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A Prediction Method for Estimating Time to Convert From Cyclic to Drive in Steam Injection Processes

Abstract

There is significant history on the use of steam injection processes in California heavy oil reservoirs. In this paper, we introduce a graphical method for estimating the optimal timing of conversion from Cyclic Steam Stimulation (CSS) to steam drive and compare our estimation to actual cases where CSS had continued with the buildup of significant water saturation around the wellbore. We use as a measure, the SOR (Steam Oil Ratio) to ascertain the optimality of the conversion points and compare it to our modeling work. During the CSS process, steam injectivity is gradually improved, resulting in low SOR which is the characteristic of the steam stimulation process. We see of course some relation between the behaviors of various oil viscosity types and the SOR during CSS. But in general, the rapid heating of the formation relates to limitations associated with contact volume. Based on our numerical modeling, we demonstrate that a log-log plot of cumulative injection vs. cumulative production for all the cycles leads to a linear relationship. When there is an indication of flattening of oil steam ratio or an increase in SOR, it is time to change to steam drive allowing the steam to contact a larger volume of the reservoir. Thus, the heat-scavenging effects of water buildup around the injection well and low relative permeabilities of oil traveling through the high water saturation interval are avoided. The estimated SOR during the CSS process depends on the oil viscosities and vertical conformance. The optimum time corresponds to the point where there is deterioration of the SOR. We showcase studies on several CSS wells from fields in Central California validating the graphical method and demonstrating the steam savings had the proposed timing been implemented. The methodology presented confirms a practical and smart way for operators to decide on the conversion timing.