Rheological Investigation of Polymer Melt Suspensions with Polymer Beads

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ABSTRACT

A polymer melt suspension with solid polymer pellets is typically formed during melting in extruders. Ethylene acrylate copolymer (EAC) and polystyrene beads were chosen as the model system to study rheological properties of polymer melt suspensions with solid polymer particles. The melting temperature of EAC is much lower than the glass transition temperature of PS. Three temperatures between T_m of EAC and T_g of PS were chosen for this study. Samples of PS beads sandwiched between two EAC films were prepared to capture the flow structure during melting in extruders. Homogeneous samples of PS beads mixed with EAC powder were also made for comparison. Dynamic rheological properties were investigated.

Under the conditions studied here, it was found that the power law model can describe the relationship between the complex viscosity and the frequency for polymer melt suspensions. The shear thinning behavior was more evident as the volume concentration of PS beads increased. For frequencies between $10s^{-1}$ and $100s^{-1}$, the curves of the log of complex viscosity vs. the volume fraction at each temperature were parallel to each other. Generally, the complex viscosity increased as the volume fraction increased. However, a viscosity plateau or decrease was found when the volume fraction reached a critical value. No satisfactory models were found to capture the relationship between the complex viscosity and the frequency.

Three possible factors were discussed to find the reason for the viscosity decrease with volume concentration. Agglomeration of PS beads at high concentration, non-uniform structure of the samples, and deformation of PS beads in the flow were possible causes of the viscosity decrease with volume concentration.