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Study on Rotational Flow of Viscoelastic Fluid

(Setting Up of a New Rotational Viscometer)

Hidehiro NONAKA*

1. Weissenberg Rheogoniometer is known as an instrument to investigate the non-Newtonian Viscosity and normal stresses of the rotational flow of viscoelastic fluid at one instance. But it can be pointed out that commercial rheometers of its type are unsuitable at some points for the precise determination of Weissenberg-Pressure distribution or for the research on the secondary flow. In this study, a new rotation viscometer expected to fit the above-mentioned research purposes was designed and constructed.

2. A cup of 30 cm internal diameter is driven with 3-h.p. induction motor. Measurements can be carried out both by parallel plate type and plate-cone type (cone-plate space angle 4°) instruments. The bob of 25 cm diameter has 9 holes of 0.1 cm and 0.8 cm diameters for pressure pick-ups and secondary flow respectively and 12 holes for c-c thermocouples. The temperature control of the cup and the bob below 150°C is possible by circulating liquid heat medium. The range of the revolution speed of the cup is from 4×10^{-2} to 9×10 rpm and the corresponding shear rate calculated is from 6×10^{-3} to $1.4 \times 10^2 \text{ sec}^{-1}$ for the cone-plate type instruments. The range of the torque at the bob measurable with a torsion rod and a differential transformer is determined from 5×10^{-3} to 1×10 kg-m. The torque loaded to the cup is also measurable by using strain gauge type torque-meter connected to the shaft. For the study of stress relaxation phenomena, electromagnetic brakeclutch unit is provided in the driving-shaft to stop the cup instantaneously.

3. The shear rate is dependence on viscosity for 10 c.s. Silicone oil was determined with cone-plate type instruments. It showed non-Newtonian property in the shear rate region larger than 10 sec^{-1} . Zero shear viscosity showed a good agreement with the value obtained with commercial instruments. But in the region more than 45 sec^{-1} shear rate, large fluctuations of the torque were observed.

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