

Numerical Modelling Of Polymer Enhanced Oil Recovery: The Influence of the Degradation and Viscoelastic Properties

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Extended Abstract

Polymer flooding is one of the most common and technically developed chemical Enhanced Oil Recovery (CEOR) processes. The main function of the polymer in solution is to increment the carrying phase's (i.e., water or brine) viscosity in order to mobilize the remaining trapped oil [1]. Along with this, many numerical simulators were developed during the last 40 years considering the influence of the polymer molecules on the viscosity as well as another physical parameters. Nonetheless, there is a number of these phenomena which were not previously considered, for instance, the interfacial effects of hydrophobically modified polymers. Moreover, the degradation of the polymer in a harsh environment such as the one found on porous media is well known and documented [2]. This causes a detriment on the viscosifying properties, diminishing the efficiency of the method. It is important also to consider the effect of the polymer viscoelasticity on the microscopic sweeping efficiency, lowering the residual oil saturation. In this chapter a new compositional 2D numerical simulator is developed for polymer flooding in a two-phase, three-component configuration, considering all the physical effects present in porous media. In order to do this, a new model is presented considering how the degradation affects the viscoelastic properties as well as the carrying phase viscosity [3,4]. Furthermore, the study is not limited to the physical effects but also to the influence of the numerical discretization schemes on the recovery efficiency. This simulator will allow setting the desired designing properties for future polymers in relationship with the characteristics of the oil field to be exploited.

This study presents the application of the numerical simulator to a polymer flooding process. The multiphase, multicomponent model takes into account all the important physical parameters present in a chemical flooding and moreover, it includes novel mathematical formulations for significant parameters in the process, such as the degradation rate and the polymer viscoelasticity [5,6]. Furthermore, the use of a simulator which allows modelling all the conditions to which the polymer is submitted is vital for the development and synthesis of new products resistant to a harsh environment. In addition to the physical phenomena, the numerical scheme developed for this model has the advantage of reducing the numerical round-up errors, as well as present an accurate front-tracking of the polymer slug which, with traditional methods (e.g., upwind, Lax-Wendroff), it would be impossible. Although there are simulators that take into account these factors, a new mathematical formulation has been developed here to study the degradation process from the point of view of molecular weight. Furthermore, since the residual saturations are function of the viscoelastic properties of oil, the desaturation curves were modified to account for this phenomenon [7]. The fundamental contribution of the model is that the viscoelastic properties depend on the relaxation time, which in turn is a function of molecular weight. A new correlation was introduced to account for the phenomenon of degradation in the relaxation time, and therefore in the desaturation curves. A correct choice of the degradation model is then essential to make an accurate simulation of polymer flooding process.

References

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