The influence of MeOH on the rheological property of C24HEUR solution

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Hydrophobic ethoxylated urethane (HEUR) is a water-soluble telechelic polymer. HEURs have hydrophobic residues at both ends of the polyethylene oxide (PEO) chains. The polymers form flower micelles in water, which become the crosslink-point of the temporary physical network structure. The viscoelastic characteristic of the HEUR aqueous solution can be described with a single-mode Maxwell model. The relaxation time is related to the temporary lifetime of the physical crosslink-point. C24HEUR, which blocks both ends of PEO with the alkyl chain of C24, has been developed as the rheology control agent for cosmetics [1]. C24HEUR is designed to produce about a 1 s relaxation time of the aqueous solution. This relaxation time close to the speed of the application motion of cosmetics, therefore, one can develop a unique usage feeling cosmetics using C24HEUR. Although C24HEUR is a water-soluble polymer, it is important to study the influence of water-miscible solvents from an applications point of view. In this study, the influence of MeOH on the rheological property of a C24HEUR aqueous solution was studied.

Linear-viscoelasticity: The sample solutions, which contain 1.5% C24HEUR, were made using MeOH aqueous solutions (2 - 15 mol %) as solvents. To estimate the equilibrium shear modulus and the relaxation time, the frequency dependence of the dynamic shear modulus was measured. With the MeOH addition, the relaxation time was reduced and the new relaxation time emerged in the slow frequency region when the MeOH concentration exceeded 15mol%. The relaxation behaviour of HEURs solutions is determined by the balance of the lifetime of the crosslink-structure and the mechanical characteristic of PEO according to the transient network theory [2, 3]. Such a MeOH effect may be caused by changing the micelles’s properties, which function as the crosslink, and the mechanical property of PEO due to the changing hydration behaviour.

Stress growths under the step shear flow: It is reported that the extraordinary stress (stress upturn) occurs because of a non-affine stretch effect of the PEO chain, which has been confirmed experimentally [4]. The stress growth behaviour under the step shear flow was studied to examine the influence of MeOH on this stress upturn phenomenon. By the adding MeOH, the stress upturn disappeared depending on the concentration of MeOH. It was clear that MeOH greatly affected the rheological properties of the C24HEUR aqueous solution. Although it is easily accepted that the addition of MeOH may reduce the relaxation time because of the change in the hydrophobic interaction of the alkyl chains, it is difficult to describe precisely the reason for the stress upturn disappearance. It is expected that the non-cosolvent effect of MeOH on the PEO chains may be related to this phenomenon.