MODIFICATION OF VISCOS FIBRES WITH POLYFLUORALKYL ACRYLATE LATEXES WITH A DIFFERENT SURFACTANT CONTENT

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The optimum conditions for obtaining aggregated stable poly-2-perfluoropentonylhexafluoro-2-propyl acrylate at 100% conversion of the monomer without formation of coagulum are established. In obtaining the latexes, the anionic active SF content in the dispersion should be a minimum of 14%. It was shown that these dispersions approach nanosystems with respect to the particle size. Such latexes are most effective in modification of fibre materials to give them water- and oil-repellent properties.

Latexes of fluorine-containing polymers, especially polyfluoroalkyl acrylates, are widely used for processing fibre materials to significantly reduce their surface energy and given them nonwettability by liquids of different nature — water, aqueous solutions of substances, organic liquids of the oil type, etc. [1]. Use of fluoropolymer latexes is based on their capacity to form a thin protective surface film on contact with the fibre, and a total of 1% polymer is sufficient for application on the support. The homogeneity and structure of this layer and the effect of reducing the wettability attained is determined by the colloid-chemical properties of the latex such as the size, the value and sign of the charge of disperse particles, and the aggregate stability. In particular [2], a decrease in the particle size or substitution of an anion-active surfactant (SF) in the latex by a cation-active SF with all other conditions remaining the same will increase the effect of reducing the wettability of the fibre materials.

However, sufficiently stable dispersive systems of this type are only obtained in the presence of an anion-active stabilizer [3]. The aggregate stability of the dispersions results in formation of coagulum in manufacturing and shipping them, and this complicates the technological process of their use and causes losses of expensive product. For this reason, it was important to find the conditions for obtaining sufficiently stable polyfluoroalkyl acrylate latexes with colloid-chemical properties that ensure the maximum possible effectiveness in treating fibre materials.

A series of poly-2-perfluoropentonylhexafluoro-2-propyl acrylate (LRM-N) latexes with a different content of an anion-active SF — S-10 (partially sulfonated hydroxyethyl derivatives of nonylphenol with ten hydroxyethyl groups) was prepared by radical aqueous emulsion polymerization in the same conditions

\[ C_9H_{19} - C_6H_4 \left( OC_2H_4 \right)_{10} \text{OSO}_3\text{Na (10\%)} \]
\[ C_9H_{19} - C_6H_4 \left( OC_2H_4 \right)_{10} \text{OH (90\%)} \]

and the efficacy of using them for modifying viscose fibres was investigated.

According to the data in Fig. 1, an increase in the S-10 content in the system significantly increased conversion of the monomer. Total transformation of monomer into polymer was observed for a SF content of 12% and higher. Such conversion was observed in all cases after 60-80 min of polymerization at 75-80°C.

At a low S-10 content, coagulum formed during polymerization, and the amount decreased significantly with an increase in the SF content and almost decreased to zero at a high content (Table 1).

The data show that completion of polymerization and obtaining quality latex containing no coagulum are only possible at a SF content in the system of 14% and higher. According to the data on the value of the rapid coagulation threshold (RCT), the most aggregated stable dispersions are also obtained in these conditions (Fig. 2).


Fig. 1. Effect of SF content in 2-perfluoropentoxypentafluoropropyl acrylate emulsion on conversion of the monomer.

Fig. 2. Aggregate stability of poly-2-perfluoropentoxypentafluoropropyl acrylate latex as a function of emulsifier content.

Fig. 3. Kinetics of emulsion polymerization of poly-2-perfluoropentoxypentafluoropropyl acrylate in dispersion at S-10 content of 8 (1), 10 (2), and 14% (3).

The aggregate stability of the latexes obtained in systems containing up to 10% SF was essentially a function of the duration of polymerization. After 60-80 min of reaction, gradual breakdown of the dispersion and an increase in the amount of coagulum was observed in these systems (Fig. 3). However, at a SF content in the system of 14% and higher, all of the polymer formed after this time was in the form of a dispersion, i.e., aggregate-stable latex was formed.

The dependence of the basic colloid-chemical properties of the latexes obtained on the SF content was investigated (Table 2). The surface tension ($\gamma$) was determined by the ring-breaking method on a Du Nouy instrument, and the particle size ($r$) was determined by an optical method based on light scattering, calculated with the equation

$$ r = \frac{\lambda_{av} \cdot z}{8 \pi}, $$

where $\lambda_{av}$ is the average value of the wavelength of light in the dispersion medium for the light filters used in measuring the optical density; $z$ is the tabular coefficient of correspondence of the tangent of the slope of the dependence of the optical density on the wavelength in logarithmic coordinates. The electrokinetic potential ($\zeta$) was determined by macroelectrophoresis calculated with the equation

$$ \zeta = \frac{\eta hL}{\tau U \varepsilon \varepsilon_0}, $$

where $\eta$ is the viscosity of the dispersion medium, Pa·sec (for water, $\eta = 1 \cdot 10^{-8}$ Pa·sec); $h$ is the movement of the interface, m; $\tau$ is the time in which movement takes place, sec; $L$ is the distance between electrodes, m; $U$ is the difference in the potentials on the electrodes, V ($U = 60$ V); $\varepsilon$ is the relative dielectric constant of the medium ($\varepsilon = 81$); $\varepsilon_0$ is the absolute dielectric constant of a vacuum ($\varepsilon_0 = 8.85 \cdot 10^{-12}$ F/m) [4].