FORMULATION OF WATER IN PARAFFIN EMULSIONS

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Abstract **- In this work, the effect of surfactant content, water content, HLB value, alcohol content, salinity, emulsion volume and mixing properties on water in paraffin emulsion stability was studied. Emulsion stability was determined by the extent of water and oil resolved after 30 days. After finishing the variables scans, the most appropriate formulation conditions were established, and a formulation protocol was defined. Emulsion density and apparent viscosity were measured, and viscosity was modeled by the Power Law**.

Keywords**: Stability, Span 80, Arkopal N40, viscosity.**

I. INTRODUCTION

In Venezuela there are more than 11,000 lagoons of waste oil emulsions. Due to environmental regulations, these materials require processing and/or disposal, but their characteristics and properties are quite variable. The problem has been extensively handled by petroleum engineers with little success and the existence of a single approach for the treatment and separation is far from possible.

The extraordinary stability of these waste oil emulsions is due to a combination of high viscosity, low density difference, and presence of solids and natural emulsifiers in part formed by the oxidation of crude oil components during the ageing process.

The scope of this work was to develop highly stable synthetic emulsions with reproducible properties, serving as a model to study several techniques for emulsion destabilization that could be also used in crude oil emulsions. Although comparisons between synthetic and crude oil emulsions is not the objective of this work, ranges of water content, density and viscosity of synthetic emulsions are in agreement with the available data of the crude oil emulsion samples.

The effect of different variables was studied in one-dimension scans and as result, an emulsion providing emulsions with maximum stability is obtained.

II. THEORETICAL BACKGROUND

Emulsions are thermodynamically unstable systems; however, the kinetic mechanisms involved in emulsion breaking can be so slow that the corresponding emulsion may be considered as metastable as far as the application is concerned (Salager, 2000).

In a broad sense, producing an emulsified system involves several choices and activities considered as variables. Each of them has an independent effect on formulation; for this reason, one-dimensional scans are used to study their effects on the emulsion properties.

Emulsions are often non-Newtonian fluids with complex rheological behavior; most of them follow the Power Law model (Fox and McDonald, 2003).

$$\eta = A \cdot \dot{\gamma}^{B-1}, \qquad (1)$$

η is the so-called apparent viscosity that would indicate the resistance to flow under some specific conditions; $\dot{\gamma}$ is the shear rate; A is called Consistency Index and B Power Law Index. The viscosity increases within the internal phase content. Many studies have reported empirical relationships to describe this behavior (Becher, 1977; Becher, 1982; Arai and Shinoda, 1967; Kunieda and Shinoda, 1985; Bourrel *et al.*, 1980; Antón *et al.,* 1997), but none of them are valid in the general case, because many other effects, as the non-Newtonian behavior, have to be considered as well (Shinoda *et al*., 1990; Graciaa *et al.*, 1984).

Griffin (1949) introduced the Hydrophilic-Lipophilic Balance or HLB concept, which is a surfactant characteristic parameter used as a measure of the relative affinity of the surfactant for the water and oil phases. The HLB concept has been extensively used (Davies, 1957; Lin, 1980; Becher and Griffin, 1970; Becher, 1982; Becher, 1996). For cost and efficiency reasons, a mixture of several surfactants is generally used as emulsifier.

III. MATERIALS AND METHODS

Surfactant suppliers maintain that to obtain a W/O emulsion, the HLB value should be between 4 and 6, approximately. Therefore, a mixture of Sorbitan Monooleate (Span 80®) with a HLB=4.3 and Nonylphenol Polyglycol Ether 4 EO (Arkopal N 040®) with a HLB=8.7 (both highly soluble in oil), were used. Paraffin and surfactants were mixed. Then, distilled water was added slowly (using a burette) during 5 minutes,