

INVESTIGATION OF THE INFLUENCE OF A MINERAL FILLER ON THE RHEOLOGICAL PROPERTIES OF PAPER-MAKING STOCKS

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The contemporary technological process of producing high-quality types of paper and carton presupposes the introduction, into a paper-making stock, of mineral substances-fillers to raise the runability of paper and to decrease the cost of its production. Account of the change in the rheological characteristics on introduction of fillers allows one to optimize the expenditure-pressure characteristics of the flow of a paper-making stock in the mass pipe-line. The aim of the present investigation was to study the influence of composite fillers, based on production wastes, on the viscoelastic properties of paper-making stocks.

Experimental investigations were carried out using a «Physica MCR 301» rheometer, with continuous deformation in the range of shear rates $0.01-3000 \text{ s}^{-1}$ at $20 \text{ }^{\circ}\text{C}$. The measuring cell of the device consists of a system of coaxial cylinders. One-percent compositions of the paper-making stock based on waste paper were investigated. As a filler, use was made of caolin, which is widely utilized at the present time in the paper-making industry, as well as newly developed composite fillers based on silicon-gel, phosphogypsum, chalk, and water glass, with and without a plasticizer.

It is shown that the experimental curves of the flow of the investigated paper-making stocks have a minimum in the vicinity of 150 s^{-1} and can be approximated to a sufficient accuracy by the rheological equation proposed by Terentiev for describing the anomalous behavior of fibrous suspensions. It has been observed that the presence of additional fillers within a paper-making stock enhances the anomaly degree – the minimum becomes deeper. Moreover, the values of the effective viscosity of the paper-making stock decrease: for example, at 150 s^{-1} , in the anomaly zone, from $6.0 \text{ mPa}\cdot\text{s}$ (for a pure fibrous suspension) to $0.9 \text{ mPa}\cdot\text{s}$ on introduction of a composite filler and to $1.7-2.0 \text{ mPa}\cdot\text{s}$ on introduction of caoline and of a composite filler additionally containing a plasticizer.

The results of measuring the static yield point τ_0 of paper-making stocks by the methods of a linearly increasing shear stress and linearly increasing strain show that the values of τ_0 for paper-making stocks lie in the range from 0.4 to 1.2 Pa , elastic deformations transform into plastic ones at a strain magnitude lying within $0.5-1.5 \%$. With the aid of mechanical testings in the regime of three (rest-shear-rest) intervals the characteristic times needed for the regeneration of the rheological parameters of paper-making stocks after an intense shear load have been found.

Thus, it is shown, that a decrease in η_{eff} of fibrous suspensions on introduction of a filler will make it possible, apart from improving the service properties of paper and carton, to reduce the expenditure of energy on the agitation of the paper-making stock and its transportation. The rheological investigations carried out have made it possible to evaluate the changes in the characteristics of the paper-making stock flows in pipe-lines in production of paper and carton on replacing of caoline by newly developed compositions of fillers.