MICROBIAL ENHANCED OIL RECOVERY

ABSTRACT

The processes involving the use of microbes for improving oil recovery efficiency is assessed from the perspective of reservoir engineering. Microbial enhanced oil recovery (MEOR) is a method which utilizes a mixed microbial population (preselected microorganisms or indigenous reservoir microorganisms) and their metabolic products such as biomass, biosurfatants, biopolymers, gases and aids to increase the displacement and/or volumetric efficiency of reservoirs. Chemical EOR methods such as polymer flooding, surfactant flooding, alkaline flooding, etc. are the same as those of MEOR processes. They are thus subject to the same technical difficulties, an example of which is the retention and dissipation of chemicals within the reservoir. The major difference between MEOR and chemical EOR however is the method by which the recovery-enhancing chemicals are introduced into the reservoir.

An examination of literature reveals a large number of successful MEOR laboratory trials but with very few field applications. This is as a result of a lack of understanding of the mechanisms involved in MEOR. This dissertation thus covers a critical review of possible microbial enhanced oil recovery methods and mechanisms in order to identify the most feasible utilization of microbial technique to enhance oil recovery. Laboratory experiments were conducted with the aim to investigate the rate of biodegradation of dodecane using glass bioreactors over an incubation period of 31days. The results obtained indicate that an increase in the rate of biodegradation can be achieved, thus resulting in an increase in the oil recovery efficiency.

In conclusion, MEOR is a ‘’high-risk, high reward” process, depending on whether the

microorganisms can produce oil recovery-enhancing chemicals by utilizing the residual oil within the reservoir as a carbon source. The high risk in this context refers to the severe constraints that the microbial system must satisfy in order to utilize an in situ carbon source. The rewards however is that the logistical cost and difficulty in implementing the process is similar to those of implementing a waterflood.

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CHAPTER ONE

1.1 INTRODUCTION

Crude oil exists worldwide in an intricate network of oil reservoirs. This oil is brought to surface facilities through production wells, using existent oil recovery technologies. As defined by the Society of Petroleum Engineers (SPE), primary and secondary recovery methods are used to target oil which can be produced due to viscous and capillary forces in the in the reservoir [1, 2]. Primary recovery occurs due to the overburden pressure of the earth on the oil bearing formation [3]. Overtime, the primary production rate decreases, and some of the production wells are transformed to injection wells. Secondary recovery however involves implementing either water flooding or gas flooding techniques to boost the pressure in the reservoir. These injected fluids (water or gas) help fracture the oil-bearing formation, and enhance the flow rate of oil and gas towards the wellhead. Whereas primary recovery produces between 5-10% of the original oil in place, secondary recovery produces between 10-40% of the total reserves [4]. Two-thirds of the initial oil in place however remains in the reservoir after these conventional recovery techniques have been applied.

The energy demand across the globe is increasing as a result of the increase in the population. In order to meet these rising energy demands throughout the world, it is therefore necessary that more attention be focused on techniques for recovering more fraction of the initial oil in place from hydrocarbon reservoirs after secondary recovery. The method by which this is achieved is termed tertiary recovery, also known as Enhanced Oil Recovery (EOR). This implies that the target for EOR methods is significant (two-thirds of the total reserves). EOR however has a close relationship with the prevailing oil price and the general economics associated with the technique. Classification of EOR methods are based on the oil displacement mechanism [5, 6]. These methods alter the viscous and capillary forces between the oil, rock surface and injected fluid. The classification of EOR include thermal methods (heat injection), miscible gas injection (solvent injection), chemical methods (injection of surfactant/polymer) and microbial (injection of microorganism). Microbial enhanced oil recovery (MEOR) is in the research and development stage, and that is the purpose of this project.

MEOR refers to the use of microorganisms and their metabolic by-products to extract the residual oil from reservoirs. Metabolic by-products include a range of compounds produced through microbial metabolism, an example of which is biosurfactant. The produced biosurfactant reduces the interfacial tension at the oil-rock interface, thereby increasing the oil recovery efficiency [7]

1.2 AIM OF THE PROJECT

There are various mechanisms by which MEOR operates. This research work presents a broad overview of EOR technologies, with focus on Microbial Enhanced Oil Recovery (MEOR), its mechanisms and the rate of biodegradation of hydrocarbon, field applications and its' challenges.

1.3 JUSTIFICATION

MEOR has obtained very few applications in the oil industry. Considering that MEOR is a novel technology still in the R & D phase. This research work was therefore carried out in order to add to the already existing body of knowledge on the subject matter, so as to increase the application of MEOR in depleting oilfields. This investigation has been carried out by potential investigation of the rate of biodegradation of hydrocarbons, with the aim of gaining more insight to the mechanisms of MEOR. In this research work, dodecane represents the hydrocarbon used, and the microbial activity is subjected to aerobic conditions. Mineral water is used to stimulate the microbial growth.

1.4 SCOPE OF WORK

This research work is limited to laboratory experiments to investigate the rate of biodegradation of dodecane under aerobic conditions. The research work terminates with additional study to investigate which MEOR mechanism plays a major role in biodegradation of hydrocarbon