Numerical analysis of tensile flow stability of a mixture of linear and branched PAN in a cross-slot geometries

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PAN polymer solutions are actively used in fiber formation. In the process of fiber formation, the solutions are subjected to elongational flow with high strain rates. The elongational flow behavior of linear PAN solutions has been well studied to date, while the effect of adding branched PAN has not yet been studied. The present work was performed as a part of the project devoted to the investigation of fiber formation from mixtures of linear and branched PAN. Given the novelty of the problem, it is proposed to analyze the behavior of homogeneous mixtures of solutions under elongational flow. It is suggested to use the so-called cross channel to solve this problem. The device represents two interpenetrating channels perpendicular to each other. The device has two inlets and two outlets. If the incoming flows have opposite directions, a steady elongational flow is formed in the area of intersection of the channels. The tensile strain rate increases as the flow velocity of the counter-currents increases. Based on the results of standard rheological measurements for solutions with different concentrations of linear and branched PAN, the coefficients for the nonlinear viscoelastic model FENE-P were obtained to calculate the stress tensor, which proved to be good in describing polymer solutions under elongational flow. Taking into account the obtained coefficients, numerical simulation of the flow in a cross channel was performed, and the stability of the flow at different flow rates and mixture composition of linear and branched PAN were analyzed. This study has been supported by the Russian Foundation for Basic Research (grant. No. 18-29-17058).