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Note

SOME RHEOLOGICAL PROPERTIES OF PLASTICISED POLYMETHYLMETHACRYLATE WITH NEW PLASTICISERS

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It is well known that polymethylmethacrylate (PMMA) undergoes depolymerisation when it is subjected to elevated temperatures, i.e. above 190°C [1]. Thus thermoforming by usual technological processes such as injection molding and extrusion is not successful.

In the present work we studied the effect of new plasticisers on the melt behaviour of this polymer at different temperatures and under different applied loads, hoping that the presence of such materials might be useful from a processing point of view since we have found that these plasticisers were efficient with other polymers [2,3].

EXPERIMENTAL

Materials

Commercial PMMA sheets $(\eta) = 263$ cm^3 g^{-1} were used in this study, after purification to remove commercial additives by reprecipitation (chloroform and petroleum ether b.p. 60–80°C). The reprecipitated polymer was dried under vacuum at 80°C, 0.1 mm Hg.
Plasticiser. The benzoate ester of 1,3-*bis*(2,4,6-trimethylol phenoxy) propan-2-ol was synthesised and characterised according to ref. 4.

Instruments

A Davenport melt flow rate (MFR) tester, model 3/80, was used in this study.

Plasticised samples

The plasticised samples were prepared by dissolving the polymer and plasticiser in acetone (10%), then casting thin films from the homogeneous

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solution. The films were dried at room temperature overnight then at 80°C, 0.1 mm Hg for 16 h.

Measurements

The melt flow rate (MFR) measurements were carried out according to ASTM D1238. Several types of measurements were carried out as follows:

(a) The MFR was measured at three different temperatures 170–190°C for the unplasticised polymer and plasticised samples containing different percentages from the plasticiser (0–50%) by weight.

(b) The MFR was measured applying different loads, 2–30 kg, and a linear relationship was obtained between log MFR and applied load.

RESULTS AND DISCUSSION

The log of the MFR for the plasticised and unplasticised PMMA varies linearly with the applied load at different temperatures. The results obtained are shown in Figs. 1, 2 and 3 at 190, 180, and 170°C respectively.

All the MFR measurements were carried out below 190°C since PMMA undergoes depolymerisation at higher temperatures. The flow rate of the unplasticised PMMA below 190°C was unmeasurable even at high loads (30 kg), while the plasticised samples flow at quite high rates even at lower temperatures e.g. 180 and 170°C (see Figs. 2 and 3).

The melt flow rate increases linearly with increase in the plasticiser content; typical results are shown in Fig. 4 at two different temperatures and applied loads.

From the MFR measurements at different temperatures we calculated the total energy input, applying the Arrhenius equation [5]. The energy input decreases with increasing plasticiser concentration; typical results are shown in Fig. 5.

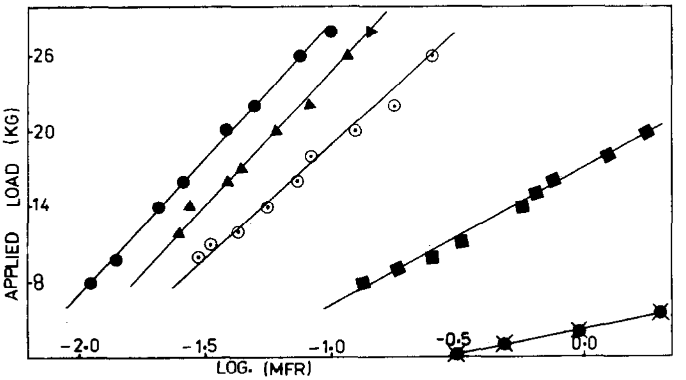

Fig. 1. The effect of applied load on the MFR of PMMA at 190°C containing different percentages of the plasticiser. ●, unplasticised PMMA; ▲, 13%; ⊙, 17%; ■, 33%; ✖, 50%.

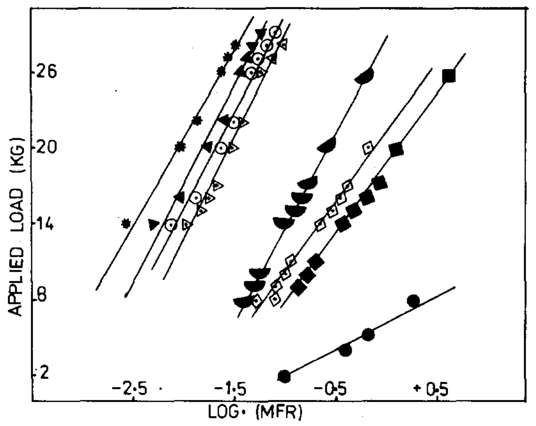

Fig. 2. The effect of applied load on the MFR of plasticised PMMA at 180°C containing different percentages of the plasticiser. ★, 9%; ▲, 13%; ⊙, 17%; △, 20%; ◒, 23%; ⊡, 29%; ■, 33%; ●, 50%.

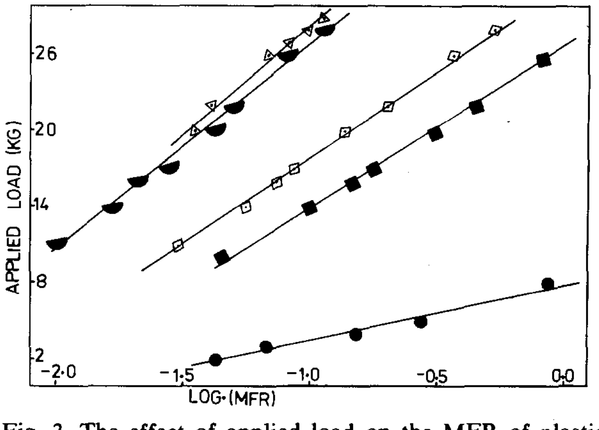

Fig. 3. The effect of applied load on the MFR of plasticised PMMA at 170°C containing different percentages of the plasticiser. △, 20%; ◒, 23%; ⊡, 29%; ■, 33%; ●, 50%.

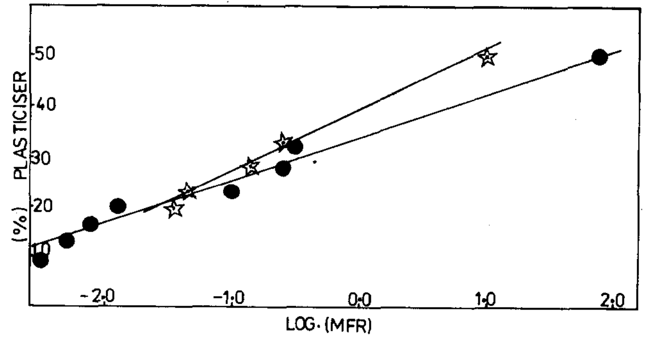

Fig. 4. The relationship between the MFR and plasticiser concentration ☆, 170°C and 20 kg; ●, 180°C and 14 kg.

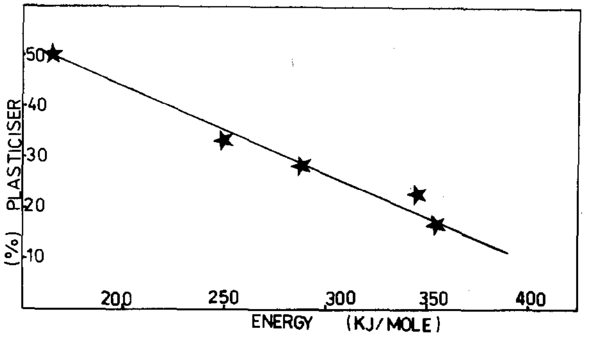

Fig. 5. The relationship between the plasticiser concentration and the total energy input at 190°C and 10 kg.

CONCLUSION

The presence of the plasticisers in PMMA appreciably increases the flow rate and markedly reduces the total energy input.

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