Exergy Analysis of Polymer Flooding in Clastic Reservoirs

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Abstract

Using a 1-D model of polymer displacement, we analyze the exergy (maximum attainable work) balance of viscosified water, e.g. with Arabic gum. The 1-D model shows the principle how such an analysis can be done. A comparison as to the displacement efficiency is made between three scenarios, i.e., (1) pure water injection, (2) constant polymer viscosified water injection and (3) polymer slug injection (water-polymer-water) injection. A numerical solution of the enhanced oil recovery (EOR) model is obtained with COMSOL Multiphysics® invoking the weak formulation option for solving pde's. At the injection point we specify the injection flux of water and polymer. At the production point, we only specify the convection term. Moreover we compare the exergy of the oil (10.7 (kWh/liter)) produced to the pumping exergy for circulating the fluids, which usually approximately accounts for 80% of the exergy used for the recovery of oil. Validation of the model results is achieved with analytical solutions using the method of characteristics. In addition the integrated Darcy velocity x pressure gradient profile is used to compute the power required to circulate the fluids. We make a comparison for the three scenario's. It is argued that this analysis, which circumvents an economic analysis, can be used to show the advantage of using polymer (e.g., Arabic gum) slugs with respect to permanent polymer injection to enhance the recovery behavior.