SOCAR Proceedings

Reservoir and petroleum engineering

journal home page: http://proceedings.socar.az

SENSITIVITY ANALYSIS OF OIL AND GAS PRODUCTION AS A RESULT OF INCREASING THE DRAINAGE AREA WITH CHANGES IN WELL PARAMETERS DURING DIFFERENT COMPLETION OF WELLS

J. Eyvazov

«OilGasScientificResearchProject» Institute, SOCAR, Baku, Azerbaijan

A B S T R A C T

Drilling of wells and their return to other horizons are planned in certain sequences and intervals in order to obtain maximum economic efficiency during the development and operation of hydrocarbon fields. It is important to determine the real layout of production wells, to study the relationship between them depending on various parameters. In the presented work, depending on the reservoir and well parameters, the drainage areas of horizontal wells and the interrelationships between these wells were determined, and the maximum final production of such wells was determined. The joint hydrodynamic model of the reservoir-well was used in the research. The results of the work can be used to determine the drainage areas depending on the angle of inclination of horizontal wells and to determine the relationship between them, to increase the economic efficiency of the field by reducing the additional costs of drilling unnecessary wells during field development.

K E Y W O R D S

Sensitivity analysis;
Drainage area;
Skin factor;
Hydraulic fracturing;
Acid treatment;
Formation damage;
Production rate.

Introduction

In optimization of hydrocarbon reservoir development optimal production well spacing considered one of the basic problems in the oil industry. Horizontal wells drilled to obtain more hydrocarbons from the reservoir and they cover more drainage area than vertical wells. Usually, longer horizontal well section will give higher gas recovery factor [1]. In our days, when setting well coordinates at a geological or reservoir model and then running these reservoir model in software, for obtaining higher oil and gas recovery , defining the best direction in effective thickness for horizontal well direction and optimal well length has been determined by using different reservoir-well model. By using, these procedures, it has been saved cost and time.

In this case, increasing horizontal well length to close to the reservoir boundary will not give higher oil and gas recovery, because, reservoir properties are low in this area [2]. This case happened because of the drainage radius achieved by the well near the reservoir boundary is getting in narrow effective thickness of reservoir layer. If the horizontal well section has reached to the reservoir boundary area, it will decrease the oil and gas production [3].

In oil or gas fields by drilling horizontal wells that have relatively large size, main issue is setting horizontal well location. Sometimes, conventional methods for horizontal well location can be ineffective and inefficient [4]. Generally, it has been defined to do a lot of sensitivity analysis for optimal production scenario in forecasting future reservoir performance. By doing sensitivity analysis for well length in horizontal well, it is possible to define optimum well length and its productivity index.

There are a lot of parameters in determining the horizontal well length, such as: Reservoir boundary. Based on the nodal well analysis reservoir production performance will be lower in the area near the reservoir boundary than wellbore area[5].

Formation damage will cause to reduce the reservoir permeability in the around of wellbore. This reduction will influence to the productivity index of the well.

Formation damage induces the formation permeability to go down in the wellbore region. The reduction in the permeability of wellbore region will influence in the reduction of productivity of the well. Skin blockage will block pore throats in the near wellbore area. The production rates are reduced as a result of this skin blockage. In this case productivity index is reduced as a result of turbulent flow. When there is turbulent flow in the well, this increase pressure drop than same flow. The reduction of permeability in turbulent flow is higher than Darcy law flow, because, pressure drop in turbulent flow is higher than Darcy law flow [6].

The skin factor

Well stimulation is a term used to characterize various operation carried out in an oil well to get optimum productivity. This method is very vital to the production operation and is employed to strengthen production to flow from the reservoir

**E-mail:* jabrayil.eyvazov88@gmail.com

http://dx.doi.org/10.5510/OGP20220200669

rocks to the wellbore since the hydrocarbons are located in the spaces between pores of reservoir rock. The pull out which the hydrocarbons flow from the reservoir rock to the wellbore is known as the permeability and it is attained when the pore spaces are connected [7].

The permeability around the wellbore is always different from the permeability near the reservoir boundary, because, these areas typically aren't effected by drilling, completion and production operations.

Figure 1 is a schematic illustration of the skin zone is shown here [8].

Partial or complete plugging of the near wellbore area, which reduces the original permeability of the formation.

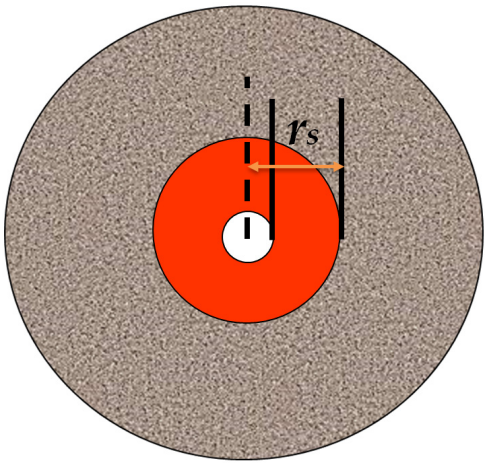

Fig.1. Formation damage

Damage is quantified by the skin (*S*).

$$S = \left[\frac{k}{ks} - 1\right] \ln \frac{rs}{rw} \quad (1)$$

Equation (1) indicates skin factor calculation for vetical wells.

$$S = \left[\sqrt{(H^k V^k HV)} \Big/ \sqrt{\left(HS^k\ VS^k\right)} - 1\right] \ln \frac{rs}{rw} \quad (2)$$

Equation (2) indicates the calculation of skin factor for horizontal wells [6].Well Stimulation is a chemical or mechanical method of increasing flow capacity to a well.

Hydraulic fracturing is a well stimulating technique used to increase the well productivity. In the hydraulic fracturing technique, fracturing fluid/pumping fluid is usually made from mixing water with sand and injecting it under high pressure into the formation [7-8].

This article describes how hydraulic fracturing, deviation angle and deviation angle with 500 m horizontal section influences to the well productivity based on real well example. Project was conducted on Prosper model. This project covers how well oil and gas production will behave in base case, in 30 deviation angle, in 30 deviation angle with hydraulic fracturing and 500 meters horizontal length with 30 deviation angle. Except that, in this well model defined how different parameters – tubing diameters, skin factor effect to the oil and gas production for determination optimum well production rates. In reality, this well is a little bit deviated well. Our purpose was to do some kind of sensitivity analysis to determine optimum parameters for future wells and how production can be in different trajectory.

PVT parameters are as following for this well in the table 1. The results of Constant Mass Expansion test are uploaded into the model and adaption of parameters done for this section. The following results are shown in the table 2.

Figure 2 shows that, how daily oil production rate will be change in base case completion, with 30 deviation angle,

Table 1

PVT parameters for well model

Solution GOR, m^3/m^3	119
Oil gravity, kg/m^3	838.369
Gas gravity, kg/m^3	0.81328
Water salinity, ppm	0

Table 2

Matching of parameters in PVT tests

Pressure, bar	GOR, m^3/m^3	Oil FVF, m^3/m^3	Oil viscosity, cp
1	0	1.0309	2.41353
8.618	4.26	1.0441	2.10595
17.237	9.1	1.0572	1.99951
34.474	17.54	1.0786	1.82365
86.184	40.66	1.1325	1.40926
137.895	65.01	1.1875	1.10401
172.369	81.96	1.2248	0.94854
189.606	90.66	1.2437	0.88249
206.843	99.47	1.2627	0.82313
241.316	117.53	1.301	0.72155
258.553	126.74	1.3203	0.67808
277.176	136.86	1.3413	0.63576
376.041	136.86	1.31785	0.083676
536.608	136.86	1.288827	1.07761
676.09	136.86	1.26811	1.28684

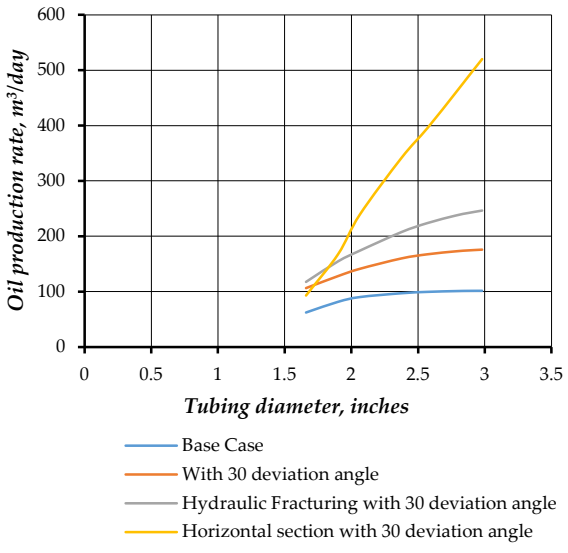

Fig.2. Oil production rate in different tubing diameters with various completion type

hydraulic fracturing with 30 deviation angle and 500 meters length horizontal section with 30 deviation angle in case of different tubing diameters. The main purpose was to define the optimal and productive tubing diameter for this well in different completion type. As a result of this analysis, it has been defined that, with 2.98 inches tubing diameter in base case daily oil production rate will be 101.4 m/day, in case of 30 deviation angle oil production rate will be 175.8 m^3/day, in case hydraulic fracturing with 30 deviation angle daily oil production will be 246.4 m^3/day, in case of 500 meters length horizontal section the oil production rate will be 520.1 m^3/day.

Figure 3 represents that, how daily oil production rate will be change in base case completion, with 30 deviation angle, hydraulic fracturing with 30 deviation angle and in case of 500 meters horizontal section with 30 deviation angle. The main target was to estimate the optimal daily gas production rate in various tubing diameters for this well in different completion type. Based on this research, it has been defined that, with -2 skin factor in base case daily oil production rate will be 127.2 m^3/day, in case of 30 deviation angle oil production rate will be 183.7 m^3/day, in case hydraulic fracturing with 30 deviation angle daily oil production will be 261.9 m^3/day, in case of 500 meters length horizontal section the gas production rate will be 495.3 m^3/day.

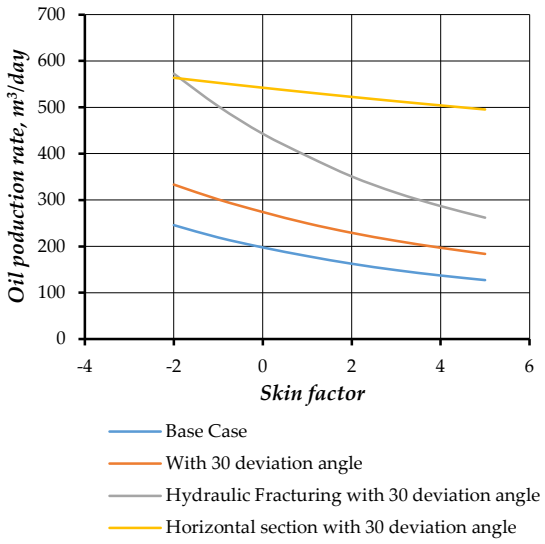

Fig.3. Oil Production rate in different skin factors with various completion type

Conclusion

Study was conducted on how different tubing diameters and skin factor influence oil and gas production in various well completion type. In different well completion type the well drainage area will be increase, it will be effect to the well oil and gas production directly. One of the goal of this project was to determine the optimum tubing diameter to extract more oil and gas from the well as a result of increased well drainage area. Another goal was to define the better undamaged area around wellbore, to set negative skin around wellbore area. Therefore, it has used hydraulic fracturing to increase permeability around well. This well stimulation technique also will increase well drainage area by improving damaged zone around wellbore.

References

1. Etesami, D. (2020). Modeling and prediction of rate of penetration for deviated wells. *Canada: Department of Mechanical Engineering, University of Saskatchewan.*

2. Prasun, S., Kumar, A. (2019, September). Drainage areas, shapes and reservoirs for wells in reservoirs with multiple fluid contacts. SPE -196184-MS. In: *SPE Annual Technical Conference and Exhibition. Society of Petroleum Engineers.*

3. Chan, K. S., Masoudi, R., Karkooti, H., et al (2014, October). Smart horizontal well drilling and completion for effective development of thin oil-rim reservoirs in Malaysia. SPE-170593-MS. In: *SPE Annual Technical Conference and Exhibition. Society of Petroleum Engineers.*

4. Prasandi, A. A., Tutuka, A. (2017). Optimization of horizontal well direction and length considering geomechanics properties and drainage area using genetic algorithm in a gas field. *Modern Applied Science,* 11(9), 114-130.

5. Szott, W., Miłek, K. (2015). Methods to determine drainage area in shale formations produced by stimulated horizontal wells using reservoir simulation modelling. *Journal «Nafta-gas»,* 12, 992-994.

6. Economides, J. M., Nolte, G. K. (2000). Reservoir stimulation. *Chichester, United Kingdom: John Wiley and Sons Ltd.*

7. Wagenhofer, T., Hatzignatiou, D. G. (1996, May). Optimization of horizontal well placement. SPE-35714-MS. In: *SPE Western Regional Meeting. Society of Petroleum Engineers.*

8. Joshi, S. D. (2003, May). Cost/benefits of horizontal wells. SPE-83621-MS. In: *SPE Western Regional/AAPG Pacific Section Joint Meeting. Society of Petroleum Engineers.*

9. Lingyan, H., Hai, T. (2015). The optimization of sidetracking horizontal well. *Development Engineering, Southwest Petroleum University,* 20(14), 5945-5946.

Анализ чувствительности добычи нефти и газа в результате увеличения площади дренирования при изменении параметров скважин при различном заканчивании скважин

Дж. Эйвазов
НИПИ «Нефтегаз», SOCAR, Баку, Азербайджан

Реферат

Бурение скважин и возврат их на другие горизонты планируются в определенной последовательности и интервалах с целью получения максимальной экономической эффективности при разработке и эксплуатации углеводородных месторождений. Важно определить реальную схему расположения добывающих скважин, изучить взаимосвязь между ними в зависимости от различных параметров. В представленной работе в зависимости от параметров пласта и скважин определены площади дренирования горизонтальных скважин и взаимосвязь между этими скважинами, определена максимальная суммарная добыча таких скважин. В расчетах использовалась совместная гидродинамическая модель пласт-скважина. Результаты работы могут быть использованы для определения площадей дренирования в зависимости от угла наклона горизонтальных скважин и определения взаимосвязи между ними, для повышения экономической эффективности месторождения за счет снижения дополнительных затрат на бурение ненужных скважин при разработке месторождения.

Ключевые слова: анализ чувствительности; площадь дренирования; скин-фактор; гидроразрыв пласта; кислотная обработка; повреждение пласта; дебит.

Quyuların müxtəlif cür tamamlanması zamanı quyu parametrlərinin dəyişməsi ilə drenaj sahəsinin artırılması nəticəsində neft və qaz hasilatının həssaslığının təhlili

C. Eyvazov
«Neftqazelmitədqiqatlayihə» İnstitutu, SOCAR, Bakı, Azərbaycan

Xülasə

Karbohidrogen yataqlarının istər işlənmə layihəsinin hazırlanmsı və istərsə də istismarı zamanı maksimum iqtisadi səmərə əldə etmək üçün quyuların qazılması, digər horizontlara qaytarılması müəyyən ardıcıllıq və intervallarla planlaşdırılır. Hasilat quyularının real yerləşmə sxeminin müəyyənləşdirilməsi, müxtəlif parametrlərdən asılı olaraq onlar arasında qarşılıqlı əlaqənin öyrənilməsi mühüm məsələlərdəndir. Təqdim olunan işdə lay və quyu parametrlərindən asılı olaraq üfqi quyuların drenaj sahələri və bu quyular arasında qarşılıqlı əlaqələr təyin olunmuş, bu tip quyuların maksimum son hasilatları müəyyən olunmuşdur. Hesablamaların aparılmasında lay-quyu birgə hidrodinamiki modelindən istifadə olunmuşdur. İşin nəticələrindən üfqi yerləşmiş quyuların əyilmə bucağından asılı olaraq drenaj sahələrinin təyini və onlar arasında qarşılıqlı əlaqənin müəyyən olunması, yatağın işlənməsi dövründə lazımsız quyuların qazılmasına çəkilən əlavə xərcləri azaltmaqla yatağın iqtisadı səmərəliliyinin artırılması məqsədilə istifadə oluna bilər.

Açar sözlər: həssaslıq analizi; drenaj sahəsi; skin faktor; hidravlik qırılma; turşu ilə işlənmə; lay zədələnməsi; hasilat miqdarı.