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Applications of Rheo-NMR-Microscopy to Complex Fluids.

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Abstract

The non-Newtonian behavior of various complex fluids is described in detail, including shear thinning, slip and spurt phenomena. Dynamic NMR microscopy velocity profiles, achieved in capillary, cylindrical-Couette and cone-and-plate geometries, demonstrate that direct measurement of the above phenomena is possible.

NMR diffusion measurements, using polyethylene oxide solutions, reveal that the onset of entanglements is observed at a concentration around 1-2 % (w/v). Shear thinning is observed in 5 % monodisperse polyethylene oxide solutions using capillary velocity profiles. A power law analysis demonstrates an increase in shear thinning with increasing shear rate. A decrease in the power law exponent, n , from 0.4 to 0.35 is observed over the range of shear rates used here.

Slip is demonstrated by the discontinuous velocity profile obtained using 0.2 % Unam Xanthan solutions. An increase in the amount of slip with increasing shear stress is suggested, demonstrated in both capillary and cylindrical-Couette geometries. The exclusiveness of slip to particular Xanthan gums is also shown.

Velocity distributions of Cetyl Pyridinium Chloride-Sodium Salicylate micelles demonstrate the spurt phenomenon as a process observed above a critical shear stress, σ_c . This process is thought to differentiate from that of slip in that its properties rely on bulk fluid properties.

The mobility of polyolefins, containing side chains, ^{was}~~were~~ investigated by relaxation measurements in the melt. As the polymers were sheared, a decrease in the mobility was observed, consistent with the disentanglement of the chain network. Viscosity scaling laws, and the influence of polymer side branch length, were also studied.

Gradient coil developments are also described in detail. Linearity, homogeneity and screening conditions are investigated for a transverse quadrupole-target-field gradient coil. The need for large gradients are discussed with the implications to removing susceptibility effects found with model and natural systems.

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