World Journal of Science and Technology Research
Vol. 1, No. 7, September 2013, PP: 168 - 173, ISSN: 2329 - 3837 (Online)
Available online at www.wjst.org

Research article

Sensitivity Analysis for Gas Injection in Southern Iranian Oil Field

Abdolreza Dabiri, Hooman Fallah, Ali Ahmadi, Mohammad Afkhami, Farhad Jamalpour, Ali Tabari

Department of Petroleum Engineering, Islamic Azad University, Marvdasht Branch, Marvdasht, Iran

E-mail: hooman.fallah2@gmail.com

Abstract

Gas injection is presently the most-commonly used approach to enhance the total cumulative oil recovery, these days. This process can increases the mobility ratio of the produced fluid and improve the oil sweep efficiency. Miscible and Immiscible gas injection are presently the most commonly used processes to enhance the recovery factor of oil reservoirs. It is accepted production method in enhanced oil recovery commonly in heavy oil fields. In this study, the production under gas injection in Soroosh, one of the southern Iranian heavy oil field has been simulated (the fluid properties are focused). In order to reveal the dominant factors in this production process, the sensitivity analysis has been done for the following effective factors, fluid viscosity, initial water saturation, fluid gravity forces and gas injection well strategy. Oil displacement by gas relies on the phase behaviour of the mixtures of that gas and the crude, which are strongly dependent on reservoir temperature, pressure and crude oil composition.

Keywords: Enhanced Oil Recovery, Gas Injection, Initial Water Saturation, Oil Viscosity, Injection Well Strategy

1. Introduction

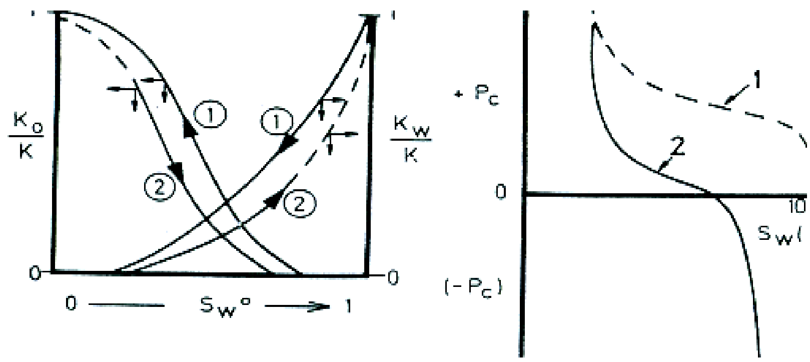
Enhanced Oil Recovery (abbreviated EOR) is a generic term for techniques for increasing the amount of crude oil that can be extracted from an oil field [1]. Gas injection is presently the most-commonly used approach to enhance the total cumulative oil recovery, these days. Miscible flooding is a general term for injection processes that introduce miscible gases into the reservoir. A miscible displacement process maintains reservoir pressure and improves oil displacement because the interfacial tension between oil and water is reduced. This refers to removing the interface between the two interacting fluids. This allows for total displacement efficiency [2]. Gases used include CO_2, natural gas or nitrogen. The fluid most commonly used for miscible displacement is carbon dioxide because it reduces the oil viscosity and is less expensive than liquefied petroleum gas [3]. Oil displacement by carbon dioxide injection relies on the phase behaviour of the mixtures of that gas and the crude, which are strongly dependent on reservoir temperature, pressure and crude oil composition [4]. In this work the theoretical gas injection mechanism are explained, then the model has been done with the CMG simulator by use of the fluid of Soroosh (one of the southern Iranian heavy oil field). The simulated model is completed in three production layers. The oil production well and the water injection wells are located in order to the most oil recovery factors.

The fluid sample has been modeled by (CMG) Winprop and got match with experimental data to gain the most accuracy.

The total oil recovery under water injection mechanism has been done then the effect of some important parameters has been done by change the one factor and to constant the others. The model has been done over and over under same condition but one changed parameter and focused on cumulative oil production, each time. So we can analyze the effect of changed parameter on the injection process recovery. The sensitivity analysis has been done each time and we supported our results by theoretical expression.

2. Imbibition and Gravity Drainage Mechanism

Displacement process in the reservoirs rock is defined by increasing the saturation of displacing fluid and decreasing in the saturation of the displaced fluid. (in matrix blocks of fomation). lots of forces are handing in movement of fluids and quantity of these forces rely on rock & fluid properties, reservoir conditions and etc.
The main dominant parameter in gravity drainage mechanism is the gravity force although it is the resistive parameter in imbibitions process [5].
Slopes of relative permability chart for gravity drainage and imbibitions are so similar to each other (fig.1).although capillary pressure chart for these mechanisms shows many differences (fig.2)



Figures 1 &2 : a) relative permability b)capillary pressure 1)drainage 2)imbibition

Gravity drainage in reservoir can be natural (gas cap expansion) or dummy(gas injection to oil reservoir);in both cases an attacked region will be made by gas region. in this region difference in oil and gas viscosity is the reason of oil displacement down and also oil saturation decreasing in attacked region [6]. Oil recovery caused by gravity drainage mechanism is much more than solution gas mechanism. There are some factors that affect on efficiency of this mechanism such as: effective permeability, production layer dip, and oil viscosity. (The drainage rate is a function of oil viscosity and will increase with decreasing in depth of production layer (This occasion has been experimented and analysed for simulated model in chapter 4.3).

3. Simulation Steps

Basically we need a model from our reservoir and it should be near to the real scale.so we have used real data in the simulation. The fluid sample has been modeled by (CMG)Winprop and we got match with experimental data to get the most accuracy. Then we've designed a immiscible gas injection by the rate of 100000 cubic feet per day in the model reservoir with the 3production by (CMG)Builder software. The total cumulative oil production has been focused after 1200 days. Then we run that base case over and over under same conditions but one parameter has been changed (for example we changed the oil viscosity) and we compared the gained total produced oil with the base case. So we can analyze and expose the effect of the changed factor on the final oil recovery very well.

World Journal of Science and Technology Research
Vol. 1, No. 7, September 2013, PP: 168 - 173, ISSN: 2329 - 3837 (Online)
Available online at www.wjst.org

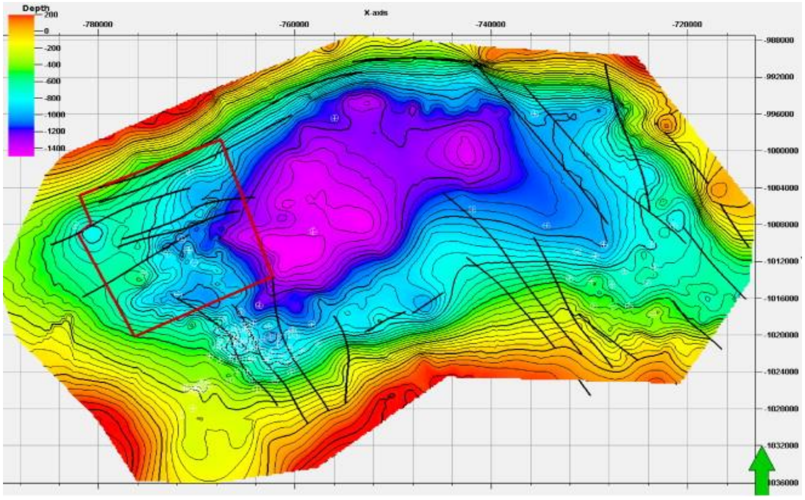


Figure 3: simulated oil reservoir under gas injection process.

4. Sensitivity Analysis of Affecting Factors in Oil Recovery under Gas Injection

4.1. The Effect of oil Viscosity

Viscosity is one of the most important factors that affect on fluid recovery from the reservoir. In the primary simulated model we assume 1000(centi poise) for viscosity (as a base case). Now in here for studying the effect of viscosity on gravity drainage mechanism we assume 575(Centi poise) for the viscosity, then we compare oil recovery in this condition with the primary condition. Figure (4) shows increasing of recovery with reducing in oil viscosity. The reason is increasing in fluid mobility with reducing in viscosity.

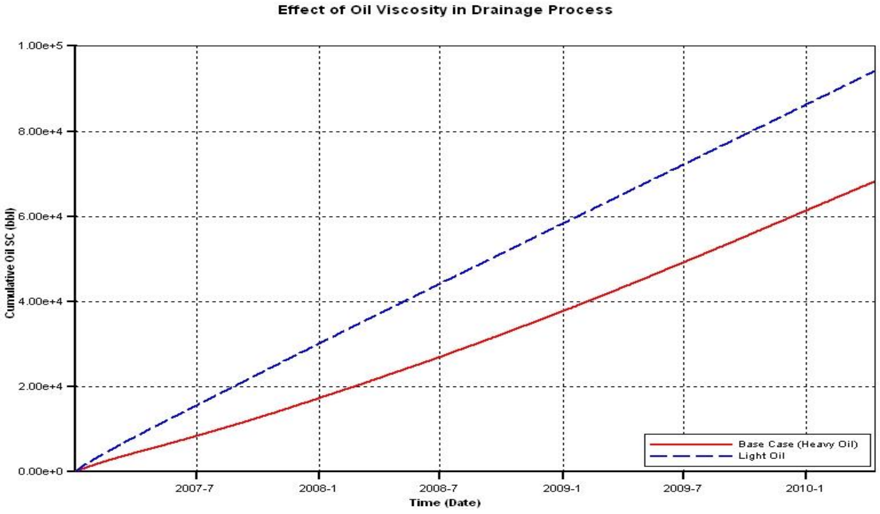


Figure 4: the effect of oil viscosity in total oil recovery under gas injection process.

4.2. The Effect of Initial Water Saturation of Formation

Here we have comparison of recovery for 3conditions. sw_i=15,sw_i=5 and primary model sw=0. According to the production figure, initial water saturation has a reverse effect on oil recovery and this is absolutely clear according to tank model, where the increasing in on phase saturation leads to decrease in another phase.

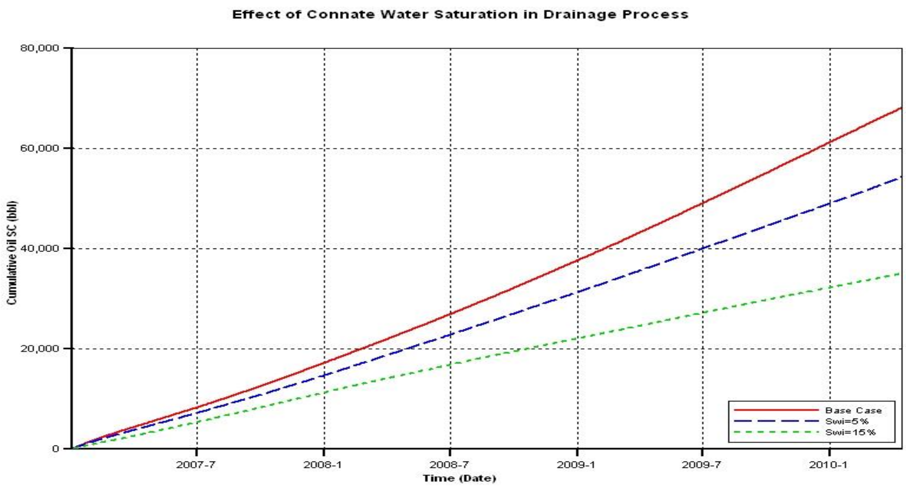


Figure 5: the effect of initial water saturation in total oil recovery under gas injection process.

4.3. The Effect of Gravity Drainage of Produced Fluid (oil)

According to chapter 2 the gravity force is a dominant factor in gravity drainage process. Fluid gravity forces are function of matrix blocks' height. Here we changed the height of production blocks to see the effect of gravity force. The gas injection well in the base case was perforated in two top layers and the production well was in the two bottom layers. Now we convert the perforation operation (the injection well perforated in two layer to simulate more height of the blocks and the production well was perforated in two top layers). For more sensitivity analysis in the next step we assume perforation of both wells only in the middle layer (so block height will be shorter and effective gravity force will be limited) [7]. In the 2nd step (reverse perforation) the perforation of two top layers changes the effect of oil blocks' height and the fluid gravity force is less than primary model, so we expect to have less oil recovery as we will see in the figure (5).

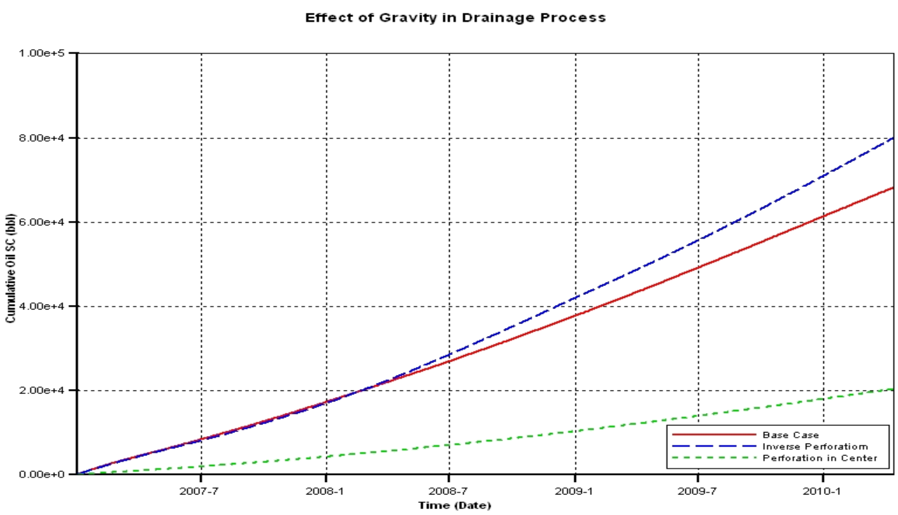


Figure 6: the effect of fluid gravity forces in total oil recovery

4.4. The Effect of Gas Injection Wells Strategy

Now we compare the two scenarios for the injection wells, the five spot model (four injection wells and one production well and line drive model (one injection well and one production well) to see the results (total cumulative oil).

The recovery factor in five spots model should be more than the line drive scenario because of the more sweeping area in five spots but a lots of factors affect under these two samples that will complicate comparison and consequences. The fingering effect had changed the results. Viscous fingering effect is the formation of patterns in a morphologically unstable interface between two fluids in a porous medium. It occurs when a less viscous fluid is injected displacing a more viscous one (in the inverse situation, with the more viscous displacing the other, the interface is stable and no patterns form). It can also occur driven by gravity (without injection) if the interface is horizontal separating two fluids of different densities, being the heavier one above the other [8]. In the rectangular configuration the system evolves until a single finger (the Saffman–Taylor finger) forms. In the radial configuration the pattern grows forming fingers by successive tip-splitting

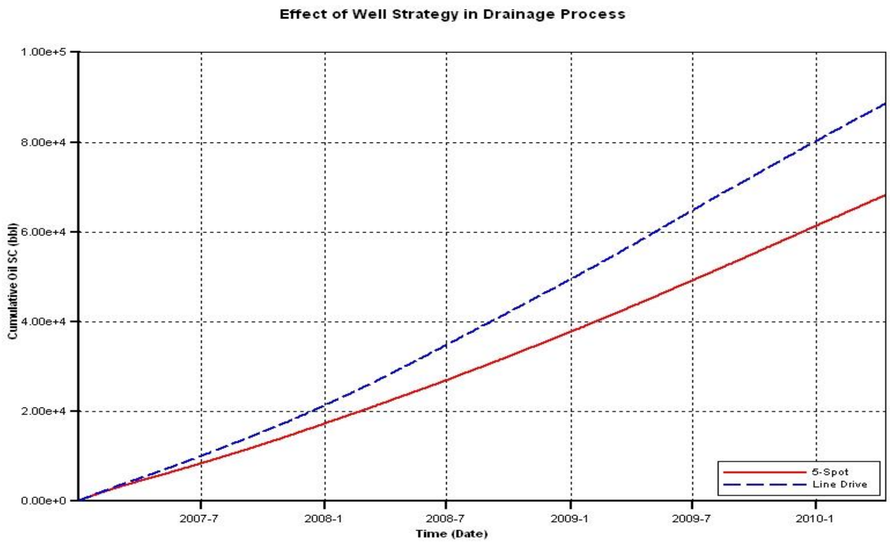


Figure 7: the effect of injected wells strategy

5. Conclusion

After gas injection simulation with 100000 (ft^3/day) rate in a period of 1200days, we noted the recovery figures for analysis then we run the simulated model several times. Each time we should only changed one factor and other conditions designed like the based case therefore we observed and analized effects of the changed factor onto the total cumulative oil recovery.

1. Sensitivity analysis shows that fluid gravity force has a positive effect on gas injection process. We can justify it according to the related forces on gravity drainage process that had been defined and proposed.
2. With reducing fluid viscosity under the same gas injection rate, more oil recovery was observed because reducing in viscosity will increase oil mobility ratio ,so more oil volume will be sweeped to the production wells and more cumulative oil has been reached.
3. The initial saturation of water has a reverse result on total oil recovery. According to the tank model more water saturation means less space for oil in the porous media.
4. Configuration analysis for injection wells strategy showed that line drive scenario will have more output than the five spots.

References

[1] P.S. Jadhawar, H.K. Sarma," Improved Production Strategy for Enhancing the Immiscibile and Miscible CO2-Assisted Gravity Drainage Oil Recovery", international Oil and Gas Conference and Exhibition in China, 8-10 June 2010, China.

[2] H.Karimaie, O. Torsæter," CO2 and C1 Gas Injection for Enhanced Oil Recovery in Fractured Reservoirs", SPE International Conference on CO2 Capture, Storage, and Utilization, 10-12 November 2010, New Orleans, Louisiana, USA

World Journal of Science and Technology Research
Vol. 1, No. 7, September 2013, PP: 168 - 173, ISSN: 2329 - 3837 (Online)
Available online at www.wjst.org

[3] Mohammad Mirzaei, David DiCarlo, Mandana Ashouripashaki, Hasan Dehghanpour, and Behdad Aminzadeh," Prediction of Three-Phase Gravity Drainage From Two-Phase Capillary Pressure Curves", SPE Improved Oil Recovery Symposium, 24-28 April 2010, Tulsa, Oklahoma, USA

[4] John Akinboyewa, Swapan K. Das, Yu-Shu Wu, Hossein Kazemi," Simulation of Expanding Solvent - Steam Assisted Gravity Drainage in a Field Case Study of a Bitumen Oil Reservoir", SPE Improved Oil Recovery Symposium, 24-28 April 2010, Tulsa, Oklahoma, USA

[5] Knut Uleberg, Pera/NTNU; Lars Høier, Statoil ," Miscible Gas Injection in Fractured Reservoirs", SPE/DOE Improved Oil Recovery Symposium, 13-17 April 2002, Tulsa, Oklahoma.

[6] M. E. McCormack," Design of Steam-Hexane Injection Wells For Gravity Drainage Systems", Journal of Canadian Petroleum Technology

[7] M. K. Liu, A. I. Andrianov, W. R. Rossen," Sweep Efficiency in CO2 Foam Simulations With Oil", SPE EUROPEC/EAGE Annual Conference and Exhibition, 23-26 May 2011, Vienna, Austria

[8] D. Olsen," CO2 EOR Production Properties of Chalk", SPE EUROPEC/EAGE Annual Conference and Exhibition, 23-26 May 2011, Vienna, Austria.