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จุฬาลงกรณ์มหาวิทยาลัย

CHAPTER I
INTRODUCTION

Corrosion of steel is a problem which is commonly found in many industries, including the petroleum and petrochemical industries. Corrosion in industrial steel pipes and vessel walls causes wall thinning. Wall thinning occurs by Flow Accelerated Corrosion (FAC) inside the pipes which have flow of water or steam. This wall thinning will be the cause of reduced plant efficiency and safety problems. To prevent damages and loss from this process, many organizations created devices for monitoring the corrosion.

One type of the device is a Hydrogen Effusion Probe, HEP, which monitors the inside wall thinning by measuring the quantity of hydrogen which effuses through the pipe wall. The atomic hydrogen, produced by the corrosion (oxide formation) reaction at the pipe inner surface, effuses through the pipe wall and forms molecular hydrogen or H_2. The rate of hydrogen effuse through the pipe wall is related to the rate of metal loss by the corrosion. This relation can be used to calculate the wall thinning rate. Other advantages of this HEP are it is online corrosion monitoring and it is non-intrusive device.

The Center for Nuclear Energy Research, CNER, has developed a HEP instrument for monitoring the rate of corrosion. The initial purpose of this instrument is for measuring the rate of corrosion on the inside of nuclear reactor feeder pipes. However, this instrument can also be used in other industries including the petroleum and petrochemical industry.

The important aspect of HEP is how well that hydrogen can effuse through the pipe wall. Previous studies about the fundamental principles and transport of hydrogen through a carbon steel pipe from FAC have been carried out at CNER. Another problem which needs attention is the effects of air (oxygen) within the cup installed on the vessel (or pipe) surface which collects the hydrogen. Oxygen can react with iron (in steel) to form iron oxides which reduces the effusion of hydrogen into the measuring device.

Many previous studies (Piggott and Siarkowski 1972; Pyun and Oriani 1989; Bruzzoni, Carranza et al. 1999) show that the iron oxide films on the steel sur-

face will act as barrier for hydrogen diffusion. One literature study (SCHOMBERG and GRABKE 1996) suggested that iron oxide films will inhibit the adsorption of hydrogen on the metal surface which inhibits the dissociation to atomic hydrogen required for diffusion through a metal wall. Most studies have been on the diffusion of the H_2 at the entrance phase but much less for the exit phase.

The purpose of this research is to determine the effect of oxide type and thickness on the exit side on the diffusion of hydrogen through steel membranes. It includes a determination of the type of oxide that will form on the membranes and characteristics of these oxide films. The rate of oxide formation on the vessel surface will be determined from the weight gain on the membranes, the decrease in pressure within a cavity and direct measurement from SEM after the experiments are completed.