Demulsificaton (Breaking) Of Water-In-Crude Oil Emulsion via Microwave Heating Technology

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ABSTRACT

Traditional ways of breaking emulsions using heat and chemicals are disadvantageous from both economic and environmental perspectives. In this research, the potentials of microwave technology in demulsification of water-in-crude oil emulsions were investigated. The study began with some characterization studies to provide understandings of fundamental issues such as formation, formulation, and breaking of emulsions by both chemical and microwave approaches. The aim was to obtain optimized operating conditions as well as fundamental understanding of water-in-oil emulsion stability upon which further developments on demulsification processes could be developed. It was found that emulsion stability was related to some parameters such as, the surfactant concentration, water content, temperature and agitation speed. Experimental results found that microwave radiation method can enhance the demulsification of water-in-oil emulsions in a very short time compared to the conventional heating methods.

The results obtained in this study have exposed the capability of microwave technology in demulsification of water-in-oil emulsion. Further works are nevertheless required to provide deeper understanding of the mechanisms involved in facilitating the development of an optimum system applicable to the industry.

Key words: Stability, microwave, demulsification, w/o emulsion, concentration, surfactant.

INTRODUCTION

Crude oil is a complex fluid comprising colloidal particles such as asphaltenes and resins dispersed in a mixture of aliphatic and aromatic solvents. Water-in-oil (W/O) emulsions are extremely stable because of the presence of these particles. For economic and operational reasons, it is necessary to separate the water completely from the crude oils before transporting or refining them. To reduce the water content of the produced crude oil, the water/crude oil emulsions have to be broken (demulsified). Therefore, it is necessary to understand the mechanisms responsible for stabilization of these emulsions (Berger, *et al.*, 1987: Mohammed, *et al.*, 1993a: Sjoblom, *et al.*, 1990: Sjoblom, *et al,*. 1992: Sjoblom, *et al.*, 1995: Mohammed, *et al.*, 1993b). The effect of asphaltene solvency on the stability of water-in-crude oil emulsions has been investigated by (Kilpatrick, *et at.*1997). The role of asphaltenes in the stability of water-in bitumen emulsions has been reported by (Yan, *et al.* 1999).

Based on the crude oil aliphatic/aromatic ratio which governs the solubility of asphaltene-resins and their interfacial activity, one can expect three major stabilization mechanisms for a crude oil film between water droplets (Krawczyk, *et al.*, 1991; Wasan, *et al.*, 1993) (1) steric stabilization due to an adsorbed layer of asphaltene at a low concentration of asphaltene-resin submicron particles; (2) depletion destabilization due to an excluded-volume effect, leading to attraction between water droplets; and (3) structural stabilization due to long-range colloidal structure formation inside the film in the presence of a sufficient effective volume fraction of colloidal particles, generally, an emulsion system is expected to have a combination of these three mechanisms. The concept of microwave demulsification of emulsions was first introduced by (Klaila, 1983; Wolf, 1986). Fang *et al.* (1995) presented demulsification of water-in-oil emulsions used microwave heating and separation method.

The objective of the present research is to examine the factors effecting emulsion stability as well as the influence of microwave heating in demulsification of water-in-crude oil emulsions.

MATERIALS AND METHODS

In this study, Elba domestic microwave oven model: EMO 808SS, with its rated power output of 900 watts and its operation frequency of 2450 MHz was modified and converted from batch process system to a continuous process and used as shown in Figure 1 and Figure 2 respectively.

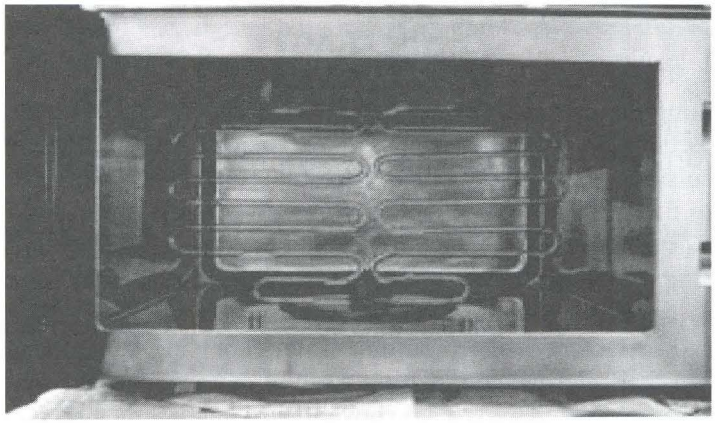

Figure 1: Continuous microwave process

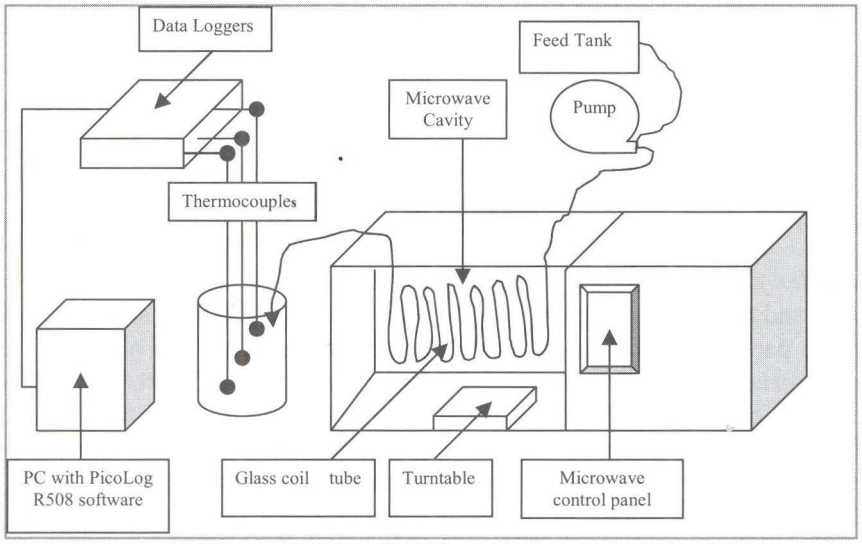

Figure 2: Continuous microwave processes

Three thermocouples type (K-IEC-584-3) were connected to Pico-TC-08 data loggers. Then the thermocouples were connected to the setting tank. The data logger was connected to Pc; with Pico Log Rs.08.3 software. The thermocouples were then inserted in the settling tank to different locations on the top, middle, and bottom of the emulsion sample to measure local temperatures.

Sample Preparation and Procedures

The crude oil samples were obtained from Petronas refinery at Malaka city, 50-50 %, and 20-80 % water-in-oil emulsions were prepared. Emulsions were prepared in 900 ml graduated beakers, with ranges by volume of the water and oil phase. The microwave radiation was set to different power settings. The water phase is distilled water. The emulsions were agitated vigorously using a standard three blade propeller at speed of 1800 rpm and temperature 30 C for 8 minutes. The concentrations of water in the samples were 20-50 %