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Experimental Investigation of Emulsion Stability in GOSPs, Part II: Emulsion Behavior

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Abstract

This paper presents an experimental study performed jointly by IFP and Saudi Aramco to characterize the stability of emulsion samples collected from different Saudi Aramco Gas Oil Separation Plants (GOSPs). The first part of the study[1] (SPE 106128) focused on the analyses of separated phases. Many techniques (differential scanning calorimeter, Karl Fisher coulometer, rheology, optical microscopy, cryo-scanning electron microscope) were applied to analyze and characterize the separated phases: crude oil, emulsion and free water. In the second part of this study, the stability of residual emulsions was investigated against several chemical demulsifiers by using classical bottle tests and an automated, vertical-scan, macroscopic analyzer (Turbiscan). This instrument is used to obtain kinetics of separation of concentrated and opaque dispersed systems such as emulsions, suspensions and foams. Interfacial tension measurements were also made to obtain information about the interfacial behavior of samples including viscoelasticity properties of the film. The results of transient emulsion separation experiments provide some useful insights into their behavior, stability and tightness. The study highlights the main physicochemical parameters responsible for the varying tightness of these emulsions, and provides recommendations to optimize their treatment costs and resolve emulsion issues in the GOSPs.

Introduction

The formation of stable water-in-crude oil emulsions during oil production poses significant challenges during oil-water separation in surface production facilities[2-3]. These emulsions can be very stable due to the presence of rigid films formed by polar compounds such as asphaltenes and resins, and other fine solids. Effective separation of crude oil and water is essential to ensure the quality of separated phases at the lowest cost. Crude-oil dehydration is generally accomplished by a combination of mechanical, electrical, thermal and chemical methods. The addition of chemical additives is by far the most common method in emulsion breaking. The chemicals disrupt the interfacial film and enhance emulsion breaking[3-4].

Earlier studies[5-6] have shown the importance of emulsion characteristics on the performance and optimization of oil-water separation at Saudi Aramco GOSPs. The present study was performed jointly by IFP and Saudi Aramco to carry out an in-depth analysis of the main physicochemical properties of emulsions, and the link to their behavior in the field. The main objective is to provide recommendations to reduce treatment costs and optimize oil-water separation in the field.

In the first part of this study[1] (SPE 106128), a strict and rigorous methodology was applied to characterize the behavior and composition of Saudi Aramco emulsion samples from several GOSPs (**Table 1**). The samples were first separated to identify the amount of separated oil, water and residual emulsion. Each phase was then analyzed separately. Bulk properties (viscosity, density) and chemical composition of crude oils were determined. Salinity and geochemical analysis of the separated water were made when possible, or assessed by differential scanning calorimetry (DSC) in other cases. The residual emulsions were characterized using several techniques including Karl Fisher titration to determine the water content, DSC, optical microscopy and/or cryo-scanning electron microscope (cryo-SEM) to assess the size and polydispersity of the dispersed droplets.

The second part of this work addresses the stability of residual emulsions from selected samples using chemical demulsifiers. The efficiency of several chemical additives, including field demulsifiers, were determined using classical bottle tests and an automated, vertical-scan, macroscopic analyzer (Turbiscan). Rheological behavior and fine solids content of emulsions were also measured. Interfacial tension measurements were made to investigate the interfacial behavior of selected samples including viscoelasticity properties of the films.

Materials and Methods

Emulsion Samples from GOSPs

Residual emulsion samples separated after gravity separation (samples # 1, 4, 8 and 10) were selected to conduct complementary tests: bottle tests screening with chemical demulsifiers, rheological and solids content measurements, and interfacial tension measurements.

Rheology

Rheological measurements on residual emulsions were performed using Haake Rheostress RS-150 technique equipped with a cone/plate geometry. All experiments were