Effect of wells location on underground natural gas storage in UM EL-Radhuma formation / Ratawie field

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Abstract:-

Underground gas storage is a good technique to face; increasing demand for natural gas during cold seasons, future expected high demand and saving the non-invested associated gas from loss. Aquifer underground storage is a one of the important ways of underground gas storage.

UM EL-Radhuma formation in Ratawie field, which is one of the largest oil fields in the south of Iraq, has been examined for underground storage purpose during this study.

Geological and dynamic model for the two mentioned formation have been built by using petrel RE and ECLIPSE softwares. UM EL-Radhuma formation is consist of three reservoirs units of dolomite beds and the purpose of this study is to investigate the feasibility of underground storage in upper reservoir unit that overlaid by impermeable bed of RUS formation which is RUS 2 unit.

The effect of injection wells location on the injection performance was studied during this study.

The result showed that upper part of UM EL-Radhuma formation is suitable for underground gas storage. This work showed that there is a high effect of injection wells location on cumulative injection and injection rate. At surface condition, the cumulative gas injected after 10 years of injection was about 228.1 MMMSCF.

Introduction

Natural gas is playing an important role in meeting the world's energy demand because of the clean burning and its huge energy. According to the

International Energy Agency, in the next twenty years, the average growth of natural gas demand is expected to be over 1.8% per year. Also, natural gas is known that it is changeable in its demand according to the year months, if it is cold or hot. [4]

Natural gas storage is used to face the expected future peak demand, maintain the balance between supply and demand and to save the non-invested gas from burning and losing. [4]

large volumes of natural gas doesn't invested and lost by burning in Iraq Because of the main type of natural gas is associated gas and needs high capitals of money to be invested, for example, more than1.5 MMMSCF/D were burned in 2016 which means, 7500 ton of liquefied gas, 1.2 MMMSCF of dry gas and 1650 ton of benzene have been lost. [1]

Static geological model

Static geological model is very important in reservoir description and represent the beginning for dynamic fluid model preparation. [5] Therefore, during this study a geological for RUS and UM EL-Radhuma formation have been built by using petrel RE software and depending well logs, properties, heads and tops of 6 wells of Ratawie field which were; RT-3, 6, 7, 8, 9, 10 and 11.

Fracture pressure estimation

Fracture pressure is important to know during gas injection to predict the maximum pressure above which, leakage may be occurred. Therefore, fracture pressure has been estimated for RUS and UM EL-Radhuma formations in this study depending on the wells RT-3, 8 and 10 by using interactive petrophysics (IP). The method that used was modified Eaton method depending on sonic or resistivity logs, but after comparison between the two methods, it is found that resistivity method gives values of fracture gradient less than sonic log; therefore, this method has been selected to be in safety side. The average fracture pressure of the cap rock was equal to 1800 psi.

Dynamic fluid model

Dynamic fluid model is important to predict reservoir behavior with time under any process such as: - production, injection, stimulation and etc.…; therefore, a black oil 3D dynamic fluid model has been built for RUS and UM EL-Radhuma formations to investigate their behavior during injection process.

Dynamic fluid model have been built depending on static geological model, initial reservoir properties, relative permeability data [2], capillary pressure data [2] and formation water with injected gas properties [3].

Formation water properties

Water density =67.549 lb/ft^3

Compressibility = $2.4*10^{-5}$ 1/psi

Formation volume factor (Bw) = 1.0003

Initial reservoir properties

Reservoir pressure=1450 psi

Datum depth= -3000 ft

water contact depth = -2000 ft

temperature = 110 f

History matching:-

History matching is very important to insure that constructed model represent the reservoir. Because of UM EL-Radhuam formation is an aquifer and located at shallow depth (800-850 M), high lack in the production data. However, history matching in this study was depending on 6 days DST tests which are conducted on the well RT-10 in 1984

Results:-

1- Available Storage volume

Volumetric calculation have been conducted on the geological model to find total pore volume to structural closure which is 45 M. **Fig.1** shows the 3D porosity distribution of the upper reservoir unit and its cap rock. However, the result showed that total pore volume of the structural closure of upper reservoir of UM EL-Radhuma formation is 22 billion cubic feet. And the available storage volume is equal to 14.3 billion cubic feet which is calculated by using the following equation;

Available volume = total pore volume of the closure area * (1-swc)

Where:-

Swc: - connate water saturation which is 0.35 from relative permeability data.

2- Effect of wells location : -

Two cases have been conducted on the upper reservoir during this step with two different 11 wells locations (group A and B) as shown in **Fig.2** and **Fig.3** at constant BHP of 1600 psi, perforation interval of 19 m and injection period of 10 years. The values of BHP have been selected less than the fracture pressure of the cap rock of the upper reservoir which is about 1800 psi. **Fig.4** and **Fig.5** show the resulted curves of gas injection cumulative, average formation pressure and gas injection rate of the mentioned two cases.

The results showed that there is a high effect of wells location on injected gas cumulative. However, injected gas cumulative was equal to 144.1 MMMSCF at group A wells location and equal to 182.8 MMMSCF at group B wells location.

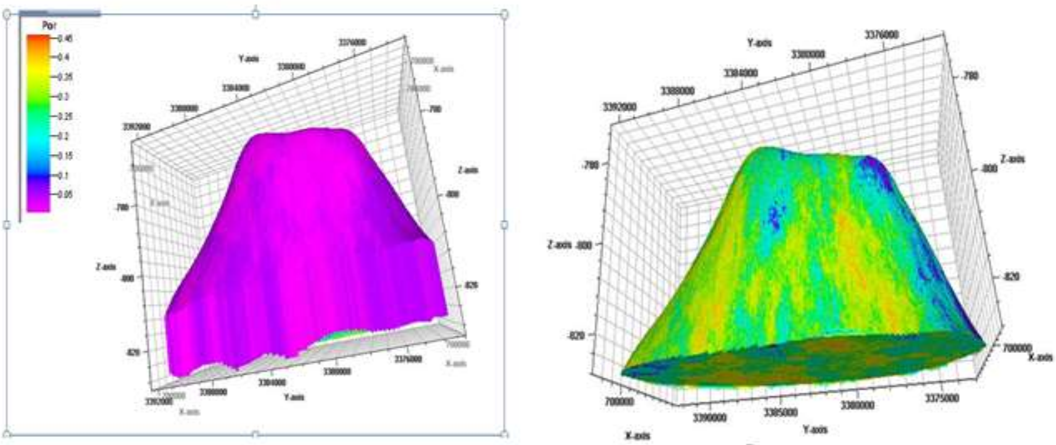

Fig.1 porosity distribution of the closure area of UM EL-Radhuma upper reservoir and its cap rock.

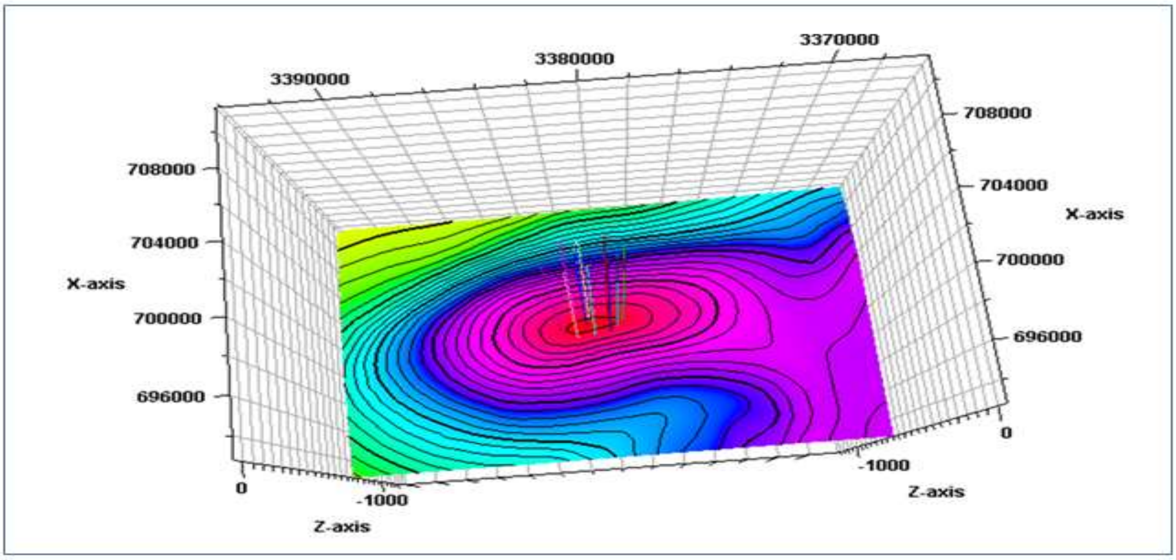

Fig.2 group A wells location.

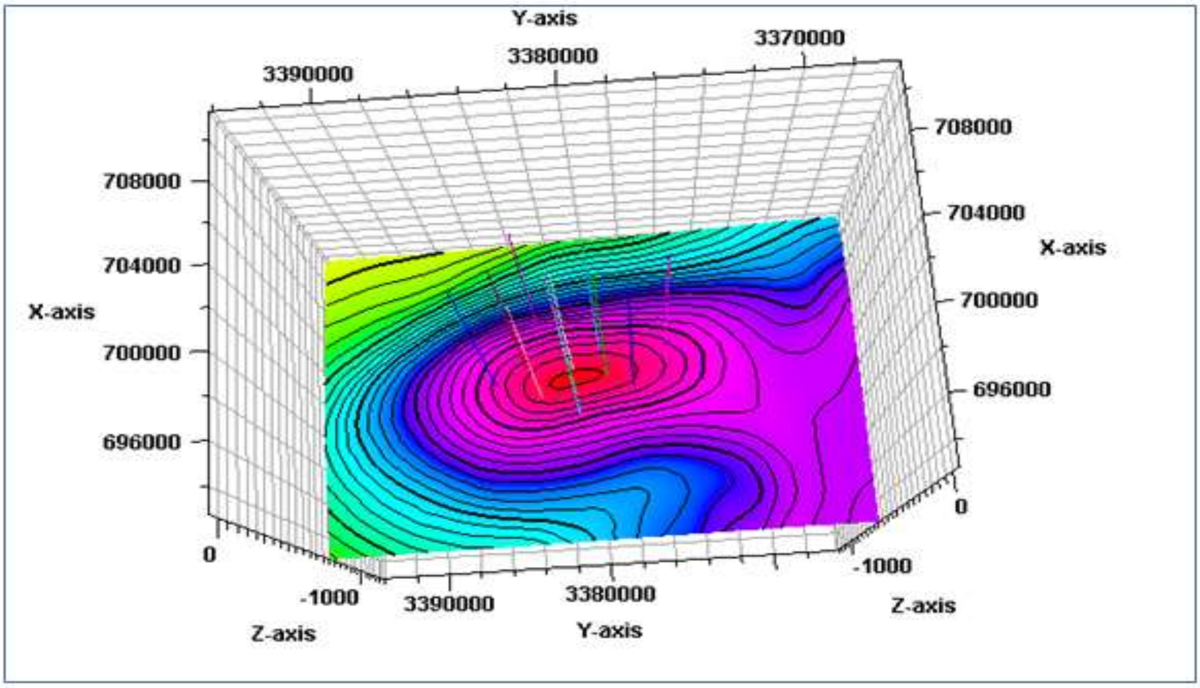

Fig.3 group B wells location.

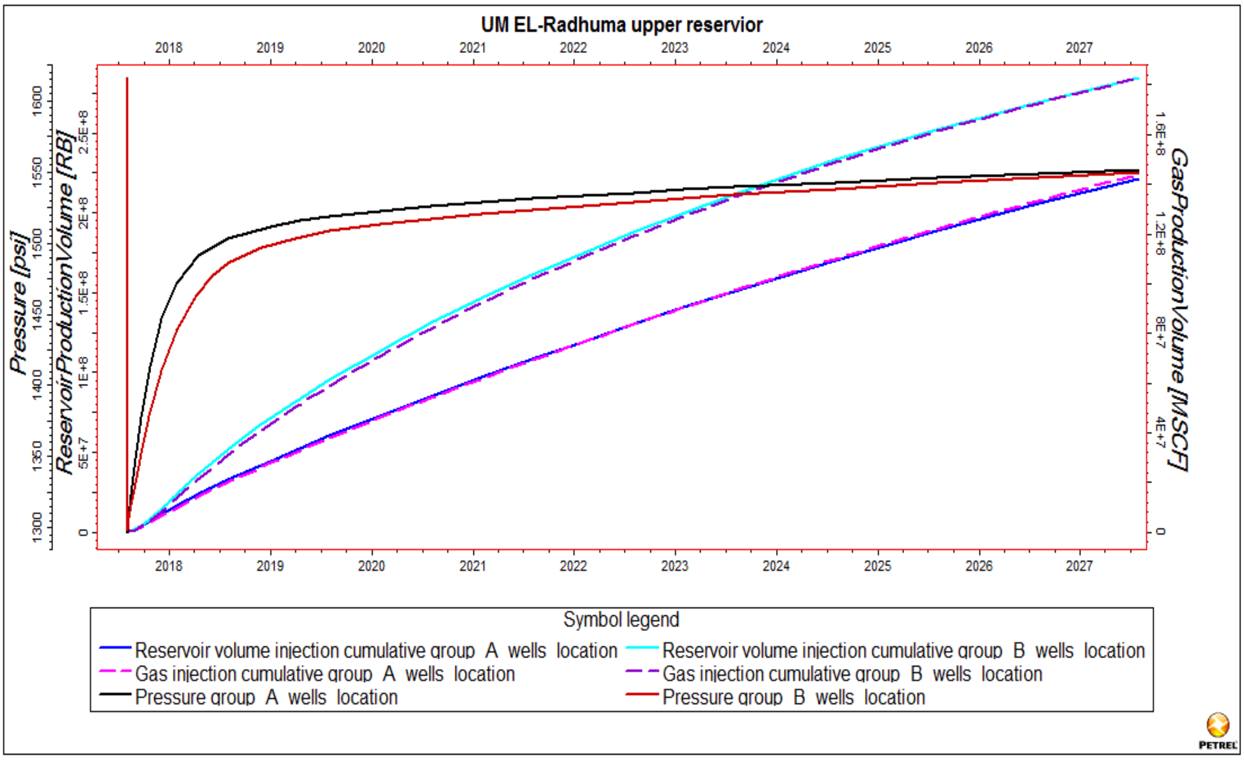

Fig.4 effect of wells location on average reservior pressure and injeceted gas cummulative.

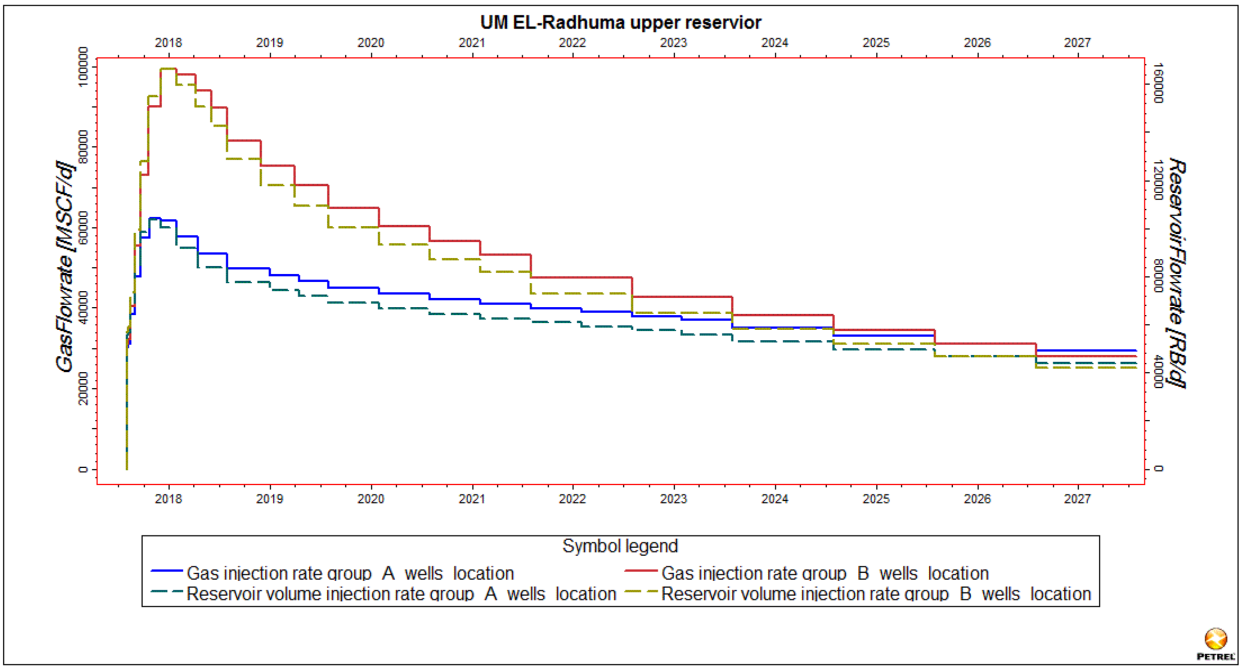

Fig.5 effect of wells location on gas injection rate during 10 years of injection.

Gas saturation distribution:-

Gas saturation distribution of the upper reservoir, when be checked during the two cases that have been conducted, showed that there is no gas saturation in the cap rock of the intended reservoir which means that the cap rock is tight and prevented upward movement of gas. **Fig.6** shows gas saturation distribution of the case group B wells location of upper reservoir and its cap rock.

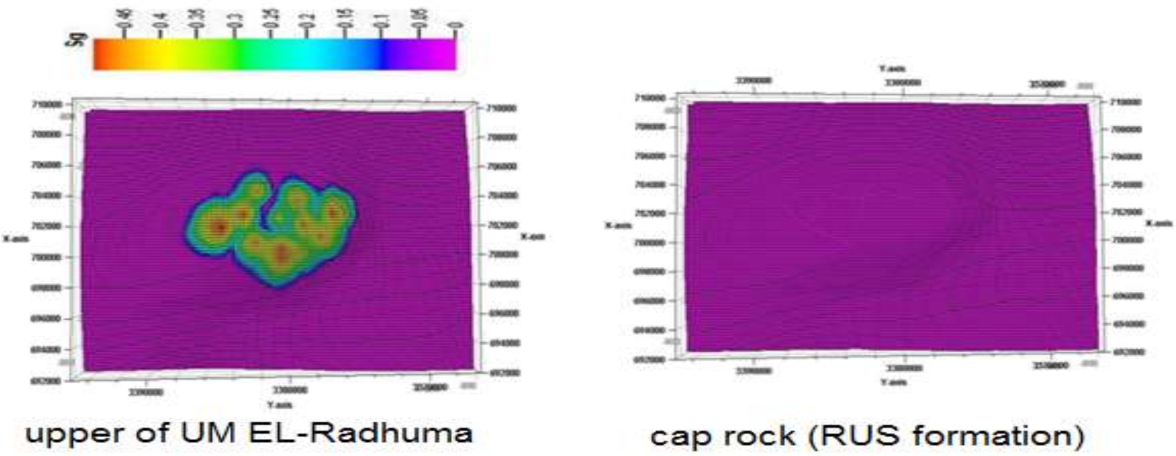

Fig.6 Gas saturation distribution of UM EL-Radhuma formation and its cap rock after 10 years of injection

Discussion

During this study, upper reservoir of um el-Radhuma formation have been tested for underground storage using two wells location groups and find the effect of wells location on cumulative injected and reservoir formation pressure during 10 years injection period.

About the injection wells location effect , it can be noticed that injection wells location have a good effect on the cumulative gas injection, formation pressure because of well location effect on formation pressure and interference between wells may be occurred which effect on the differential pressure between BHP and formation pressure, therefore; changing in well location from small well spacing (group A) to a high well spacing (group B) between injection wells leads to a high increment in cumulative gas injection.

As noticed in injection rate curve **Fig.10**, injection rate is changing during 10 years period. This changing in gas injection rate is due to the increasing in formation pressure which leads to a decrease in differential pressure value, In order to decrease the increment in formation pressure during injection, pressure relief is recommended which is done either by water withdrawal from the bottom of the reservoir or by making a shut in period between injection periods.

From gas saturation distribution of UM EL-Radhuma formation and it cap rock **Fig.6**, it is noticed that gas saturation in the cap rock and all the remaining upper part of RUS formation is equal to zero which means that there is no gas escaped above the cap rock which gives that RUS formation is good cap rock and UM EL-Radhuma is suitable for underground storage purposes.

Conclusions

1- Upper reservoir of UM EL-Radhuma formation is suitable for underground storage purpose and high volume is available for storage.
2- Wells location is very effective on gas injection rate and cumulative injected gas because it is effect on pressure distribution and high spacing between injection wells (group B) gives a good result.
3- Fracture pressure of the cap rock of UM EL-Radhuma upper reservoir is equal to 1800 psi, therefore, injection pressure must be less than this value with more than 100 psi to be in safety side.
4- Well logging data showed that there are another two cap rocks inside UM EL-Radhuma formation. The two cap rocks

divided it into three reservoir units (upper, middle and lower).

References.

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تأثير مواقع الابار على الخزن الجوفي للغاز في حقل رطاوي/ طبقة ام الرضومة

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الخلاصة:-

ان عمليات الخزن الجوفي للغاز تعتبر تقنية جيدة في مواجهة التذبذب الحاصل في العرض والطلب على الغاز ومواجهة الطلب الهائل المتوقع خلال السنين القادمة وكذلك حفظ الغاز المصاحب الغير مستثمر من الضياع بسبب الحرق. طبقة ام الرضومة في حقل رطاوي واللذي يعتبر احد الحقول العراقية المهمه في محافظة البصرة سوف يتم فحص مدى صلاحيتها لاغراض الخزن الجوفي للغاز خلال هذه الدراسة.حيث تم بناء موديل جيولوجي ومكمني باستخدام برنامج بترال وايكلبس لطبقة ام الرضومة وطبقة الرص التي تعلوها والتتي تتكون من الانهايدرايت واللذي يعتبر بمثابة غطاء صخري غير نفاذ. طبقة ام الرضومة تتكون من ثلاث وحدات مكمنية من الدولامايت والهدف من هذه الدراسة هو دراسة امكانية الخزن في الوحده العلوية من الطبقة التي تكون في تماس مع طبقة الرص الغير نفاذة. تاثير مواقع ابار الحقن سوف يتم

دراستها خلال هذه الدراسة كذلك.

النتائج اظهرت ان مكمن ام الرضومة العلوي صالح لاغراض الخزن بسبب فعالية غطائة الصخري لحجز الغاز وكذلك اظهرت النتائج بان مواقع الابار تؤثر بصورة عالية على نتائج الحقن من حجم محقون ومعدل حقن حيث كان حجم الغاز المحقون بعد مضي 10 سنوات من الحقن حوالي 182.8 مليار قدم مكعب سطحي.