

# Study the effect of Water content and Temperature on the stability of Crude Oil/Water Emulsions.

**Abouther Thalib Halboose**

**Mudhaffar Yacoub Hussein**

Petroleum Engineering – Misan University

**Raheem Jafar Aziz**

Science Department – Basic Education College

Al Mustansiriyah University

## Abstract

During the crude oil production, water-in-oil stable emulsions may be created. Water which is naturally present in oil reservoirs mixes with crude oil to form very stable emulsions due to very high shear rates and zones of turbulence encountered at the wellhead and pipe of production. The formation of these emulsions is generally caused by the presence of resins, asphaltenes, wax and naphthenic acid which play the role of "natural emulsifiers. The aim of this study was to focus on some important factors in the formation and stabilize crude oil/water emulsions. These factors are the water content, which varies from oil field to another and to understand its role in the Stability of the emulsion, which vary depending on the oil fields. Another factor is the temperature at which the physicist has a role in a large non-oil emulsions Stability. The study deals with the effect of water content and temperature on the stability of crude oil emulsion. The emulsion was prepared by mixing the crude oil and desired content of water and shaking by hand. The volume percent of water were studied in this paper to the total volume of crude oil emulsion (10, 20, 30, 40, 50, 60) and temperature were (20, 30, 40, 50) °C. The results showed that, the emulsion stability decrease with increase water concentration. Change in temperature had a significant effect where the higher temperature became unstable emulsions

Key words : emulsion, crude oil / water emulsion stability

## 1. Introduction

Water in oil emulsion occurs at many stages in the production and treatment of crude oil. About two third of petroleum production of every oil field exists in the form of water in oil emulsion. The emulsion stability results from the presence of interfacial barrier preventing coalescence of the dispersed water droplets. This is due to the present of polar components such as asphaltenes, resins, wax and naphtenic acids in the crude oil. Therefore before transporting or refining the oil, it is essential to separate the water for economic and operational reasons. Minimizing the water level in the oil reduces pipeline corrosion and maximizes pipeline usage [1]. Crude oils have natural emulsifiers, such as resins and asphaltenes and these components contribute to the formation of a viscoelastic film on the crude oil-water interface [2]. An emulsion is usually defined as a system consisting of a liquid dispersed in another immiscible liquid, as droplets of colloidal sizes ( $\sim 0.1-10 \mu\text{m}$ ) or larger [3]. Oil-water emulsions are fine dispersions of oil in water (O/W) or of water in oil (W/O) [4]. Water-in-crude oil emulsions are a main problem in the exploitation of petroleum reservoirs, especially for the high internal volume fraction, where the emulsion viscosity increases significantly. Moreover, salt dissolved in droplets may be very corrosive, and it must be removed before the refining process [5]. In oil fields both water in crude oil and crude oil in water emulsion may be formed, and the emulsion is a major problem in crude oil production. Therefore, the factors contributing to the stability of water / oil and oil / water crude oil emulsions are of great concern and economic importance to oil companies [6]. A good knowledge of petroleum emulsions is necessary for controlling and improving processes at all stages. Many studies have been carried out in the last 40 years and have led to a better understanding of these complex systems [7] The study investigates the influence of water content and temperature on stability of the crude oil emulsions.

## 2. Experimental work

### 2.1 Material

1. To accomplish the objective of this study, the crude oil samples were obtained from Al Bezergan crude oil field (Specific Gravity 0.9038).
2. Distillated water

### 2.2 Preparation of emulsion and Measurement of stability

There are a large variety of emulsification methods : simple shaking, mixing with rotor – stator systems, liquid injection through porous membranes, or high pressure devices ( homogenizers, liquid jets), etc. [8]

The oil / water emulsion was formed by shaking the mixture of crude oil phase and water phase in 50 ml cylinder for 200 times [6]. Stability of emulsion was determined visually by measuring the water separated from the emulsion as a function of time at 20 °C.

### 3. Results and discussion

#### 3.1 Effect oil content on emulsion

The effect of oil content of the emulsion on its stability was investigated. In this study the water content of the emulsion was (10, 20, 30, 40, 50, 60) vol. % with respect to the total volume of the emulsion. Figure 1 shows the influence of water content on stability of emulsions. It can be seen from this figure the stability of the emulsion increase with decrease water content. When the water volume percentage increases, the oil content and its surfactant molecule content decreases accordingly. The main mechanism at the origin of bigger droplets, like coalescence, is favored when asphaltene content is low. Indeed, it is well known that asphaltenes stabilize the water/oil interfaces and prevent coalescence [9]. When the coalescence of water drops take place, it lead to increase the separation of water because of the increase of water drop volume causes increase the settling velocity according to Stoke's Law.

Stoke's Law [10, 11, 12, 13]

$$U_T = \frac{D^2 \Delta \rho g}{18 \eta_c} \dots \dots \dots (1)$$

Where  $U_T$  is the terminal velocity of a droplet,  $D$  is the droplet diameter,  $\Delta \rho$  is the density difference between aqueous and oil phase,  $g$  is the gravitational acceleration and  $\eta_c$  is the viscosity of the continuous phase (oily).

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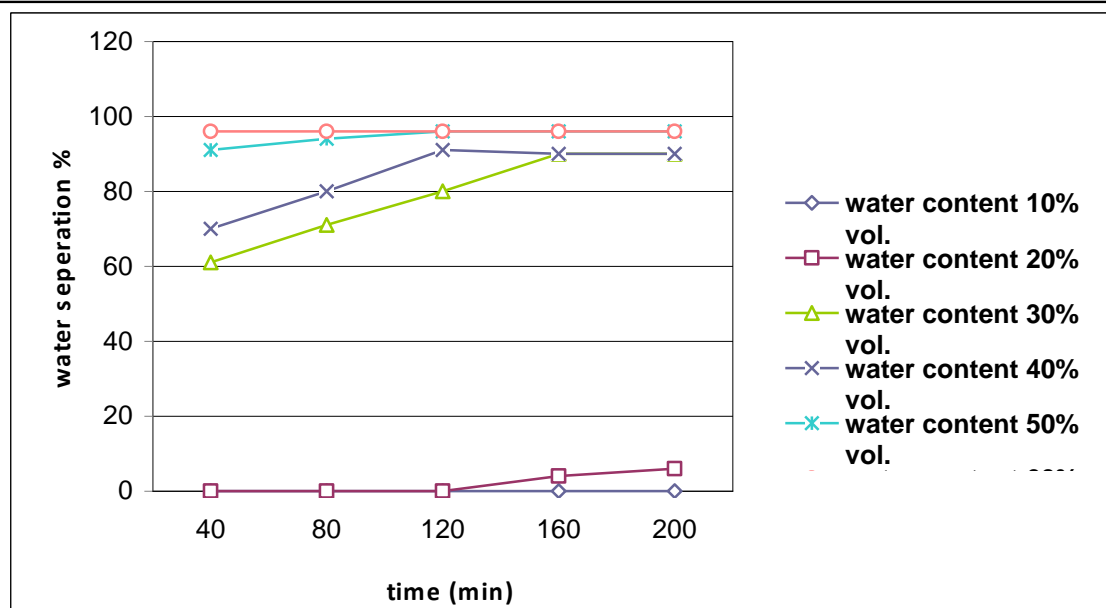


Fig. 1 effect of water content on stability of crude oil / water emulsion at room temperature 20 °C

## 3.2 Effect of temperature

The effect of temperature on stability of emulsion has been investigated. Emulsion (20 % water vol.) was placed in water bath and heated to required temperature. as shown in fig. 2 the stability of emulsion decrease with increase the temperature. The separation involves two processes: coalescence of emulsified water droplets and sedimentation of coalesced droplets. Both processes depend upon temperature. Sedimentation of water droplets can be described by Stoke's law, if the droplet concentration is not high. Even for the case of high concentration where hindered settling is significant, Stoke's law still provides a good indication of water separation by showing the terminal settling velocity of water droplets. The viscosity of oil is very sensitive to temperature, much more than density difference ( $\Delta\rho$ ). Therefore, as temperature increases, viscosity decreases much faster than the density difference does. The results are a higher settling velocity and faster separation of emulsified water from oil [14].

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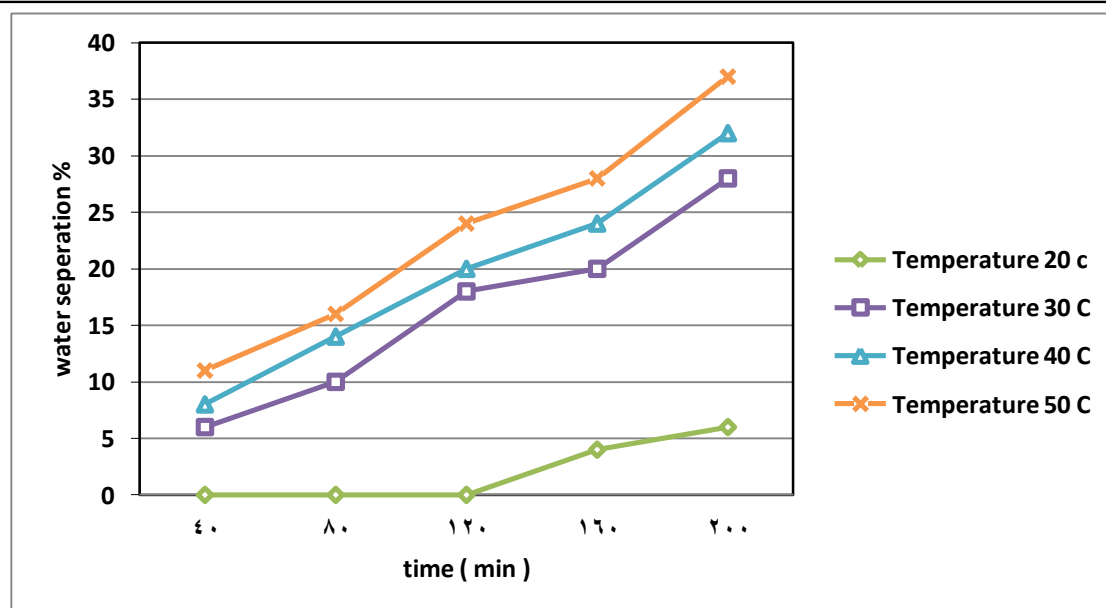


Fig. 2 effect of temperature on stability of crude oil / water emulsion at (20% vol. water content)

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### دراسة تأثير المحتوى المائي ودرجة الحرارة على استقراره المستحلبات النفطية

#### الخلاصة

يُصاحب عمليات انتاج النفط الخام تكوين المستحلبات بسبب وجود الماء مع النفط الخام في البئر النفطي بنسب تختلف من موقع الى اخر. خلال عمليات الاستخراج واثناء مرور النفط مع الماء في انابيب الانتاج تحدث عمليات الاستحلاب بمساعدة بعض المواد الموجودة اصلا في النفط الخام مثل ( الاسفلتينيات , الراتنجات , الشمع , وحامض النفطنك ) التي تعمل على تكوين جدار كثيف في الحد الفاصل بين القطرات المائية يمنع من عمليات الاندماج فيما بينها . كان الهدف من هذه الدراسة هو التركيز على بعض العوامل المهمة في تكوين واستقرارية المستحلبات النفطية من هذه العوامل هو المحتوى المائي الذي يختلف من موقع نفطي الى اخر ولفهم الدور الذي يؤديه في استقرارية المستحلب وكذلك فهم استقرارية المستحلبات التي تختلف حسب المواقع النفطية . والعامل الاخر هو درجة الحرارة التي لها دور فيزيائي كبير في عدم استقرارية المستحلبات النفطية. في هذا البحث اجريت دراسة مختبريه لمعرفة تأثير كل من المحتوى المائي ودرجة الحرارة على استقرارية المستحلبات النفطية . النفط الخام المستخدم في هذه الدراسة من الحقول النفطية في البزركان تم تحضير المستحلب النفطي بواسطة مزج كل من الماء والنفط الخام ثم رجه بواسطة اليد . النسب الحجمية للمحتوى المائي التي تم دراستها الى الحجم الكلي للمستحلب النفطي المائي كانت (10, 20, 30, 40, 50, 60) فمثلا عند النسبة الحجمية 10 ناخذ 10 مل ماء و 90 مل نفط خام وعند نسبة حجمية 20 مل ناخذ 20 مل ماء و 80 مل نفط خام وهكذا . درجة الحرارة التي تم دراستها كانت ( 20, 30, 40, 50 ) درجة سليزية . بينت النتائج التي تم الحصول ان استقرارية المستحلب تقل كلما زاد المحتوى المائي . التغير في درجة الحرارة كان لها تأثير ملحوظ حيث كلما زادت درجة الحرارة قلت استقرارية المستحلب.

مفتاح : استقرارية المستحلبات , المستحلبات , النفط الخام