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Evaluation of Sequential Polymer Flooding in Multi-Layered Heterogeneous Reservoir

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Abstract : Polymer flooding is a well-known technique used for controlling mobility ratio in heterogeneous reservoirs, leading to improvement of sweep efficiency as well as wellbore profile. However, low injectivity of viscous polymer solution attenuates oil recovery rate and consecutively adds extra operating cost. An attempt of this study is to improve injectivity of polymer solution while maintaining recovery factor, enhancing effectiveness of polymer flooding method. This study is performed by using reservoir simulation program to modify conventional single polymer slug into sequential polymer flooding, emphasizing on increasing of injectivity and also reduction of polymer amount. Selection of operating conditions for single slug polymer including pre-injected water, polymer concentration and polymer slug size is firstly performed for a layered-heterogeneous reservoir with Lorenz coefficient (Lk) of 0.32. A selected single slug polymer flooding scheme is modified into sequential polymer flooding with reduction of polymer concentration in two different modes: Constant polymer mass and reduction of polymer mass. Effects of Residual Resistance Factor (RRF) is also evaluated. From simulation results, it is observed that first polymer slug with the highest concentration has the main function to buffer between displacing phase and reservoir oil. Moreover, part of polymer from this slug is also sacrificed for adsorption. Reduction of polymer concentration in the following slug prevents bypassing due to unfavorable mobility ratio. At the same time, following slugs with lower viscosity can be injected easily through formation, improving injectivity of the whole process. A sequential polymer flooding with reduction of polymer mass shows great benefit by reducing total production time and amount of polymer consumed up to 10% without any downside effect. The only advantage of using constant polymer mass is slightly increment of recovery factor (up to 1.4%) while total production time is almost the same. Increasing of residual resistance factor of polymer solution yields a benefit on mobility control by reducing effective permeability to water. Nevertheless, higher adsorption results in low injectivity, extending total production time. Modifying single polymer slug into sequence of reduced polymer concentration yields major benefits on reducing production time as well as polymer mass. With certain design of polymer flooding scheme, recovery factor can even be further increased. This study shows that application of sequential polymer flooding can be certainly applied to reservoir with high value of heterogeneity since it requires nothing complex for real implementation but just a proper design of polymer slug size and concentration.

Keywords : polymer flooding, sequential, heterogeneous reservoir, residual resistance factor
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