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CP02 Behavior of polycomplexes of nonionic surfactants at the different interfaces and at the displacement of nonpolar liquids from porous systems

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Nowadays the oil industry has a problem of oil recovery increase (the displacement of residual oil with water). The problem can be solved by using aqueous solutions of surfactants (SF) and different compositions. The displacement of nonpolar liquids from porous systems with aqueous solutions is connected with decrease of surface tension at the oil–water interface and decrease of work expended for moving of nonpolar liquids. But low viscosity of surfactant solutions results in appearing of "tongue of invasion"—moving in the center of capillary. This effect decreases the coverage with flooding and volume of discharged liquid.

The base of regulating of oil recovery is a using of viscoelastic systems. The polymers, polymer-polymer complexes, gel compositions are new generation reagents for oil recovery increase. The main defect of polymer solutions is their low surface activity at the different interfaces, their mechanical destruction at the displacement and decrease of viscoelastic properties.

In this regard, solutions of associates of nonionic surfactants and polyelectrolytes (PE) are of interest. Polycomplexes based on the nonionic surfactants have high surface activity, hydrophilic effect on hydrophobic surfaces. Aqueous solutions of surfactant polycomplexes have high viscosity at the high molar ratio (n = [SF]/[PE]) of components.

Complexes based on the synthetic polyelectrolytes (SPE): polyacrilic acid (PAA), polymethacrilic acid (PMAA), polyethyleneimine (PEI) and oxyethylated phenol (OP-10) form due to hydrogen bond and hydrophobic interactions. They form a new class of high molecular surfactants. The nature of polycomplex depends on molar ratio of components.

The OP-10/SPE polycomplexes reduce surface tension to 8…10 mJ/m^2 at the water–(toluene + cyclohexane + hexane) interface. The main decrease of surface tension occurs at n = 0.5…1. At high molar ratios (n > 1) OP-10 is in micellar state. The interaction between polymer macromolecules with micelles of surfactant results in formation of strong hydrophilic water soluble polycomplexes. In aqueous solutions the complexes are basically in the bulk and their travel to the interface is difficult. The adsorption of OP-10 molecules influences the change of surface tension. They have constant concentration in the micellar region and the interfacial tension is modified slightly.

High rates of displacement of nonpolar liquids (hexane, 50…70 % solutions of oil in water) from porous systems (the diaphragm from quartz particles) have been found. It has been also suggested that a surface diffusion of polycomplex macromolecules on the capillary surface under oil (cleansing action), and oil demulsifying are mechanisms of displacement. The index of displacement of oil is 18…20 % higher than one for water. The degree of water content in oil depends on intensity of cleansing action of polycomplex solutions of OP-10. The maximal water content was observed for polycomplexes of OP-10/PEI.

The detergency of nonionic SF polycomplexes on the oil substrate from glass plates, the stability of model oil-in water (O/W) and water-in-oil (W/O) emulsions based on the toluene and water, hydrocarbon mixes (toluene + cyclohexane + hexane) and oil emulsions stabilized with OP-10/PEI polycomplexes have been studied.

For all types of emulsions, the concentration of dispersed phase (water, aqueous solutions of polycomplexes) was 30 % (vol.). The stability of model O/W emulsions based on mixes of