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ORIGINAL PAPER

Novel crosslinking method for preparation of acrylic thickener microgels through inverse emulsion polymerization

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Abstract Novel crosslinking method was introduced for preparation of acrylic thickener microgels based on sodium acrylate and 2-acrylamido-2-methylpropane sulfonic acid (AMPS) through inverse emulsion polymerization (IEP). Usually multifunctional vinyl crosslinkers such as methylene bisacrylamide are used in preparation of microgels through IEP. In this paper, a novel crosslinking method was introduced for microgel preparation through IEP. Diglycidyl materials were used instead of vinyl crosslinkers for microgel preparation. The effect of two diglycidyl materials such as polyethylene glycol diglycidyl ether (PEGDGE) and ehylene glycol diglycidyl ether (EGDGE) was investigated as crosslinker in microgel synthesis. Acrylic microgels prepared through IEP can be used as a thickener for many industrial applications. The effects of parameters such as comonomer composition, drying temperature and crosslinker content on the thickening properties of microgels were investigated. According to the viscosity measurements, the microgel containing 12.5 % AMPS possessed the highest viscosity, while the lower viscosities were found to be observed for the microgels having the lower and higher percentages of AMPS. Moreover, the microgel containing AMPS showed the thickening properties over a wide range of pH and was nearly pH independent. Increasing drying temperature and amount of crosslinker led to enhance the crosslink density. The apparent viscosity was reduced and the storage modulus was increased in higher crosslink density. These microgels showed superior thickening properties in comparison to vinyl-crosslinked microgels, i.e., the thickening efficiency of PEGDGE-crosslinked microgels was significantly higher (about 500 %) than the conventional MBA-crosslinked microgels.

Keywords Inverse emulsion polymerization · Crosslinking · Thickener · Microgel · Diglycidyl ether

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Introduction

Water-soluble polymers are a significant class of materials with important industrial applications. These hydrophilic polymers can be used as coagulants and flocculants in waste water treatments [1], pushing fluids in oil recovery [2], as a retention aid in paper manufacturing [3], in separation and purification technologies [4], as carriers for controlled drug delivery [5] and as viscosity thickeners in cosmetics and personal care products [6, 7]. These polymers are synthesized by two methods of (1) homogeneous aqueous solution polymerization and (2) heterogeneous polymerizations, respectively, such as inverse emulsion or inverse suspension polymerization [8]. Mechanism and kinetics of polymerization have been investigated by Hunkeler [9], Landfester [10] and Candau [11].

One of the major applications of water-soluble polymers is their use as thickeners. Small amounts of these materials have a great impact on fluid rheological properties. Microgels as thickeners are used for modifying or controlling fluid viscosity [12]. Microgels can be defined as inter- and intra-molecularly crosslinked polymeric micro-particles that are swollen in appropriate solvents [13–15]. The high surface areas of microgels allow them to absorb large amounts of solvent to increase the viscosity of the solution [15–17]. Based on the crosslinking mechanisms, microgels are divided into two categories: physically crosslinked microgels