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Study on the efficiency of ARPD (asphaltenes, resin and paraffin deposit) hydrocarbon solvents

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Study on the efficiency of ARPD (asphaltenes, resin and paraffin deposit) hydrocarbon solvents

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Abstract. Intensive asphaltene-resin-paraffin deposits (ARPD) precipitation is one of the main problems in oil production, processing and transportation. The present study describes the selection of ARPD hydrocarbon solvents using the express method of effective hydrocarbon solvents according to which optimal ratio of alkane and aromatic component is determined. On the basis of laboratory data, the binary solvents efficiency graphs of n-hexane-toluene mixtures were produced, and the conclusion was drawn about the optimal ratio of alkane and aromatic components for dissolving the Vankor field (ARPD) asphaltene-resin-paraffin deposits.

Various methods are used to remove ARPD in oilfield systems, as well as in commodity and raw material tanks. These methods are usually classified into: mechanical, thermal, unconventional and chemical.

The most perspective ARPD removal method is considered a chemical method as having both high efficiency and adaptability. The method is based on partial dissolution and dispersion of deposits under the influence of solvents (removers). With this method loosening of deposits is also possible as a result of which the deposits become mobile and can be carried away by raw material flow [1].

It should be noted that in our opinion the name “chemical” method is purely arbitrary since chemical transformations do not occur in most cases and the name of the method is associated only with the use of various chemical reagents in ARPD removal process.

The use of organic solvents for ARPD removal is one of the most common methods in technological processes of extraction, transport and storage of oils. However, ARPD compositions are very diverse and determined not only by nature, oil composition and geological conditions but also by oil field development technology. And therefore, when selecting solvents it is necessary to consider all aspects of sediment dissolution process. Generally, common ARPD organic solvents can be divided into several classification groups:

- individual solvents (target products of oil refining and petrochemistry);
- natural solvents;
- oil refining and petrochemistry products and wastes, their mixtures;
- solvents and their mixtures with (SAA) surfactant additives [2].

The selection of ARPD hydrocarbon solvents was carried out. Being a complex dispersed system represented by paraffins, resins and asphaltenes in the oil phase ARPD hydrocarbon solvents are dissolved in hydrocarbon solvents in accordance with their nature and properties of the solvent. ARPD



can be paraffin, asphaltene and mixed types. Therefore, the solubility of each of these types in hydrocarbon solvents will be different. A number of researches have shown that the most effective solvents in relation to paraffins are alkane hydrocarbons; their dissolution in naphthenic and aromatic hydrocarbons is hampered by the lack of solvation. The most effective solvents in relation to asphaltene-resin deposits (ARD) are aromatic hydrocarbons [3].

In our case, the Vankor field oil is characterized by a high paraffin content (table 1), which determines paraffin deposits type.

Table 1. Physico-chemical characteristics of the Vankor field oil sample.

Characteristics	Value
Density at 20 °C, kg/m ³	901,4
Kinematic viscosity, mm ² /s:	
at a temperature of 20 °C	81,68
at a temperature of 50 °C	19,65
Oil congelation temperature, °C	<-45
Content of, % by weight:	
silica-gel resins	9,5
asphaltenes	0,3
paraffin	1,7
sulfur	0,173
water	full absence
vanadium	<2
nickel	<1
Cocking behavior, % by weight	1,77
Content of chlorine-organic compounds in fraction-204 °C, ppm	<5
Mass fraction of, ppm:	
hydrogen sulphide	full absence
methyl-ethyl-mercaptan	33

The relative dissolution efficiency of various types deposits corresponds to a specific group composition of hydrocarbon solvents. Therefore, to increase hydrocarbon solvent efficiency it is necessary to obtain a universal hydrocarbon solvent that is effective for ARPD various types. In order to increase hydrocarbon solvent efficiency, it must have a multicomponent composition due to the presence of aromatic, aliphatic, and heteroatomic polar fractions since they are capable of providing favorable solvation of all deposits components. To solve this problem, we used the express method of selecting effective hydrocarbon solvents according to which the optimum ratio of alkane and aromatic component in the hydrocarbon solvent is determined. The express method of selecting effective hydrocarbon solvents is to construct the efficiency graph of binary hydrocarbon mixtures (EGBHM) [4, 5]. It is based on the evaluation of solvents effectiveness according to three criteria. The determining factors include detergency effect, dissolving and dispersing abilities of hydrocarbon mixtures in a static research mode. The static mode is set to ensure maximum accuracy of the results and eliminate experimental error component due to possible inconsistency of experiment conditions.

Table 2 shows the group composition of hydrocarbon solvents studied.

Table 2. Components content in the solvent.

Component	1	2	3	4	5	6
Toluene	0	20	40	60	80	100
Hexane	100	80	60	40	20	0

The obtained data are presented in figures 1 – 3.

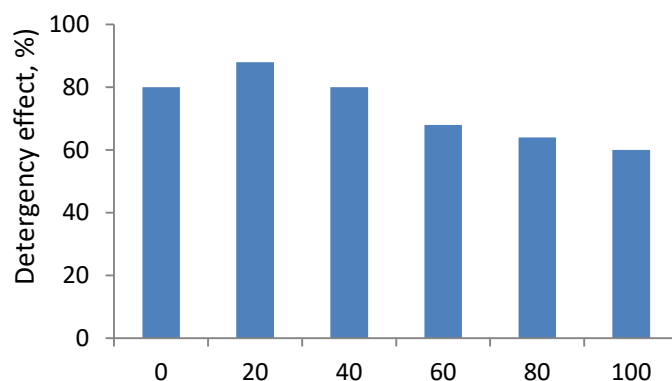


Figure 1. Comparative assessment of hydrocarbon solvent detergency effect.

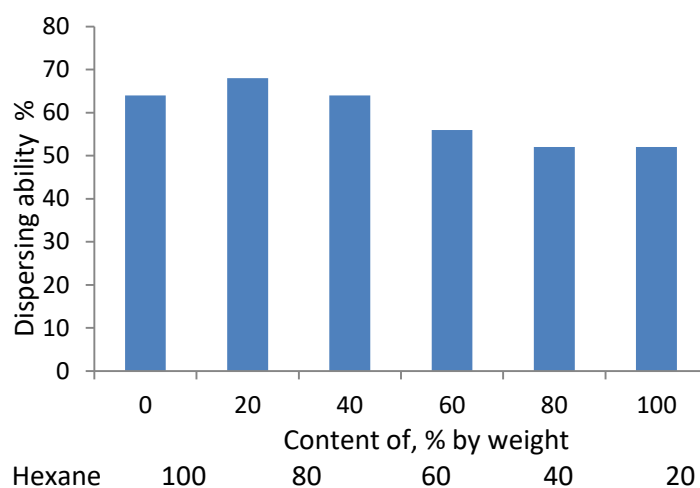


Figure 2. Comparative assessment of hydrocarbon solvent dispersing ability.

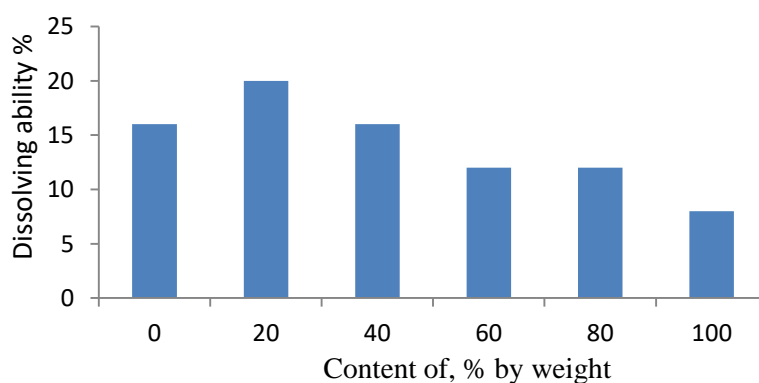


Figure 3. Comparative assessment of hydrocarbon solvent dissolving ability.

The most important stage of research connected with selecting solvent composition is experimental obtaining of the binary solvents efficiency graph (BSEG). BSEG is based on laboratory data to determine detergency effect, dissolving and dispersing abilities of n-hexane-toluene binary mixtures with a given step of components ratio changing. According to the data obtained the conclusion is drawn about the optimal ratio of alkane and aromatic solvent components in which its efficiency is maximum [6, 7].

The binary solvents efficiency graphs (BSEG) for the Vankor oil field paraffin-type (ARPD) asphaltene-resin-paraffin deposits obtained as a result of laboratory studies with n-hexane-toluene model solvent are presented in figures 1-3. The data submitted demonstrate solvent effectiveness change in accordance with its group composition. The maximums of dispersing, dissolving and detergency effect coincide for the Vankor oil field paraffin-type ARPD and they have been fixed for a mixture of 20% (vol.) toluene and 80% (vol.) n-hexane, which coincides with data analysis in sci-tech literary studies on the solubility of paraffin deposits types.

The results of studies concerning influence of the solvent group composition on its effectiveness showed that the best solvent is hydrocarbons mixtures of different classes compared with individual substances. The mixture efficiency is not efficiency arithmetic mean of the individual components and exceeds the efficiency of components individually. Thus, there is a synergistic effect of experimentally selected solvent composition.

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