IMPACT OF ENHANCE OIL RECOVERY USING POLYMER FLOODING FOR ALPHA-X OILFIELD IN NIGER DELTA

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ABSTRACT

Nigeria being the 12th producer of crude oil globally has neglected the use of enhance oil recovery methods especially in medium to small oil fields. In this research the impact of enhanced oil recovery is provided in Alpha-x oilfield located in Niger Delta. Polymer flooding which is a chemical method of enhanced oil recovery that works by increasing viscosity of injected water to improve sweep efficiency was simulated using Schlumberger Eclipse 100 simulator. A Niger Delta well with a weak aquifer was mimicked using Fetkovich method and modelled using a grid block with 20x15x5 XYZ, with an injection well placed at cell (1,11,1) and a producer at cell (20,1,1). Three cases were run which were the production on natural drive (primary recovery), production with water injection (secondary recovery) and oil production with polymer flooding (Enhanced oil recovery), each case was ran for 38 years. After successfully running the simulation and at an oil production rate of 2000 bbl/day: the natural drive had a recovery factor of 17.07% with 8.05 MMSTB of oil; the water injection has a recovery factor of 34% with 12.15 MMSTB; and the polymer flooding at an injection rate of 3000 stb/day and concentration of 0.525 has 38% recovery factor with 13.38 MMSTB. This indicates that with injection of polymer an increment of 4% recovery factor and 1.23 MMSTB of oil produced.

ABSTRAK

Walaupun sebagai pengeluar minyak ke-12 terbesar dunia, Nigeria telah mengabaikan penggunaan kaedah perolehan minyak tertingkat terutamanya bagi lapangan minyak kecil dan sederhana. Dalam kajian ini, kesan perolehan minyak tertingkat terhadap lapangan Alpha-X di Delta Niger akan diberikan. Banjiran polimer iaitu kaedah perolehan minyak tertingkat kimia yang membantu meningkatkan kelikatan air suntikan untuk memperbaiki kecekapan sapuan disimulasi dengan perisian simulator Eclipse 100. Telaga di Delta Niger dengan akuifer lemah digambarkan oleh kaedah Fetkovich dan dimodelkan dengan blok grid 20x15x5 dalam arah XYZ, dimana telaga suntikan di sel (1,11,1) dan pengeluaran di sel (20,1,1). Tiga kes pengeluaran dijalankan yang meliputi pacuan semulajadi (perolehan primer), suntikan air (perolehan sekunder), dan banjiran polimer (perolehan minyak tertingkat). Setiap kes disimulasi selama 38 tahun. Hasil simulasi pada kadar pengeluaran 2000 tong/hari, pacuan semulajadi memperolehi faktor perolehan sebanyak 17% dengan 8.05 juta tong minyak. Sementara itu, suntikan air memberi faktor perolehan sebanyak 34% dengan 12.15 juta tong minyak, dan banjiran polimer pada kadar suntikan 3000 tong/hari dan kepekatan polimer 0.525 menghasilakan 38% dangan 13.38 juta tong. Ini menunjukkan bahawa banjiran polimer menghasilkan peningkatan faktor perolehan sebanyak 4% atau tambahan 1.23 juta tong minyak yang dikeluarkan.

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ASP	-	Alkaline surfactant flooding
CEOR	-	Chemical Enhanced Oil Recover
EOR	-	Enhanced Oil Recovery
PAC	-	Polyacrylates
PAM	-	Polyacrylamides
XG	-	Xanthan Gum

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The oil industry is presently facing pressing challenges to increase well productivity as demand for oil is increasing day by day, particularly in the developed and developing countries. It is found that the rate of increase in consumption is a major issue when compared to the rate of oil produced. On the other hand, discovery of new oil fields is very limited. Most of the reservoirs are now at matured state with low production rate. Thus methods of enhancing the production are strongly used. The conventional methods of production are divided into three: the primary which uses natural drive; the secondary recovery; and the tertiary which is mainly the enhanced oil recovery that deals with using different mechanisms to boost production recovering about 30-60% of oil originally in place (OOIP) compared to the 20-40% recoverable by the secondary and primary methods of recovery (Ahmed, 2001).

Oil production from the reservoir requires energy to the surface, as pressure reduces the natural reservoir energy becomes unable to produce the desired rate therefore methods are used to increase the level of production. The most frequently used method after the natural energy is waterflooding. Waterflooding is the most used method of secondary recovery, Waterflooding entails the injection of water through and injection well to increase the rate of recovery majorly by increasing the sweep efficiency. When waterflooding is not yielding the desired result, is uneconomical or the characteristics of the well do not encourage using waterflood then the well can either be abandoned or a tertiary method can be used to continue production if the reservoir still contains a substantial amount of oil. it is highly encouraged to use the tertiary method if it is economical , at this crucial time as much oil as possible should be extracted in a well to be able to reach the demand of oil globally. The tertiary method mostly entails enhanced oil recovery (EOR) which are majorly divided into

three the Thermal Recovery, Chemical Recovery and Gas recovery. Chemical Recovery comprises of Chemical enhanced oil recovery (CEOR) is defined as an EOR process using the injection of a combination of chemicals such as alkaline, polymer, surfactant, and cosolvent. The main mechanisms include mobility control and interfacial tension reduction, which contribute to both volumetric sweep efficiency and displacement sweep efficiency (Lake, 1989; Green and Willhite, 1998).

Polymer is a viscosifier used as a mobility control agent for CEOR processes such as polymer flooding (P), surfactant/polymer flooding (SP) and alkaline/surfactant/polymer flooding (ASP). Polymer flooding is one of the most used processes to produce residual oil mostly after waterflooding. These methods are utilized in order to increase brine viscosity for mobility control to avoid viscous fingering, and to increase sweep efficiency pushing the oil to the direction of the production well during tertiary oil recovery. Polymers tend to work better in different conditions, thus several factors would be taken into consideration. The use of water-soluble polymers is one of the most promising methods of enhanced oil recovery. Polymer flooding is a method of Enhancing Oil Recovery which works simply by using the solutions of polymer to decrease the water or oil mobility ratio thereby increasing the recovery of oil. In recent years, polymer flooding has also attracted interest for improving oil recovery of heavy oil reservoirs, which requires polymer solutions of high concentrations and high molecular weights. These polymers may show strong viscoelastic effect and reduce residual oil saturation after waterflooding (Koh, 2015; Lee, 2015; Qi *et al.,* 2016). In addition, possible presence of active aquifer in offshore heavy oil reservoirs may cause polymer loss which decreases the economic attractiveness of polymer flooding.

Mainly, the selection process of methods of enhancing oil recovery in petroleum engineering is selection of most suitable method with respect to the method that is capable of producing the highest rate of oil at an economical and shortest time. The concept of assessing the rate of production before undergoing the process of enhanced oil recovery makes savings in cost and time and reducing the rate of risk. The well simulation is the best method of getting the predicted data of a reservoir. Simulation software used in assessing the performance of the well are improved and

more are created as time goes by, one of the most reliable is the Eclipse 100 black oil simulator this entails creating a static and dynamic model of the well and inserting reservoir properties to obtain the predicted performance of a well.

1.2 Statement of Problem

During the production of crude oil as pressure declines which leads to the decrease in volume of production, Although the reservoir still contains oil it needs an additional force to help enhance and maximize the recovery of crude oil. After the use of natural enhanced oil recovery in most cases secondary recovery is used, the most used secondary recovery method is waterflooding. Waterflooding is mostly considered not sufficient to get the desired recovery which methods of Enhanced oil recovery are highly encouraged to be able to boost the level of production.

Nigeria is one of the major producers of crude oil, According to Organization of Petroleum Exporting Countries (OPEC) in 2018, Nigeria is ranked the 12^{th} highest producer of crude oil but unfortunately EOR methods are mostly neglected in moderate oilfields, leaving a substantial amount of oil in the reservoir. In this project field and laboratory data of an abandoned Alfa-x oilfield in Niger Delta Basin in Nigeria is modelled using Eclipse 100 simulator to show the production performance of the natural drive, secondary and EOR method. Polymer flooding is used as the method of enhancing recovery in this project, where polymers are injected after waterflooding to show the increase of recovery , the optimum polymer system and a comparison of the primary, secondary and EOR showing the amount of oil that could have been extracted if enhanced oil recovery method was carried out.

1.3 Objectives of Study

The objective of the research are the following:

i. To develop, run and interpret the production performance of natural drive, waterflooding and polymer flooding model using eclipse 100.
ii. To compare the cumulative oil production, watercut at the time of breakthrough and recovery factor between the natural drive, water injection and polymer injection.
iii. To obtain the optimal polymer flooding system to maximize recovery.

1.4 Scope of Study

The scope of this research are listed below:

i. Develop a polymer flooding model using Eclipse 100
ii. Simulate three cases the oil production on natural drive, waterflooding and polymer flooding after waterflooding.
iii. Accounting for variables for the production of oil, gas, water and the recovery factor of natural drive, waterflooding and polymer flooding.
iv. Comparison and analysis of the oil production and watercut at the point of breakthrough of the primary secondary and tertiary recovery.
v. Summarization of recovery factor of the three cases and comparing them.
vi. Show the distribution of oil saturation in the well and the pressure loss in the reservoir.
vii. Obtain the optimum condition of polymer flooding.

1.5 Significance of Study

Waterflooding is the most used method of secondary recovery when primary recovery is no longer economical or yielding good results. Polymer flooding is one of the most promising method of enhanced oil recovery. Polymer flooding is mostly done when waterflooding is no longer economical and substantial amount of oil is in the reservoir. Polymer flooding is done by injecting a substantial amount of polymer in the reservoir reducing the Mobility ratio thereby increasing production. These two procedures help in maximizing production to about 40-60%. Generally, studies on understanding and improving the rate of recovery in the oil industry is highly encouraged due to the limited discoveries of new large oil fields and endless demand of oil globally. In most developing countries like Nigeria EOR methods are sometimes neglected. This project uses the field and laboratory data of oil field XX in the Niger Delta region of Nigeria where only waterflooding was carried out and the well was abandoned, this project shows how the rate of injection would have increased when a method of EOR specifically the polymer flooding was used and how to obtain the optimum recovery. A well reservoir stimulator Eclipse 100 was used to model waterflooding and polymer flooding showing the production performance and how to get the optimum production rate when using the polymer flooding and comparing the rate of production of the primary, secondary and tertiary while clearly showing why Enhanced oil recovery method should highly be encouraged not just in Nigeria but globally wherever it is neglected at this critical time in the oil industry.

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