

ABSTRACT

In this study, we will try to develop different microgel systems for enhanced oil recovery applications. The usage of microgels for this application has not been much studied, but it seems to have a great potential. The discussion regarding these systems has been subdivided into two parts. In the first part, chemically cross-linked nanoparticles from dilute aqueous alkali solutions of hydroxyethylcellulose (HEC) in the presence of a cross-linker agent (divinyl sulfone, DVS) have been examined. These nanoparticles were prepared from a reaction mixture, which was exposed to different stirring speeds during the cross-linking process. At various stages during the cross-linking procedure, the reaction was terminated and the species were characterized by means of turbidimetry, asymmetric flow field-flow fractionation (AFFFF), dynamic light scattering (DLS), and rheo-small-angle light scattering (Rheo-SALS) methods. During the cross-linking of a dilute polymer solutions, there is a constant competition between intrapolymer and interpolymer cross-linking. The DLS results show that intrachain cross-linking with contraction of the complexes is promoted and the growth of aggregates is inhibited by high stirring speed. The results from the Rheo-SALS measurements disclosed that at early stages during the cross-linker reaction, the complexes are fragile against shear forces, especially if the reaction mixture had been subjected to low stirring speeds. At a later state of cross-linking, more cross-links lead to a better stability of the species. The strategy discussed in this study is of special interest for enhancing the oil recovery applications, since the size and polydispersity of the particles can be tuned by changing the stirring speed and quenching time.

In the second part, uncharged chemically cross-linked poly(*N*-isopropylacrylamide) (PNIPAAm) microgels and charged PNIPAAm microgels with different amount of acrylic acid groups (PNIPAAm-*co*-PAA) were synthesized and the temperature-induced aggregation behavior of aqueous suspensions of these microgels were explored with the aid of dynamic light scattering (DLS), and turbidimetry. The DLS results show that the particles at all conditions would shrink at temperatures below the lower critical solution temperature (LCST). For the uncharged particles, the relative contraction effect is larger than what is observed for charged particles. The compression of the microgels cannot be traced from the turbidity results, but rather the values of the turbidity increase in the whole temperature interval. This phenomenon is discussed in the framework of a theoretical model. In a very dilute suspension, the size of the uncharged microgels is unaffected by temperatures above LCST. In this temperature range, uncharged particles of higher concentration and particles containing acrylic acid groups at low pH (pH = 2) aggregate, and macroscopic phase separation is approached at higher temperatures. The charged particles (pH = 7 and pH = 11) continue to collapse with increasing temperature over the entire temperature domain. The addition of an anionic surfactant such as SDS to the uncharged particles has been studied. This adsorption of the anionic SDS may endow a polyelectrolyte character of the uncharged polymer and will stabilize those against aggregation. This study demonstrates how the stabilization of microgels can be affected by factors such as polymer concentration, addition of ionic surfactant to uncharged particles, the amount of charged groups in the polymer, and/or pH.