

Rheology and Mechanical Degradation of Enhanced Oil Recovery Polymers

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Abstract

A study of rheological behavior and mechanical degradation of non-ionic and an-ionic polyacrylamides used in EOR/IOR applications has been carried out. Aqueous polymer solutions have been injected into stainless steel capillaries and core samples. 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, salinities and concentrations.

The capillary study showed that increasing solvent salinity resulted in an increase in polymer degradation. From the evaluation of capillary entry point contribution to mobility reduction, three regions with different rheological behavior were observed; apparent thickening behavior until a critical shear rate, a plateau region, followed by a shear thinning behavior. Capillary length was found to impact more the degradation and mobility reduction of high salinity solutions. No impact of length was observed in low salinity solvents and distilled water. For the solutions tested, the non-ionic polymer showed relatively higher degradation.

Experiments on core samples revealed that polymer degradation in cores is low and no further degradation was observed above a critical shear rate. Degradation due to re-injection of polymer effluent into the core was found to be very small (3 - 5 %). Similar to capillaries, degradation increases with salinity. An apparent shear thinning behavior was observed at low shear rates until a critical shear rate above which shear thickening behavior took place.

This study showed that the two polymers are mechanically stable once flowing through the bulk of the formation. Also, the more flexible is the polymer in solution, the more degradable it is. Elongation flow at capillary entrance was found 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.