UNIVERSITI TEKNOLOGI MARA

INTERFACIAL TENSION PREDICTION OF SILICA NANOPARTICLE ADDITION AT ELEVATED TEMPERATURE USING DYNAMIC SIMULATION

MUHAMMAD NOOR SHAFEE BIN KAMISAN

Thesis submitted in fulfilment

of the requirements needed for the award of

Bachelor Eng. (Hons)

Faculty of Chemical Engineering

July 2019

ABSTRACT

Foam flooding is introduced in the Enhance Oil Recovery as improvement method in surfactant flooding recovery processes. Foam flooding will take place in tertiary recovery of oil at reservoirs to increase the crude oil recovery in oil industry. To increase the oil recovery, sweep efficiency of residual oil need to increase but there is one challenge existed in foam flooding. The main issue in foam flooding is foam stability. Surfactant used in this study is sodium dodecyl sulfate (SDS) and is known as a foaming agent. The price of SDS is low and economical friendly. SDS is used along with water and carbon dioxide to produce foam through direct injection to the reservoir. However, the stability of the foam still be low and the structure of the form film will rupture when it is directly in contact with oil. To improve the stability of foam, silica nanoparticle is used during injection of foam. The nanoparticle of silica will support the structure of foam film by attaching closely with surfactant along the form film that contact with oil. The form film stability will increase. There are many factors that affect the stability of the foam especially the condition of oil reservoir itself. The extreme condition including temperature and pressure at the reservoir affect to the stability of the foam and become limitation factor to study. Therefore, molecular dynamic simulation is introduced to depict the formation of foam film in order to emulate actual condition with some assumption of parameter and variable. The temperatures used in this simulation are 400K and 450K. Mean square displacement of the molecules in all system is higher at 450K compared the results at 400K. The gradient of the mean square displacement graph gradient is proportional to the diffusion coefficient. Therefore, diffusion coefficient result is in the order of CO_2 > Hexane > SDS > SiO_2 at 450K compared with 400K. Diffusion coefficient is increased when temperature increased. Interfacial tension decreased when temperature increased while SDS molecules and SiO_2 molecules increased.

Keywords— **Interfacial Tension, Silica Nanoparticle, Elevated Temperature, Dynamic Simulation.**

ACKNOWLEDGEMENT

Firstly, I wish to thank Allah for giving me the opportunity to embark on my Degree journey and for completion of the first half of my research project. My gratitude and thanks go to my supervisor, Assoc. Prof. Dr. Noor Fitrah Binti Abu Bakar for her priceless guidance.

My appreciation goes to the Faculty of Chemical Engineering UiTM Shah Alam for facilities and assistance during the research implementation. Special thanks for my colleagues and friends for helping me with this project.

Finally, this work is dedicated to the two greatest souls in my life, my endless loving father and mother for their vision and hardship to provide quality education for me. If it is not for every breath that they take, I would not be standing here looking at the world upon my shoulders. May my success, be your triumph.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 Research Background

In most cases, porous rock at the oil reservoirs consists of oil and gas but temperature and pressure are very extreme at deep underground of Earth. 50% of the residual oil have recover from original oil at the reservoir after primary and secondary recovery of oil [2]. To increase the residual oil recovery, enhanced oil recovery [3] methods are introduced and developed by upgrade the macroscopic and also microscopic sweep capability [4] by using different applications as shown in Figure 1.1. In the EOR method, interfacial tension (IFT) is being essential part that recover the residual oil at 30% by water flooding or solution gas drive. The injection of the carbon dioxide to the interfacial tension of the residual oil will take the place and deliquesce some of the residual crude oil and improve the oil recovery [5]. EOR method also can decrease propensity of fingering and the mobility ratio [6]. To handle that problems, foams is used. To produce the forms, gas and surfactant usually injected together. The stability of the forms is important in the process because when the forms is in contact with oil, it can be weaken the foam [7].

Nowadays, surfactant or known as form flooding is a famous of the chemical methods in enhance oil recovery used where the blend of the surfactant and water is flooded in the residual oil reservoir to increase the performance of sweep efficiency of the residual oil. The advantageous condition can be created to mobilize trapped oil through this method [8]. Moreover, surfactant flooding also will increase the attraction ability to interact with water and oil. The molecular structure of surfactant usually consists of a polar head group and a non-polar tail. The polar head group section in surfactant is attract with aqueous element and other hand, the non-polar tail is attract with oil. Hydrophilic head is part of polar head and hydrophobic tail is part of non-polar tail. These properties exert a great significance in the aid of oil detachment process from rocks and pores in the oil reservoir.