MICROBIAL ENHANCED OIL RECOVERY: LITERATURE REVIEW AND EXPERIMENTAL INVESTIGATION.

ABSTRACT

Despite being around since the 1920s, Microbial Enhanced Oil Recovery (MEOR) has not yet been widely accepted in the oil and gas industry as a large scale means of oil recovery. Primary and secondary oil recovery methods at best the two methods can only retrieve about a third of the oil in place since production progresses, capillary forces, interfacial forces, rheology of the oil and lithology of the formation all conspire to gradually reduce the amount of oil that can be produced. Declining production renders operations uneconomical and the wells are eventually abandoned.

MEOR involves the injection of nutrients and of microorganisms into the reservoir. Several mechanism are theorized as to how MEOR results in improved oil recovery. Once microbes acclimate to reservoir conditions and nutrients, biodegradation occurs and results in reduction of interfacial tension by surfactant production, reducing viscosity of the oil by produced biogas, permeability modification through selective plugging and bioacid production, which combine to improve oil recovery.

The aim of this report is to firstly, carry out a literature review of past studies and field trials of MEOR so as to gain some understanding of its current state in the industry and secondly, to undertake experimental investigation to attain a fundamental understanding of hydrocarbon biodegradation.

From review of available literature, it is clear that despite the numerous studies that have been carried out on MEOR, a true understanding of the process and its mechanisms is yet to

be attained even though most field tests recorded improved oil recovery after MEOR treatment. Experimental investigation revealed decane to be biodegradable under aerobic conditions with a yield coefficient of 0.53g of biomass produced per 1g of substrate consumed.

MEOR has the potential to greatly improve the output of the industry as whole. More laboratory and field studies must be carried out to avail more information on the most effective strains of microorganisms, conditions that favor and hinder MEOR operations as well as continued documentation both successful and unsuccessful treatments for future reference.

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LIST OF ABBREVIATIONS

MEOR	Microbial Enhanced Oil Recovery
EOR	Enhanced Oil Recovery
MIOR	Microbial Improved Oil Recovery
IFT	Interfacial Tension
CSS	Cyclic Steam Stimulation
SAGD	Steam Assisted Gravity Drainage
OIP	Oil In Place
LPG	Liquid Petroleum Gas
HCPV	Hydrocarbon Pore Volume
SRB	Sulphate Reducing Bacteria
API	American Petroleum Institute
MMBBL	Million Barrels
MBBL	Thousand Barrels
TDS	Total Dissolved Solids
WOR	Water Oil Ratio
HDB	Hydrocarbon Degrading Bacteria
MSL	Mean Sea Line
OOIP	Original Oil In Place
GOR	Gas Oil Ratio
GC	Gas Chromatograph
RT	Retention Time
TSS	Total Suspended Solids
DO	Dissolved Oxygen

CHAPTER ONE

1. INTRODUCTION

1.1 OVERVIEW

Conventional oil recovery techniques are estimated to recover only about a third of the oil carried in oil-bearing strata around the world [1]. The increased dependence of world economies on oil means that the demand and price of oil have increased almost exponentially since the advent of oil production and thus producers cannot afford to leave the producing formations unexhausted [2, 3]. In addition to being unable to completely exhaust the reservoir, primary and secondary oil recovery techniques are often not very environmentally friendly as they produce a host of pollutants that are difficult to dispose of safely [4].

Microbial Enhanced Oil recovery (MEOR) is an area of research, which potentially offers a lot of solutions to the current issues faced by the industry. MEOR is defined simply as the use of microorganisms to improve the output of a producing facility and is considered a tertiary means of oil recovery. Research is being carried out to investigate the efficiency, cost-effectiveness and environmental impact that widespread use of MEOR would have on today's industry.

Harsh reservoir conditions dictate the choice of microbes because they must able to withstand and also thrive in high-temperature, high-pressure, high-salinity regions [4-6]. No one specific microbe can meet all the criteria and such a collection of them must be used to ensure sustainability of life, growth and eventual multiplication of the organisms.

The unpredictability of microorganisms coupled with insufficient understanding of the mechanism of MEOR have contributed to the limited field implication of MEOR despite the fact that it was first proposed as early as the 1920s. The myths and misinformation that surround this method are what this dissertation will aim to dispel as well offer recommendations for laboratory testing and field implementation.

1.2 OBJECTIVES OF THE REPORT

This has report has two major objectives, Literature review and experimental investigation, both of which are geared toward gaining a better understanding of MEOR.

1. Literature Review.

To date numerous laboratory and field have been carried out on MEOR to shed light on this tertiary oil recovery process. The aim of the literature review is to access the available data and use it to,

a) Understand the where and when MEOR is applicable to a field.
b) To understand the mechanisms of MEOR and how they help improve oil recovery.
c) Establish the current status of MEOR in the industry and its prospects going forward.

2. Experimental Investigation.

This is geared at gaining a fundamental understanding of biodegradation through experimental analysis. A sample hydrocarbon representative of the average composition of a reservoir is evaluated to determine its rate of biodegradation under aerobic conditions. This investigation will also;

a) Provide an opportunity for learning and familiarizing oneself with laboratory procedure and equipment before commencement of testing.
b) Help to provide an understanding of any accompanying processes that may be occurring alongside or as a result of said biodegradation.

Once completed, findings of the literature review and results of the experiments shall be compiled for presentation and submitted in compliance with the requirements for completion of the dissertation.