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RHEOLOGY AND STABILITY MECHANISM OF WATER-IN-CRUDE OIL EMULSIONS STABILIZED BY SPAN 83

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ABSTRACT

Water-in-crude oil (W/O) emulsions are found in many industries such as cosmetic, pharmaceutical, and petroleum. The study was aimed to investigate the rheological properties and the stability mechanism of W/O emulsions at different water to oil ratios of (20-80 vol.%) and (40-60 vol.%). The emulsions were stabilized by a non-ionic surfactant (Span 83) at concentrations of 1.5-2.5 vol.%. The heavy and light crude oils were mixed at 50-50 vol.% and characterized in terms of physical and chemical properties. From the results, it was found that the emulsion with higher water volume fraction obtained more viscosity with larger droplet sizes which present low stability. As well as, the higher viscosity was obtained in emulsion with higher emulsifier concentration (2.5 vol.%). However, 20-80 % W/O emulsion and emulsions stabilized with 2.5 % Span 83 produced more stable emulsions as observed through the optical microscopy images. In order to determine the dynamic viscosity, different temperatures from (30 to 90 ºC) and spindle rotational speeds from (50 to 250 rpm) were used. Furthermore, all types of prepared emulsions were visually stable over a period of more than one week, where no water separation was observed during this period, besides; they exhibited a non- Newtonian shear thinning fluid behavior.

Keywords: W/O emulsions, span 83, viscosity, stability, crude oil.

INTRODUCTION

The productions of W/O emulsions are of the great interest in many industrial applications such as cosmetic, pharmaceutical, food, and petroleum industries. The stability mechanism of the emulsions differs, in particular industries. In petroleum industries, the emulsified water generally presents in crude oil, and this phenomenon occurs during the production operation due to the existence of natural surfactants such as resin and asphaltenes (Fingas and Fieldhouse, 2004; Rondón *et al.* 2008). Apparently, these surfactants promote the stability of the emulsions by adsorbing at the water-oil interface to form a rigid film surrounding the water droplets. The function of the stabilizers is that the water droplets cannot contact directly to the surface of the transportation pipeline (Ali and Alqam, 2000; Sjöblom *et al.* 2003; Xia *et al.* 2004). Therefore, these stable water droplets prevent the pipeline corrosion.

Surface active materials play a very important role in stability of an emulsion; they lower the interfacial tension between water and oil and hence increase the emulsion stability (Ghannam, 2005; Nesterenko *et al.* 2014). It is generally believed, that the rheological properties and stability of the emulsions are mainly influenced by several factors such as, volume fraction of the dispersed phase, temperature, surfactant concentration, and chemical composition of the crude oil (Derkach, 2009; Aomari *et al.* 1998; Mohammed *et al.* 2009).The emulsifier used in this work is a non-ionic surfactant with hydrophilic–lipophilic balance (HLB) of 3.7. Surfactant molecules with low HLB values are effective for preparing W/O emulsions (Khan *et al.* 2011). The present work is aimed to evaluate the stability mechanism and rheology properties of W/O emulsion stabilized with Span 83 at different water volume fractions and surfactant concentrations. This work is intended to be the first step in developing W/O emulsion demulsification through the microwave heating technology.

MATERIALS AND METHODS

In this study, two types of different Malaysian crude oils, namely; heavy and light crude oils were used in order to prepare water-in-crude oil emulsions. The heavy and light crude oils were mixed together at a volume ratio of (50-50 %). Table-1 presents the physico-chemical characteristics of heavy-light blended crude oil used in this research.

SARA Fractionation of Crude Oil

The SARA method of analysis was employed to separate the crude oil into four chemical group classes, namely saturates, aromatics, resins, and asphaltenes, through the SARA method of analysis. The Saturates, aromatic, and resin were extracted according to the American Society for Testing and Materials (ASTM D2007) by using open-column liquid chromatography method. Table-2 shows the SARA fractionation of (50-50 vol.%) heavy-light blended crude oil.

Emulsion Preparation

In order to evaluate the effect of different water volume fraction and emulsifier concentration in stability of W/O emulsions the emulsions were prepared in (20-80) and (40-60) vol.% W/O ratios and emulsifier concentrations 1.5 and 2.5 vol.%. For the preparation of the W/O emulsion, the surfactant (Span 83) was added to the crude oil and agitated for 5 minutes under a mechanical agitation of 2000 rpm. Then the dispersed phase (water) was added to the oil phase while mixing in a standard three blade propeller and sheared for another 5