

Mechanical Degradation of High Molecular Weight Partially Hydrolyzed Polyacrylamide used in Enhanced Oil Recovery (EOR)

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Abstract

A study of rheological behavior and mechanical degradation of hydrolyzed polyacrylamide (HPAM) used in EOR applications has been carried out. Aqueous polymer solutions have been injected into stainless steel capillaries. Polymer degradation rate was evaluated from the flow-induced viscosity loss of the polymer solution. Polymer degradation and mobility reduction were evaluated at different shear rates, temperatures, capillary lengths and contraction ratios.

The study showed that increasing contraction ratio resulted in an increase in polymer degradation while increasing capillary length between 10 and 30 cm and increasing the temperature between 30 and 65 °C showed no significant change in degradation rates. The Capillary results also showed that degradation increases slightly with shear rate below a critical shear rate of 10,000 s⁻¹ after which capillaries with larger contraction ratios have higher degradation rate with increasing shear rate.

Three regions with different rheological behavior were observed in capillaries with contraction ratios of 14 and 7; apparent thickening behavior until a critical shear rate, then a plateau region, followed by a shear thinning behavior. The shear thinning reign was not observed in contraction ratios of 3.5 and 2.33.

Mobility reduction and degradation rate were found to be related. When degradation rate is below 10% a shear thickening behavior was found in all capillaries while at degradation rates between 10% - 50% a plateau region was found. Capillaries with contractions of 14 and 7 both show a shear thickening behavior when degradation rate is above 50% while in contractions 3.5 and 2.33 the shear thickening behavior is not clear as the degradation rates are less than 50% at maximum shear rates reached. Elongation flow at capillary entrance is believed to be the main contributor to polymer degradation. This clearly indicates that degradation of the polymer in EOR/IOR applications could be mainly due to the presence of highly elongational flow through some surface and subsurface facilities (e.g. chocks) and at the sandface.

viscosity.