Modern Conceptualization Of Oil Disperse Systems Composition And Structure

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Abstract- In practice of naphtha transportation and processing, as well as oil products with specific properties recovery theoretical ideas of oil disperse systems (ODS) are widely used. Importance of naphtha colloid chemical properties accounting in the course of production is being emphasized constantly, however the experimental data allowing to estimate influence of its separate textural features composition and structure on ODS mobility – the composite base units (CBU) and dispersion medium (DM), are absent.

On the basis of oil disperse systems (ODS) theoretical ideas the composition of ODS and structure of their separate textural features are characterized quantitatively [1,2,3]. Data of component structure and pulse method of spectroscopy nuclear magnetic resonances (NMR) received for the movable oils of Devonian deposits and less movable oils of carboniferous deposits are used [4,5,6,7]. As a part of ODS movable and less movable oils there are associative combinations, the share of which can exceed the share of dispersion medium. Low molecular mobility of the ODS does not depend on associative and dispersion medium contribution ratio. It is bound to low dispersion of system as it is possible to judge on a high share of solvent molecules sheath being part of associative combinations. The increase in solvent molecules sheath is due to immobilization of dispersion medium oil components owing to 50% affinity of their structure with the structure of benzene pitches of solvent molecules external sheath.

Keywords: Oil disperse systems, group chemical composition, nuclear – magnetic resonance

Introduction

For completion of the absent data the study of component structure and relaxational properties of Devonian deposits high movable oils (exemplars 1-6, $\mu = 14$-53 cSt) and less movable oils of coal deposits is carried out (exemplars 7-12, $\mu = 46$-92 cSt).

On the basis of CBU share component structure data in relation to dispersion medium (table 1) the maintenance of tarry asphaltene substances (TAS) of relatively substantival composition of fraction - 200 °C and oil hydrocarbons (HS) was estimated. During assessment of CBU structure we presumed that CBU core consists of asphaltenes (A), and the sheath of solvent molecules - of pitches (P). It is also possible to calculate the share of internal and external sheath of solvent molecules as a contents ratio according to diethyl hydrine-benzene pitches (P_{dh-b}) and benzene pitches (P_b) to the maintenance of TAS.

Results and Discussion

Table (1). ODS structure according to component structure and pulse spectroscopy nuclear magnetic resonance

According to component structure	According to spectroscopy nuclear magnetic resonance	
Composite Base Unit (CBU):		
CBU=(A+P)/HC Core (Co) Co=A/CBU Sheath of solvent molecules (SSM) SSM=P/CCBU	CBU=$(Pв+Pc)/Pa$ Core (Co) Co=$Pc/(Pв+Pc)$ Sheath of solvent molecules (SSM) SSM=$Pв(Pв+Pc)$	CBU=$Pв/Pa$

Dispersion medium (DM)		
DM=HC	DM=Pa	DM=Pa

According to nuclear magnetic resonance these parameters were estimated as the relation of protons population density of phases (P_i), differing by molecular mobility (T_{2i}). Relaxational naphtha dependence are presented by two-three phases. For each phase time of spin-spin relaxation T_{2i} and proton concentration (density of population) P_i are defined. In three-phase systems the allocated phases characterize naphtha components according to high *a*, average *b* and low *c* molecular mobility. Proceeding from ideas of oxidated asphalts ODS structure [8] it is possible to correlate *a* phase (tab. 1) with dispersion medium, *b* phase – with CBU sheath of solvent molecules, and *c* phase - with its core. In two-phase systems phase *a* corresponds to dispersion medium, and *b* phase – to CBU. The ratio of CBU and dispersion medium estimated as the relation of cooperative proton population density of phases *b* and *c* to *a* phase and proton population densities of *b* phase to *a* phase. The share of core and sheath of solvent molecules in CBU was counted in the form of proton population density relation according to phases *c* and *b* to cooperative proton population density of phases *b* and *c*.

According to component structure (fig. 1) distinctiveness of the naphtha ODS with low mobility from more movable oils is the raised CBU share in dispersion medium (0,51-0,55 against 0,27-0,4). As a part of CBU, less components are accounted for by the share of core (0,1-0,15 against 0,13-0,24) and more – by the sheath of solvent molecules (0,85-0,91 against 0,77-0,87).

According to pulse nuclear magnetic resonance spectroscopy it is established (fig. 1) that CBU share in dispersion medium is higher, than when using results of component structure. The explanation is the following. The ODS structure according to component structure corresponds to the maximal degree of system building blocks order, which is impossible for actual oil disperse systems. Besides, according to the existing representations [9], in tarry asphaltene type naphtha CBU is the partial component of associative combinations (AC). Thus, data of nuclear magnetic resonance spectroscopy confirm the transition of dispersion medium components part to CBU structure and associative combinations formation from CBU - the local textural features connected in some nonrigid way (three-phase systems) or through layers (two-phase systems).
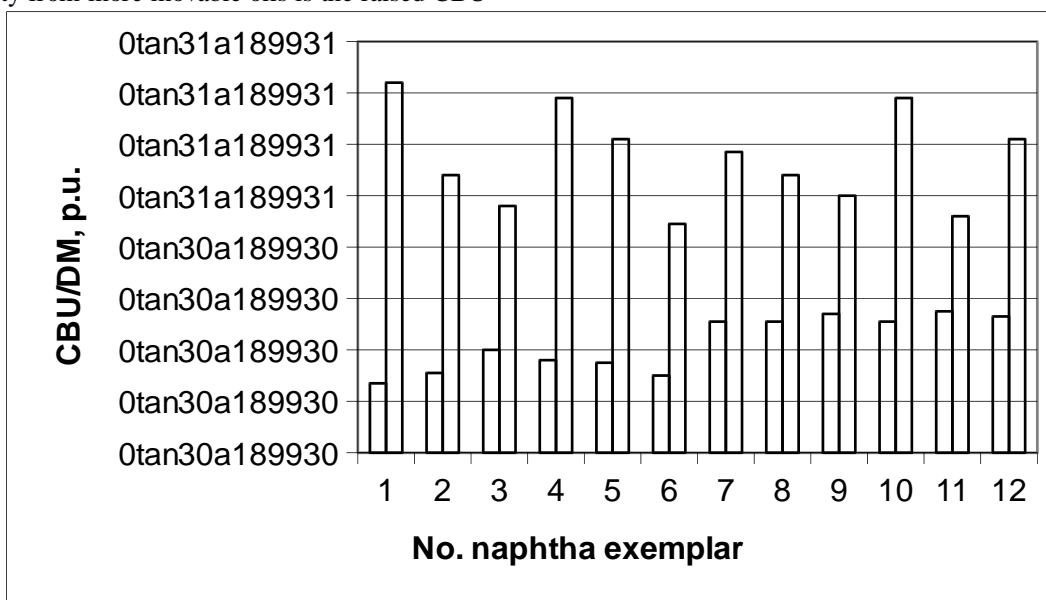

Fig. 1. Distribution of CBU in ODS dispersion medium according to component composition of naphtha (first column) and nuclear magnetic resonance (second column)

Components of associative combinations according to nuclear magnetic resonance (fig. 2) regularity are the same as CBU according to component structure: for less movable oils the core (0,15-0,3 against 0,32-0,46) and more for sheath of solvent molecules (0,78-0,85 against 0,53-0,63).

Distinctiveness of the ODS (fig. 1) is that the share of associative combinations (0,92-1,38 against 0,72-1,43) has no essential impact on decrease in mobility. Nevertheless, for naphtha of coal deposits viscosity is higher and amplitude of spin-spin relaxation which serves as measure of molecular mobility is lower (table 2).
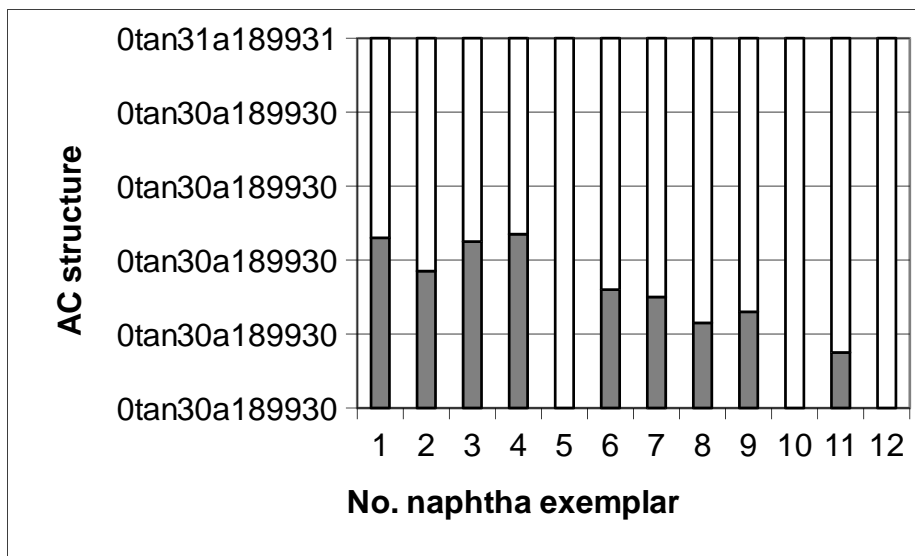

Fig.2. Core share - ▆ and sheath of solvent molecules - ☐ in AC according to spectroscopy nuclear magnetic resonance; AC - ▨

For clarification, the reasons for such discrepancy features of components structure textural features of the ODS are studied. Common in structure of an average naphtha components molecules of Devonian and coal deposits according to IEML spectroscopy is the presence of paraffin and aromatic structures. On a ratio of absorption optical densities $(D_{720}+D_{1380})/D_{1600}$ the share of paraffin structures is calculated to aromatic or aliphatic (Al). On the basis of this parameter coefficients of the next ODS textural features affinity structure are calculated (table 2). Coefficients of affinity include three structural parameters - methylene groups with number of atoms in chains more than four, methyl group and aromatic structures, which therefore are representative parameters:

$C_{M-Cb} = Al_{Cb}/Al_{m*}100\%$ - structure affinity of external sheath of solvent molecules and oil components in dispersion medium;

$C_{Cb-CCp-B} = Al_{Cb}/Al_{CCp-B*}100\%$ - structure affinity of external and internal sheaths of solvent molecules;

$C_{CCb-A} = Al_{CCp-B}/Al_{A*}100\%$ - structure affinity of internal sheath of solvent molecules and core.

Table 2. Structure affinity coefficients of the ODS components

No. exemplar	Mobility of the ODS (amplitude, %)	Affinity of the ODS components, %		
		C_{M-Cb}	$C_{Cb-CCp-B}$	C_{CCb-A}
1	73.9	28.6	56.3	76.7
2	74.6	27.7	60.6	66.5
3	86.7	39.3	57.6	75.8
4	76.2	38.9	54.3	72.6
5	44.2	33.7	53.1	72.4
6	73.8	41.5	55.9	75.8
7	42.3	60.3	42.6	71.0
8	29.0	49.4	51.2	72.9
9	32.6	47.0	48.9	69.6
10	36.4	57.3	41.9	81.1
11	45.0	47.8	47.7	68.1
12	22.1	45.9	58.8	70.5

In the naphtha ODS of Devon are similar by core component structure and internal sheath of solvent molecules. Degree of component affinity of internal and external sheath of solvent CBU molecules is lower, and external sheath of solvent molecules and oil components of dispersion medium - the least. ODS component degree of affinity increases as follows: $C_{M-Cb} < C_{Cb-Ccb} < C_{Ccb-A}$.

In the naphtha ODS of coal deposits components of core and internal sheath of solvent molecules also are the closest by structure. Degree of structure affinity for external sheath of solvent molecules and internal sheath of solvent molecules of CBU, as well as components of external sheath of solvent molecules of CBU and dispersion medium are approximately identical. ODS components degree of affinity changes as follows: $C_{M-Cb} \approx C_{Cb-Ccb} < C_{Ccb-A}$. The single distinctiveness of naphtha with low mobility is higher degree of component affinity for external sheath of solvent molecules and dispersion medium. As a result the dispersion medium participates in structuring the ODS more, which leads to decrease of system dispersion degree and decrease in its mobility.

Summary

As a part of ODS movable, and less movable oils there are associative combinations, a share of which can exceed the share of dispersion medium. Low molecular mobility of the ODS does not depend on ratio of associative combinations contribution and dispersion medium. It is bound to low dispersion of system as it is possible to judge on high share of sheath of solvent molecules being part of associative combinations.

Conclusion

The increase in solvent molecules sheath is due to immobilization of dispersion medium oil components owing to 50% affinity of their structure with the structure of benzene pitches of solvent molecules external sheath.

Conflict of Interests

The author confirms that the presented data do not contain the conflict of interests.

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