CHAPTER I
INTRODUCTION

Flow-assisted corrosion (FAC) is a significant problem with carbon steel components exposed to rapidly moving water or water-steam mixtures. Such components often develop distinctive patterns of surface damage. A distinct signature of FAC is the contouring or sculpting of the metal surface to produce a dimpled surface looking like orange peel that has been given the name of "Scalloping". Recently, scallops were observed on some of the steel surfaces of the primary coolant system of CANDU reactors (Lister et al., 1998). This roughness plays an important role in the corrosion of pipes made of carbon steel and it is believed to increase the rate of mass transfer which strongly affects the thinning rate of the pipes, which is much faster than expected. This is a problem for calculating the lifetime of the piping and equipment which may be reduced and cause expensive outages of the reactor. Scallops are often treated as hydraulic roughness, increasing pressure drop and mass transfer accordingly.

At UNB Nuclear, the corrosion of water-based cooling systems and the fouling of the surfaces of heat exchangers have been studied. Scalloping was found on outlet feeder pipes in the primary coolant system of CANDU reactors as shown in Figure 1.1. It seems that the formation and the development of scallops are major factors in the thinning rate of the pipes.

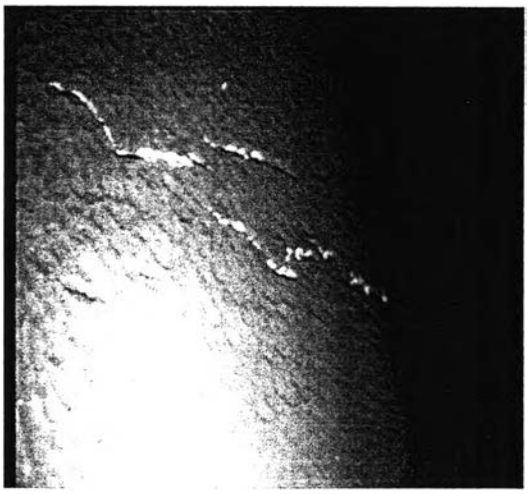

Figure 1.1 Scallops found on outlet feeder pipe k16 (Lister, 2004).

The relation between features of the scalloped surface and other corrosion parameters is not well established. The pattern has features in common with those developed on some other dissolving surfaces, including geological systems such as limestone deposits in flowing groundwater. The scalloping phenomenon has been observed in many different fields like geomorphology and geology, civil, mechanical and especially chemical engineering (Curl, 1966; Henderson and Perry, 1958; Leighly, 1948).

It is believed that the development of scallops in FAC is linked to the corrosion process and depends on factors such as dissolution rate, mass transfer coefficient, hydrodynamics, roughness, local turbulence, etc. Blumberg (1970) studied stabilization of scallop shapes and he mainly focused on the hydrodynamic factors affecting the origination and propagation of flutes. Sharp (1947) and Leighly (1948) proposed that the sizes and shapes of scallops in ice were controlled by the characteristics of adjacent air-vortices, not by any irregularities within the ice. Villien *et al.* (2005) studied the development of scallops in a pipe made of plaster of Paris in a water loop and observed the effect on the scallop size of adding sand grains to the plaster during the mixing of plaster. Yong Shao *et al.* (2006) studied the effect of scalloping on pressure drop and operated with different types of surface materials (pure plaster of Paris and commercial plaster of Paris).

In order to characterize scallops, study the mechanisms of scallop formation and investigate how the formation of scallops and scallop phenomena affect the dissolution rate, pressure drop and flow characteristics in test sections made of plaster of Paris were measured. The experiments were operated at different pH, flow rate, plaster purity, fluid turbulence, pressure drop and mass transfer coefficient. The application to corrosion systems will follow.