CHAPTER I

INTRODUCTION

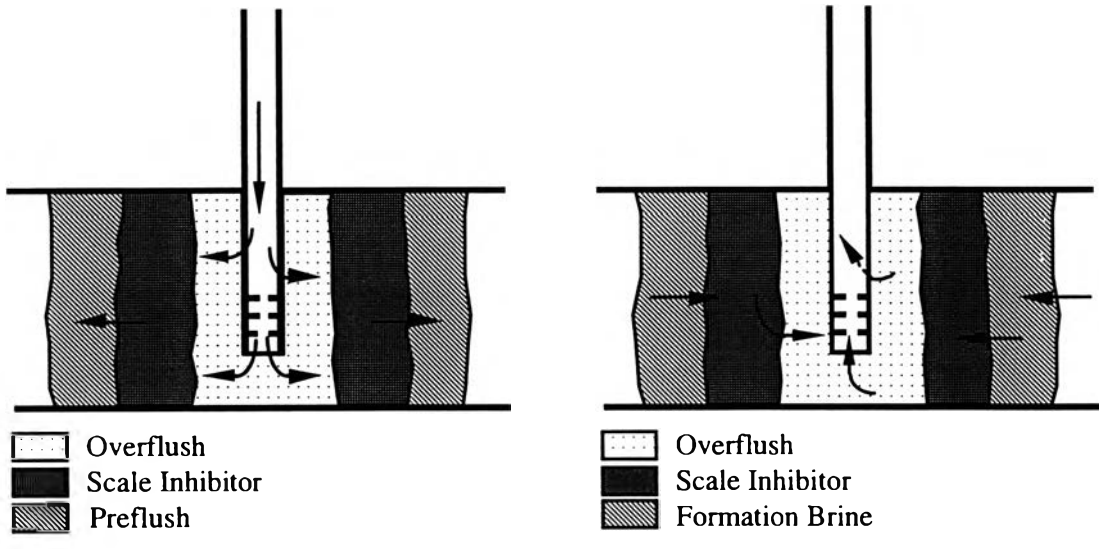
The capacity loss of oil production resulting from the scale deposition is one of major problems often found in oilfields. Most of oil producers try to find effective ways in preventing the formation of scale. They are satisfied to inject the scale inhibitor into the matrix formation for controlling the scale formation and situated in the reservoir rock for a long time. Scale inhibitor, phosphonate, is a successive choice in controlling the scale deposition as well as its property offers in protecting the equipments from corrosion.

Some of the prominent scales found in a production system include calcium carbonate, barium sulfate, calcium sulfate and strontium sulfate. The formation of scale does not only occur in oil and gas industies but also almost present in many industrial and biological processes. Some of the scaling problems occur in places such as cooling water towers, biological systems involving brines, and petroleum system. The scale found in a production system mostly influents to damage equipments and affects to loss effeciency.

1.1 Squeeze Treatment

At present, one of the most common and effective means to control the scaling problem in the oil production system is "*squeeze*" treatment technique. Squeeze treatment is a technique to inject a slug of scale inhibitor, along with a brine overflush, under high pressure through the oil production well where it is

shut-in for approximately twenty-four hours. After the oil production is resumed, the scale inhibitor is released from the formation at the effective concentration, near threshold level with the dissolution of the precipitate. The squeeze operation program is shown in Figure 1.1 (Yuan et.al.,1993). The advantages and disadvantages of the squeeze treatment are given in Appendix A.



1) Preflush Injection

2) Scale Inhibitor Injection

3) Overflush Injection

4) Shut-in to Maximize Inhibitor Retention

5) Back-Production.

Figure 1.1 The Procedure of Squeeze Treatment Technique.

The purpose of preflush step is to prevent the formation of emulsion in the main inhibitor slug and to preferentially water-wet the near-well formation. The scale inhibitor is then injected which is dissolved in filtrated seawater. For pushing the inhibitor to a designed position, the appropriate value of brine

overflush is employed. The well is shut-in for about one day to allow further inhibitor adsorption and precipitation on the rock. Finally, the inhibitor released is monitored over the period of the squeeze lifetime.

There are two main types of the squeeze process which are currently applied in the field. It depends on the inhibitor retention mechanism with in formation, as follows:

(1) inhibitor "adsorption/desorption" squeeze treatments and ;

(2) inhibitor "precipitation/dissolution" squeeze treatments.

Adsorption treatments offer advantages in that they release the scale inhibitor with a minimal chance for formation damage. The amount of inhibitor adsorbed is dependent upon the number of active adsorption sites that the inhibitor contacts. The number of active sites is dependent upon many factors such as the formation surface charge, the formation water pH, and the salinity of the formation water (Meyers et.al.,1985).

Precipitation treatments are often implemented in the field to enhance adsorption of inhibitor molecules onto the active sites or squeeze lifetimes. Precipitation treatments occur when the inhibitor reacts with divalent cations in a controlled manner during the shut-in period. The precipitate is then dissolved and the residual mobile inhibitor solution is pushed back into the produced fluid when normal production is resumed (Carlberg, 1987).

During shut-in period, the scale inhibitor retains in the formation and follows one of three mechanisms : 1) the inhibitor is adsorbed onto the surface of the formation, 2) the inhibitor precipitates with available cations in the

system, or 3) the inhibitor solution leaks into small fractures in the formation. After shut-in period, the production is resumed, the release of inhibitor is presented with the produced fluid through the production well, and then it is able to prevent scale from forming.

The effectiveness of squeeze treatment is justified by the lifetime of inhibitor in which the inhibitor is released back into the produced fluid at the threshold concentration to prevent scale formation. A finite amount of inhibitor, however, is retained in the formation, then the concentration of inhibitor will be gradually depleted from the formation until concentration is below than the effective level and the system will have to be resqueezed (Browning et.al., 1993).

Ideally, the concentration released from the formation should be kept at the minimum effective concentration along the treatment period as shown in Figure 1.2.

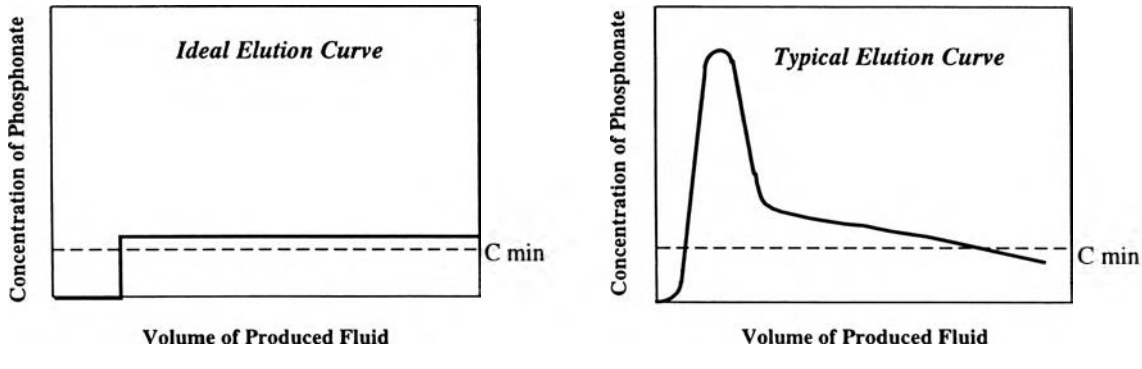


Figure 1.2 Comparison Between an Ideal Elution Curve and a Typical Elution Curve (Browning et.al., 1993).

1.2 Scale Inhibitor

Scale inhibitors consumed in gas and oil industries can be generally classified into three groups : 1) esters of phosphoric acid, 2) phosphonates, and 3) polymers such as polyacrylic acid (Vetter, 1972).

Phosphonate was selected as scale inhibitor for this study because many advantages of this chemical are suitable to control scale in the oilfield conditions. Phosphonate used in this study was ***Aminotri(methylene phosphonic acid)*** or **ATMP**. A small amount of phosphonate is able to keep large quantities of scalants in solution in which it is known as *"threshold effect"* . Many theories describe this effect that the threshold agent interacts with the nucleated crystals and then is adsorbed on the growth sites of the scalant crystal for highly distortion (Monsanto Technical Bulletin, No. 9023). It is imperative to understand the mechanisms of ATMP in preventing the scale formation.

The goals of this research project were *to study the characteristics of distinct calcium-ATMP precipitates which situated in a porous medium and to perform the elution curves obtained from the dissolution squeeze treatments.*

1.3 Objectives

1) Determine the properties of calcium-ATMP precipitates at each extreme conditions.
2) Study the mechanisms of precipitaion and dissolution of calcium-ATMP precipitates in porous media.

3) Determine the squeeze lifetimes of scale inhibitor through micromodel and coreflood experiments.