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Nodal analysis calculation for the estimation of the best operating conditions using two wells

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***Abstract*—one of the main challenges in the petroleum industry is to design the best natural production system which is begin from the type of the well thought the completion and ending with the surface facilities, in this study a sensitivity analysis is applied for two wells (Z1 and Z2) in AL_Nafoora field for the simulation of the IPR and OPR model using PIPESIM software to obtained the best operating conditions for the flow rate and flowing bottom hole pressure, a water cut and well head sensitivities are examines in order to figure out the maximum ratio for water cut and the maximum value for the wellhead pressure that should not be excess in order to maintain the natural flowing phase as long as possible.**

The main findings from this study includes that as for the first well (Z1), after conducting the study on it and calculating the percentage of increase in the future water rate, it was found that the maximum value of the well's productivity is when the water saturation rate reaches about 90%, and if this percentage exceeds this limit, the production will not remain normal and will turn to artificial production because the well is not able to flow normally, and for the second well (Z2), when the water production volume reaches 80%, it will stop natural production

Keywords—IPR, OPR, natural production, oil wells, water cut.

I. Introduction

In petroleum engineering, there are many types of wells used, depending on the purpose of drilling and the good type of fluids that can be produced. They are drilled to make sure that reservoir rocks can contain hydrocarbon fluids, and to collect the necessary data and information on geological rocks. These are the first wells to be drilled in the field, while the rest of the other wells that are drilled after them are called orthodontic oil wells in order to evaluate the production of the oil well from the oil reservoir, after confirming the presence of hydrocarbon fluids, and after studying the economic and practical side of the field, the development oil wells are drilled in order to raise and increase the production of the oil well.

The wells were drilled after the discovery of oil or gas, for the purpose of determining the dimensions of the oil reservoir and providing the minimum necessary geological and reservoir data and information, for the purpose of assessing and knowing the existing oil reserves and approving the development of the reservoir or not.

Development oil wells are drilled after the approval of the development of the reservoir, which may be for production purposes (oil or gas), or for injection purposes (water or gas). The term "production well" refers to the type of well used to extract oil or gas from underground formations. Production wells thousands of feet into the ground are drilled directly into oil- or gas-rich deposits found in underground formations.

II. Problem Statement

There are many studies that are concerned with measuring daily production rates and designing the natural production system in order to suit the required amount of production, in addition to the fact that the pipes used in this process are of great importance in this subject as a result of the flow rate that is controlled according to the diameter of the production pipes and the problem of threshing can be summarized in the following points:

1. What are the best operational and design conditions in which the values must be evaluated to ensure the best productivity.
2. What are the future conditions under which the production of the well will stop as a result of the increase in the proportion of water.

III. Objective of the study

1. Learn how to conduct simulations of oil wells with natural production.
2. Identify the effect of natural production and the relationship of variables with each other during the production process.
3. Recognize the best operational roof to ensure the best production rate for the longest possible period of time.

IV. Study Methodolog

1. The work on the project was divided into theoretical and practical parts, for the theoretical part, the information material was collected from the available references and available information about the natural production process in addition to the design of the oil wells, and for the practical part, the PIPESIM software was used to simulate the number of two wells.

2. The use of modern software in order to design a natural production system that includes pipe diameters, type of completion and type of valves used, in addition to choosing the best operational specifications for these tools equipment using the analyzes available in the software.

3. Study Area Location:-

4. Nafoora Field one of Arabian gulf oil company fields that is located in sert basin behind jalu city in the southwest of libya is selected for this study, data collected is from GOSP number X (gas oil separator) and done used data for two Natural production wells Z1 & Z2 that is connected to this GOSP, therefore, done used history files for this wells for collect these data required in this study. 6. Basic information of the wells under study

5. To simulate the process of natural production from the oil reservoir using the wells under study, 3 main types of information must be available, namely information on the oil and gas produced from the oil reservoir, in addition to the well test data represented by the temperature of the reservoir, the pressure of the reservoir and the pressure of the bottom of the static and flowing well for each of the wells under study and the third type of panna is the data related to the completion of the wells and the smellof The general shape of the well and the internal and external diameters of the wells as well as the depth of installation of the envelope pipes and production pipes in the wells under study.

V. Results And Discussion

Table (1) shows the main data of the study

WELL, Z2	WELL, Z1	Parameters
4000	4000	Reservoir Pressure (Psi)
230	230	Reservoir Temperature (F)
130	110	Well Head Pressure Pwh (Psi)
45	50	Separator Pressure (Psi)
1020	2650	Flow Line Length (M)
32.2	38.1	API
2788	2792	Shut In Pressure (Pws)
2556	1602	Flowing Pressure (Pwf)
520	592	Gas Oil Ratio (scf/stb)
4.6	2	Water Cut %
3200	3500	Test flow rate STB/Day

1. Calculations for the well (Z1)

First, the main data of the well, which is represented in the completion data, is entered to obtain the full shape of the well by taking advantage of the design data that has already been indicated.

- ***Calculation of the natural productivity of the well***

The best production point can be found by drawing the relationship between the internal flow and the outer flow of the well and as shown in Figure (1) the value of the operating flow rate is 2500 standard barrels per day and the pressure below the well under these conditions is 2200 psi

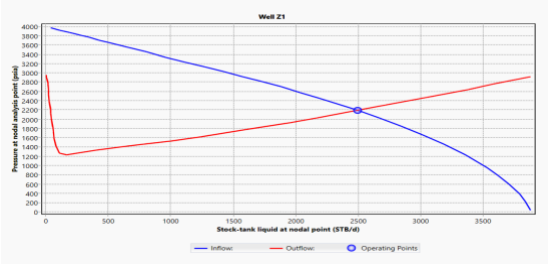
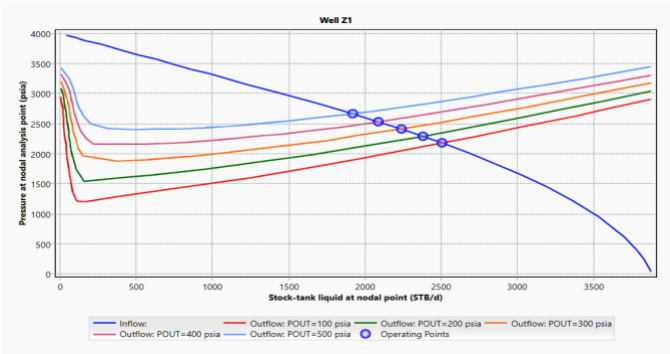


Figure (1) General Figure of Z1 Well Completion Data

- ***Calculation of the effect of the pressure of the well head on the flow.***

The production system is a system that is linked to each other and every pressure of this system is affected by the pressure that preceded it, and of course, the higher the value of the pressure difference between any two points, the rate of flow rate increases, but the best drop of DG must be chosen so that the process is more conservative in a stable state, and Figure (2) shows the effect of the change of well head pressure on the flow rate where noted that the best pressure for the well



head to increase productivity while maintaining production is 100 psi

Figure (2) shows the effect of wellhead pressure on the production rate

- ***Calculation of the effect of the internal diameter of the production pipe on the productivity of the wel.l***

One of the basic things during the design process is to choose the best diameter of the production pipes to be in line with the design process, the higher the diameter values the lower the production value and vice versa and Figure (3) shows the results obtained to calculate the effect of the change of internal diameter where we note that the best diameter of the pipe is 3 inches.

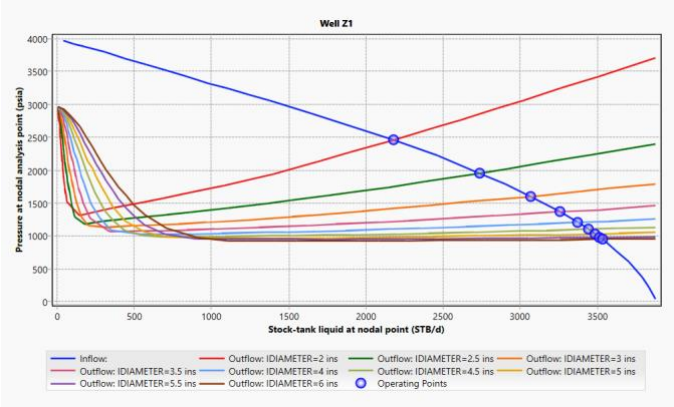


Figure (3) Shows the effect of internal diameter on the production rate

- **Calculation of the effect of the water ratio on total production**

The higher the value of water productivity with oil, the greater the percentage of water produced, and therefore the mixture of fluid produced will become heavier and with time production will not rise to the surface and by doing calculations of the proportion of water in production the main results are obtained as shown in Figure (4) We note that when the water productivity reaches 90%, the well will not be able to produce on its own and we will need industrial lifting methods to enable the well to produce.

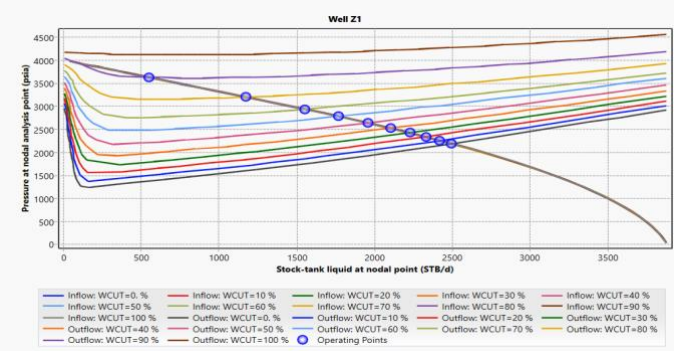


Figure (4) Shows the effect of internal diameter on the production rate

The previous results can be summarized in the following table:

Table (2) Summary of the readings obtained for well Z1

Value	Variables
3 inch	Internal diameter
2500 standard barrels per day	Flow rate
2000 psi	Pressure
100 psi	Pressure of the well head
90%	Maximum water productivity ratio before the completion of the natural production phase

2. calculations of well (Z2)

First, the main data of the well, which is represented in the completion data, is entered to obtain the full shape of the well by taking advantage of the design data that has already been indicated as shown in Figure (5).

- ***Calculation of the natural productivity of a well***

The best production point can be found by drawing the relationship between the internal flow and the outer flow of the well as shown in Figure (5) The value of the operating flow rate is 2400 standard barrels per day and the pressure below the well under these conditions is 3000 psi

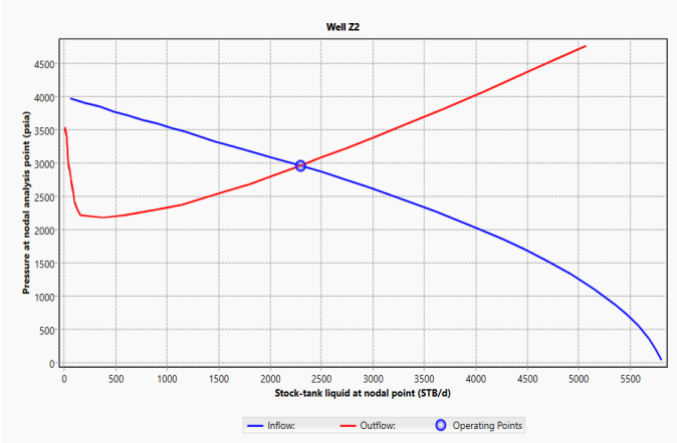


Figure (5) General Figure of Z1 Well Completion Data

- ***Calculation of the effect of the pressure of the well head on the flow***

As the previous trend for well Z1 an increasement of the well head pressure may cause a decrease of the flow rsate and vice versa. Figure (6) shows the effect of the change of well head pressure on the flow rate.
the best pressure for the well head to increase productivity while maintaining production is 100 psi.

Figure (6) illustrates the effect of the pressure of the well head on the rate of production

- ***Calculation of the effect of the internal diameter of the production pipe on the productivity of the well***

One of the basic things during the design process is to choose the best diameter of the production pipes to be in line with the design process, the more diameter values the lower the production value and vice versa and Figure (7) shows the results obtained to calculate the effect of the change of internal diameter where we note that the best diameter of the pipe is 3 inches.

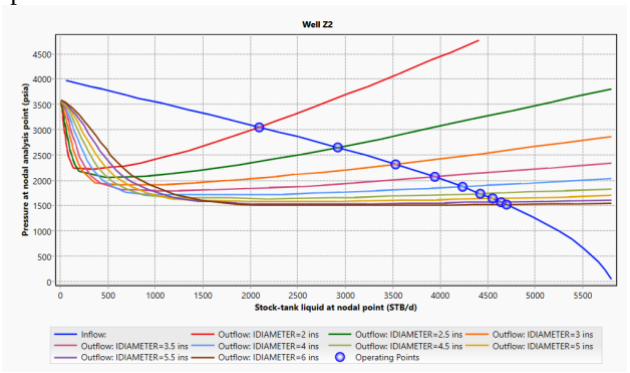


Figure (7) Shows the effect of internal diameter on the production rate

- ***Calculation of the effect of the water ratio on total production***

The higher the value of water productivity with oil, the higher the percentage of water produced, and therefore the mixture of fluids produced will become heavier and with time production will not rise to the surface and by doing calculations of the proportion of water in production the main results are obtained as shown in Figure (8) , when the water productivity reaches 80%, the well will not be able to produce on its own and we will need industrial lifting methods to enable the well to produce.

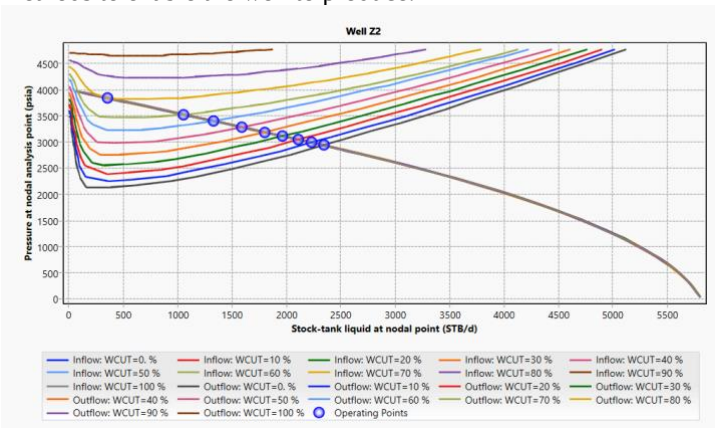


Figure (8) Demonstrates the effect of internal diameter on the production rate

The previous results can be summarized in the following table:

Table (3) Summary of the readings obtained for well Z2

Value	Variables
3 inch	Internal diameter
2400 standard barrels per day	Flow rate
psi3000	Pressure
100 psi	Pressure of the well head
80%	Maximum water productivity ratio before the completion of the natural production phase

VI. Conclusions

Through the study that was conducted on the natural production system we have come to the following conclusions:

1. Oil wellsanda medical gas bar are among the most important wells that are used to extract natural sources from the ground.

2. For the wells under study, the higher the value of the pressure difference between the pressure of the oil reservoir and the pressure below the well, the greater the value of the productivity index, which leads to an increase in the flow rate.

3. For the inner diameters of pipes, the smaller the diameter, the greater the flow rate value.

4. The lower the value of the wellhead pressure, the higher the value of productivity, but the value of the

5. As for the first well (Z1), after conducting the study on it and calculating the percentage of increase in the future water rate, it was found that the maximum value of the well's productivity is when the water saturation rate reaches about 90%, and if this percentage exceeds this limit, the production will not remain normal and will turn to industrial production because the well is not able to flow normally, and for the second well (Z2), when the water production volume reaches 80%, it will stop normal production.

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