

Treatment of Oily Produced Water with Alkaline Surfactant Polymer Using Ceramic Membrane, Coagulation and Flotation

Mundhir AL Batashi

Abstract

Production from ageing oil fields is sustained by various techniques such as water injection, polymer injection or alkaline surfactant polymer injection (ASP). One of the main ageing fields in the south of Oman is Marmul, which currently operates at 90% water cut. It is being operated with waterflood for more than 10 years. In order to enhance the oil recovery, Petroleum Development Oman (PDO) Company has implemented chemical enhanced oil recovery (cEOR) using polymer flood in 2010. ASP is a sub-sequent recovery method, which is planned as a final option to recover more oil from Marmul. ASP breakthrough is expected to deteriorate the performance of the deoiling processes.

Based on some trials done in Marmul field, ceramic membranes had shown some success in treating different types of produced water. However due to some design limitations in the tested membranes, it was operated for 2 hours only and its applicability was not fully investigated. In addition, aluminum sulfate was used in treating produced water with polymer and showed some success. The aim of this study is to investigate the efficiency of ceramic membrane and aluminum sulfate as a coagulation agent with and without gas flotation in treating ASP produced water.

Results showed complete rejection of oil using ceramic membranes with pore size of 100 nm for PW with high and low OiW concentrations. However, only around 2% recovery factor (permeate/inlet flowrate) was achieved. The low recovery factor is mainly due to membrane fouling. Using aluminum sulfate as a coagulant with concentration lower than 200 mg/L was not very effective in treating oily PW. However, at 500 mg/L, the OiW in the treated water was below the first stage treatment target of 50 ppm (v). In contrast, aluminum sulfate was very effective in treating produced water with 500 ppm polymer. At 150 mg/L concentration of aluminum sulfate, the outlet OiW was 39 ppm (v) which is lower than first stage OiW target. When 500 mg/L of aluminum sulfate was used, the OiW in the treated water was 2 ppm (v) which is lower than the second stage OiW treatment target of 5 ppm (v). When aluminum sulfate concentration higher than 500 mg/L was used, the viscosity of the treated produced water was very close to the viscosity of the normal produced water (1.1 cP). This gives an indication that most of the polymer in the produced water was removed. Introducing ASP to the PW had increased the oil droplet stability. Using 500 mg/L of aluminum sulfate to treat produced water with ASP resulted in 65 ppm (v) in the outlet which is higher than first stage OiW treatment target. Oil was fully removed when 700 mg/L of aluminum sulfate was used. Introducing gas flotation improved the OiW removal efficiency by 15%. Based on the above results, gas flotation along with 500 mg/L of aluminum sulfate solution concentration is recommended for treating Marmul produced water with ASP.