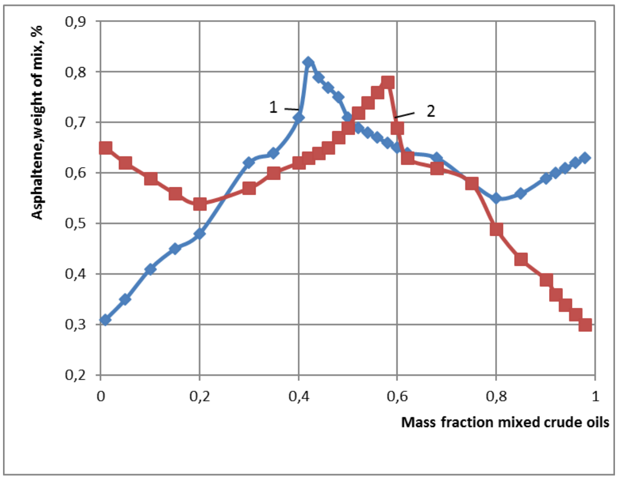
1-GCO+BCO, **2**-BCO+GCO

Figure 7. Change of kinematic viscosity of mix



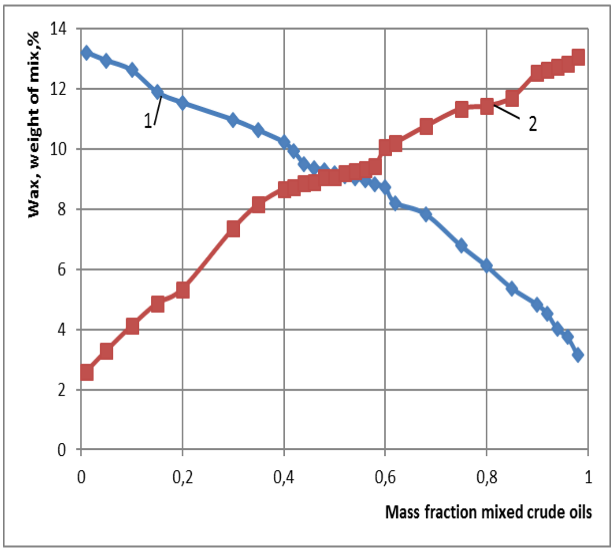
1-GCO+BCO, **2**-BCO+GCO

Figure 8. Change the content of pitches in mix



1-GCO+BCO, **2**-BCO+GCO

Figure 9. Change of maintenance of asphaltene in mix



1-GCO+BCO, **2**-BCO+GCO

Figure 10. Change of content of wax in mix

Apparently from fig. 7-10, in change of parameters of, viscosity, content of pitches and asphaltene irrespective of sequence of mixture at a ratio of the GCO:BCO=42:58 components of % (or % BCO:GCO=58:42) observes abnormal growth.

Thus, it has been shown that as a result of interference crude oil at their mixture in technological pipelines of system of collecting production of wells formation of various traffic jams and abnormal changes of almost important parameters, such as density, viscosity, hardening temperature, volume, etc. can be observed. Therefore when mixing crude oil it is necessary to consider a factor of interference of structures crude oil for the purpose of an assessment "inadmissible" and "optimum" concentration of separate components. For this purpose when mixing crude oil and crude oil products under production conditions, physical and chemical and rheological characteristics of the received oil mixtures it is expedient to define experimentally. Laboratory researches as it is possible a bigger, variety of crude oil mixtures also for development of sufficient exact empirical formulas are extremely necessary.

5. CONCLUSIONS

In the oil and gas industry of nanotechnology so far weren't widely adopted, except for processes of oil refining and gas. In oil production and drilling the bigger attention began to be paid to researches and developments of the new nanostructured clever liquids for an intensification of production, oil recovery increase only recently layers and safe performance of drilling operations.

Our researches have shown that now there are enough facts to consider also oil as associative nanoliquid, by the nature which is object of nanotechnologies. Therefore, and traditional technologies for development of oil and gas fields can (have to) become in fact nanotechnologies in the sense that they have to be optimized or designed anew with the accounting of complex phase charts of the nanocolloids entering oil. As a result, it will allow if not to improve, then at least, to keep thin internal structure natural crude oils (in the latter case it is possible to call such approach oil nanoecology). Moreover, the similar nanoideology, can be necessary and during the work with some macroscopic disperse systems to which emulsions sheeted belong waters in oil. Morphological/phase charts of water oil emulsions find the complex structure reminding some lines of phase charts of natural nanocolloids of oil environments.

Acknowledgements

The authors gratefully acknowledge the research council of State Oil Company of the Azerbaijan Republic (SOCAR) and Azerbaijan State University of Oil and Industry.

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