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Acrylamide copolymers: A review of methods for the determination of concentration and degree of hydrolysis

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Abstract

Polyacrylamides are used extensively in enhanced oil recovery, drilling fluids, and in gels for profile control. This review enables drilling engineers or reservoir engineers to choose the most appropriate analytical method for measuring polyacrylamide concentration for their particular project. Seventeen groups of methods were reviewed for the determination of acrylamide copolymers, whereas eight groups of methods were reviewed for the measurement of degree of hydrolysis. In each case, a description of the method, advantages, limitations and interferences is provided.

1. Introduction

Acrylamide copolymers are used worldwide in large quantities for improved oil recovery (IOR), for papermaking, for water treatment and in mining operations (Hendrickson and Neuman, 1984; Thomas and Wang, 1983; Leung et al., 1987b; Leung, 1987a). In IOR they are used for polymer flooding, in drilling fluids and in gels for profile control.

Determination of acrylamide copolymer concentration in these industries is often difficult because complex sample matrices may be involved. Concentrations must be determined accurately at low concentrations for success of the process. It is also important to determine the degree of hydrolysis (mole fraction of carboxylate groups) of acrylamide copolymers because this parameter is a critical factor in determining rheology, adsorption and flocculating ability (Gao, 1987; Thomas and Wang, 1983; Yen et al., 1989; Morgan and McCormick, 1990; Myagchenkov and Kurenkov, 1991; Sorbie, 1991).

Oilfield brines can contain high levels of dissolved salts and divalent ions. Increasing salinity results in a decrease of the hydrodynamic volume of the polymer (Hester and Puckett, 1988), which may affect some analytical methods. Divalent ions can chelate with partially hydrolyzed polyacrylamide and at high concentrations this can result in polymer precipitation (Ryles, 1988). In addition, samples produced from micellar flooding and alkali/surfactant/polymer flooding may be emulsions or may contain solubilized crude oil that can give them a yellow or brown color (Beazley, 1985). If high pH is encountered, the degree of hydrolysis of the polymer can increase. This is significant because at low salinity it can result in a change in the hydrodynamic volume of the polymer. In as much as amide groups are converted to carboxylate groups during hydrolysis, any determination based on the amide group will be affected.

Several reviews have been published recently on the use of acrylamide copolymers in IOR (Gao, 1987; Yen

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