CHAPTER I
INTRODUCTION

The petroleum industry is regarded as one of the most important industries since most human activities revolve around the production of gas and oil. Petroleum is found in reservoirs situated both below sea beds (offshore) and underground (onshore). The petroleum (oil) in young well can be delivered by natural pressure but it will become harder to remove as the time passes. Therefore, additional equipment must be installed in order to enhance the oil recovery. Frequently, the reciprocating plunger pump is used to pump the oil up to the surface. However, use of plunger pump may be hindered by the occurrence of some formation damages which are mainly caused by fines migration. The particles resulted from the damages may deposit in a well bore in many patterns and lead to plugging of pore spaces. Thus other processes must be employed in order to overcome these problems. In this aspect, many methods have been suggested including fracturing and acidizing. Acidizing is the method that employs acid to contact and react with the damage zones, which leads to an increase in permeability near the well bore.

A technique commonly used throughout industry to stimulate reservoirs is known as matrix acidizing. In matrix acidizing, acid is injected into the well bore in order to remove pore blockage and thereby increase permeability. This acid will dissolve minerals that make up formation matrix as it passes through and then the permeability of the well can be recovered. Since the pressure used in this method is considerably low compared with other alternatives such as fracturing, the operating costs of matrix acidizing are lower, and thus, more preferable.

Unfortunately, despite its economical advantage, matrix acidizing has a high failure rate. Several consequences may occur during the stimulation treatment: (1) clay swelling resulting from ion exchange on clay, (2) fines migration, (3) mineral precipitation in hydrofluoric acid (HF) and hydrochloric acid (HCl) treatment, and (4) gel formation caused by clay instability during (HCl) treatment.

The discovery of the common occurrence of the zeolite mineral analcime as sandstone cement has contributed to an overhaul of standard completion and stimulation procedure in the field. Analcime is found to have a strong tendency to form hydrated gels in high concentrated hydrochloric acid. This property can potentially create a serious damage to the near well bore region.

Much of previous research has focused on the dissolution of layered alumino-silicate minerals rather than zeolites. Only a few of them have been conducted to dissolution of zeolite. The solubility and the stability of analcime in different types of solutions have been studied (Wilkin and Barnes, 1998). The dissolution and growth of analcime were also studied to understand the kinetics and the mechanism of the reaction occurred (Murphy, *et. al.*, 1996). However, most of these experiments were performed under the condition of high pH value which is not applicable for acidization in oil field industry.

The dissolution of alumino-silicates such as Kaolinite, Chlorite, Carbonate or Illite has previously been studied. The types of the acid used were mostly inorganic acid such as hydrochloric acid, hydrofluoric acid or mixture of these acids (Kline and Fogler, 1981, Gdanski, 2000, Underdown, *et. al.*, 1990). However, many researchers have encountered the problem with silica and alumina precipitation. Recently, the use of organic acids and some chelating agents such as acetic acid, citric acid and EDTA (or mixtures) has been investigated as potential stimulation fluids (Fredd and Fogler, 1998, Shucart, 1997, Rogers, *et. al.*, 1998). Citric acid was found to have the properties of Al-chelation (Yokel, 2002), thus may lead to less mineral precipitation. It has also been reported to enhance the solubility of Si (Rogers, *et. al.*, 1998). In addition, since it is a multiprotonic acid, citric acid may probably be able to improve the acidization process (Marinovic and Despic, 1997, Underdown, *et. al.*, 1990).

In this study, the kinetics of the dissolution of analcime with citric acid was studied by the initial rate method. Different initial sizes of analcime particles were used in order to observe the effect of mass transfer. The morphology, the elemental analysis, and the particle size distribution analysis of analcime particles were comparatively studied to understand the nature of the acid attack. The effects of the particle size, acid type, acid concentration, and surface composition on the breaking of analcime particles were also investigated.