



INVESTIGATION OF THE VISCOSITY PROPERTIES OF POLYMERS USED IN DRILLING FLUIDS

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ABSTRACT

Explored physic-chemical characteristic new copolymers got on base GIPAN and lignophosphat, and copolymers with different quaternairing salt. The study velocity features water solution copolymers has shown that they are a typical polyelectrolyte

A huge number of works have been devoted to the study of the physicochemical properties of aqueous solutions of polymers. The most common method is to determine the viscosity of polymer solutions. It depends, first of all, on the volume occupied by the macromolecule in the solution, the molecular weight, the nature of the interaction of the solvent with the polymer, the structure of the polymer and the concentration of the solution.

When studying the viscosity of highly dilute solutions of the copolymer we synthesized, it was found that the developed copolymers, starting from a certain critical concentration, show a deviation of the reduced viscosity from a linear dependence. Typically, in these cases, extrema appear on the curves, the reason for which is explained by the fact that with large dilute solutions, the degree of ionization of macromolecules increases. Due to this, macromolecular coils straighten and become looser, which leads to an increase in viscosity.

V.G.Aldoshin and S.Ya. Frenkel [5] note that polyacrylamide-based polymers in an aqueous solution are gradually hydrolyzed to the ammonium salt of polyacrylic acid and converted into a polyelectrolyte. It was found that in dilute solutions the synthesized copolymers are completely ionized, but due to the relatively small amount of free carboxyl groups in its composition, the ionization effect is not very pronounced. A study of the dependence of viscosity on pH and concentration of copolymer solutions showed that with increasing copolymer concentration in solution, the pH value changes slightly (Table 1). the

concentration is reflected somewhat more strongly on the pH values of the copolymer based on hydrolyzed polyacrylonitrile (HIPAN) with monomeric quaternary salts, which is apparently due to different methods of their synthesis.

The nature of the change in the dependence of η_{sp} on concentration (Fig. 1) in solutions turned out to be the same. However, sharp structuring in a solution of GIPAN + lignophosphate, compared to other GIPAN copolymers, occurs in the region of high concentrations, which is apparently caused by differences in the functional composition and molecular weights of the copolymers. Electron microscopic studies have established that solutions of freshly synthesized copolymers are characterized by a collapsed type of structure in the form of shapeless aggregates that change depending on the concentration of copolymers; the system in this case is homogeneous. Over time (over 10 hours), orientation occurs in the system, especially in concentrated solutions.

With further aging (more than 1 month) of the solution, a second type of structure appears - fibrillar supramolecular formations. Thanks to scratching, a homogeneous system becomes microheterogeneous. Aging processes with the formation of a fibrillar structure also occur in powdered copolymers of GIPANA with lignophosphate. Apparently, the globular type of structure is determined by the insignificant degree of electrolytic dissociation of $-\text{CON}+\text{H}_3$ groups and their low hydration.

Aging of copolymers and its solutions is associated with saponification of amide groups, which can be confirmed by an increase in the pH of aqueous solutions with decreasing concentration. Thanks to the saponification of the amide group, new functional groups - COONH_4 - appear in the chain of the copolymer macromolecule, the degree of dissociation of which is many times greater than that of amide groups. Due to the electrostatic repulsion of like-charged groups, COO macromolecules are straightened. This creates favorable conditions for the formation of bonds between macromolecules, which enhances their mutual orientation and leads to the formation of fibrils. Heating has the same effect on the process of structure formation in copolymer solutions as storage. Thus, when heating a 10% freshly prepared solution of GIPANA copolymer with lignophosphate for half an hour at 60°C , the same acceleration of fibril formation is observed as during aging of the solution; this phenomenon is absent when heating solutions of GIPANA copolymers with quaternary salts. This is apparently explained by the coordination structure of the latter, as well as the presence of a supramolecular structure.

Electron microscopic examination of other HIPAN products showed that they are microheterogeneous and consist of various aggregates of macromolecules. They are combined into aggregates of various shapes, varying depending on the concentration of copolymer solutions. In concentrated solutions, clots of varying densities are observed; with the transition from high to low concentrations, favorable conditions for film formation are created. Further dilution leads to the destruction of the films. The final element of this process is a fibrillar structure consisting of oriented straightened bundles of macromolecules. As solutions age, fibrillar structural elements become ordered. For the product of 26-hour hydrolysis, the electron micrograph of the solution shows fibers consisting of fibrils. The appearance of such fibrous structures is apparently due to further hydrolysis of amide groups in an alkaline environment. A study of the structural and mechanical properties of copolymer solutions showed that at concentrations above 1% they give rheological curves characteristic

of liquid-like hydrophilic systems.

According to Rehbinder's molecular kinetic theory, the internal cohesion of bodies in a copolymer is due to the forces of interaction between molecules. Inside the copolymer, these forces are balanced. The attractive forces of molecules located at the interface between two phases are stably balanced. As a result of excess attractive forces from the liquid, molecules from the interface tend to be drawn inward, so the interface surface tends to decrease. In this regard, surface molecules at the phase interface have some uncompensated excess energy, called surface energy. Surface tension, in this case using the example of the developed copolymer, can be represented as the work of formation of 1 m² of surface (J/m²). Thus, the copolymers we developed based on chemical industry waste exhibit the properties of surfactants and polyelectrolytes, i.e. reduces surface tension to a certain extent. During the experiments, it was revealed that the developed copolymer increases the wettability of dispersed systems, which is of great importance in the applied areas of drilling fluids. Wetting, characterized by the contact angle of an aqueous solution of a solid copolymer, can be considered as a result of the action of surface tension forces.

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