An Investigation of the Melt Flow Properties of PP/LDPE Blends

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Abstract:

Blends of the polypropylene with polyethylene have been prepared by using a Brabender twin-screw extruder. The flow properties of the blends were measured with the Davenport capillary rheometer. The dependence of shear stress on shear rate was approximately represented, for all the blends, by the power law equation. The manner of the dependence of blend viscosity on composition varies widely for the system studied. The viscosity of the blends at 200^{0}c goes through a minimum, all the viscosity of the blends at 230^{0}c go through a maximum. However, the viscosity of the blends, which have the same shear stress at 230^{0}c become lower than those of 200^{0}c. It is possible to produce blends with either greater or less melt viscosity than the individual components by adjusting the composition of blending.

Keywords: polypropylene blends, twin-screw extrusion, melt viscosity.

INTRODUCTION

In order to understand and predict rheological and behavior, the melt properties of low-density polyethylene and polypropylene, the blends have been measured by using a Davenport rheometer. The objective of the work reported here is to first characterize and compare the melt properties of the individual polymers and then to prepare the blends of materials, with the ultimate objective of obtaining an understanding of the relationship of the melt properties of the blends to the melt properties of their individual components.The basic requirement for the section of a blend for development and manufacture, depends on the rheological composition, ie. one needs to know the melt viscosity with respect to composition of the blends.Heat shrinkable film, extruded from a blend of PP/LDPE display toughness superior over LDPE films with several advantages in the shrink wrapping operation (1). Applications of melt rheology in the development of polymer blends have been effective in manufacture of blow moulding and extrusion moulding too.

EXPERIMENTAL PROCEDURES

Materials

Raw materials used in this work were summarized in Table 1. General formulation are represented in Table 2.

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Table 1. Raw materials

Raw materials	Trade name	Grade	Suppliers
PP	Propathene	GSE 111	ICI
LDPE	Novex	LM2103AA	BP Chemicals

Table 2. General formulation compounds containing PP and LDPE

	Weight percentage (%)						
PP	100	90	70	50	30	10	-
LDPE	-	10	30	50	70	90	100

Blend preparation

The formulations were blended in a Brabender twin screw extruder. Extrudate from the Brabender was cooled in a long water bath and that it was chopped into short granules.

Characterization

The melt flow index (MFI) of raw materials was determined according to BS 2782. The measurements were taken at T=230°c, M= 2.16 kg for reference time 600 seconds.Flow properties of PP, LDPE and the corresponding blends in pellet form were measured using an Davenport Rheometer that consists of a barrel of 22.50 mm.diameter, a standard die of 2.00 mm. diameter and 20 mm. long. The temperature was set at 200°c and 230°c respectively.

RESULTS AND DISCUSSION

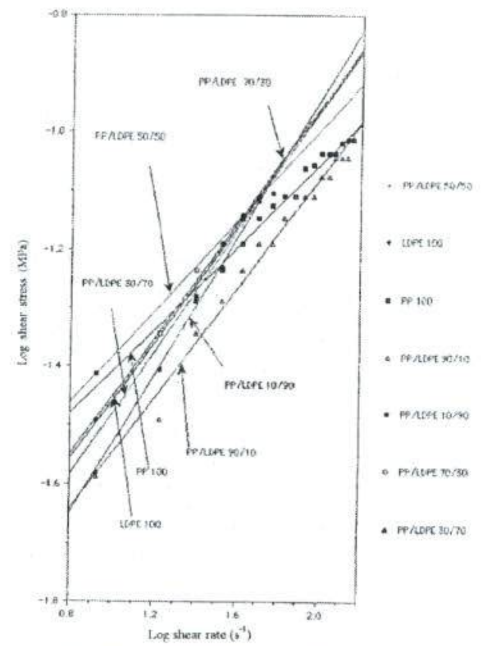

Fig 1. Flow curves of the PP/LDPE blended at 230 °C

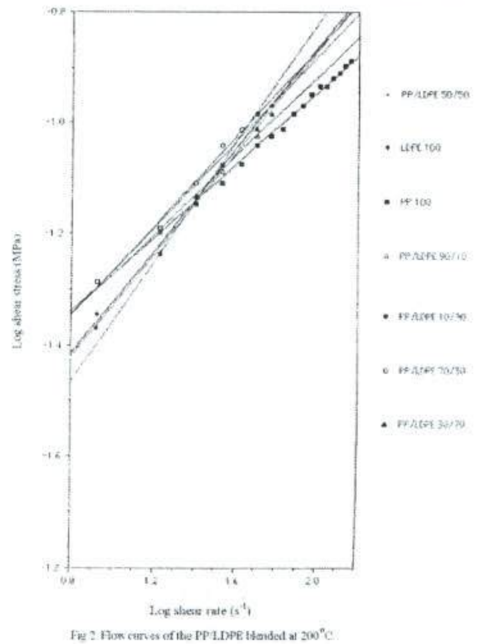

Fig 2. Flow curves of the PP/LDPE blended at 200 °C

Comparison of PP/LDPE (blended)

It is interesting to note in figure 1 that the curves for the blends except PP/LDPE = 90/10 tend to have the same log shear stress (-1.11 MPa) at log shear rate of 1.72 sec^{-1}. For the blended PP/LDPE = 50/50 the log shear rate below this value gives value of log shear stress higher than the rest. Furthermore at 200°c all the blends have an approximately close relationship. It is also interesting to note in figure 2 that the log shear stress for PP/LDPE = 50/50 is lower than others at low log shear rate (0.8 sec-1), however at high log share rate (2.0 sec-1), the log share stress of this blend becomes greater than others.

Viscosity of the blended material

More interestings for this work are the plotted of viscosity versus composition at different shear stress as illustrated in figures 3 and 4. These are obtained by cross plotting the flow curves at various shear stresses of 0.035, 0.044, 0.056 and 0.070 MPa.It is seen in figure 3 that at 200°c for different shear stress, the viscosity of LDPE are less than that of PP. The viscosities of the blends show a minimum value at a blending ratio of about 55 wt% of LDPE. While they show the maximum value at a blending ratio of about 90 wt% of LDPE. If Han and Co-worker's theory is consider here, This behaviour might be explained as follow: Because at 200°c the blend for 55wt% of LDPE contains deformable droplets which shall give less resistance to flow and hence less pressure drop (ie. lower apparent viscosity). Figure 4 illustrates the viscosities of the blends which show its maximum at blending ratio of about 50wt% of LDPE at 230°c All curves have a similar behaviour of flow. However, the viscosities of the blends which have the same shear stress at 230°c become lower than those of 200°c. If Han and Co-worker's theory is used again. This behavior can be interpreted as that the composition (PP/LDPE = 50/50) have a morphology in which they are interlocked and hence the system may give higher viscosities.

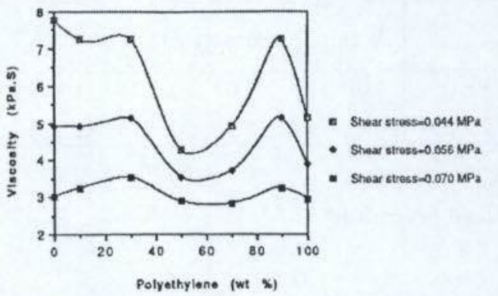

Fig. 3 Viscosity versus blending ratio for LDPE/PP at 200 °C

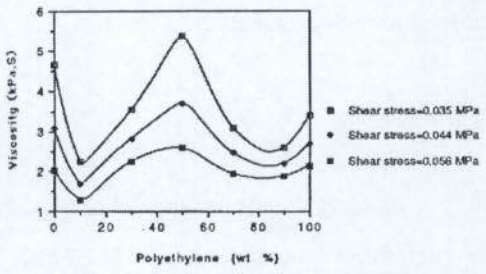

Fig. 4 Viscosity versus blending ratio for LDPE/PP at 230 °C

CONCLUSIONS

The MFI under the same test conditions of PP grade: GSE III and LDPE grade: LM2103AA are approximately close. We have shown that the melt flow curves at 200°c and 230°c for two resins and their blends are represented by using the power law relationship of shear stress values to shear strain values. Furthermore we can measure the slope (η) for each of samples. The properties of such blends appears dependent on shear modification at demonstrated by the change in properties of the unblended polymers on treatment by twin screw extrusion. For twin screws blending process under the same conditions, it is possible to obtain either greater or less melt viscosity of the blends than the pure components.

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