

EVALUATION OF STABILITY AND VISCOSITY MEASUREMENT OF LIGHT OIL AND ITS EMULSION FROM FANG OILFIELD IN THAILAND

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ABSTRACT

Emulsion is normally present in oil due to the mixing occurring during oil recovery. The formation of emulsion can cause some problems in production and transportation. Viscosity and stability of emulsion play a key roles in oil transportation and separation to meet sales specification. Therefore, the aims of this research are to measure the viscosity of oil an emulsion and to evaluate the stability of emulsion of light oil from Fang oilfield in Thailand. The parameters of this study are temperature, shear rate and water cut ranging from 50 to 80 °C, 3.75 to 70 s⁻¹ and 0 to 60%, respectively. These effects of parameters on viscosity and stability of emulsion are required for the design of the process and to increase oil production with various conditions. The results show that viscosity decreases as temperature and shear rate increase. In contrast, viscosity becomes higher when water cut is lower. Furthermore, droplet sizes of water-in-oil emulsion at different conditions are investigated the stablity of emulsion. The droplet sizes become smaller when high shear rate is applied and emulsion becomes more stable. Furthermore, correlations are developed to predict the viscosity and stability of the oil and emulsion from Thailand.

Keywords: Light oil; emulsion; viscosity; stability; shear rate; droplet size distribution

INTRODUCTION

In petroleum industry, emulsion, a mixture of oil and produced water can be formed from oil recovery. It is found in many processes such as production, pipeline transportation and separation [9]. This emulsion can result in several problems in handling facilities and separation [7]. Stability of emulsion, attributed to surface-active films consisting of several components [3] implicated with viscosity because stable emulsions might be classified by their viscoelastic, elastis and viscosity, properties [2]. Viscosity and stability of emulsion are the key parameters to transport and separate oil and water to meet sales specification. Therefore, the objectives of this work are to measure and investigate the viscosity and stability of emulsion. Futhermore, correlate viscosity and stability of the oil and emulsion from Fang oilfield in Thailand for applied

to predict the viscosities of oil and its emulsion.

EXPERIMENTAL

Viscosity measurements are proceeded by Brookfield viscometer model LVDV2T with spindle number 40Z and 52Z. Temperature is controlled by using a glycol solution bath. The droplet size distribution is investigated by light microscope with trinocular head and eyepiece for droplet size measurement.

The oil sample is obtained from Fang oilfield. Emulsion of oil is prepared with various percents of water content at 0, 20, 40 and 60% by volume and mixed with water at the speed of 600 rpm for 15 minute with temperature at 50°. Each viscosity measurement uses 0.5 cm³ of emulsion for various conditions, i.e. temperature from 50, 60, 70 and 80°C and water content from 0, 20, 40 and 60%. Also shear rate ranges from 3.75, 7.5, 15, 30 and 60 s⁻¹. The measurement is performed for 90 minutes and recorded for every 3 minutes. The droplet size is investigated by using microscope with 100 times magnification and photograph of emulsion is taken.

RESULTS AND DISCUSSION

Effect of temperature on viscosity

The results of the effects of temperature from 50°C to 80°C on viscosity of oil and its emulsion are presented in Figure 1. The results shows that viscosities of the light oil and its emulsions decrease as temperature increases because at higher temperature, oil and emulsion molecules obtain higher energy from heat thus making them less viscous and oil can flow easily (Ronningsen, 1995). From this study, temperature can reduce viscosity up to 54.68%.

Effect of water content on viscosity

Water contents for this study is at 0%, 20% , 40% and 60%. The oil and emulsion are measured and the results are shown in Figure 2. The viscosity becomes higher when water content is increased corresponding to Maneeintr et al., [4] and Farah et al., [1] which is found that when volume of water increases, the droplet-droplet interaction and water-oil interfacial area are greater. This phenomenon influences the contribution of the increase in interfacial viscosity. In addition, the effect of water content can increase viscosity ranging from 37.91% to 221.95%.

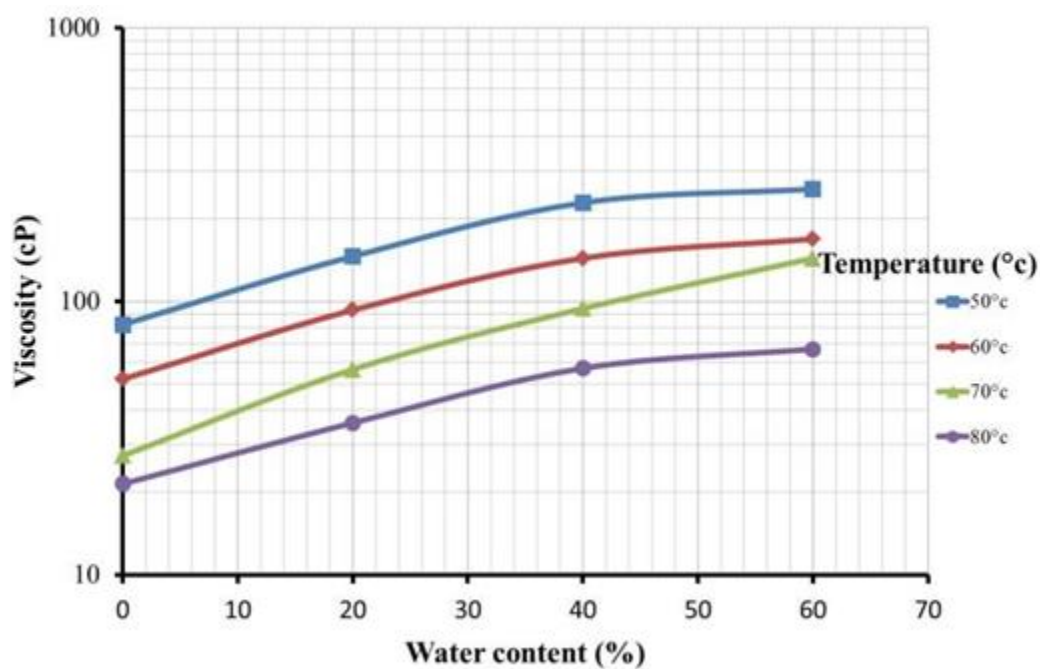


Figure 1: Effect of temperature on viscosity of oil emulsions at 20% water content

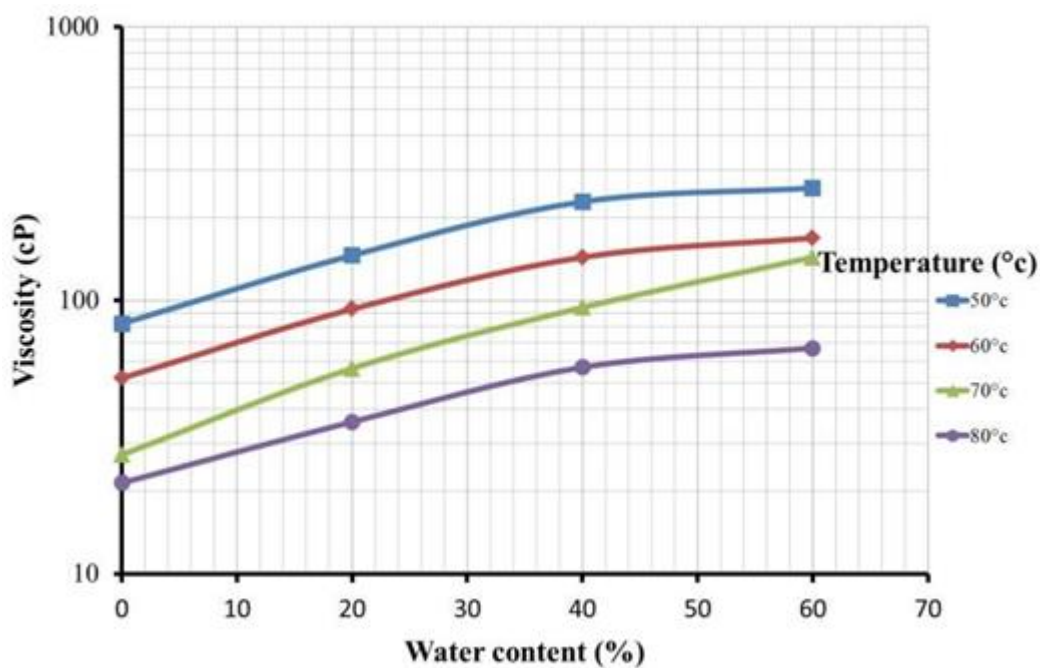


Figure 2: Effect of water content on viscosity of oil emulsions at 30 s⁻¹ shear rate

Effect of shear rate on viscosity

Shear rates used for this study are 3.75, 7.5, 15, 30 and 60 s^{-1} . The result is presented in Figure 3. At high water content, once the larger the shear rate is applied, viscosity becomes lower. At lower water content, on the other hand, the larger shear rate in original oil, viscosity becomes higher. The shearing effects upset the stability of the drop, oscillate in to smaller drops [5]. This phenomena can be explained from the break-up of water droplet to form smaller size as shown in Figure 4 [7,8].

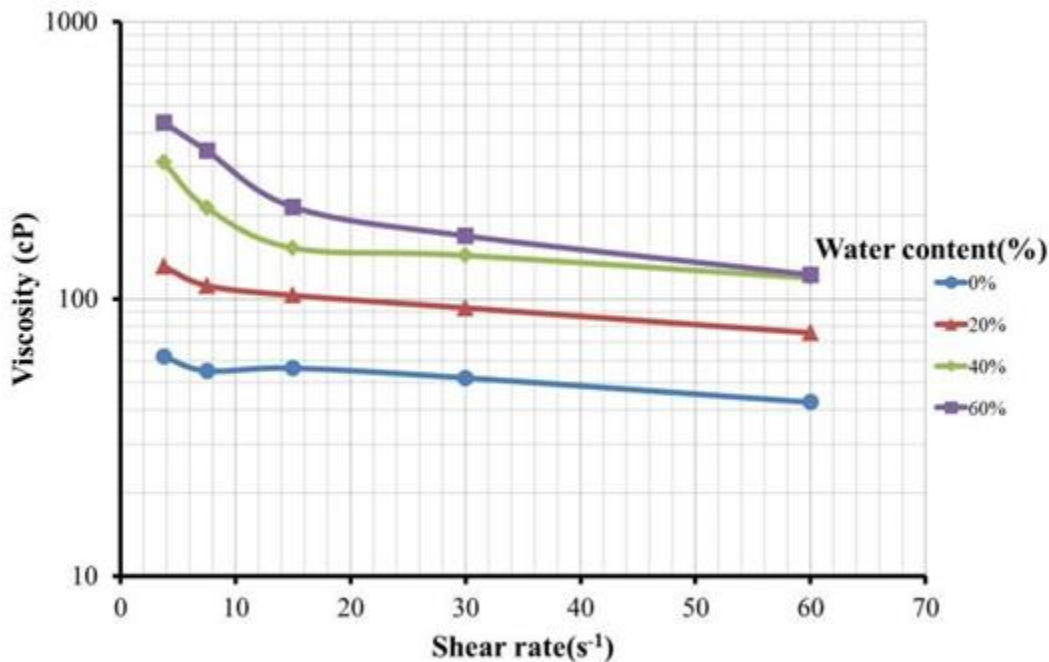


Figure 3: Effect of shear rate on viscosity of oil emulsions at 60°C temperature

Effect of droplet of water on stability of emulsion.

Figure 4 shows the result of water droplets dispersed in emulsion of oil at different shear rate at 70°C and 20% water cut. It is obvious that the droplets become smaller with increasing shear rate because when high shear rate is applied, the droplets of water split to small droplets thus making emulsion stable because interfacial tension and area of oil and water is increased [10].

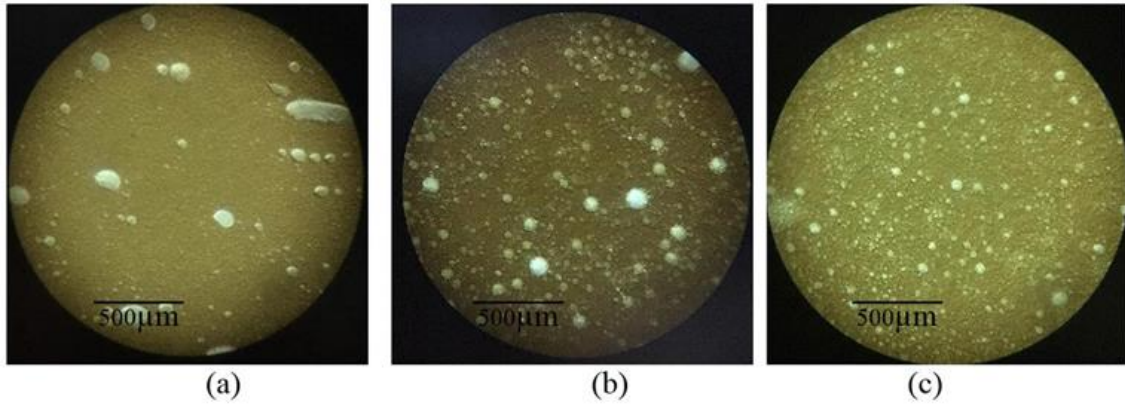


Figure 4: Microscopic observation of water droplet in 20 % water content at (a) shear rate 3.75 s^{-1} (b) shear rate 7.5 s^{-1} and (c) shear rate 15 s^{-1} at temperature 70°C

The correlation for predict the viscosity of emulsion.

The viscosities of oil and its emulsions from Fang's oilfield, Thailand correlated with equation developed from Al-Roomi's correlation. Figure 5 and Table 1 show the viscosities from experiment and correlation.

The average absolute deviations (AADs) between experimental and correlated viscosity estimated from %ADD equation (refer with: Eq. 1)

$$\%AAD = \frac{100}{n} \sum_{i=1}^n \left| \frac{P_{exp} - P_{cor}}{P_{exp}} \right| \quad (1)$$

Where n is number of data.

The average absolute deviations (%AAD) from this correlation is 15.79% so this correlation can predict the viscosity of oil and its emulsion.

Table 1: Experimental and correlation results of viscosity measurement at 70°C temperature

Water content (%)	Shear rate (s ⁻¹)	Viscosity (cP)		Water content (%)	Shear rate (s ⁻¹)	Viscosity (cP)	
		Experimental	Calculated			Experimental	Calculated
0	3.75	51.40	61.69	40	3.75	178.80	171.66
	7.5	45.37	47.15		7.5	142.80	131.21
	15	38.32	36.04		15	73.50	100.29
	30	27.29	27.29		30	94.20	76.65
	60	20.23	20.23		60	52.09	58.59
20	3.75	106.01	102.90	60	3.75	328.30	286.35
	7.5	72.04	78.65		7.5	206.10	218.87
	15	65.00	60.12		15	169.90	167.29
	30	56.43	45.95		30	143.90	127.87
	60	40.31	35.12		60	74.90	97.74

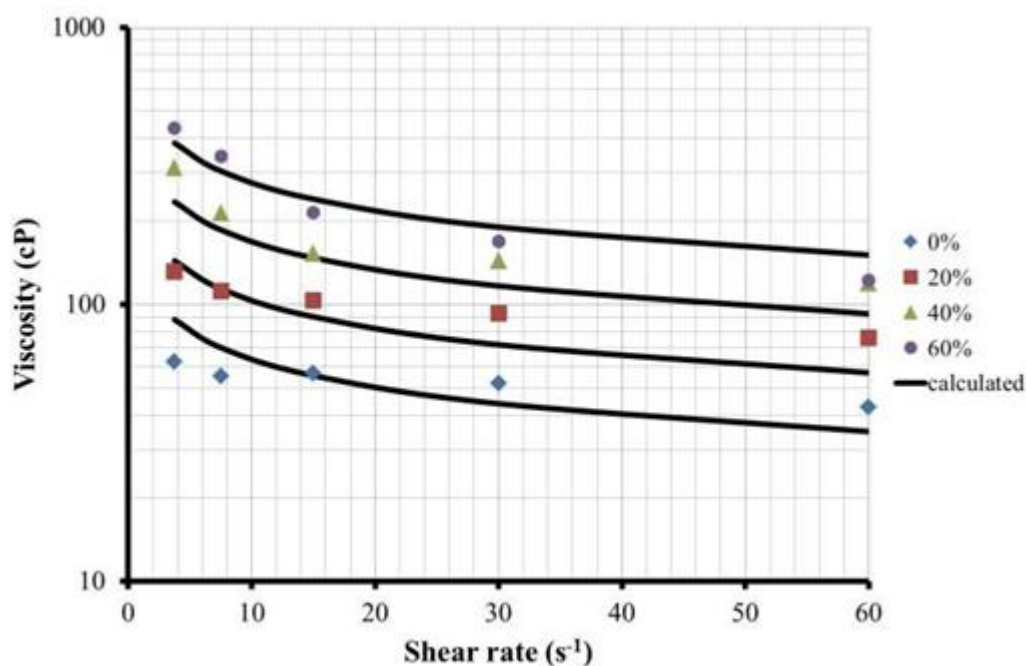


Figure 5: Correlation for viscosities of oil and its emulsion at 60 °C temperature

CONCLUSIONS

Viscosities of light oil and its emulsions from Fang Oilfield are measured. The parameters are temperature, water content, shear rate. Also, the effect of droplets of water and oil for emulsion is investigated to evaluate the emulsion stability. It is demonstrated that the viscosity decrease with increasing temperature and shear rate at

high water content and decreasing water content. Temperature and water content affect on viscosity more than shear rate. Moreover, the water droplets become smaller with higher shear rate and emulsion stability will be higher at smaller droplet and lower temperature.

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