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Time-Dependent Viscoelastic Functions for cis-1,4-Polybutadiene Melts

G. A. Alvarez and H.-J. Cantow

Institut für Makromolekulare Chemie, Universität Freiburg, Hermann-Staudinger-Haus, Stefan-Meier-Straße 31, D-7800 Freiburg i. Br., Federal Republic of Germany

SUMMARY

Relevant recent advances in slit die rheometry are discussed, and an error in the cited publication is corrected.

In our recent publication, a comparison was made between steady-state viscosity and first stress coefficient for cis-1,4-polybutadiene (PB) melts, obtained in an INSTRON 3250 cone-and-plate rheometer and in a GÖTTFERT 2000 slit die rheometer (Figure 2 of ALVAREZ and CANTOW 1982a). Unfortunately, an error was made in the calculation of the wall shear rate in the slit die, and the same error was carried into the calculation of material functions; this had the consequence that both viscosity and first normal stress coefficient were displaced to higher shear rates than actually measured, although along the same line as the correct data. The corrected Figure is given below.

The wall shear stress and shear rate in the slit die rheometer were calculated according to well-known assumptions (WALTERS 1975). However, a novel analysis of the pressure distribution along the slit wall with a quadratic instead of a linear extrapolation to exit pressure (ALVAREZ and CANTOW 1982b), allowed us to calculate first normal stress coefficients well within order of magnitude of the values obtained from the rotary rheometer, as shown in Figure 1. Additionally, anomalous entry pressure losses were corrected by the same analysis.

The constant density assumption gives rise to an upper limit in the shear rate obtainable in the slit die rheometer for highly viscous materials in view of the large hydrostatic pressures, here up to 100 MPa, required for the flow of material along the slit die. Finally, the hole pressure, the velocity rearrangement at the exit and the temperature homogeneity are sources of large error and deserve special attention.

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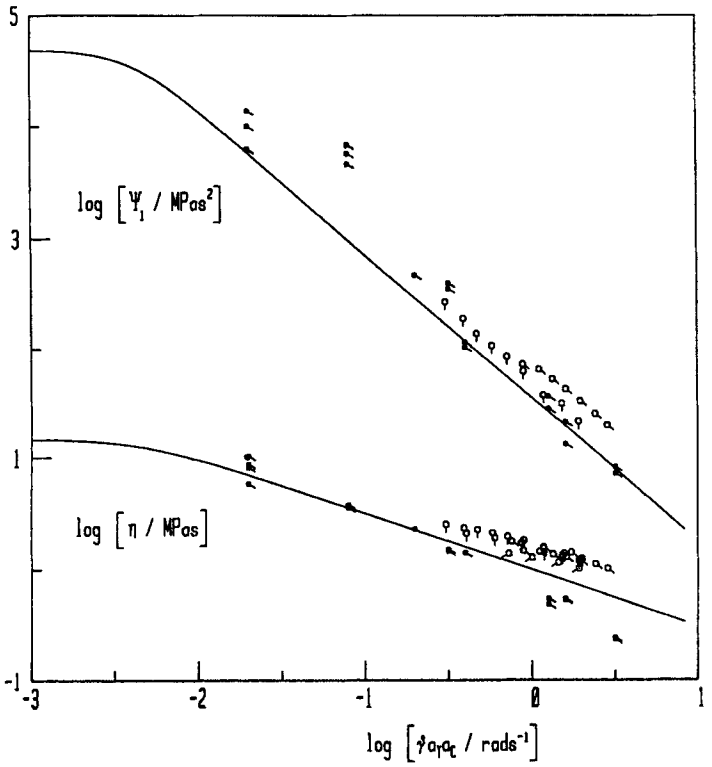

Figure 1. Comparison of steady-state viscosity and first normal stress coefficient for PB melt, obtained in cone-and-plate and slit die rheometers, reduced to 298 K; pips indicate measuring temperatures increasing clockwise, 253 K = 12 o'clock 313 K = 6 o'clock. Lines are predicted by CARREAU's model with parameters of ROUSE theory plus a time constant characterizing onset of non-Newtonian flow

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