

Estimation of surfactants adsorption in oil dispersive systems

N. V. Yakavets, O. N. Opanasenko, N. P. Krut'ko

SSI Institute of General and Inorganic Chemistry NAS of Belarus, Minsk, Belarus

e-mail: yakov25@tut.by

Investigations initiated to change physicochemical properties of oil dispersed systems (ODS) and to modify them by surfactants are of special urgency nowadays. A number of scientific problems are directly connected with adsorptive interactions between surfactant and ODS, but information about the study of surfactant adsorption from nonaqueous media in such colloid systems is practically absent in literary sources. The aim of this work was to study adsorptive interaction between surfactant and dispersed asphaltene particles in ODS.

Two surfactants that are quaternary ammonium compound ether based on triethanolamine, oleic acid and methosulphate (EQAC) and ethylenediamine tetrakis (EO-PO) block copolymer ((EO-PO)-EDA) have been used as the test subjects. The oil bitumen of gel type performed the role of ODS and contained next chemical elements (wt. %): C – 76,87; H – 10,55; N – 2,35; S – 2,21; O + metals – 8,02. ODS have been modified at 170 ± 5 °C under intensive mixing with surfactant (1 wt %). Methods of thin-layer chromatography with flame-ionization detection and Fourier-transform infrared spectroscopy have been applied for investigations.

Determination of chemical group composition of ODS allowed us to establish that under ODS modification by surfactant the asphaltene percentage in system is reduced and composition of dispersion medium is changed: EQAC increases resins content by 3.6 %, but (EO-PO)-EDA raises the quantity of aromatic hydrocarbons in ODS by 1.5 %. Probably, it is connected with different mechanism of adsorption owing to interaction between the surface and polar groups of surfactants that can be caused by distinctions in the way of self-organization of surfactant molecules in discrete micelles on the surface of asphaltenes.

Results IR-spectroscopy and the data on elements composition of ODS give evidence to the fact that there are active polar centers in bitumen structure on the surface of disperse asphaltene particles being able to interactions with surfactant molecules distributed in dispersion medium of ODS. So, comparative analysis of infrared spectra gives evidence that besides characteristic absorption peaks observed in initial ODS spectrum new peak appear in case of ODS modified with EQAC. It belongs to stretching vibrations of the sulfoxide group -S=O (1031 cm^{-1}), but as compared with EQAC spectrum it is less intensive and shifts for 30 cm^{-1} to the near-wave spectral region. The weak 'ammonium' line (2358 cm^{-1}) characterizing stretching vibrations of amino-group in unsaturated and aromatic amines has been also found out.

In addition to characteristic absorption lines observed in initial ODS spectrum, in case of ODS modified with (EO-PO)-EDA the line at 1290 cm^{-1} appears, which is responsible for stretching vibrations of -C-N group in Ar-N-R_2 . As compared with surfactant spectrum, it has weaker intensity and is shifted to near-wave spectral region. Moreover, the weak 'ammonium' line (2356 cm^{-1}) verifies chemical interactions with formation of aromatic amines. Four lines, typical for (EO-PO)-EDA, that belong to stretching vibrations of -C-O group, were not discovered in modified ODS spectrum. Evidently, it is related with the transformation of alcohol and ether groups -C-O in carbonyl groups -C=O , connected with aromatic structures peculiar to aromatic ketones, aldehydes and acids, that is confirmed by the availability of peaks belonging to stretching vibrations at 1697 и 2727 cm^{-1} .

Thus, it had been found that the studied surfactants of cationic and nonionic nature are bound up with the surface of dispersed phase in ODS by means of Vandervaals forces and chemisorptive interaction forces. So, the surfactant adsorption on nucleophilic parts of low-polarity particles of dispersed phase occurs due to the acid-base interaction of functional polar groups and provides screening of dispersible particles in oil dispersion and an increase in its stability.