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Feasibility Study of the Cyclic VAPEX process for Low permeable carbonate systems

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Abstract

Vaporized hydrocarbon solvents injection in low permeable carbonate systems poses a serious challenge to petroleum engineers as well as a potentially effective and efficient oil recovery method. Thus, there is an incentive for the development of better vaporized solvent injection techniques since heavy oil reservoirs drastically draw attention of huge oil and gas companies. Cyclic VAPEX could be a key tool to achieving economic production from reservoirs containing very viscous oil.

The rate of transfer of the solvent molecules in the crude directly reflects on extraction rate, therefore, cyclic process gives more time for the solvent to diffuse into heavy oil that it can be very interesting in very low permeability formations. Furthermore, breakthrough can be controlled by solvent injection rate during intervals as well as releasing surface facilities during the period of soaking being important from economical point of view.

In this paper, a comprehensive study is conducted in order to understand the effects of cyclic injection operation properties; moreover, to show the capability of combination of immiscible displacement process with diffusion phenomena, different solvent compositions for each cycle were conducted. Also, the possibility of enhancing the extraction rate by combining of continuous and cyclic injection systems is investigated. This comparative sensitivity analysis is performed using 2D model including actual characteristics of a heavy oil reservoir of south west of Iran with oil gravity about 7-10 °API, and viscosity about 2000 cp.

Introduction

Recovery of the huge reserves of highly viscous heavy oil and poses a serious challenge to the engineers. Heavy oil reserves can only be recovered with low recovery efficiency by conventional methods. Primary recovery in the best of these heavy oil reservoirs can yield about 6% of the original-oil-in-place. Thermal stimulation of heavy oil-producing wells by cyclic steam injection has received attention since early 1960's.Currently, steam stimulation is being applied on a commercial scale, practically in Venezuela, California and Canada.

With arrival of horizontal well technology, the production from heavy oil reservoirs has been considerably improved. Horizontal wells represent an indispensable technology for the production of heavy oil and extra heavy oil formations. Thermal process like SAGD and non-thermal process like VAPEX have been specially designed using horizontal wells for recovery of oil that is immobile at original reservoir conditions.

In non-thermal oil recovery like cyclic solvent injection and VAPEX, horizontal wells have notable advantages over vertical wells such as better molecular diffusion and lateral transportation of fluids.

Success in the combination of cyclic solvent injection with horizontal wells depends upon an appropriate technical and economic design. To the best of our knowledge, no optimization methodology has been developed to support design decisions about non-thermal simulation of horizontal wells. Among the complication associated with this task are the lack of field experience under a wide range of conditions, and the lack of numerical solution to predict the oil recovery from non-thermally stimulated horizontal well.

Therefore, it is an interesting challenge and an imminent necessity to investigate numerical simulation of cyclic solvent injection and study the process of each cycle and design the conditions of each cycle which improve production rate such as soaking time, amount of solvent and composition of each solvent.

Cyclic Solvent Injection Using Horizontal Wells

Modeling the cyclic solvent injection process is one of the most challenging tasks in reservoir engineering. Abrupt molecular