World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Rheological Properties of Polymer Systems in Magnetic Field

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Abstract : The liquid crystals combining properties of a liquid and an anisotropic crystal substance play an important role in a science and engineering. Molecules of cellulose and its derivatives have rigid helical conformation, stabilized by intramolecular hydrogen bonds. Therefore the macromolecules of these polymers are capable to be ordered at dissolution and form liquid crystals of cholesteric type. Phase diagrams of solutions of some cellulose derivatives are known. However, little is known about the effect of a magnetic field on the viscosity of polymer solutions. The systems hydroxypropyl cellulose (HPC) – ethanol, HPC – ethylene glycol, HPC–DMAA, HPC–DMF, ethyl cellulose (EC)–ethanol, EC–DMF, were studied in the presence and absence of magnetic field. The solution viscosity was determined on a Rheotest RN 4.1 rheometer. The effect of a magnetic field on the solution properties was studied with the use of two magnets, which induces a magnetic-field-lines directed perpendicularly and parallel to the rotational axis of a rotor. Application of the magnetic field is shown to be accompanied by an increase in the additional assembly of macromolecules, as is evident from a gain in the radii of light scattering particles. In the presence of a magnetic field, the long chains of macromolecules are oriented in parallel with field lines. Such an orientation is associated with the molecular diamagnetic anisotropy of macromolecules. As a result, supramolecular particles are formed, especially in the vicinity of the region of liquid crystalline phase transition. The magnetic field leads to the increase in viscosity of solutions. The results were used to plot the concentration dependence of η/η0, where η and η0 are the viscosities of solutions in the presence and absence of a magnetic field, respectively. In this case, the values of viscosity corresponding to low shear rates were chosen because the concentration dependence of viscosity at low shear rates is typical for anisotropic systems. In the investigated composition range, the values of η/η0 are described by a curve with a maximum.

Keywords : rheology, liquid crystals, magnetic field, cellulose ethers
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020