



CHAPTER I INTRODUCTION

In order to produce oil from a well, oil has to be displaced from the pores in the formation rock, oil recovery. Initially oil production occurs by natural pressure, primary recovery, but when natural pressure has dropped, pressured gas, seawater or chemical agents have to be injected into the reservoir to maintain reservoir pressure. The injection of seawater into the reservoir can cause scale formation. Precipitation of CaSO_4 , BaSO_4 and SrSO_4 scales occur when the injected seawater which contains a high concentration of sulfate ions (SO_4^{2-}) contacts the formation water in the reservoir which contains a high concentration of calcium, barium and strontium ions (Ca^{2+} , Ba^{2+} and Sr^{2+}) (Yuan *et al.*, 1994; Yen *et al.*, 1999; Muller-Steinhagen *et al.*, 2006; Binmerdhah *et al.*, 2010).



Scale formation can damage oil field water injection systems, blocks production flow lines, production equipments, decreases fluid flow, reduces heat transfer efficiency and causes fouling and corrosion in equipments (Morizot *et al.*, 1999; Muller-Steinhagen *et al.*, 2006). Consequences are failure in production and equipment and decreases production efficiency. Moreover, even high cost of remediation cannot restore the original productivity of a well that has been damaged.

One of the scales that causes significant problem in the petroleum industry is barium sulfate (BaSO_4) because it has the lowest solubility (2 mg/L in water at 20 °C) when compared with other scales and it cannot be dissolved easily by chemical agents (Morizot *et al.*, 1999). In order to predict and prevent the scale formation of BaSO_4 , it is necessary to understand the mechanism and conditions which affect scale deposition.

Various studies have been conducted to investigate the nucleation and growth of barium sulfate (Klein *et al.*, 1964; Ring *et al.*, 1991; Kashchiev *et al.*, 2003; Kucher *et al.*, 2006). Moreover, factors which affect barium sulfate formation have also been investigated. These factors include temperature, pressure,

supersaturation ratio, ionic strength and induction time (Jiang, 1996; Graham *et al.*, 2002; Kucher *et al.*, 2006).

The purpose of this research is to develop a capillary flow technique to investigate the possible mechanisms of barium sulfate deposition. Moreover, the deposit location and uniformity of scale deposition inside the capillary was investigated.