The effect of temperature on the rheological behavior of polyethylene oxide (PEO) solutions

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Abstract

The rheological properties of polyethylene oxide (PEO) solutions were investigated, at different temperatures, using small and large deformation rheological methods. Steady-state flow measurements showed that the flow behavior of the PEO solutions is well described by the Cross model, which yields the critical concentrations c* (from the dilute regime to semidilute regime) and c** (from the semi-dilute regime to the concentrated regime). In the range of the temperatures investigated here, the apparent viscosity is found to obey the Arrhenius equation below a critical temperature we believe corresponds to the cloud point temperature. Above the cloud point temperature, the viscosity increased with temperature. Similarly below the cloud point, both transient and dynamic tests showed that PEO solutions exhibit viscoelastic behavior, where both the elastic G' and viscous G'' modules increased with the increase in concentration and with the decrease in temperature. The Cox-Merz rule was found to apply to the PEO solutions at temperatures lower than the cloud point temperature, whilst divergence was reported after phase separation. The frequencies at which G' = G'', i.e. the reciprocal of the relaxation times of the temporary polymer network, was found to increase (the relaxation times decline) with decreasing polymer concentration, in agreement with the relaxation times, derived from the Cross model. In essence, this study demonstrates that it is possible to monitor accurately the cloud point temperature of PEO solutions by viscometric analysis.