CHAPTER I
INTRODUCTION

The deposition of inorganic scales from supersaturated solutions of sparingly soluble salts has long been a serious problem in petroleum industry. For example, it has been reported that during 1984 and the early part of 1985, for off-shore oil recovery in a number of North Sea oilfields where sea water was injected, calcium carbonate was found to occur as a prominent scalant mainly in the upper part of production tubulars, and in surface processes (Browning and Fogler, 1996).

One of the most common and efficient methods for preventing the formation of such deposits is through the use of small amounts of certain chemical scale inhibitors which deal with problems in a cost effective manner in a technique known as "squeeze treatment". This type of treatment protects the near wellbore region and the downstream production system (Browning, 1996).

Phosphonate scale inhibitors are important industrial chemicals widely used in the squeeze treatment. The scale inhibitor solution is injected into the formation and displaced out some distance by overflushing, usually with an injected brine due to its low cost. In many applications, phosphonates encounter high concentrations of metal ions and precipitate as metal salts. Therefore, it is important to understand the precipitation and the dissolution of metal phosphonate as a function of pH and temperature in order to predict the performance of these metal phosphonate precipitates under various conditions. For example, oil and gas industries use phosphonate scale inhibitors to control carbonate scale in production systems. The inhibitor is retained in the porous matrix by adsorption onto the rock surfaces (adsorption squeeze) and/or by

forming an insoluble salt with calcium (precipitation squeeze). However, this work considers only the precipitation squeeze technique.

When a well is treated by the squeeze treatment, the phosphonate inhibitor concentration in the produced brine drops exponentially over time and eventually levels off to a low concentration (mg/l) which may become lower than the effective concentration. That means the concentration level depletes to a point at which it no longer gives scale protection resulting in the premature end to the squeeze lifetime, then another squeeze treatment is required (Browning and Fogler, 1993).

Therefore, it is important to ensure effective precipitation squeeze treatments with longer lifetimes. In this study, phosphonate scale inhibitor precipitation squeeze processes involving batch, differential reactor and dynamic glass micromodels were carried out at various conditions. In particular, the main objective of this study was to clarify the effects of various parameters, such as pH, temperature, and inhibitor and Ca^{2+} concentrations. 1-Hydroxyethylidene-1,1-diphosphonic acid (HEDP) was used as a model scale inhibitor because it is extensively used in field squeeze treatments.