Rheological characterization of poly(ethylene oxide) solutions of different molecular weights

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Abstract

The rheological properties of aqueous solutions of poly(ethylene oxide) (PEO) of different molecular weights (1×10^5, 4×10^5, 1×10^6 and 4×10^6 g mol^{-1}) and concentrations were investigated using shear viscosity and dynamic rheological measurements. It was found that the aqueous solutions of PEO do not exhibit a yield stress and that, above a critical shear rate, all PEO solutions exhibit shear-thinning behavior, well described by the Cross model, except for the solutions made by the lowest molecular weight (1×10^5 g mol^{-1}) which were almost Newtonian. The parameters of the Cross model, namely the zero-shear rate viscosity and reciprocal of the time constant, allowed the determination of the critical concentrations c^* and c^{**} (respectively, the transition to semi-dilute network solution and concentrated solution). At concentrations higher than c^{**} and below a critical shear rate, solutions made of PEO of high molecular weight exhibited a clearly shear-thickening behavior at very low shear rates. In addition, the dynamic tests showed that PEO solutions exhibit concentration-dependent viscoelastic properties, with a dominant viscous behavior at PEO concentrations lower than c^{**} and a dominant elastic behavior at PEO concentrations greater than c^{**}.

Keywords: Poly(ethylene oxide) (PEO); Cross model; Shear-thickening; Viscoelasticity; Molecular weight; Overlap critical concentration.

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