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Development of East Baghdad Oil Field By Clusters of Horizontal Wells

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Abstract

There are varieties of reasons lead for drilling horizontal wells rather than verticals. Increasing the recovery of oil, especially from thin or tight reservoir permeability is the most important parameter.

East Baghdad oil field considered as a giant field with approximately more than 1billion barrel of a proved reserves accompanying recently to low production rate problems in many of the existing wells.

It is important to say that presence of of horizontal wells in East Baghdad field especially by converting some of already drilled wells by re-entry drilling horizontal sections may provide one of best solutions for the primary development stage in East Baghdad field which may be followed by drilling new horizontal wells or using multilateral wells.

Advance software (Well Test/FAST) has been used to convert the production data for the already drilled vertical wells to horizontals to simulate the productivity. It can be concluded that no measurements available for the ratio of anisotropy (Kv/Kh); in East Baghdad Oil Field therefore, the wells productivity has been estimated using wide range of anisotropy ratios that will help the field operator to determine exactly wells productivity. Moreover, it helps to recommend the effectiveness of applying hydraulic fracturing in improving horizontal well productivity.

The results show that it could be used well EB-32 as a re-entry horizontal well with an optimum section length of 1500-2000ft wich give the best production rate. The same result could be stated for EB-10 with somewhat higher productivity than EB-32.

Keywords: Horizontal wells, Productivity, Vertical permeability, Reentry drilling wells

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1- Introduction

Horizontal drilling represents a tool to reduce drilling operations costs of an oil field due to two concerns; first improving formation production, and second the cost of rig operations and mobilization will be minimized because drilling more than one well in the same land or platform [1]. In other words, horizontal wells are of great interest in petroleum industry because they provide an attractive means for improving both production rate and recovery efficiency [2].

It was found that the factors (well length, permeability ratio, reservoir thickness, skin factor, drainage radius and well radius) affect the pressure drop between the well bore and the reservoir which affect the productivity index in horizontal wells [3].

Also an analytical method could be applied in any position within the entire reservoir area to provide the tilt of originally oil-water contact in all directions in horizontal wells [4].

East Baghdad oil field was discovered by seismic survey which was carried in 1960 and 1974. The first well was drilled and completed in the south part of the field in 1975 and till now already drilled and completed many exploration delineation and production wells in different parts of the field.

East Baghdad Field has actually multi reservoirs, main of them are Tanuma, Khasib and Zubair with different grades of crude oil 21 - 23and 35 API in Zubair formation [5].

East Baghdad oil field considered as giant field with proved reserves estimated at more than11billion barrels and probable reserves to about 17 billion barrels.

The geological structure of East Baghdad oil field is very complicated due to presence of many faults. In the same time the field is locating under treated agriculture lands and urban areas .The total area of the field is about 660 km^2. In 1985 diction was taken to develop the field by clusters and directional wells .Thirteen clusters 700 by 800 m and 49 emergency drilling locations were fixed and reserved to develop that part of the field to reach production rate at 120000 bbl per day.

The development of the field was planned to do by stages and the first stage was done to produce 20000 barrel per day and that stage called the Pilot Project and the selected area was in Rashdya region. The project was completed and the facilities were commissioned in Aug 1990.

The average grade of produced crude was 21-23 API from two reservoirs Tanuma and Khasib by 21 producers and 6 injector's wells with dual completions.

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Eighteen wells were drilled directionally from two clusters by modified skid mounted rigs moved by jacking system on skidding rails gantry slot [6].
One's decision was taken to continue the development of East Baghdad oil field by clusters and directional wells, it is advisable to drill and complete some or reentry drilling horizontal wells for economic reasons and reduction the number of wells. According to the last study done by reservoir engineering department shows that upper Khasib has six layers with total thickness about 70 m and these layers are connected between them vertically [6].

2- Reservoir Selection

Consider the thicker interval with total thickness of 25 m which is the main productive zone of S_w=0.37, so according to that it is recommended to drill the first horizontal well to produce from this layer of upper Khasib formation.

It is possible on lateral horizontal drilling to produce from multilayer or more than one reservoir. Actually, horizontal drilling recently used in development of Iraqi oil fields due to high production rates presence of thick reservoirs. The major purpose of drilling horizontal wells is to enhance reservoir contact and there by enhance well prod activity also in reservoirs with water and gas coning problems; horizontal wells have been used to minimize conning problems [7].

In general, a horizontal well is drilled parallel to reservoir bedding plane [8], that means a horizontal well is a well which intersects the reservoir bedding plane at 90 degree. A typical horizontal well project is different from a vertical well project because productivity of a well depends upon the well length.

3- Selection Horizontal Well Type

There are five types of horizontal wells that have evolved for reasons of hydrocarbon reservoir requirements or to designate the equipment required to drill the wells. The types of wells have become known as [8],[9]:

1- Long – Radius
2- Medium- Radius
3- Short – Radius
4- Tangent
5- Combination

In this study, it is recommended to choose the first type (long- radius) because the depth of productive zone (2000-2200m) allows drilling such types of drilling. The builds section it takes longer time than the other types but the long-radius wells are usually drill with standard directional equipment while short – radius wells require an assortment of special equipment.

Vertical well drains cylindrical volume whereas horizontal well drains an ellipsoid; three-dimensional ellipse. Since, horizontal wells expectable to drain larger reservoir volume than vertical wells [10].

4- Work Development

Advance software technology (F.A.S.T well test) (Appendix A) has been used to convert the production data for the already drilled vertical wells to horizontals to simulate the productivity [11].

The converted horizontal wells have been simulated to oil production assuming the cases of (1- No-communication exist between the layers, 2- Degree of communication exist between the layers). The simulated results show that the first assumption led to incorrect results, while the second assumption led to give the most reliable results.

Two vertical wells EB-10 and EB-32 have been selected to be converted to horizontal wells and simulated for different lateral section lengths (260-3000 ft).

Moreover two values of skin factor (S=0 and S= -4) have been processed to analyze the sensitivity of simulation the hydraulic fracturing in production increment.
It can be stated that no measurements available for the ratio of anisotropy (K_v/K_h); therefore the wells productivity has been estimated using wide range of anisotropy ratios that will help the field operator to determine exactly wells productivity soonest getting this value.

Moreover, it helps to determine the effectiveness of hydraulic fracturing in improving horizontal well productivity.

5- Results and Discussion

Fig. **1** shows the effect various lateral horizontal lengths (500-2500 ft) for different estimated (K_v/K_h) ratios for well EB-32.

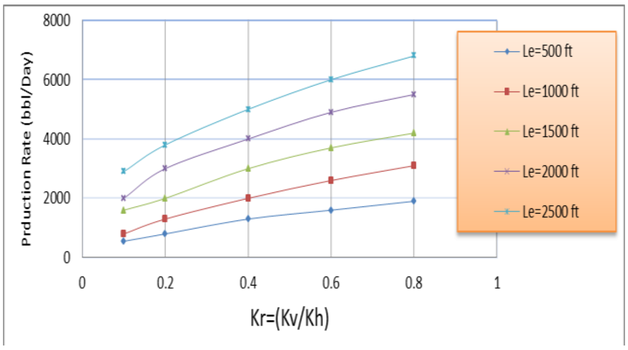

Fig. 1. Production /rate versus (Kr) for different lateral section length. Well No. (32)

Also, it could be noticed that increasing well lateral section in low (K_v/K_h) ratio has little effects in increasing well production rate.

Fig. **2** shows the variation of the productivity index versus different ratios of (K_v/K_h) with different lateral section lengths (well EB-32).

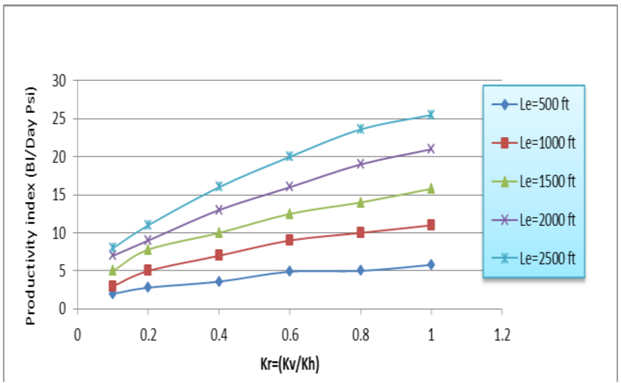

Fig. 2. Productivity index versus (K_r) for different lateral section length (Le.) Well No. (32)

In the same trend, Fig. **3** shows the productivity index versus lateral section lengths for different K_r ratios for well EB-10. It could be noticed that the well EB-32 requires higher flowing pressure in lateral section length less than 1500 ft especially in low (K_v/K_h) ratios as shown in Fig. **4**.

A comparison for the productivity index versus lateral section length for the two wells has been made shown in Fig. **5**. The results show the same trend for both wells with some what little higher values for well EB-10. The production capacity for the well EB-32 is also simulated for two simulation values of (S=0 and S= -4) for various vertical to horizontal permeability ratios (K_r) as shown in Fig. **6** and Fig. **7** respectively.

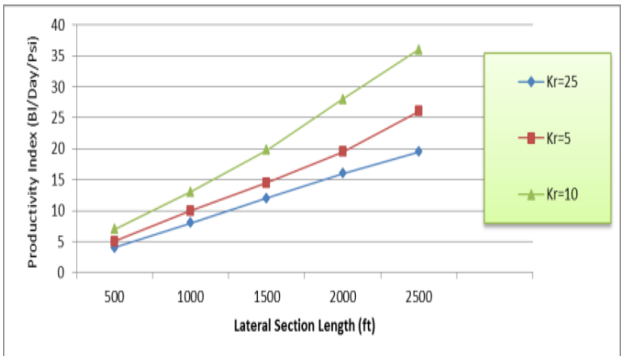

Fig. 3. Productivity index versus lateral length for different (k_r) ratios, well no. (32)

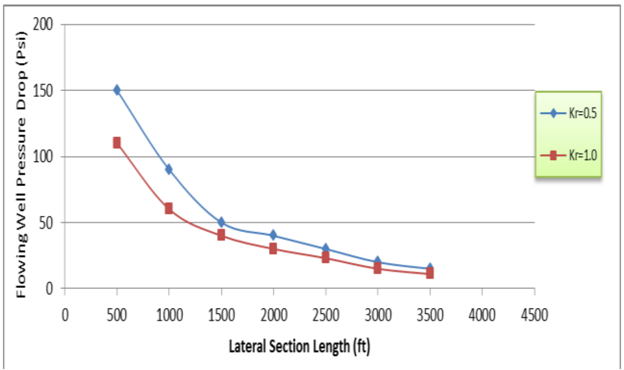

Fig. 4. Following well pressure drop versus lateral length for two different (k_r) , well no. (32) with s=0

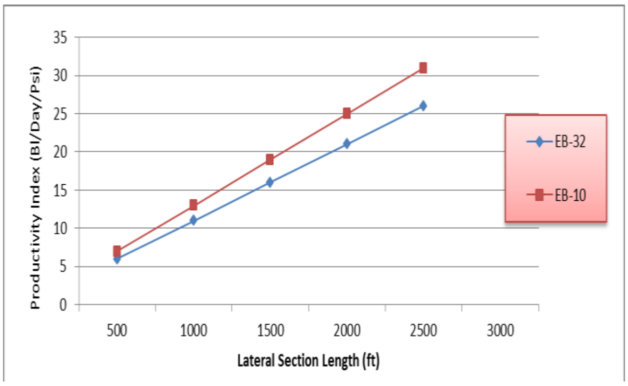

Fig. 5. Comparison for the Productivity Lateral Section Length for two wells

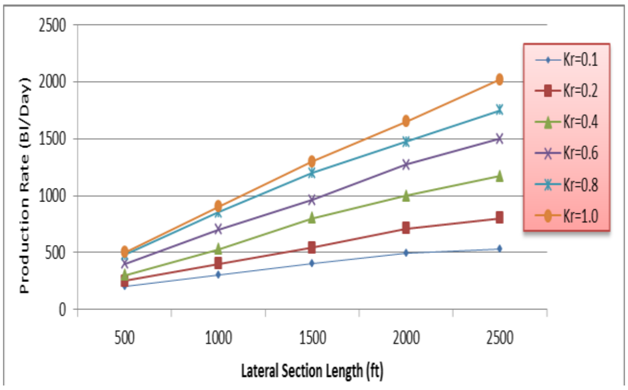

Fig. 6. Production rate versus lateral section lenght for different (k_r) ratio well no. (32) with s=0

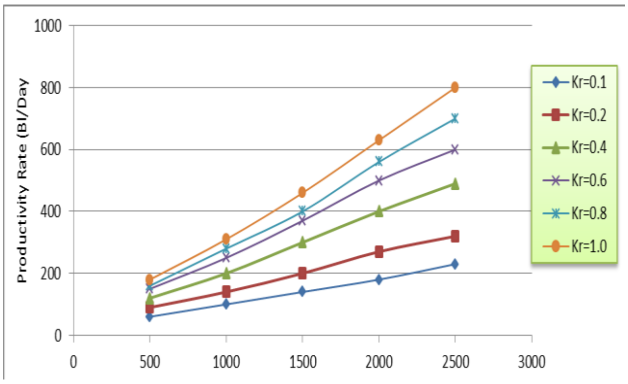

Fig. 7. Well production rate versus lateral section length for different (k_r) ratios, well (eb-10) with s=-4

For the well EB-32, the results show that the production capacity could be increased between (30%-100%) than the production capacity for that of vertical well for each (100 ft) lateral section length increment depends on the vertical to horizontal permeability ratios (K_r), notice that minimum section length in which the production capacity will be equal to that of vertical well should be not less than (260 ft).

While, the well shows high sensitive to the acids stimulation activity (-S) and could be response to increase the production capacity between (68%-80%) for each degree of stimulation (S= -1). Meanwhile, the well shows poor response to stimulation by fracturing stimulation.

6- Conclusion and Recommendations

Investigating Figures 1 and 6; it could be noticed that increasing well lateral section in low vertical to horizontal permeability ratios (Kr) has little effects in increasing well production and then could be recommend to use small lateral section lengths (1000 – 2000 ft) and by adding the effects of acid stimulation activity to those wells to extra increase the production rate as shown in Figure 7. Moreover, it could be seen from Figure 4 the wells will need for high flowing pressure drop in low vertical to horizontal permeability ratios (Kr) when using lateral sections less than (1500 ft), while the required flowing pressure drop could be much lower when using lateral section lengths of (2000 – 3000 ft).

However, wells of lateral section greater than (2000ft) may not cause a considerable minimizing the flowing pressure drop, that conclusion led us to recommend converting well EB-32 to a re-entry horizontal well with lateral section of (1500- 2000 ft) keeping in mind acid stimulation process to increase the production rate.

It can be concluded that no measurements available for the ratio of anisotropy (K_v/K_h); in East Baghdad Oil Field therefore, the wells productivity has been estimated using wide range of anisotropy ratios that will help the field operator to determine exactly wells productivity. Moreover, it helps to recommend the effectiveness of applying hydraulic fracturing in improving horizontal well productivity

Nomenclatures

API: American Petroleum institute
EB: East Baghdad Oil Field
K_v: Vertical Permeability
K_h: Horizantal Permeability
K_r: Relative Permability
PTA: Pressure Transient Analysis
S: Skin factor
S_w: Water Saturation

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Appendix A

F.A.S.T Well Test™ is used to perform pressure transient analysis (PTA) to interpret reservoir flow characteristics and predict future reservoir production. The information contained within this help document describes the appropriate PTA theory and terminology used in the software

Horizontal Model

The horizontal model simulates the pressure response in a horizontal well within a rectangular shaped reservoir with anisotropic heterogeneities (differences in permeability in the x, y, and z directions) or dual porosity characteristics. The anisotropy is handled using a conformal mapping procedure which adjusts the boundary sizes accordingly to mimic the effect of increased or decreased permeability in each direction.

The horizontal well is oriented in the x-direction and may be at any location within the reservoir and support infinite no flow, and constant pressure boundaries. Note that the effective wellbore length (L_e) defines the wellbore area open to fluid flow. Thus, classical configuration like a well near a sealing fault or a constant pressure boundary near intersecting faults can be easily modeled . No flow boundaries are modeled using the method of images. The result is superposed in time based on the rate history provided.

تطوير حقل شرق بغداد النفطي بواسطة مجاميع من الآبار الافقية

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الخلاصة

توجد العديد من الاسباب التي تؤدي الى تفضيل حفر الآبار الافقية على الآبارالعمودية.زيادة استخلاص النفط من التراكيب القليلة السمك او المكامن القليلة النفاذيه يعتبر من اهم العوامل لاختيار هذه الطريقة من الحفر.

يعتبر حقل شرقي بغداد النفطي من الحقول النفطية العملاقه باحتياطي مؤكد يتجاوز 11 مليار برميل نفطي يترافق معه حاليا مشكلة الانتاج القليل في العديد من الآبار الموجودة. لذلك فان دراسة استخدام الآبار الافقية في حقل شرقي بغداد وخصوصا تغيير بعض الآبار المحفورة باعادة حفر بعض المقاطع منها افقيا قد يعتبر واحدا من افضل الحلول التطويرية في هذا الحقل والذي يمكن ان يتبع بحفر آبار افقية او استخدام الحفر متعدد الاذرع. تم استخدام برنامج متطور(مع بعض التحويرات) لتغيير الآبار العمودية الحالية الى افقية لتحسين الانتاج.

تبين نتائج الدراسه انه يمكن استنتاج انه لاتوجد قياسات حقليه للنسبه(النفاذيه العموديه /النفاذيه الافقيه) في حقل شرقي بغداد النفطي وعليه فان انتاجية الابار قد تم تخمينها باستخدام مدى واسع من نسب تباين النفاذيه والتي ستساعد مشغلي الحقل في حساب او معرفة انتاجية الابار بصورة دقيقة. اضافة الى ذلك فانها تساعد في التوصية بكفاءة استخدام تقنية التشقيق الهايدروليكي لتطوير انتاجية الابار الافقيه في حقل شرقي بغداد النفطي. اظهرت النتائج انه يمكن استخدام البئر EB-32 كبئر افقي جديد مع امثل مقطع افقي بطول (1500-2000) قدم والذي سيعطي افضل معدل انتاج و يمكن الحصول على نفس النتيجة مع البئر EB-10 مع معدل انتاج اعلى مقارنة بالبئر EB-32

الكلمات الدالة: الابار الافقية, الانتاجية, النفاذية العمودية