

CHAPTER I

INTRODUCTION

At the present, most of the daily energy consumption is derived either directly or indirectly from oil and gas. Moreover, petroleum is also used as feedstocks in manufacture of several products, such as benzene, toluene and olefins. Petroleum is normally found in reservoirs situated at various depths below sea bottom (offshore) and underground (onshore). To bring oil to the surface, oil must be displaced from the capillary interstices of the porous reservoirs. In young wells, the oil delivery can occur by natural pressure. After the inherent well pressure dissipates, unconventional methods are employed to force the oil moving up to the surface. For offshore wells, seawater is commonly pumped downhole to displace the petroleum. The water present in the reservoir, usually known as formation water, contains significant contents of certain ions that tend to form scale when are mixed with the seawater, similar phenomenon also occur in the onshore wells (Monsanto, 1996). The mixture of these two incompatible brines, which causes the sudden changes in produced fluid conditions, such as temperature, pressure and pH, will result in scale deposition. Scale nucleation and growth can also occur anywhere in a production system, most notably on surface production equipment, on the wellbore surface, or in the near wellbore formation (Browning and Fogler, 1993). The scale formation can reduce the production efficiency and also foul/damage equipment if the scaling problem is not treated properly. This is one of the most serious problems that the petroleum industry has been facing today. Injecting threshold scale inhibitors into reservoirs during production downtime (i.e., the shut-in period) can prevent or slow the crystal nucleation and growth of scale. This method, known as squeeze

treatment, is an effective way to combat the scaling problem. One of the most commonly used scale inhibitors is phosphonate. The precipitation of calcium with scale inhibitors in Mg-free solution have been investigated intensively in many studies (Meyers *et al.*, 1985; Browning and Fogler, 1993, 1995, 1996; Rerkpattanapipat, 1996; Jordan *et al.*, 1997; Wattana, 1997; Raju, 1998; Suwannamek, 1998; and Liwsrisakul, 1999). It is very interesting to point out that both seawater and formation water normally contain high magnesium concentrations. Therefore, numerous investigations concerning the effect of magnesium on the precipitation of calcium carbonate have been carried out (Nancollas and Sawada, 1982; Nancollas *et al.*, 1985; and Pokrovsky, 1998). It has been reported that the presence of magnesium ion can retard the growth rate of calcite. In the case of unseeded precipitation from supersaturated solutions, aragonite is the ubiquitous phase forming at a $Mg^{2+}:Ca^{2+}$ activity ratio higher than 3:1. At a lower $Mg^{2+}:Ca^{2+}$ ratio, calcite and magnesian calcite are mostly formed (Pokrovsky, 1998). Therefore, it is imperative to studying a the effect of magnesium ion on the properties of calcium-inhibitor precipitates. Before study this effect, it is needed to clearly understand the Mg-scale inhibitor system first.

In this study, the effect of the precipitating conditions on the formation of magnesium-inhibitor precipitates was carried out systematically. The scale inhibitor used was 1-hydroxyethylidene-1,1-diphosphonic Acid (HEDP).