Mathematical Modeling of One-dimensional Oil Displacement by Combined Solvent-Thermal Flooding

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Enhanced oil recovery (EOR) is defined as a set of techniques applied to improve the recovery of hydrocarbons by the injection of materials that are not normally present in the reservoir [La89]. Most EOR methods may be classified into thermal, chemical and miscible. The chemical methods improve the sweep efficiency through the reduction of the water mobility and/or interfacial tension. Thermal methods consist of injecting a fluid (heat source), which can be steam or hot water, that causes the reduction of the oil viscosity in the reservoir, and the miscible methods are based on the injection of a solvent to decrease the capillary and interfacial forces. There are large heavy oil and bitumen deposits in many areas in the world [Zh04]. Under this scenario, it is important to develop new technologies to extract the vast amount of oil from these reservoirs. Carbonated water flooding (CWF) is an improved oil recovery technique that combines the advantages of waterflooding with carbon dioxide sequestration [HiEtAl60, Na89, Pi07, SoEtAl09, DoEtAl11]. The system of governing equations that models the injection of a hot fluid containing a solvent into an oil reservoir consists of oil, solvent and water mass balance and energy conservation. In this work we present the analytical solution for the problem of 1D oil displacement by a combined thermal-solvent EOR method.

References

[1] [DoEtAl11] Dong, Y., Dondoruk, B., Ishizawa, C., Lewis, E. J., and Kubicek, T., *An experimental investigation of carbonated water flooding*, In SPE Annual Technical Conference and Exhibition, Denver, CO (2011)

[2] [HiEtAl60] Hickok, C. W., Christensen, R. J., and Ramsay, H. J. *Progress review of the K&S carbonated waterflood project*, J. Pet. Sci. Technol., 12, 20–24 (1960).

[3] [La89] Lake, W. L., *Enhanced oil recovery, Prentice-Hall* Englewood Cliffs, NJ (1989).

[4] [Na89] Nars, T. N., and McKay, A. S *Novel oil recovery processes using caustic and carbon dioxide as dual additives in hot water*, In Petroleum Conference of The South Saskatchewan Section, Regina, CA (1989).

[5] [Pi07] Picha, M. S.: Enhanced oil recovery by hot CO2 flooding *Novel oil recovery processes using caustic and carbon dioxide as dual additives in hot water*, in SPE Middle East Oil & Gas Show and Conference, Kingdon of Bahrain, BA (2007).

[6] [SoEtAl09] Sohrabi, M., Riazi, M., Jamiolahmady, M., Ireland, S., and Brown, C. *Mechanisms of oil recovery by carbonated water injection*, In International Symposium of the Society of Core Analysts, Noordwijk, HO (2009).

[7] [Zh04] Zhao, L. *Steam alternating solvent process*, In SPE International Thermal Operations and Heavy Oil Symposium and Western Meeting, Bakersfield, CA (2004).