CHAPTER I
INTRODUCTION

Enhanced Oil Recovery (EOR) techniques have a vast strategic value in terms of the world's hydrocarbon resources, and a great potential for recovering large quantities of oil – whose quantity and position in the Earth's surface is already known. One type of EOR technique widely used is chemical flooding. In this process, chemicals are added into the displacing water to make the displacement process more effective. Polymer flooding, a type of chemical flooding, is one way to control drive-water mobility and to modify fluid flow patterns in reservoirs by viscosifying the water. Crosslinked polymer gel, an in-situ permeability-modification agent, could be applied to reduce the effective permeability of the high-permeability channels and/or fractures in the reservoir. The main objective of these processes is to improve sweep efficiency of the reservoir and recover incremental oil.

The methodologies that will be used to assess the efficiency of EOR techniques and their mechanisms in this thesis are based on two different approaches. The first approach will be based on the macroscopic evaluation of EOR techniques through flood testing process. The aim of this experimental approach is to monitor the displacement front as a function of the volume of displacing fluid injected through material-balance measurements, as well as the evaluation of oil recovery efficiency after EOR treatments.

The second experimental approach uses Magnetic Resonance Imaging (MRI) as a tool to visualize the microscopic displacement during flood testing experiments. MRI is a non-destructive and non-invasive measurement widely used by physicists, chemists, biologists, and others. Several recent studies report the use of MRI to determine fluid distributions in static and dynamic systems in porous media. The Centric Scan SPRITE (Single Point Ramped Imaging with T_1-Enhancement) MRI technique is introduced as a potential tool for direct visualization and quantitative evaluation of the displacement process and oil recovery in porous media.

The main objective of this study is to evaluate the use of MRI to visualize and quantify the displacement of fluids through porous media. The experimental approach is to monitor fluid flow fronts, or interfaces, between displaced and displac-

ing fluids and to determine in-situ fluid saturations and residual oil mobilization by MRI during EOR treatments. EOR techniques such as polymer flooding, and crosslinked polymer gel treatment in unconsolidated porous media are investigated. Also, secondary oil recovery processed such as waterflooding are observed as the basis of all experiments. Validation of the MRI observations is conducted through material balance measurement.

In this research, fluorolube oil containing ^{19}F nuclei for ^{19}F MRI was used to distinguish between the oil and water phases during MRI measurements. A sand pack sample was used to represent unconsolidated porous media. Partially hydrolyzed polyacrylamide (HPAM) was the polymer used in this study. Cr(III)-carboxylate/acrylamide-polymer (CC/AP) gels were applied in the channel system. Consolidated rocks are also investigated as a preliminary step in a larger initiative into the waterflooding process.

The scope of this research work will cover the following:

1. Characterization of the porous media such as porosity, pore volume, permeability, and wettability.
2. The effects of sand pack preparation on fluids displacement and saturation in porous media such as sand wettability, and porous media configuration i.e. unconsolidated sand pack and channel system.
3. The application of MRI to visualize, monitor, and quantify fluid saturation in porous media during fluid displacement processes.
4. Flood testing of different fluid displacement processes.
5. The effect of varying polymer concentration on polymer flooding.
6. The effect of crosslinked polymer gel treatment on channel systems.
7. The validation of MRI observations by material balances.

It is expected that the use of MRI will allow a better understanding of the dynamic microscopic processes involved in the mobilization of residual oil during the application of EOR processes.