Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijssJunel/2017/026

Original Article

Assessment the Effect of Water Injection on Improving Oil Recovery inX Field

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Abstract

Considering the life of natural production of Iranian oil reservoirs is over Consideration of the appropriate and modern methods of harvesting is essential for the continuation of oil production. The present study focuses specifically on the issue of enhanced recovery in theX overbeach field informationX oil field is used to create analytical processing models and the SWORD 1.0 prediction module has been used for this research. The module is designed to simulate injector-to-generator segments. The X oilfield is located 25.5 kilometers (4.5 kilometers) northwest of the Persian Gulf. This field consists of two parts of land and sea and has more than 50 years of production history that can simultaneously injected water and gas in this field to increase the recovery factor. A special case in the Assessmentfound in this study was that the simultaneous management of water injection into different formations was a misplaced strategy for taking off the X field and damaging the wells of this region. In some Assessment and scenarios, we find that drilling programs between the wells to accelerate oil recovery and thus accelerate the rate of return on investment are needed or suggested.

Key words: Enhanced recovery, Water injection, Overbeach fields, X field

INTRODUCTION

Considering the increasing reduction of oil resources in the world, it is necessary to utilize recovery methods and enhanced oil recovery from reservoirs. One of the common and inexpensive ways to enhanced oil reservoirs is to inject water. The advantages of this method are the ease of water injection, water availability, high water distribution through the oil areaand the high efficiency of oil displacement by water in the oil-rich area. One of the main problems of this method is the low volume of water sweeping efficiency, especially in heterogeneous reservoirs.

Oil recovery from hydrocarbon underground reservoirs is the ultimate goal of the oil industry. At present, major oil production comes from mature or mature oil fields, and exploration of new fields has failed to meet the growing demand for oil. The global average recovery rate of hydrocarbon reservoirs remains at 30%. If this average can be raised beyond the current level, some energy-related issues will be addressed in the world. The challenge has paved the way for technologies of oil secondary recovery and Enhancedoilrecovery (EORs).

The need to plan for the life cycle of the reservoir will inevitably lead us to enhanced of recovery, and implementation of such projects plays an important role in maintaining the value of the reservoir's capital. Evaluations of oil harvesting include a combination of complex decisions with the help of different information sources. Step-by-step implementation of the laboratory scale into a single well, then the scale of the test, and finally the comprehensive scale of the field, as well as the integration of field planning studies with available technologies, require engineers. All of these issues are tied to the workforce of the complexity of the enhanced recovery projects. Occasionally adopting a misplaced correction strategyenhanced of recovery in a field has reduced the overall recovery of that field.

With a brief look at Iran's (E.O.R)projects, we find that the share of these projects from the total Iranian oil production

Access this article online

IJSS
www.ijss-sn.com

Month of Submission : 05-2017
Month of Peer Review : 06-2017
Month of Acceptance : 07-2017
Month of Publishing : 08-2017

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is less than 1 percent, mainly due to over beach fields at field Comprehensive scale and tests scale. The present study focuses specifically on the issue of Enhanced of recoveryin the field of Xover beachis paid.

The X oil field is located in the north of the Persian Gulf, and part of it is inland. The production of this field began in September of 1343. Square X consists of four oil reservoirs called Asmari, Yamama, Manifa and Arabs. The project of injection of water into 12 wells of X field began in 1384, and injection of gas began with two wells since 87. This research describes strategies for Reservoir development RDP design based on water injection in X field and, in this way, evaluating the impact of this project by presenting several scenarios on the decision making that led to the implementation of the EOR project This field will focus.

THE RESEARCH PAST

Oil production from the X field began in the fall of 1343. Since the beginning of the exploration up to 1376, 42 wells were drilled in the oil field, 18 of which were at sea under the name of X1 field and 24 wells in the field under the title X2 field, drilling and exploitationAlso land crude oil processing facilities were designed and implemented in accordance with the title of X1 and X2 installations, with capacity of 100,000 barrels and 110,000 barrels per day, respectively.

At the time of the signing of the X field development contract with one of the major international oil companies in 1999, the company undertook the implementation of the X field development project with a good investment in Iran, which at that time was a major move in attracting capital Foreign would count.

The design, known as the X3, was supposed to add about 800 million barrels of oil to the reservoir by simultaneous injection of gas and water, resulting in an increase of 10% from the X field. The commitment of this large international oil company at X3 field was 83,000 barrels per day, but due to the expected production of some wells, the production capacity in the field was less than the commitment of the major international oil company. The start of the first oil production increase on X field on April 10, 2002, which was April 21, 2002, with a capacity of 15,000 to 16,000 barrels per day, was realized in the framework of its development plan, and in the following years, step by step with entry New wells were added to this oil field, production increased, and eventually it was launched in the first half of 2007. The factory includes: various departments including gas injection facilities, water injection facilities, gas sweeteners, etc. Production is now taking place from the X1, X2 and X3 fields.

Drilling 29 newly productive and injector wells (15 wells, 12 wells of water injection and 2 wells of gas injection) in the sea and inland, and injection of water and gas into the reservoir. Construction of 110,000 barrels per day (Factory) X3) was also one of the main sections of the project. The large international oil company failed to deliver the time agreed with Iran, the injection gas Xfield in line and halted halfway.

The initial forecast recovery value for the X3 oil field was, according to the study, the largest international oil company,21%, by simultaneous injection of water and gas into the field, which was expected to increase by about 31%.

In a report that actually spoke, Professor Ali Mohammad Saeedi (Report 6594 Iranian Parliamentary Research Center, 2001), Referring to his previous studiesby him reported that the recovery factor was 35% without injection, and that in the case of Injecting about 500 million cubic feet of gas into it, the recycling rate would increase by about 60 percent, and that the numbers provided by this large international oil company were completely fake and in order to justify the project.Unfortunately, a study that was completed in 1394 under the name of the enhanced oil recovery project from field X and based on the latest information in the field at the Iranian Oil National Company, proved the Sayings of Professor Saeedi's statement, and stated: According to information Available from field X, while reviewing the past performance of this field, the scenarios outlined above, which were identified in the field performance survey, were completely unreliable, and the use of artificial lift system was emphasized in this field (Hafezzi, 1394).

But finally, on the eighth day of December, 1395, under the new model of Iran's Oil and Gas Contracts (IPC), the developed X oil field was introduced to foreign investors along with other oilfields.

All research done on the project enhanced recovery of this field is as follows:

Kazemzadeh (Petroleum Research, 2011) In a research study of the conditions and types of deposits created in injection and production wells, the study of mechanisms of damaged formation in the process of injection of water into reservoirs, full knowledge of the phenomenon of damage formation and sedimentation in the operation of water injection in X field and providing an appropriate identification card for injection water in X field and formation of sediment in the injection wells of this field.

Mihandoost, Ahmadi and Karim Beigi (1394) in an paper to evaluate the process of water injection and non-melt mixing gas to increase the amount of oil recovery in the X field and the effect of water and gas injection on the motivation of X oil wells and the response of the wells to be considered. The results of the increase in the coefficient and the increase in production are exactly the figures provided by this major international oil company.

Taheri Fard and Dr. Mostafa Salimifar (1394) studied the optimization of the crude oil production process in a randomized model and compared it with production in the framework of unconventional contracts of X field. In this paper, the proposed production program of company A for the years 2000-2024 is compared with the optimum route of oil production from X field. According to the results of this paper, the framework of non-integrative contracts of the first generation, including the unconnected X field, is such that in the optimal production of the disturbance field It creates.

Aria et al. (1997) examined the gas injection in the X oil reservoir in a laboratory study. The phases of this project include examining and conducting PVT tests on oil and gas reservoir X and conducting studies to determine the minimum mixing pressure.

DISCUSSION AND SIMULATION

The X field water and gas injection project was designed for deep-sea reservoirs located in the Persian Gulf. One of the sources of information for examining this was the Comprehensive Model X field. However, only limited information was obtained, especially in a small number of optimized flood patterns that were presented as options for water and gas injection. The two regions of the reservoir are analyzed here.

Comprehensive field information was processed to create analytical models. The particular details of the completion plan can not be completely analyzed, but as far as possible realism was applied in the models. The SWORD 1.0 prediction module was used for this example. The module is designed to simulate injector to Producer. We use the same steps as analytical simulation steps.

As a preliminary review, an unofficial review of the team working on the X project was carried out. As far as the results of the water and gas injections were concerned, the test water and gas helped improve oil production and control the production of water and gas. However, the results of the field implementation generated a slight surprise due to the continuity of the production area between the injectable-to-producer pairs.

The problem of supplying gas to infusion is almost uncommon, which was a critical issue for this field. Optimization of water flooding was considered as a medium term alternative for water and gas injection. Hence, it was decided to study the flood function in a pair of regions from the reservoir. The goal was to determine whether there was a significant difference between the lower flow conditions and the potential for flood water in the field. The results were expected to show differences in the potential of the two reservoir regions.

Stratigraphy, reservoir maps and production history were obtained from several sources. The four upper reservoirs in the Eocene C2 unit are C-20, C-21, C-22 and C-23. The C-23 unit focuses on the water and gas project. Layering information was taken directly from parts of the model used.

Relative Permeability data and PVT were derived from the model. It was reported that relative permeability in high water saturation, except at the endpoint, is reliable. Saturation, porosity, pure to gross, and layer thickness were all directly derived from the comprehensive field model.

Flooding has been ongoing for some time with relatively good successes in the field. Several reservoirs are still under water injection, although the cutting of water in some wells is quite high. The Eocene C2 unit reservoir examined here is evaluated as a nomination for the water and gas process. As we will see later, gas injection, not for technical reasons, but as far as the process goes forward, is due to the lack of sufficient gas injection. Below, a cycle water injection was simulated in the experimental area and showed the potential results of water-flood optimization. The reservoir represents a highly adapted environment with limited vertical connections and sufficient storage for the feasibility of running the process. The water injection process equipment has enough capacity remaining to handle the new IOR process, but are still under careful consideration.

Due to extensive experience related to water flooding around the world, it is relatively easy to identify some of the critical parameters in this project. To show the goals, we have chosen uncertainties in relative permeability. In addition, water and gas saturation can greatly affect water flooding, as the field has been under water and gas injection for a long time. It was discovered that the selected area for optimizing water flooding has an unstable water scan. The latter implies that layer cohesion can play an important role in water flooding. Vertical communication can also cause a significant difference in flood water performance,

although not discussed here, and is considered to be non-critical. Injection water quality is not questioned at this stage, because this category has already been resolved by water in the design of the first flood.

In the next step, geological features were identified as important faults, so that they could be treated individually with isolated blocks. Then, \ "Utility Maps \" were used. These maps are the result of the analysis of CPPs on the reservoir map.

In area X, a section of a light oil reservoir selected as a target for the EOR is a good example of the dramatic changes in pressure. Figure 1 shows the distribution of pressure in the blocks separated by the X field. The most important thing was to extract the heuristicprocesses to determine a small number of cross-sectional levels in the extraction reservoirs, but we did not have to do a lot of refinement because regional statistics (Patterns consist of a few wells) were needed to complete the whole process.

In the end, the average patterns of local wells was required. Here, it is assumed that a pattern, along with its local features, represents a region of the reservoir. Properties such as saturation of oil or water in a region should be sufficiently homogeneous, or there should be a suitable volume (volume average).

Selective reservoir with geological features is clearly indicated, which allows us to divide it into separate blocks. As shown in Figure1, the reservoir of the four regions shows that the pressure values allow us to conclude that the well-known major faults have effectively separated them-in other words, they Obstacles are flowing. The high pressure region in the east is small enough to have no significant effect on any analyzes that relate to this area. Production history suggests that there may even be more partial segregation in the reservoir. However, we do not need to do any more partitioning for the reservoir. Because theFloating aquifer in the field SinceConstruction is dumped, no additional potential is expected from those areas.

The northwest block was remainder with enough reserves to turn it into a good candidate for analysis. Figure 2 shows this block, which is derived from the comprehensive simulation model of the reservoir and can be seen in Figure 1. The two rectangles highlight the areas selected for evaluation. These two regions are equivalent to the selected areas for optimizing water in the comprehensive simulation of the reservoir. They are considered as representing two

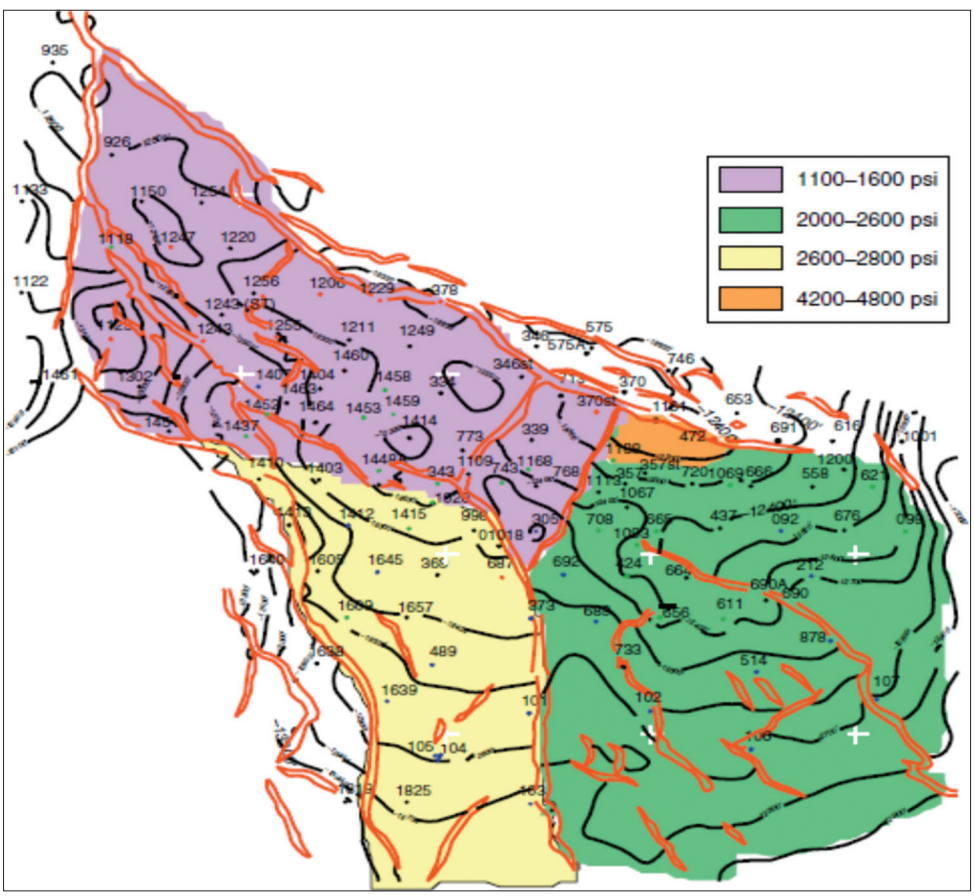

Figure 1: Compressive map for area X field

different blocks of the block: the buildingprominence and the building dip (respectively, to account for high saturation of the gas and high saturation of the water).

Figures 2 to 6 show enlarged areas of selected blocks with 2-D slices between the injection-producing pairs in each region. The intervals due to the high water saturation, underwater flood operation, have a limited potential for simulation, will be blocked. We can see that the cross-section between the wells X0692 and X0708 (Figure 4) shows a higher water saturation in lower intervals than in Figure 6. The sensitivity analysis in these 2-D sections took into account the types of results that can be obtained by the SWORD 1.0 IOR prediction module.

At this stage, the history of previous production or well operation is used to estimate the coherence of the production area and the amount of kh. Beglerby and colleagues (1994) identified two methods for modeling the continuity of the production area and as a result of a matching history. The \ "pure production \" method is preferable because it is physically more reliable and can be easily applied to most simulators. Flow duct models (such as IDPM) can handle vertical heterogeneities directly or with a Dickster-Parsons (DP) coefficient (Fuller, Sarm and Gould, 1992). The SWORD prediction module is part of the SWORD simulator (2009, IRIS), which can be used

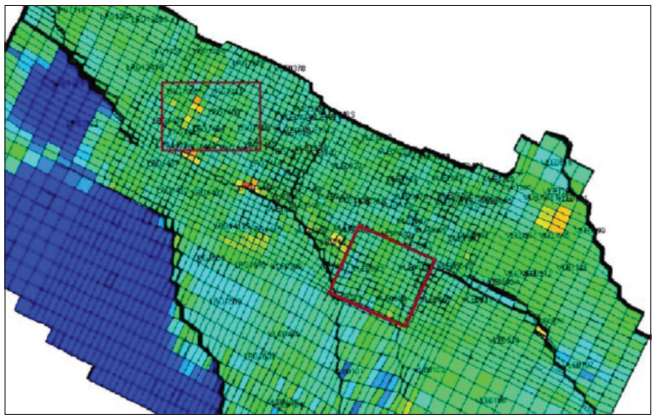

Figure 2: Northwest region of the Comprehensive Model-Field X field. Two red rectangles represent the selected regions for analytic simulations

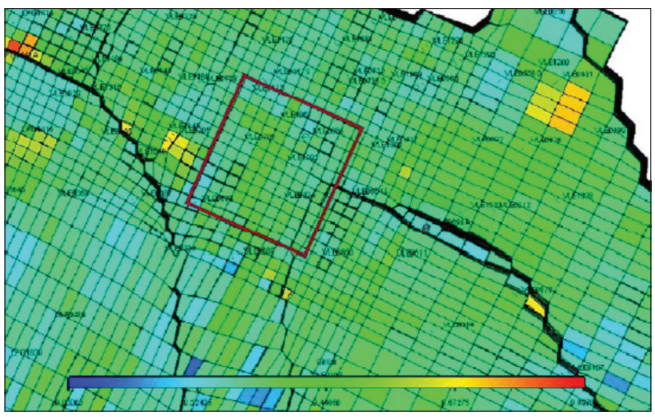

Figure 3: Close-up of the lower area Figure 2

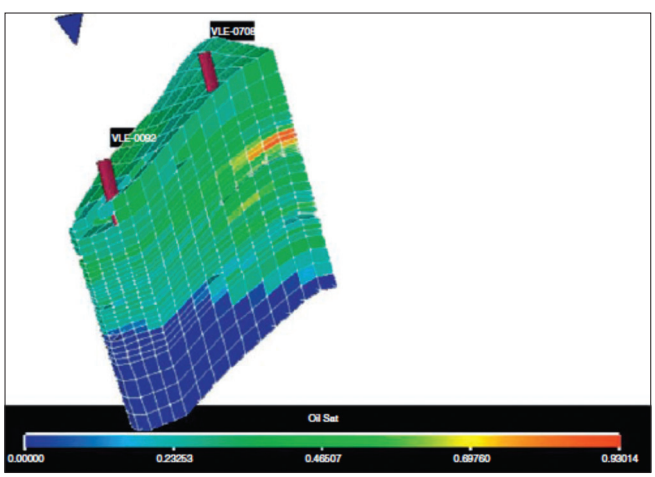

Figure 4: Injector-to-manufacturer cross-section between wells X0692 and X0708 (see Figure 7). This cross-section represents the northernmost area under analysis

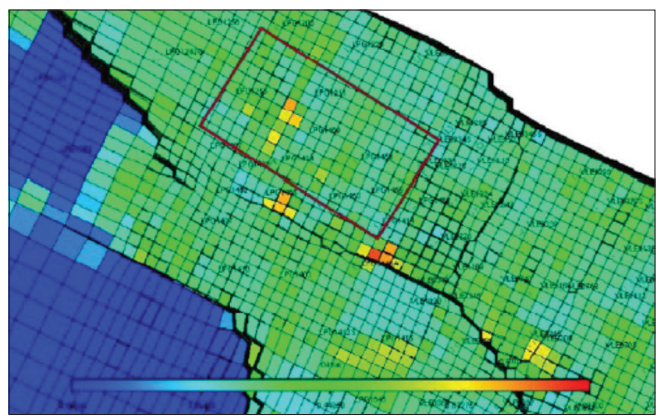

Figure 5 Close-up of upper area Figure 2

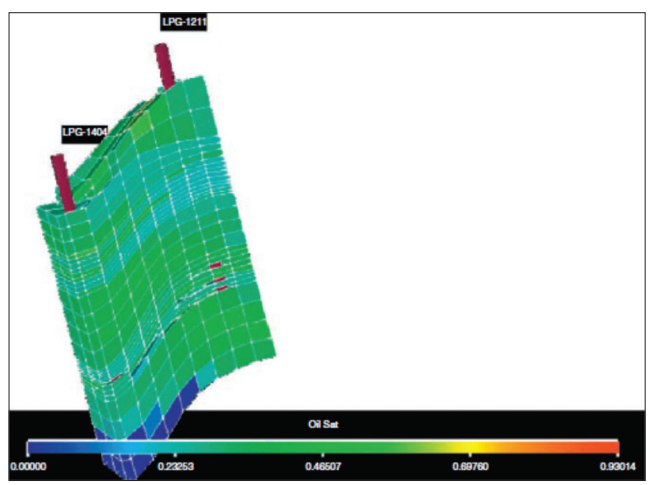

Figure 6: Injector-to-manufacturer cross section between LPG-1404 and LPG-1211 wells. This is the southern representation of the cross section under analysis

in the same way for this purpose. PRIise, except for water flooding, only uses the D-P coefficient, because it does not explicitly interfere with layering.

In the case of X, there was no explicit history matching, but instead, a production history was used to verify the side-by-side connectivity of the reservoir and saturation of the water and gas index in that block. Water injection began in 2001 with a pilot test, but the secondary water injection project did not officially begin until 2002. On the other hand, gas injection has not followed the initial design and, in order to compensate for the deficiency of the pressure to support injected gas, water injection has increased over time. The irregular progress of the water displacement front has, in addition to channeling, also demonstrated the heterogeneous nature of the reservoir. Secondly, the demand for drilling between the wells with a 300-meter-long gap was raised (Figure 7).

Drilling wells between wells at a distance of 300 meters has shown very little interfering effect on older adjacent wells. The current perspective of the continuity of the reservoir, as shown in Figure 8, perfectly reflects the latter case. The sedimentation shows that the reservoir environment includes Umbrella and alluvium canals.

We can see in the figure that it is expected that the C-32, the lowest reservoir, is only at ainterwell distance of 300 meters from continuous crater, because the masses have a

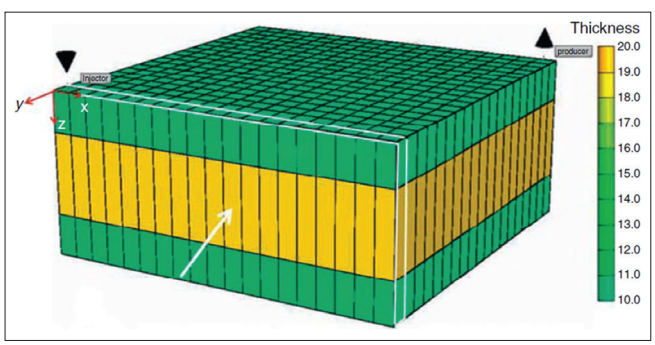

Figure 7: Quarter of the 5-point model for water-flood simulations

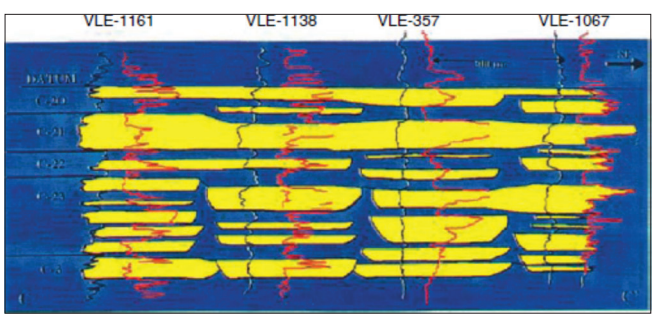

Figure 8: The cross-sectional area of the reservoir that shows its current heterogeneity

cross section of the same size. It seems that the situation for the higher reservoirs is somewhat different, maybe they have better side by side Continuous, but in all cases depends on the orientation in the field. To compare the results, both sections are orientation toward the same. To model the side by side Continuous, it is possible to model a drop in reservoir Continuous as a function of the distance. In regards to greetings, the amount of side by side Continuous can be placed at a separation distance of 300 meters (90%). This number is only referenced, and simulations should be sensitized to it. The sensitivity analysis should be done definitively and the variance of variables should be avoided. As a result, Ternadu charts were generated (Skinner, 1999).

As shown in Figures 4 and 6, most results are related to the cross sections from the injector to the Producer. The layering map in the simulator requires Permeability horizontal and vertical permeation, porosity, pure thickness, and initial saturation of water and gas. Also, all the data that was taken to the recovery factor was calculated not by the OOIP, but rather by the current saturation of the oil. The total production fluid is equal to the total injection rate. In this case, fluids are considered to be incompressible. The fraction of the injection rate designed in the 5-point pattern is used to simulate the cross sectional simulate. In this case, 500 bbl/day was injected. Only DP calculations are shown. The simulations performed with the vertical equilibrium approximation provide a warning about the validity of this approximation. From this study, it was understood that the constant value of Kv/Kh is considered to be 0.1 for the entire field.

Although the wells completion in the selected well to well differs from each other, the whole range is simulated. Except in certain cases, the Continuity of 1 is used in simulations. The first simulation of sensitivity analysis is based on the cross-sectional width for a constant water injection. From the data collected, it is understood that for some patterns in this field up to1000 bbl/day water is proposed. A fraction of this injection volume (500 bbl) is used to simulate. Figure 9 shows the behavior of the oil recovery factor (calculated from oil at the current location) as a function of time in a 20-year period. Three cross-sectional widths were tested: 60 feet, 120 feet, and 180 feet.

Figure 10 shows the oil production rate for the same parameters used to generate Figure 9. As shown in Figures 11 and 12, three cross-sectional widths were tested: 60 feet, 120 feet, and 180 feet. Assuming that wells are closed when the oil production rate in the field falls below50 bbl/day or the water cut to over 95%, the wider (180ft) section of the well results in a reasonable production profile. Both conditions are coming closer after the sixth year, but this is enough for the purpose of this simulation.

All results presented here will be of a 180-foot cross-sectional widths (similar results can be obtained with lower injection rates and channel widths). Here it is important to note that due to the saturation of the water and gas observed in the production well, the Relative permeability end points should be adapted in one or two layers to ensure that the correct mass balance is met. Figures 9 and 10 show that the recovery factor and the oil production rate are not very sensitive to the properties of the injected or produced well, although some differences are apparent.

This is probably due to the fact that the selective cross section in this direction has good properties on the reservoir. Some of the side wells exhibit a small, net of pure sand at the same interval in this cross-section. The latter reflects the highly heterogeneous characteristics of the reservoir. In each case, the behavior of the oil flow rate and, therefore, the recovery factor, should be addressed to be among the cases of acute cases. On the other hand, no trace of un Continuity has been included until this stage.

Relative permeability has been identified as a critical parameter for water flooding (this is true for many enhanced oil recovery). The endpoints indicate a relative permeability obtained from weaknesses in reliability tests. Figure 13 shows the cumulative production of the same 2-D cut-off for the three S_{orw} values, while Figure 14 shows the oil production rate for the same conditions. As shown in Figure 13, a large difference in the recovery should be expected. Even in this simple analytical model, the Relativepermeability effect is obvious. This implies that a high risk factor assumes that the Relativepermeability curve is established for the entire field.

From here, simulations are using $S_{orw} = 0.25$. In C2 reservoir, there are several intermediate spaces that are isolated from non-permeable layers with zero porosity (shale). By looking

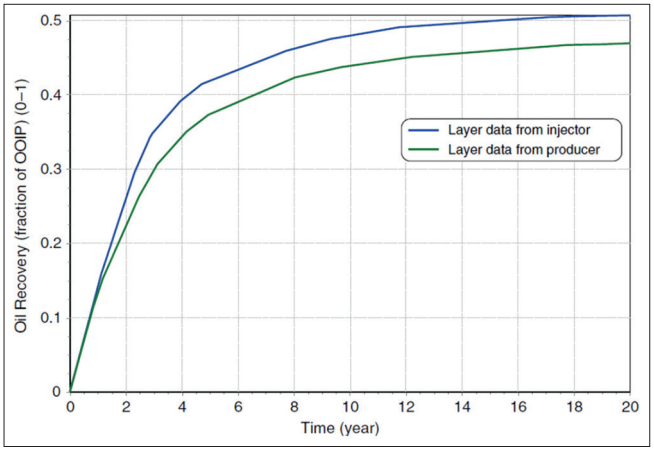

Figure 9: The withdrawal coefficient for a 2-D cut between wells X0692 and X0708. Net production is specified in Section 2-D or from injection or production wells

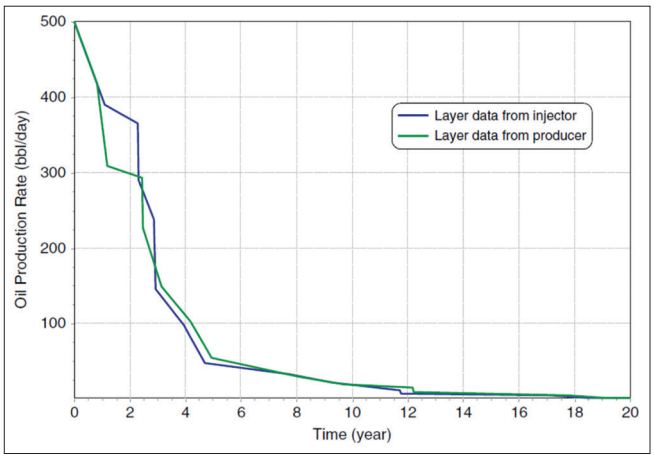

Figure 10: Oil production for a 2-D cut is determined between pure wells X0692 and X0708 in Section 2-D or from injection wells or production wells

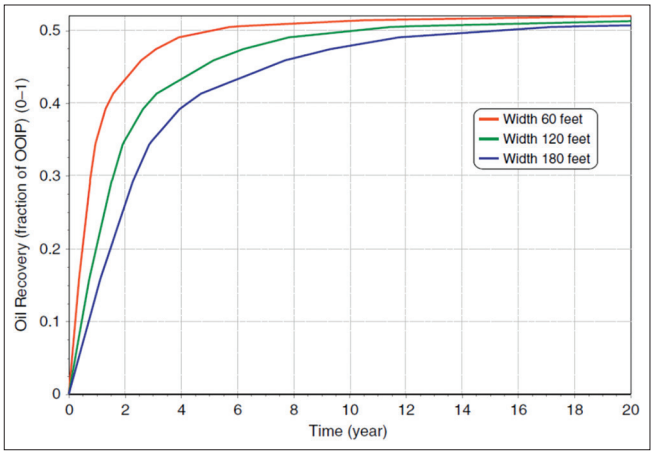

Figure 11: Oil production for a 2-D cut is determined between pure wells X0692 and X0708 in Section 2-D or from injection wells or production wells

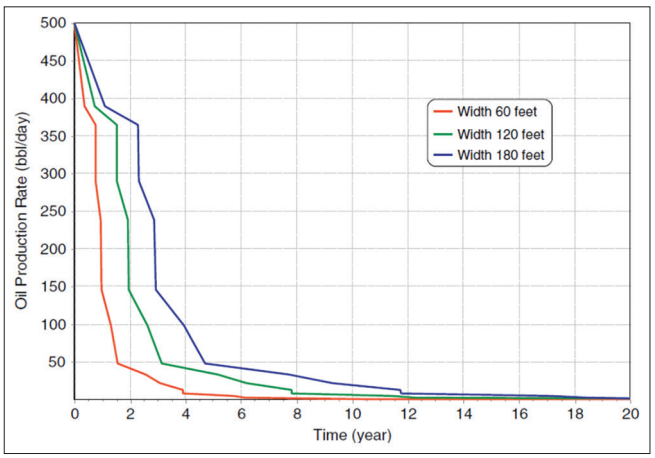

Figure 12: Sensitivity analysis for a 2-D section between wells X0692 and X0708. Water injection rates of 500 bbl / day and three different widths tested are 60, 120 and 180 feet

at the oil production profiles, the cutting of water, and the layer injection rate, we can determine the contribution (significance) of each layer quantitatively (no image is shown).

The category we have not been dealing with so far is the fact that the average saturation can change from the position of the injection well to the wells produced. In the case of X0692, the aquifer has reached the bottom of the reservoir because it is located at the downhill. This situation may have an adverse effect bad performed on the simulations when those distances open. The reason for this is that although it may be suitable for injection, it reduces the amount of remaining oil in the movable Decrease. The last issue when considering the production of this area should be considered. The over slope, where the LPG-1404 wells are located, shows a lower saturation of water, which is a less risky situation. Now, a comparison between the two sections is planned. According to the results so far, all sensitivity analyzes will not be done. Performances on both cross sections were performed with the same parameters (180 ft. Width, 500 bbl/day water injection, 0.25 = S_{row}, and similar relative permeability endpoints).

Figure 15-16 shows the production rate, the water recovery factor and cross. From the three preceding forms, it should be revealed that the potential of the cross-sectional of LPG-1404 and LPG1211 is lower than the cross-section potential X0692 and X0708. There are several possible reasons for this. By reviewing the history of fluid injection in this reservoir, it can be seen that the gas shaft injection is responsible for the displacement of over slope oil, which is the building prominence. Under a water injection scenario, the saturated layers are by gas in the LPG-1404 and LPG1211 sections, which include most of the upper layers expected to a very poor performance (Figure 17).

CONCLUSION

The results of this study are related of X field study, based on the latest information in this field. After reviewing the

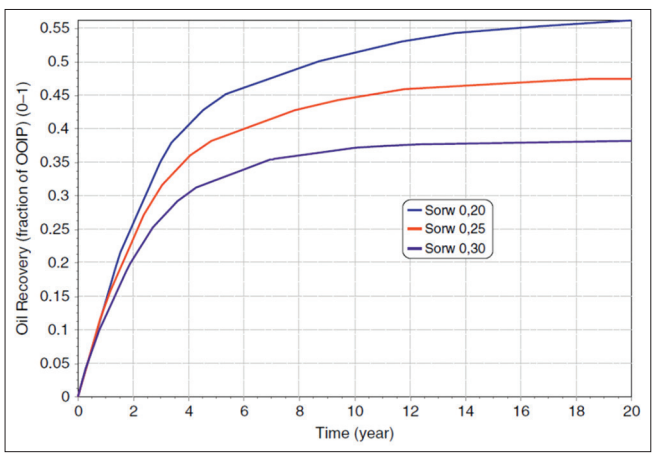

Figure 13: The withdrawal coefficient for a 2-D cutting between the wells X0692 and X0708 and the effect of the end points of permeability

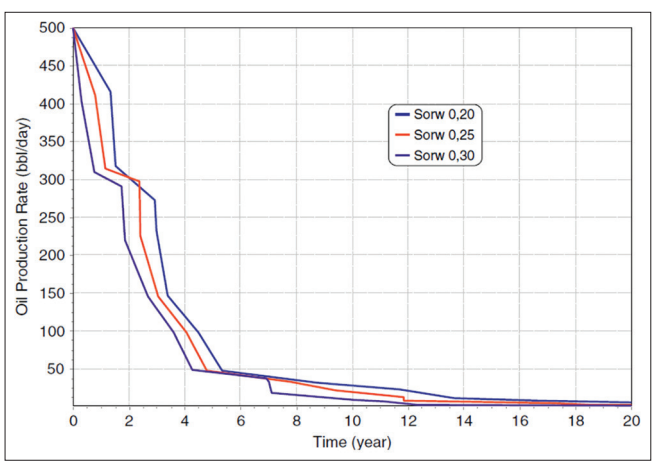

Figure 14: The oil production rate as shown in Figure 13

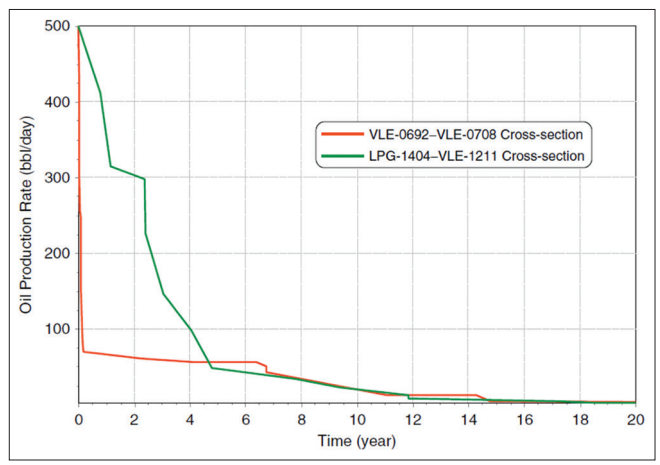

Figure 15: The oil production rate and a comparison between the two cross sections

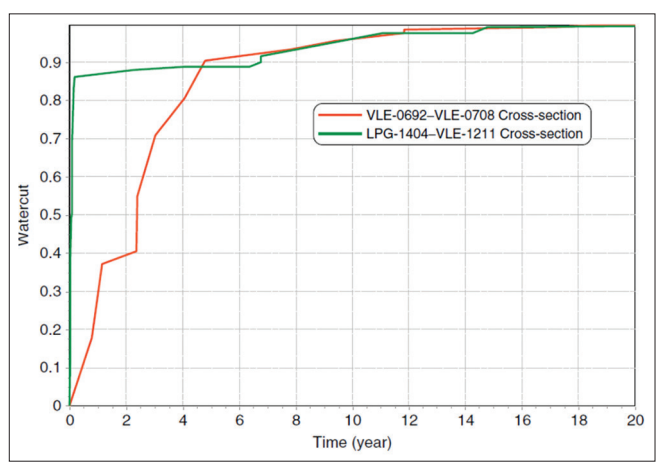

Figure 16: Comparing the cutting of water between two cross-sections. All simulation parameters are the same

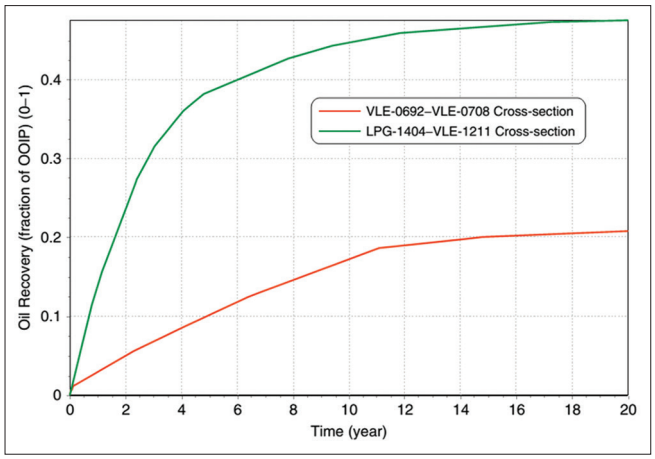

Figure 17: Oil accumulation production from two cross-sections. It should be taken care of precisely because the current amount of oil in the place is not the same

characteristics of the reservoir, its static and dynamic model and reservoir performance in different scenarios such as water and gas injection for Asmari reservoir and Fahlian's reservoir shows that the simultaneous management of various Fahlian formations (Eocene) was not entirely correct, and that different Fahlian formations should be managed individually, which would lead to an increase in water cuts in the wells of this field and the desertification of a number of wells Of this region.

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How to cite this article: Amiri A, Manshad AK. Assessment the Effect of Water Injection on Improving Oil Recovery inX Field. Int J Sci Stud 2017;5(3):173-181.

Source of Support: Nil, **Conflict of Interest:** None declared.