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Different Development Scenarios to Increase the Production Rates for Fauqi Oil Field Southeastern Iraq

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Abstract

The Fauqi field is located about 50Km North-East Amara town in Missan providence in Iraq. Fauqi field has 1,640 MMbbl STOIIP, which lies partly in Iran. Oil is produced from both Mishrif and Asmari zones. Geologically, the Fauqi anticline straddles the Iraqi/Iranian border and is most probably segmented by several faults. There are several reasons leading to drilling horizontal wells rather than vertical wells. The most important parameter is increasing oil recovery, particularly from thin or tight reservoir permeability. The Fauqi oil field is regarded as a giant field with approximately more than 1 billion barrels of proven reserves, but it has recently experienced low production rate problems in many of its existing wells. This study will concentrate on analyzing the Asmari reservoir as the main production reservoir in this field for an oil gravity of 18 API. While, well (FQ-8) has been selected as a pilot well to verify different development scenarios that could be taken to increase the reservoir production rate. The results show that both drilling lateral sections and performing the stimulation process in some reservoir intervals yield positive results to increase good productivity with different percentages. The lateral sections occasionally gave higher productivity than the stimulation process by (2-3) times.

Keywords: productivity, vertical well, multilateral, Horizontal well, Fauqi oilfield.

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1- Introduction

Horizontal wells may be more productive than vertical wells drilled in the same formation because of the extensive exposure to the reservoir. Therefore, it is anticipated that longer horizontal wells will produce more than shorter wells. That might not always be the case, though. The main uncertainty is whether a horizontal well's productivity will rise according to the well's length and horizontal section perforation rate [1].

Due to the many benefits presented, horizontal well drilling has achieved widespread acceptance over the last decade. Horizontal wells are primarily used to increase well productivity by increasing contact with reservoir rocks. From an economic perspective, increasing the area of contact with the reservoir will result in an increase in the well's productivity index. These findings suggest that longer horizontal wells are more productive, and that horizontal wells should be drilled as long as practicable [2].

An excellent and shining example of innovative technology applied to meet modern economic needs is the multilateral concept. Actually, the idea of a multilateral well is not new. The first multilateral well was actually sunk in 1953 at a field in Russia, and in 1997, over 35 multilaterals of various descriptions being drilled in the Middle East [2].

Due to two reason, including improved formation production and reduced rig operations and mobilization costs as a result of drilling multiple wells on the same piece of land or platform, horizontal drilling is a method to lower drilling operations costs of an oil field [3]. In other meaning, the petroleum industry is particularly interested in horizontal wells since they offer a convenient way to increase both production rate and recovery efficiency [4].

The parameters (well length, permeability ratio, reservoir thickness, skin factor, drainage radius, and well radius) were discovered to have an impact on the pressure drop between the well bore and the reservoir, which in turn effects the productivity index in horizontal wells [5]. The analytical method can be applied to provide the position of OWC in all direction in Horizontal wells [6].

Fractures play an important role for fluid flow and well productivity in the Asmari carbonates. Currently the field is producing oil under primary recovery from two reservoirs: (i) the Tertiary Asmari carbonates and siliciclastics (151 MMbbl STOIIP) and (ii) the Cretaceous Mishrif limestones (585 MMbbl STOIIP).

Advanced software computer programs have been used to analyze the production history of 2005 for the well (FQ-8) using rate time analysis software and to verify different development scenarios to increase the production rates using the advance well test analysis software.

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2- Asmari Formation Characteristics [7]

From top to bottom the Asmari consists of a dolomite-dominated subunit, a limestone subunit with intercalated several meter-thick sandstone complexes, a siliclastic subunit, and the carbonates of the Middle/Lower Kirkuk. These subunits were deposited in different environments as reflected by their highly variable reservoir characteristics.

3- Development Scenarios

The productivity of the Asmari wells varies greatly with a productivity index (PI) between 3 and 56. This large range is interpreted to be due to the combined heterogeneity in matrix and fracture properties.

The causes for the reservoir heterogeneity are very poorly understood, results in severely limiting uncertainty management during the future field development [8].

The current production and perforation policy concerning the Asmari and the Mishrif reservoir is not evident. Possibly, the production from the Fauqi field could be significantly increased by optimizing the field development strategy. This reservoir consists also from unconsolidated sandstone, since the hydraulic fracturing may have excluded from the development scenarios. Then only acid stimulation and drilling horizontal well sections are taken into consideration.

The productivity provided by the lateral horizontal sections have been verified while penetrating some of the productive intervals to select the best section that has potential to provide more productivity.

4- Result and Discussion

4.1. Results of stimulating the productive intervals of the vertical well

Fig. 1 show the stimulation results for different interval lengths of the vertical well; this shows that thicker section provides higher sensitivity to stimulation and provide higher flow capacity than thin intervals.

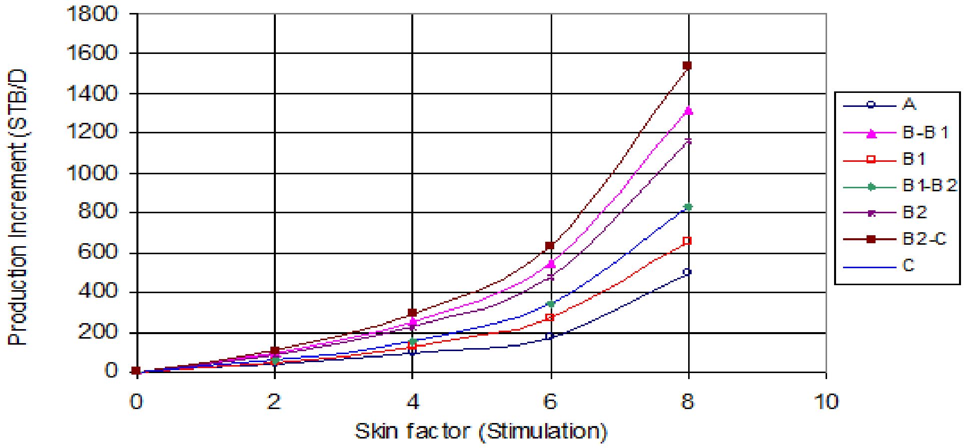

Fig. 1. Production Increment in Well FQ – 8 Using Stimulation Operations within its Intervals

Fig. 2 and Fig. 3 show the increment in the productivity index and the production rates respectively versus lateral section lengths in various expected vertical to horizontal permeability ratios. This indicates the high sensitivity of the thin beds to response with the lateral sections, but no effect for the vertical to horizontal permeability ratios to increase the productivity in such thin beds. Hence, Fig. 4 show the high response for the stimulation process with the lateral sections.

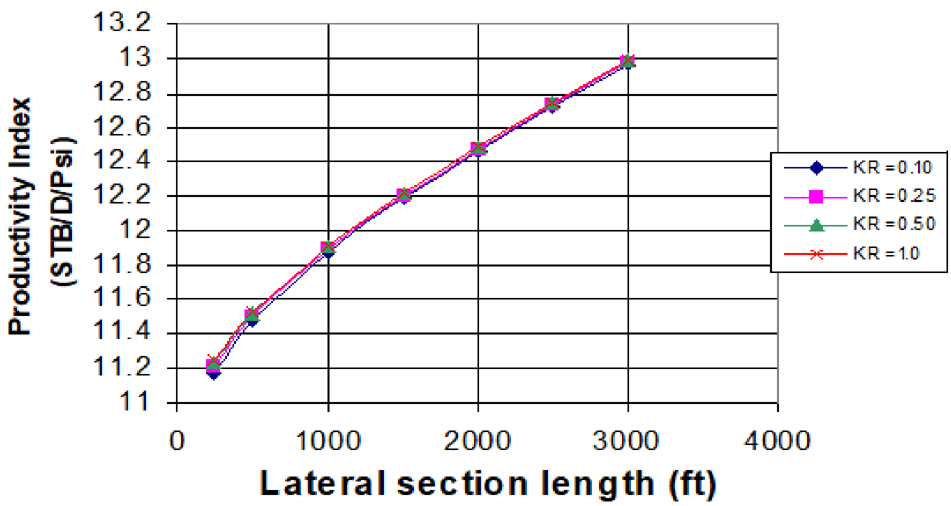

Fig. 2. Productivity Index vs. Lateral Section Length Drilled in (10 ft Interval) for Different K_R Values , Skin =0

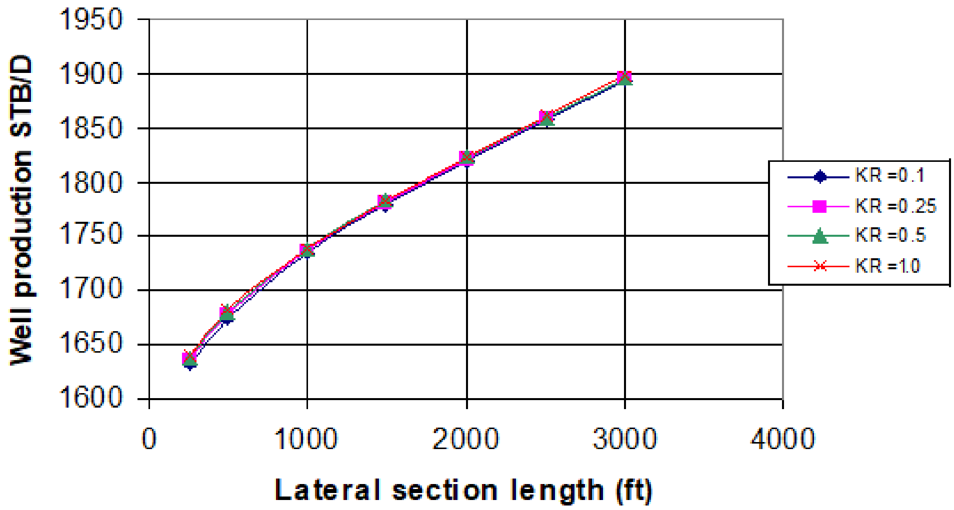

Fig. 3. Well Production Vs. Lateral Section Length Drilled in (10 ft Interval) for Different K_R Values , Skin =0

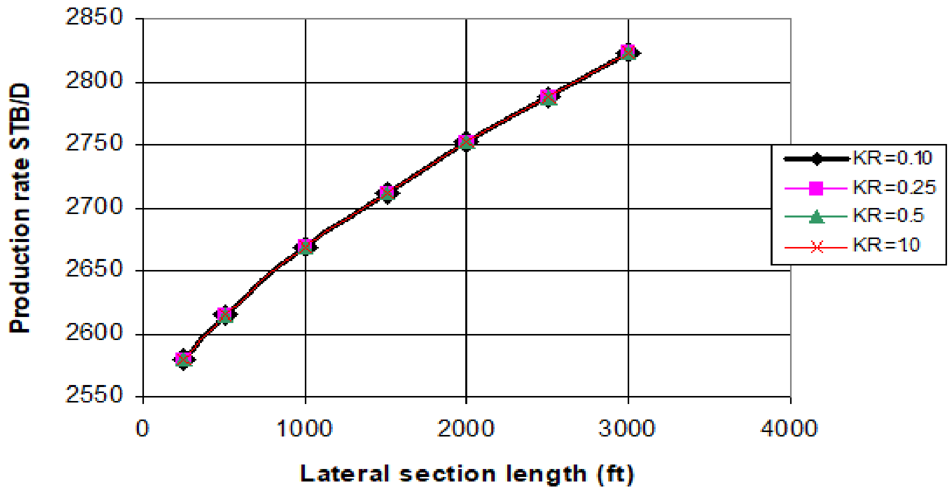

Fig. 4. Well Production Vs. Lateral Section Length Drilled in (10 ft Interval) for Different K_R Values , Skin =4

4.2. Results of drilling horizontal section penetrating interval (B-B1)

Fig. 5 and Fig. 6 show the increment in the productivity index and the production rates respectively versus lateral section lengths in various expected vertical to horizontal permeability ratios. The results indicate low sensitivity of the thicker beds to response with the lateral sections (approximately 0.26 STB/D/Meter), in spite of it is still yields higher flow rate capacity than thin beds. Moreover, the results show no considerable effect for the vertical to horizontal permeability ratios to increase the productivity in such thin beds.

4.3. Results of drilling horizontal section penetrating interval (B2-C)

Fig. 7 and Fig. 8 show the increment in the productivity index and the production rates respectively versus lateral section lengths in various expected vertical to horizontal permeability ratios. The results also indicate the low sensitivity of the thicker beds to response with the lateral sections, in spite of it is still yields higher flow rate capacity than thin beds. Moreover, the results show small effect for the vertical to horizontal permeability ratios to increase the productivity in such thin beds especially in small lateral section lengths.

Fig. 1 show different response for the percentage productivity increment while drilling horizontal lateral sections that is ranging between (30-150 %) for the lateral section length of (3000 ft); Hence, it could also be noticed that the thicker intervals provides the most increment in the productivity than thin intervals.

Fig. 9 show weak response in percentage productivity increment while stimulation activities for the various bed sections that is ranging between (10-40 %) for the stimulation value reach to (skin= - 6); However, larger values of stimulation in sandstone formation could not be reached and so it is just stated theoretically between (-1 to -8). Hence, it could also be noticed that the thicker intervals provide the most increment in the productivity than thin intervals.

The results show that penetrating thicker formations yield for higher production rates than that of thin formations. Moreover, it seems that the thicker formation is more sensitive to vertical to horizontal permeability ratios that thin interval sections. However, this sensitivity stills not considerable even while penetrating the section (B2-C) of 9m thickness. In fact, this results conform the primary results of weak communication may exist between the reservoir productive intervals.

Fig. 1 and Fig. 9 shows that drilling lateral sections usually provides higher productivity increments than stimulation process, these results indicates that lateral sections provides productivity increments (2-3) times higher than stimulation activities may made in any of the reservoir interval sections. Hence, it could be useful to mention that the theoretical results show in higher stimulation values greater than (Skin = -8), the productivity of the stimulated sections reached that of the lateral sections greater than 2500 ft, but practically this could be difficult to be reached in weak sandstone formation to prevent quick sand production [9, 10]. This point could be extended to the damage may accompanying the drilling length lateral sections, because the horizontal wells are much more susceptible to damage than their vertical counterparts due to several number of reasons.

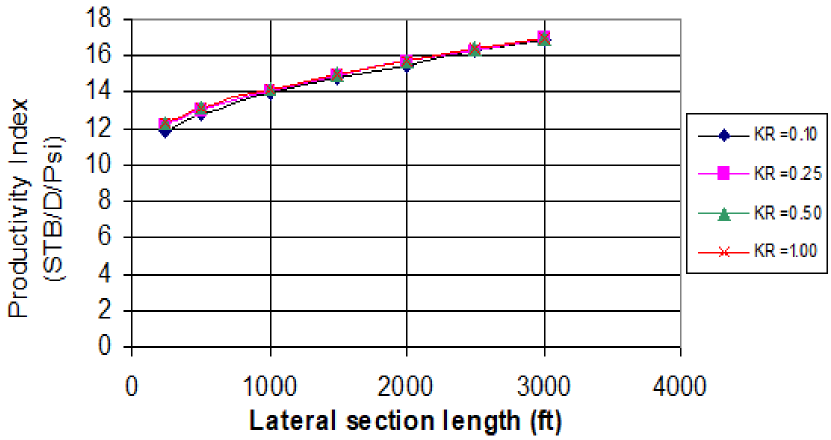

Fig. 5. Productivity Index Vs. Lateral Section Length Drilled in (26 ft Interval) for Different K_R Values , Skin =0

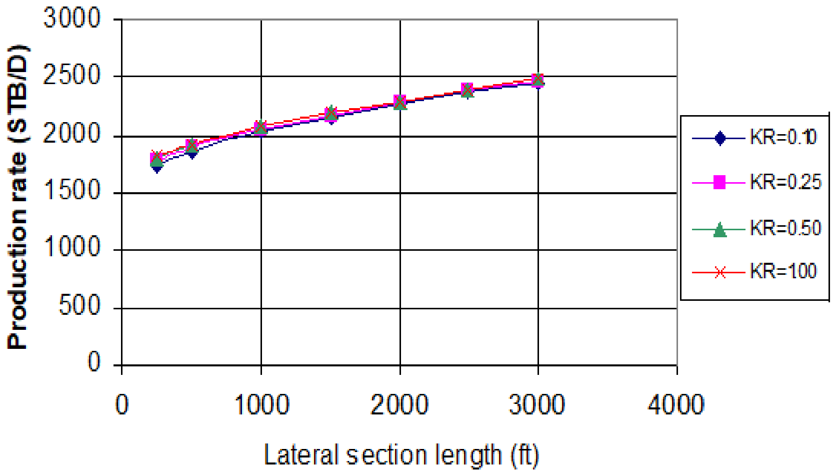

Fig. 6. Production Rate Vs. Lateral Section Length Drilled in (26 ft Layer Thick) for Different K_R Values , Skin =0

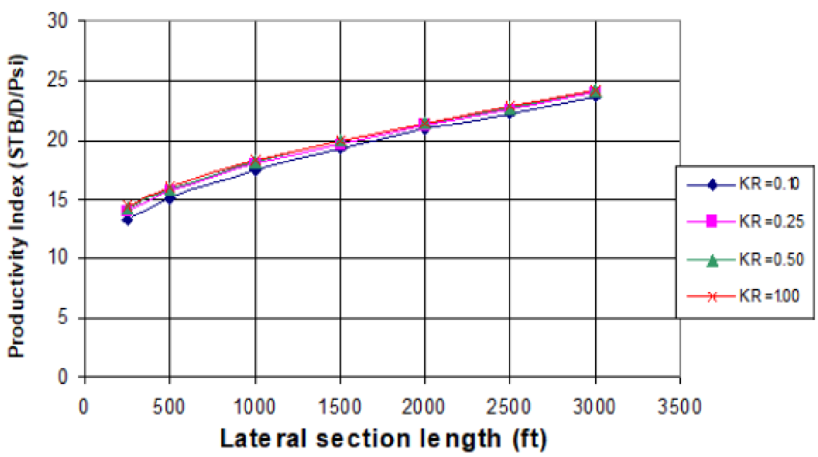

Fig. 7. Productivity Index Vs. Lateral Section Length Drilled in (29.5 ft Interval) for Different K_R Values , Skin =0

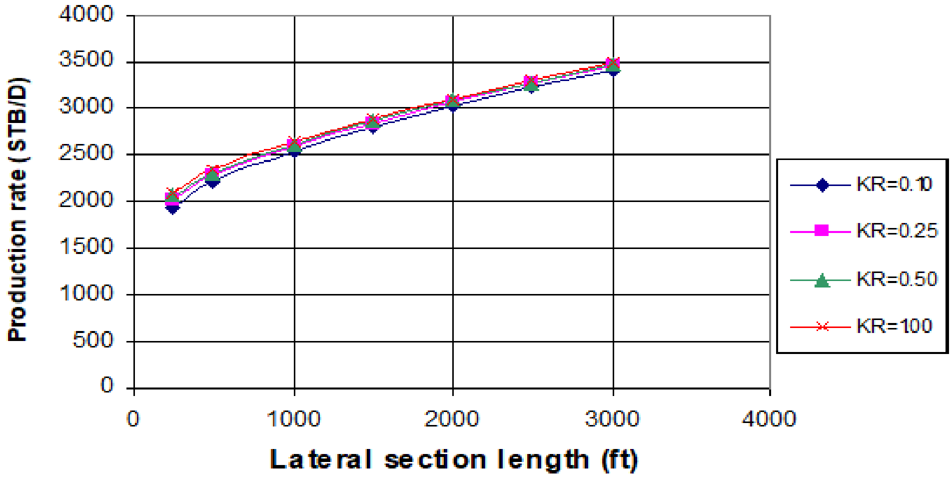

Fig. 8. Production Rate Vs. Lateral Section Length Drilled in (29.5 ft Interval) for Different K_R Values , Skin =0

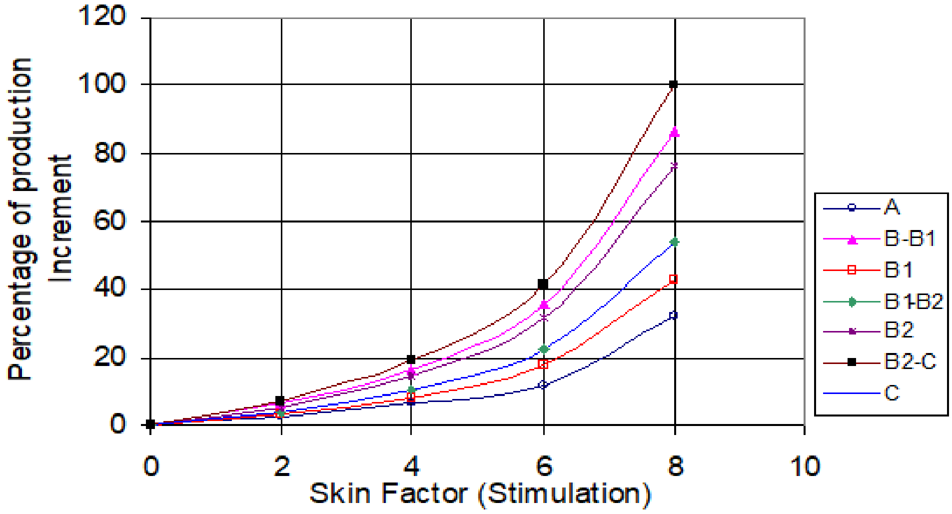

Fig. 9. The Percentage Production Increments Vs. Stimulation Value by the Vertical Well Interval

Hence, Fig. 10 show the percent increment of the productivity for well Fauqi (8) against lateral section extensions within the main productive intervals of Asmari reservoir.

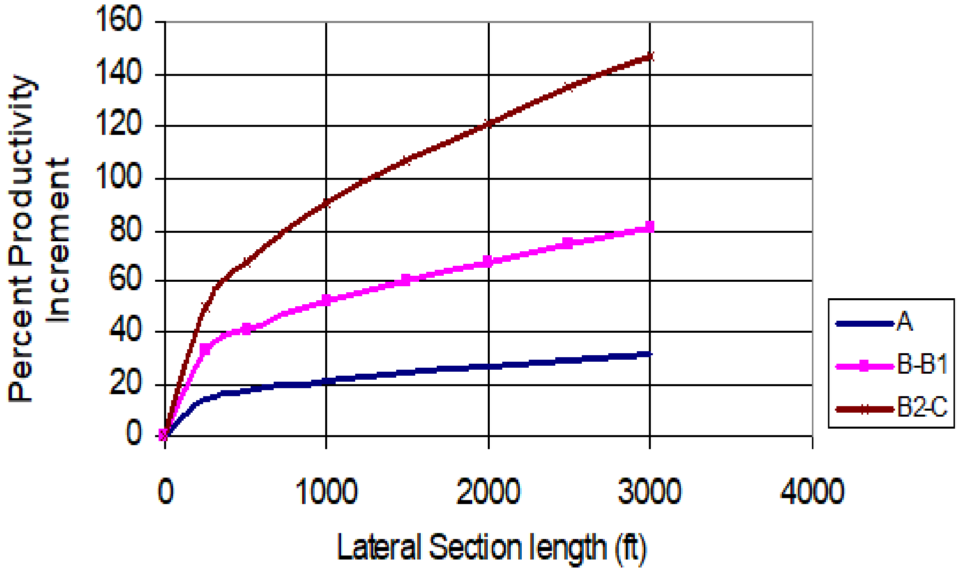

Fig. 10. Percentage Productivity Increment Vs. Lateral Section Length in Different Interval

5- Conclusion

1- Due to uncertainty in the reservoir architecture and the presence of fractures in addition to un availability formation for the production history from Iranian side, a detailed reservoir simulation study will be useful for accurate reservoir performance.
2- It could be easily concluded a multilateral horizontal wells could be performed in formation intervals (B-B1) and (B2-C) to achieve higher production capacity for this well using lateral sections of (2000-3000 ft). While increasing the horizontal section in the thin intervals like (A) has very low sensitivity to lateral section incremental as shown in Fig. 10.

Nomenclature

K_R: Vertical to horizontal permeability ratio, Dimensionless.
L_e: Lateral section length of horizontal well, ft.
OWC: Oil water contact.
PI: Productivity Index, STB/D/Psi.
A, B-B1, B2-C: Formation intervals.

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تطوير تحليلات مختلفة لزيادة معدلات انتاج حقل فكة النفطي جنوب شرق العراق

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الخلاصة

يقع حقل الفكة حوالي ٥٠ كم شمال شرق مدينة العمارة في محافظة ميسان في العراق. هذا الحقل له ١٦٤٠ مليار برميل خزين نفطي والذي يمتد جزئيا داخل ايران. ينتج النفط من طبقة المشرف والاسمري. ومن الناحية الجيولوجية فأن حقل الفكة يتكون من قبة تقع على الحدود العراقية الايرانية والتي يحتمل تواجد فيها بعض التشققات والفواصل. هناك عدة أسباب تؤدي إلى حفر الآبار الأفقية بدلاً من الآبار العمودية. العامل الأكثر أهمية هو زيادة استخلاص النفط، لا سيما من نفاذية مكمن رقيقة أو ضيقة. يعتبر حقل فَكة النفطي حقلا عملاقًا يحتوي على ما يقرب من ١ مليار برميل من الاحتياطيات المؤكدة، لكنه شهد مؤخرًا مشاكل انخفاض معدل الإنتاج في العديد من آباره الحالية. هذه الدراسة ستركز على تحليل مكمن الاسمري كمكمن أنتاجي رئيسي لنفط ذو كثافة (١٨ ا.ب.أ). كما أختير البئر (فكة ٨) لملاحظة طريقتين لزيادة الانتاجية. النتائج أوضحت أن عملية حفر مقاطع أفقية وكذلك أجراء عمليات التنشيط في بعض المقاطع التكوينية تؤدي الى زيادة الانتاجية وبنسب مختلفة. وبالطبع فأن حفر المقاطع الافقية أعطى أعلى أنتاجية من عمليات التنشيط بحوالي (٢-٣) مرة.

الكلمات الدالة: الانتاجية، بئر عمودي، متعدد الأطراف، بئر افقي، حقل فكة النفطي.