



## Study Influence Arabic Gum on Improved Oil Recovery with Gaberoun Water Leak by Using Spontaneous Imbibition Tests for Sandstone Core Samples

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Enhanced Oil Recovery  
Polymer  
Gaberoun Water  
Distillate Water  
Long Time Period  
Sandstone Core Samples  
Arabic Gum

### ABSTRACT

In the life of oil production can define into three steps, primary, secondary, and tertiary. Primary recovery can include natural mechanisms such as rock expansion, gas cap, and solution gas, secondary recovery that uses injection water or gas to maintenance reservoir pressure, tertiary recovery that includes injection special materials that are chemical fluids, gas injection, and polymer injection. In this research use the Arabic Gum as polymer with the Gaberoun Water Leak & distillate water as soluble material and to make a comparison between two different water, use done three scenarios of the Arabic gum concentration, the first scenario Arabic Gum with a concentration of 1%wt, the second scenario Arabic gum with concentration 3%wt and the third scenario with 5%wt. Imbibition test was used for this study by using sandstone core samples matured in oil for a lengthy time period reaches about 3 weeks, the results of recovery are obtained in oven temperature from 30°C to 70°C. Oil recovery results are not very good as oil recovery by using Gaberoun Water Leak without any change on sandstone core samples, in this research reach to about 65, 62, and to 74 for 1wt%, 3wt% and 5wt% Arabic gum with Gaberoun Water Leak.

## دراسة تأثير الصمغ العربي على تحسين استخلاص النفط مع مياه قيرعون باستخدام اختبارات التشرّب التلقائية لعينات الحجر الرملي الأساسية

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### الكلمات المفتاحية:

استخراج الزيت المحسن  
البوليمر  
ماء بحيرة قيرعون  
الماء المقطر  
فترة زمنية طويلة  
عينات أساسية من الحجر الرملي  
الصمغ العربي

### المخلص

مراحل إنتاج النفط يمكن تعريفه في ثلاث خطوات، أولية وثانوية وثالثية. يمكن أن يشمل الاسترداد الأولي آليات طبيعية مثل تمدد الصخور، وغطاء الغاز، وغاز النفط، والاسترداد الثانوي الذي يستخدم حقن الماء أو الغاز لزيادة ضغط خزان، واسترداد الزيت المحسن (الاسترداد الثالث) الذي يشمل مواد خاصة للحقن وهي سوائل كيميائية، وحقن الغاز، وحقن البوليمر. في هذا البحث تم استخدام الصمغ العربي كغمر للبوليمر باستخدام ماء بحيرة قيرعون وماء التقطير كمادة قابلة للذوبان ولإجراء مقارنة بين نوعين مختلفين من المياه، استخدم ثلاثة سيناريوهات لتركيز الصمغ العربي، السيناريو الأول الصمغ العربي بتركيز 1٪ بالوزن، السيناريو الثاني الصمغ العربي بتركيز 3٪ بالوزن والسيناريو الثالث 5٪ بالوزن. تم إجراء اختبار التشرّب المستخدم لهذه الدراسة باستخدام عينات من الحجر الرملي التي تتراوح فترة تشبعها في الزيت لفترة طويلة تصل إلى حوالي 3 أسابيع، ويتم الحصول على نتائج الاسترداد في درجة حرارة الفرن من 30 إلى 70 درجة مئوية. نتائج استخلاص الزيت ليست

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جيدة جدًا حيث أن استخلاص الزيت باستخدام ماء بحيرة قبرعون دون أي تغيير على عينات قلب الحجر الرملي ، في هذا البحث يصل إلى حوالي 65 ، 62 ، و 74 للوزن %1 ، %3 ، بالوزن و %5 بالوزن من الصمغ العربي بمياه القبرعون .

## 1.Introduction

Enhanced oil recovery (EOR) is the extraction of crude oil from oil fields that cannot be extracted otherwise. EOR 30% to 60% or more of reservoir oil be able to be extracted, [1] versus 20% to 40% using primary and secondary recovery. [2] [3] According to the US Department of Energy, carbon dioxide and water are injected along with one of three EOR technologies: thermal injection, gas injection, and chemical injection. [1] The most advanced and hypothetical EOR methods are from time to time called quadruple recovery. [4] [5] [6] [7]

Here are three basic EOR technologies: gas, thermal, and chemical injections. Gas injection such as natural gas, nitrogen, or carbon dioxide (CO<sub>2</sub>). [1] Heat injection, which involves the introduction of heat. [1] Chemical injection use of long-chain molecules called polymers to increase the efficiency of flood waters. [1]

In 2013, a technology called pulse plasma technology was introduced and resulted in another 50 percent improvement in existing well production. [8]

Madi Naser et al (2016) investigated of the special effects of temperature, hardness, surfactants, and alkaline on oil recovery from carbonate reservoirs using spontaneous imbibition tests. They showed that, at with elevated temperature, the oil recovery is higher than at low temperature. The hardness has various impacts on the wetting properties. [9]

Madi Naser et al (2018) comparted experiment results by using sea water in carbonate and sandstone reservoirs and effected of temperature and aging time on oil recovery from room temperature to oven temperature 80 °C. Their result shows that the influence of seawater on oil recovery in sandstone is higher than carbonate. [10]

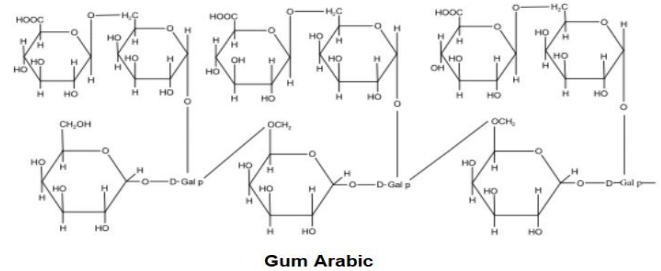
Madi Naser et al (2018) studied the effects of temperature and aging time on oil recovery in carbonate and sandstone reservoirs using seawater. They showed that the influence of sea-water on oil recovery in sandstone was greater than carbonate. At higher temperature, the oil recovery was more moderate than low temperature. [11]

Madi Naser et al (2018) discovered of Gaberoun Water Leak Injection by means of chemical flooding by using the Spontaneous Imbibition Test and investigation on key influence factor for oil recovery upgrading. They showed that, oil recovery was decreased with a decrease in pH values and increased with a decrease salinity. [12]

Madi Naser et al (2019) investigated of a new Libyan Chemical EOR and impact of Gaberoun Water Leak Injection on relative permeability, wettability, oil recovery, breakthrough and fractional flow. The experimental results indicate that, the Gaberoun Water Leak Injection has caused the increasing of oil recovery in sandstone and carbonate core and in sandstone core samples was higher than carbonate core samples. [13]

Madi et al (2020) investigated the optimum of salinity and pH of sea water to improve oil recovery from a sandstone reservoir as a secondary recovery process. They conducted the oil recovery increases as the injected water salinity and pH. [14]

In this research used Arabic Gum as polymer material, Arabic Gum can dissolve simply in water and its viscosity irreversible decrease in temperature because of precipitation of mass protein, high molecular mass, and rich components. Arabic Gum can make thick visco-elastic films at oil-water contact area (15, 16) as shown in Figure (1) Arabic Gum Organic Structure.



**Figure (1)** Organic Structure of Arabic Gum (11)

Other name – acacia gum, gum acacia, Arabic gum, acacia, Indian gum and Senegal gum (16).

**Table 1:** Organic Structure of Arabic Gum

Property	Value
Arabic Gum Density	1.35-1.49
Arabic Gum Molecular Weight/ Molar Mass	≈ 0.25×10 <sup>6</sup>
Arabic Gum Boiling Point	> 250 °C
Arabic Gum Melting Point	0 – 100 °C

## Material

Arabic Gum as Polymer Material were used in this study as shown in the figure 3. Toluene used to clean core samples. Figure 2 shows the sandstone samples were used after routine testing and distilled water and Gaberoun Water, Medium crude oil was used (density: 0.897, API: 26.24, @ 25 °C and @ 37.5 °C, Sp.Gr @ 60/60Fo :0.897).



**Figure (2)** Sandstone Samples



Figure (3) Arabic Gum



Figure (4) Oil Sample



Figure (5) Distillate Water Container

**Method**

**Core Sample Preparation:** First, clean the basic sample. Second, dry the basic samples and weigh them. Third, bulk size dimension. Fourth, soaked cores with oil by using a vacuum pump and weight as shown in figures (6, 7 and 8). Fifth, OOIP amount. Tenth, porosity oil quantity.



Figure (6) Soxhlet Device



Figure (7) Vacuum Chamber Device



Figure (8) Core



Figure (11) Graduated Tester That By gum Arabic solution in (Gaberoun Water Leak & distilled) water.

**Preparation of the Polymeric Solution (Arabic Gum) and Mix with Distilled Water and Gaberoun Water Leak:**

We brought Arabic Gum and conducted several tests and analyses on it. We crushed it, sifted it, and weighed it as shown in the figure 9.



Figure (9) Process of Sifting Gum Arabic

**The Spontaneous Imbibition Test:** The Weight of Arabic gum powder, powder particles divided into three parts to calculate the concentration of quantitative powder Arabic gum, concentration of (1g/100ml) = 1 weight%, concentration of (3 g/100ml) = 3 weight%, concentration of (5 g/100ml) = 5 weight%. We brought two cups and put distilled water and the other of Gaberoun Water Leak. Then, heated them and added the gum Arabic. After that, mixed both separately as shown in figure (10).



Figure (10) Solution Mixing Process

Take the Arabic Gum and Gaberoun Water Leak solution and Arabic Gum and distilled water solution with a sample and place it in a graduated tester. Then, raise the temperature at room temperature to oven temperature (30 C°, 40 C°, 50 C°, 60 C°, 70 C°). After that, take the result of oil recovery on many times until constant result. Then calculate oil recovery as shown in figure (11).

**Results of Analysis of Gaberoun Water Leak:**

Table 1 shows the Gaberoun Water Leak properties.

Table 1: Gaberoun Water Leak

CL <sup>-1</sup>	2.3
Na <sup>+1</sup>	3.8
Mg <sup>+2</sup>	5
Ca <sup>+2</sup>	21
K	5.6*250
So <sub>4</sub>	7.3
Total Alkalinity	490*250
HCO <sub>3</sub>	600*250
Zn	1.32*25
pH	10.25

**Spontaneous Imbibition Test Results:**

**1. The First Scenario of 1wt% Arabic Gum:**

By using two sandstone core samples A & B in this scenario at oven temperature from 30 C to 70 C, noted that recovery factor increases from 1% to 65% and to about 60% for A & B respectively. With distillate water for the same scenario by using sample noted by G the oil recovery reaches to about 70%. Figure (12) shows oil recovery versus imbibition time in the scenario of Arabic gum 1%wt

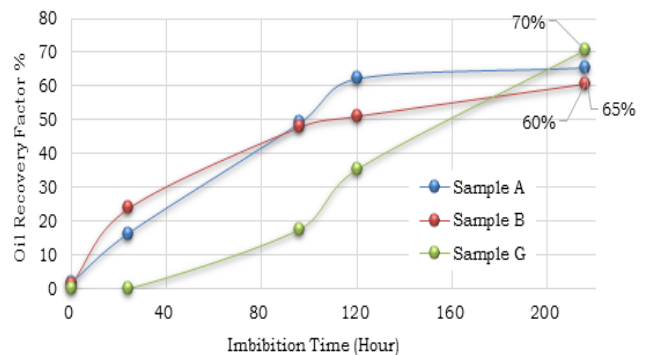
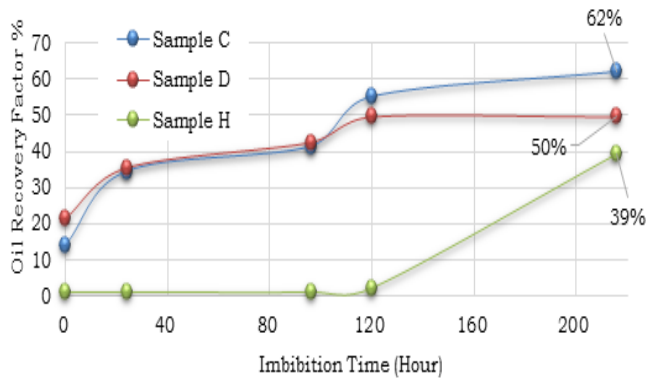


Figure (12) Oil Recovery vs. Imbibition Time for 1wt% Arabic Gum on Sandstone Core Samples.

**2. The Second Scenario of 3wt% Arabic Gum**

By using the two sandstone core C& d that flooded in Gaberoun Water Leak at oven temperature from 30 C to 70 C, noted that oil recovery increases from 13 to 62 and from 21 to 49 respectively. With distillate water for the same scenario by used the sandstone core sample named H the oil recovery reaches to about 39%.

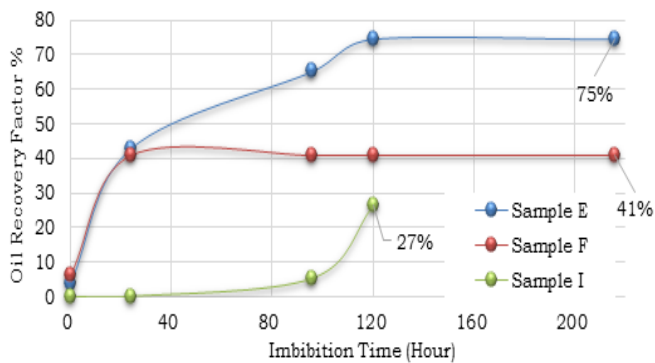
As shown in the figure (13) the increase in the oil recovery versus imbibition time for this scenario of 3wt% Arabic gum.



**Figure (13)** Oil Recovery vs. Imbibition Time for 3wt% Arabic Gum on Sandstone Core Samples.

**3. The Third Scenario of 5wt% Arabic Gum**

By the use of two sandstone core samples E & F in this scenario by using imbibition test in oven temperature from 30 C to 70 C, the oil recovery increase from 3 to 74 & from 6 to 41 respectively. By using the distillate water in this scenario, the oil recovery increase from 0 to about 26 for the sandstone core sample named by I. The oil recovery versus imbibition time for this scenario showed in the figure (14).



**Figure (14)** Oil Recovery vs. Imbibition Time for 5wt% Arabic Gum on Sandstone Core Samples.

**Note:**

While taking the results, we tested the Emulsions Figure 15 between crude oil and solution of gum Arabic dissolved in (Gaberoun Water Leak & Distillate) water and it was tested at several temperatures (30 C, 40 C, 50 C, 60 C, 70 C), where there was no emulsion between them.



**Figure (15)** Emulsions

**Conclusion**

This paper presents the results of study influence Arabic Gum on improved oil recovery with Gaberoun Water Leak by using spontaneous imbibition tests for sandstone core samples. Based on the primary data, the following main conclusions may be drawn:

1. Noted that from results oil recovery increases immediately with increase Arabic gum concentration.

2. Oil recovery by using Gaberoun Water Leak with Arabic gum is good. However, while using Gaberoun Water Leak only the oil recovery is very good that reach to about 81% in previous research.
3. With distillate water oil recovery increase with decrease Arabic gum concentration reach to about 70%
4. The highest oil recovery obtained in this research is from Gaberoun Water Leak with 5wt% Arabic Gum reach to about 74%.
5. This present study may hopeful be useful as reference of information for any operating company to establish the injection of Gaberoun Water Leak.

**Current and Future Work**

The Arabic Gum has been resulted in effects on improved oil recovery with Gaberoun Water Leak by using spontaneous imbibition tests for sandstone core samples. Therefore, it is very important to evaluate the effects of Gaberoun Water Leak with Arabic Gum. In order to achieve that, this research is currently ongoing and being expanded in the following designated directions:

- ✚ Future work, assessment of the effects of acidity and different salinity on oil recovery.
- ✚ Continued with different live oil sample at elevated pressure and temperature at reservoir condition.

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