Microbial Enhanced Oil Recovery (MEOR): Experiments and Simulation

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Extensive laboratory research and field trials have been performed to evaluate the potential of microbial enhanced oil recovery (MEOR) in mature fields. In this work, the author tries to study the potential of injecting nutrient in a mature field in the Norwegian Continental Shelf (NCS) to improve the oil recovery by stimulating the growth of indigenous microorganisms. The technology of the focus does not require live microorganisms to be injected; instead, it depends on the resident microbes in the reservoir. With a specifically formulated nutrient solution, the resident microbes are stimulated to grow and to reproduce. The nutrient formulation plays a key role, and it must contain a carbon source and other elements required for the bacterial growth such as nitrogen and phosphorous. Furthermore; the success of the process depends on the microbes, which are present in the reservoir. The injected water is the transport medium of the nutrient and it distributes the nutrient throughout the reservoir.

Several mechanisms have been proposed in the literature attributed to the enhancement of oil recovery by microbial interaction. In this study, we focus on the MEOR mechanisms of interfacial tension reduction and wettability modification via bio-surfactant, and selective plugging via bio-film. The effect of MEOR is simulated in Eclipse by a combination of SURFACTANT and POLYMER options to predict, estimate, and to monitor the process during the field trial. The field is a mature field, which is producing at about 95% water cut. The main drainage strategy of the field is water flooding; the implementation of MEOR does not need major modifications, and the investment is low. The reservoir is a complex and heterogeneous reservoir with an estimated ultimate oil recovery of about 35%. Therefore; there is a huge potential for the application of enhanced oil recovery processes.

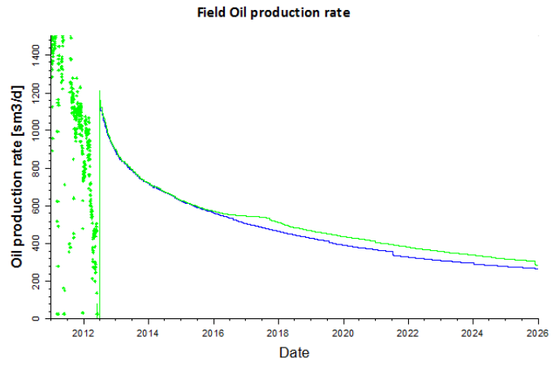

Figure 1 Field oil production rate (nutrient treatment for two years)

In the field case study, the nutrient is injected in two water injectors at 500 ppm concentration for two years. The response is studied in four producers, which are supported by the injectors. The simulation results indicate that the nutrient injection has a potential to recover 1-5% of the remaining oil. Injecting nutrient can achieve about 160000 Sm^3 of incremental oil after 10 years (Jan. 2026), **Figure 1 & 2**. Also, water cut is reduced by about 1% due to the formation of bio-film and permeability reduction in the high permeable zones, **Figure 3**. The estimated response time is about 2-6 months in the producers; depending on the distance and communication between the producers and injectors. The process is identified as a potential technique to target the remaining oil in the reservoir. The results can be used to predict and to monitor the application of the MEOR technology during the field trial.

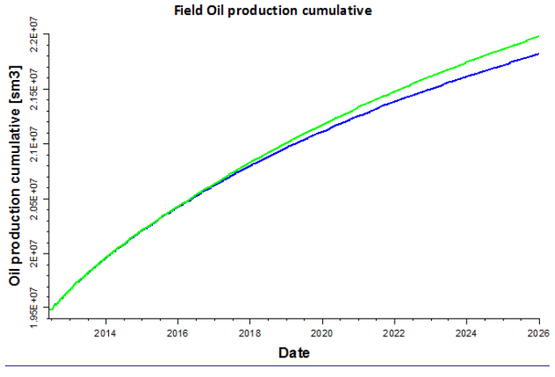

Figure 2 Cumulative oil production after 10 years

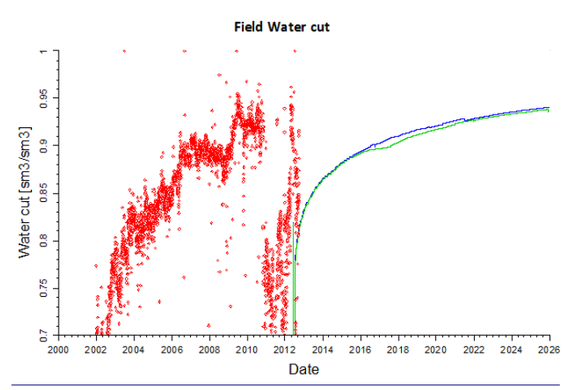

Figure 3 Reduction in the water cut due to formation of bio-film in high permeable channels

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