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SOME RHEOLOGICAL PROPERTIES OF PLASTICISED POLYSTYRENE WITH NEW PLASTICISERS

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ABSTRACT

The rheological properties of plasticised polystyrene with a new plasticiser, i.e. benzoate esters of 1,3-[bis(2,4,6-trimethylol phenoxy) propanol-2], are examined, and the melt flow rate of the plasticised polystyrene containing different percentages of plasticiser (0–50%) are measured at several different temperatures (120–220°C). The relationship between log (melt flow rate) and applied load is included. From the melt flow rate measurements at different temperatures the energy input in the melting process is determined under different applied loads.

INTRODUCTION

During an earlier research programme a series of new plasticisers derived from 1,3-bis(2,4,6-trimethylol phenoxy) propan-2-ol [1] as benzoate esters was synthesised and characterised and these new plasticisers were found to be efficient for polyvinylchloride [2]. In the course of this programme the efficiency of this new plasticiser for polystyrene was studied.

EXPERIMENTAL

Materials

A commercial polystyrene with $[\eta] = 91.5$ cm^3 g^{-1}, [3] and $M_v = 355\,000$ was used in this study.

Plasticiser: the benzoate esters of compound (I) were prepared and characterised according to ref. 1.

Instrument

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

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Plasticised samples

The plasticised samples were prepared by dissolving the polymer and plasticiser in ethylmethyl ketone, $\epsilon = 10\%$. Thin films were then cast from the homogeneous solutions, dried at room temperature overnight, then at 80°C under vacuum for 16 h.

Measurements

The melt flow rate (MFR) measurements were carried out according to ASTM D 1238. Several types of measurements were carried out.

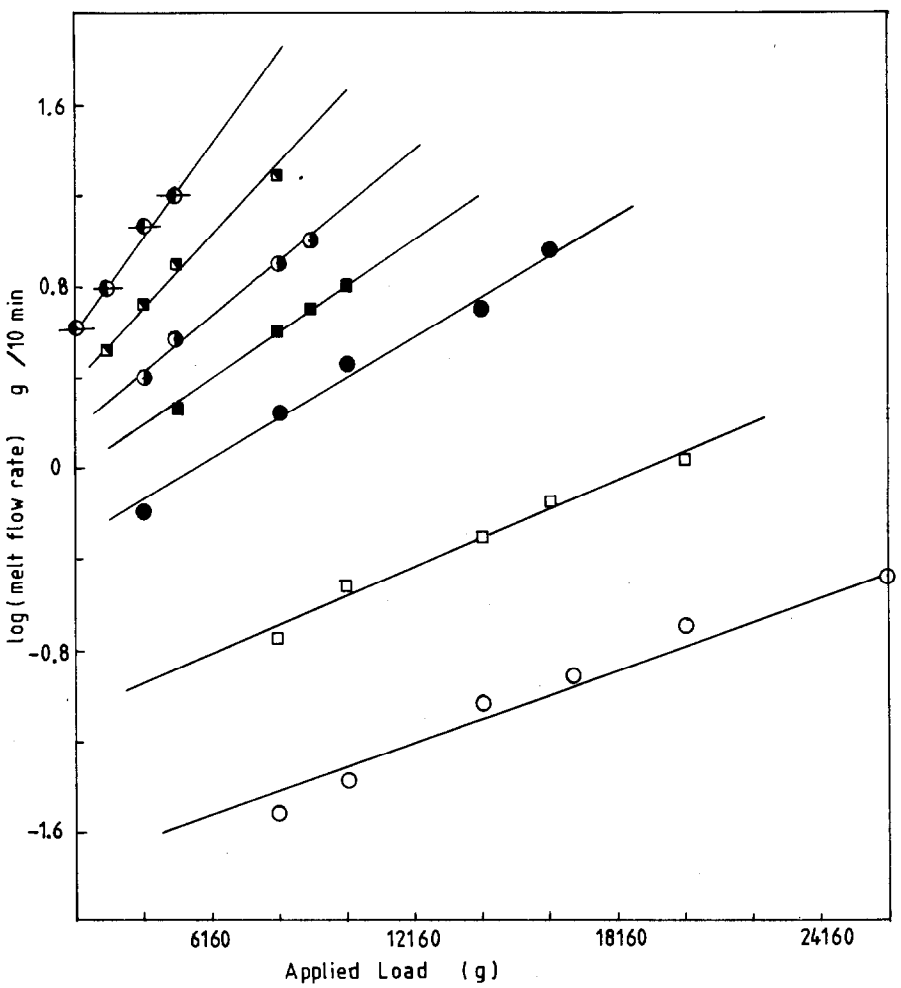

Fig. 1. The effect of temperature on the melt flow rate of polystyrene. ○, 150°C; □, 160°C; ●, 180°C; ■, 190°C; ◑, 200°C; ◪, 210°C; ⊖, 220°C.

(a) The MFR was measured at several different temperatures (150–220°C). The results obtained are shown in Fig. 1.

(b) The MFR was measured by applying different loads; the relationship between applied load and log MFR was found both for polystyrene and plasticised polystyrene.

(c) The effect of the plasticiser concentration on the MFR was also examined at 120 and 150°C.

RESULTS AND DISCUSSION

The log of the melt flow rate for polystyrene at different temperatures (150–220°C) varies linearly with applied load. Typical results are shown in

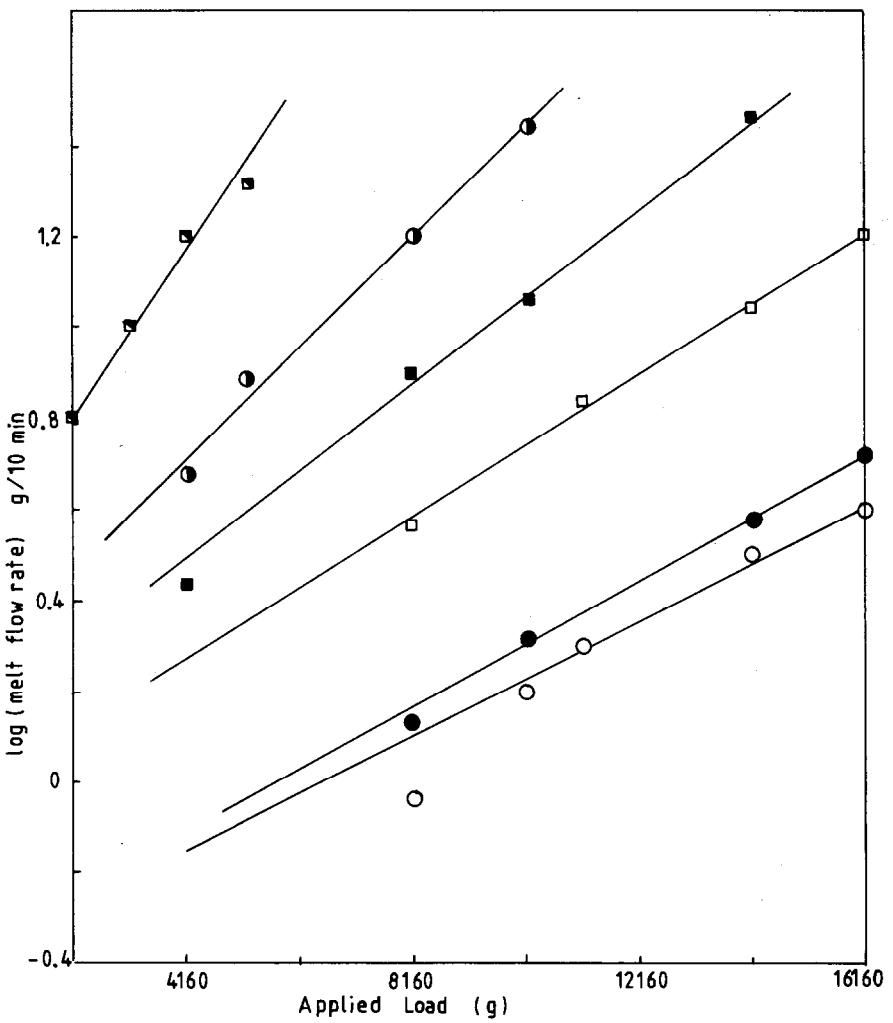

Fig. 2. The effect of benzoate plasticiser concentration on the melt flow rate of plasticised polystyrene at 150°C. ○, 2%; ●, 5%; □, 10%; ■, 15%; ◑, 20%; ◪, 25%.

Fig. 1. On the other hand, the MFR increases substantially with increased plasticiser concentration. The results obtained at 120 and 150°C are shown in Figs. 2 and 3, respectively. The relationship between log MFR and % plasticiser is shown in Fig. 4.

The MFR of polystyrene was very low at 150°C (Fig. 1), and unmeasurable at 120°C under the indicated loads, while the MFR of the 5% plasticised polystyrene was measurable even at 120°C.

From the MFR measurements at different temperatures the total energy input in the melting process was calculated by applying the Arrhenius

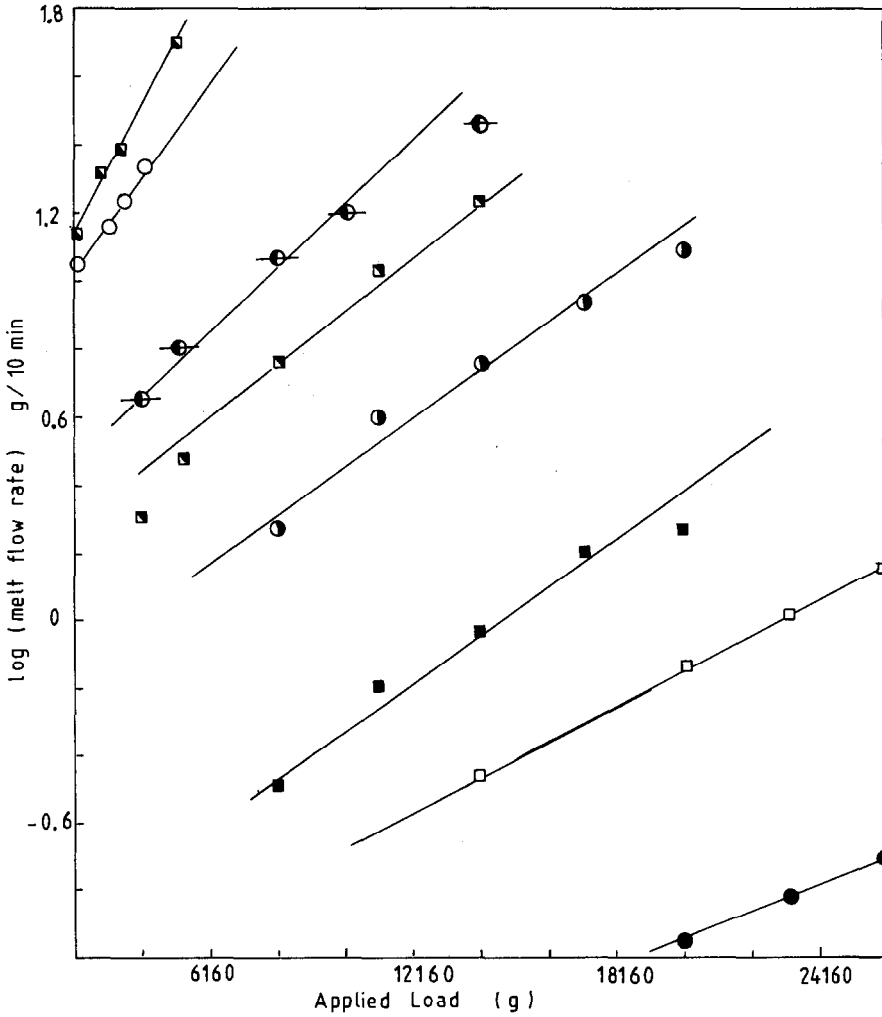

Fig. 3. The effect of benzoate plasticiser concentration on the melt flow rate of plasticised polystyrene at 120°C. ●, 5%; □, 10%; ■, 15%; ◑, 20%; ◪, 25%; ⊕, 35%; ○, 45%; ◪, 55%.

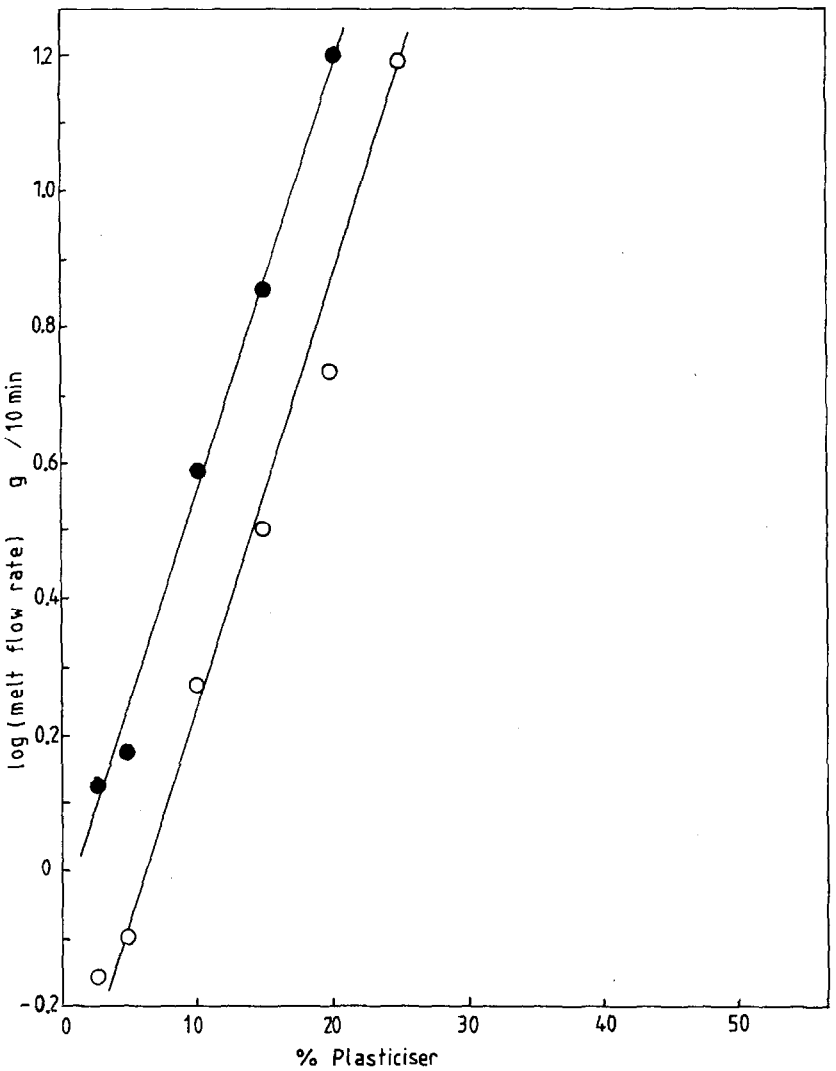

Fig. 4. The effect of plasticiser concentration on the melt flow rate at constant temperature (150°C). Applied load = 4160 g (○), and 8160 g (●).

equation [4]

$$\log \text{MFR} = \log A - \frac{E}{R} \cdot \frac{1}{T}$$

The results obtained are shown in Fig. 5. Typical relationships between log MFR and $1/T$ under different applied loads are shown in Fig. 6.

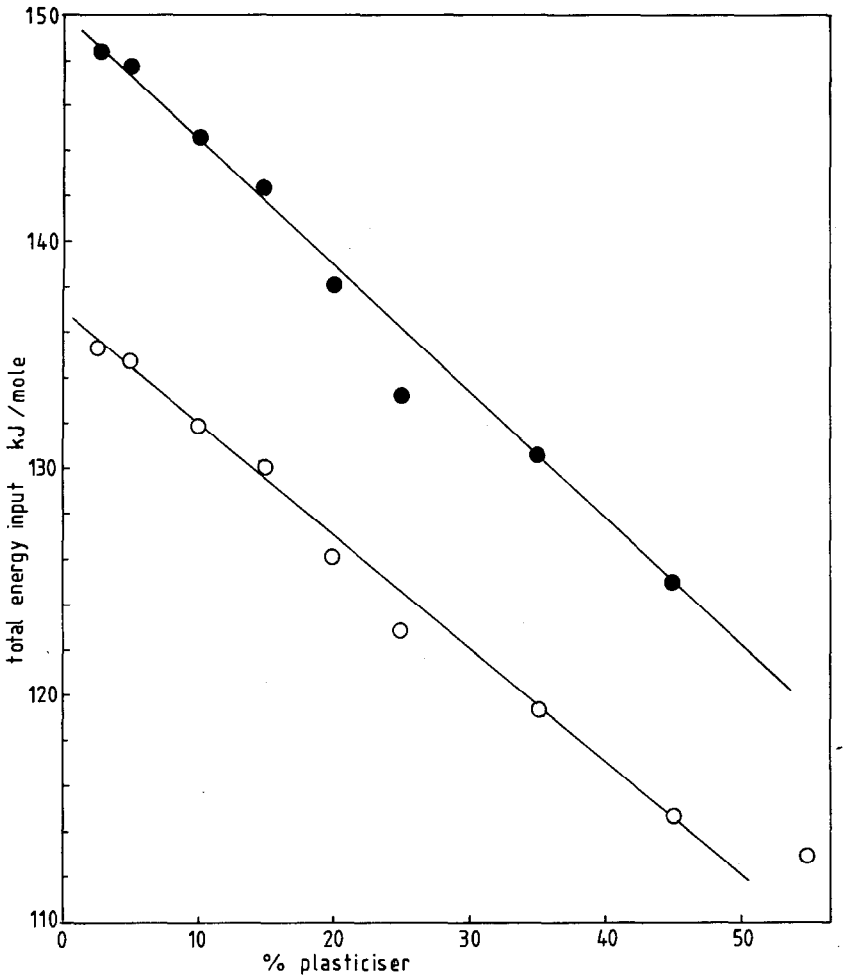

Fig. 5. The effect of plasticiser concentration on the total energy input at two different applied loads. Applied load = 4160 g (○), and 8160 g (●); temperature range = 120–150°C.

CONCLUSION

The plasticisers have a great effect on the MFR of the polystyrene and reduce the total energy input to a large extent. Thus, the use of such plasticisers with polystyrene may be valuable from the point of view of processing as well as their effect on its mechanical properties [5].

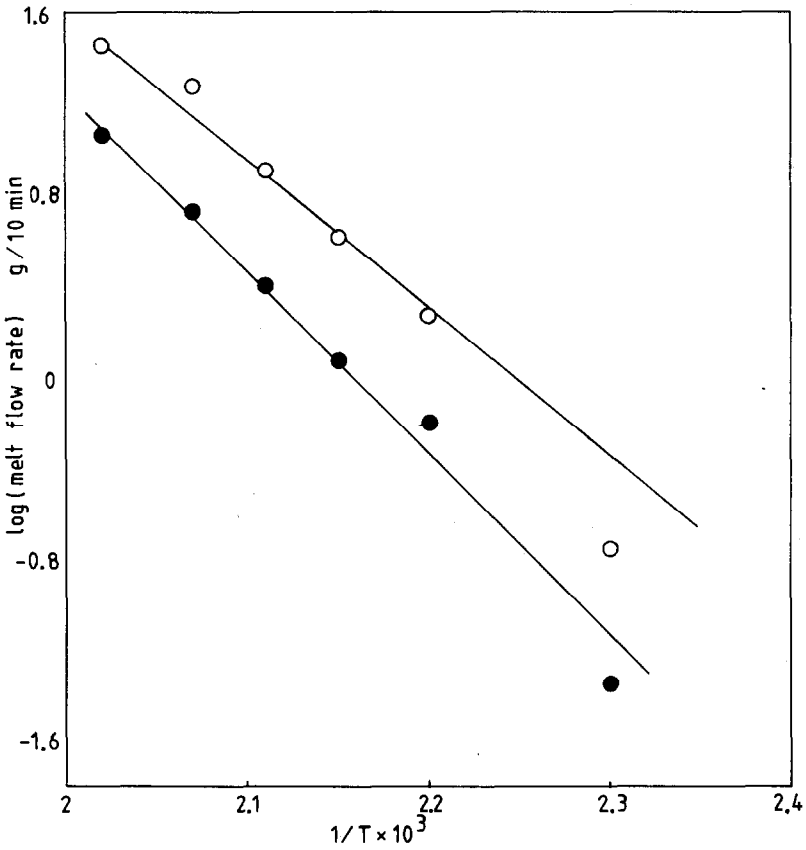

Fig. 6. Typical relationship between the melt flow rate and temperature for polystyrene at constant loads. Applied load = 4160 g (●), and 8160 g (○).

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