Thesis Rheological and Morphological Studies of Polypropylene / Polyoctenamer Blends

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ABSTRACT

The rheological properties of polypropylene (PP), polyoctenamer (TOR) and PP/TOR blends were measured and depended on the testing conditions (temperature,shear rate and die geometry). All the materials were pseudoplastic. The PP had higher degrees of pseudoplasticity than those of the TOR elastomers. For the blends the degrees of pseudoplasticity were affected by the elastomer content. But there were no clear relationships between the blend ratio and the degree of pseudoplasticity for both the PP/TOR 6 or the PP/TOR 8 systems. In addition, the viscosity of PP was more sensitive to temperature than those of the TOR elastomers. In both cases of blend systems, the elastomer content did not affect the temperature sensitivity of the blend viscosity. In the case of the blend containing 20% elastomers, it was found that the mixing speed had either a slight or no influential affect on the viscosity of the blends.

The rheology of the blends from model calculations can only be used for comparison purposes due to their relative nature. They should not be considered the true values because they resulted from highly simplified models for Newtonian fluids. Furthermore, the accuracy of the predicted viscosity of the polymer from model calculations depended on the nature of the polymer (the more Newtonian-like behaviour, the more accurate the predicted value). The degree of dispersion of the elastomer in the PP may not be accurately predicted from the calculated viscosity ratio from the equations (models) used, due to their pseudoplastic nature. The major disadvantage of the viscosity ratio obtained from the rheology of the mixer was that the calculated viscosity ratio did not depend on the elastomer content. From comparison of the experimental and predicted viscosities of the blends using the three model equations, it can concluded that these equations were too simple for accurate predictions of the viscosity of these blends. Relative to the additivity rule the PP/TOR 8 blend system at 1000 s^{-1} exhibited Positive-Negative Deviation Behaviour (PNDB). Phase inversion occured within the range of 30-50 wt% TOR 8 where the behaviour changed from PDB to NDB. The morphology results confirmed this observation, showing that phase inversion occured at 50% TOR 8 content.

The morphology of the blend was found to be dependent on temperature, shear rate, mixing speed and the elastomer concentration. The degree of dispersion of both PP/TOR 6 and PP/TOR 8 blends increased with decreasing temperature and with increasing rates of shear. The effect of mixing speed on blend morphology depended on the blend system. For PP/TOR 6 blends, a higher mixing speed gave a better dispersion. Conversely, higher mixing speed gave a lower dispersion level for the PP/TOR 8 blends. In addition, at 12 s^{-1}, the degree of dispersion of both the PP/TOR 6 and PP/TOR 8 blends decreased when the rubber concentration increased. Whereas, at 1000 s^{-1}, the degree of dispersion of PP/TOR 6 blends decreased with increasing the rubber content, which was the

inverse of behaviour observed for PP/TOR 8 blends. For accurate morphological predictions, the equation

$$\frac{\eta_1(\dot{\gamma})}{\eta_2(\dot{\gamma})} \approx \frac{\phi_1}{\phi_2}$$

would need to be modified so that the term for the volume fraction of the rubber accounts for the possible changes observed in experiments.