



CHAPTER I INTRODUCTION

Corrosion is a significant problem in the modern business environment; it can cause equipment damage, personal injuries, fatalities and environmental contamination. In particular, we are interested in metal corrosion. In water-based systems such as the cooling circuits in power plants, carbon steel is usually used as the construction material. During operation, high temperature, high pressure drop, high velocity and other severe conditions make corrosion a serious concern.

Flow-Accelerated Corrosion (FAC) is a well-known damage mechanism of carbon steel components carrying water at high flow velocities. Under operating conditions in water-cooling systems, FAC may be rapid enough to thin piping walls to unsafe levels; the resulting dimpled surface looks like orange peel - a characteristic pattern that has been called scalloping. In the primary coolant system of CANDU reactors, this phenomenon plays an important role in the corrosion of carbon steel pipe. It seems that FAC and the formation and the evolution of scallops in outlet feeders made of carbon steel has been much faster than expected (Lister et al., 2001). The development of scallops in FAC can be linked to the corrosion process and depends on several factors: hydrodynamics, pH, level of certain trace elements in the steel, fluid velocity, component geometry, single or two-phase conditions, dissolved oxygen and fluid temperature.

The formation of an oxide film on the carbon steel surface, mainly magnetite (Fe_3O_4), reduces the corrosion rate of steel. Such oxides can be degraded by dissolution; therefore, their stability plays a major role in ensuring the integrity of carbon steel. The development of the magnetite layer depends on the operating conditions; with increasing fluid velocity the degradation may be aggravated, since the film will be thinner. In order to predict FAC, oxide dissolution and mass transfer are considered while the erosion component is characterised by the combined action of flow-induced mechanical forces (shear stresses, pressure variations by high flow velocity and particle impact in multiphase flows) and electrochemical processes; the process with the slowest kinetics is expected to control. However, the dissolution kinetics of the oxide are generally unknown and need to be measured for many of the

coolant conditions. Several room-temperature experiments are needed to verify the existing measurement technique and the associated correlations for mass transfer coefficient.

The purpose of this work is to study the dissolution of a moderately-soluble substance such as a single crystal of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), or of a pellet made from commercial and pure plaster of Paris (chemically the same), trans-cinnamic acid, potassium bitartrate and aspartic acid, with a moderately-rapid dissolution rate that will be measured under a range of hydrodynamic conditions by using room-temperature equipment built to simulate a high-temperature system in which we measure dissolution rates of oxide pellets. The hydrodynamics will be related to the high-temperature system via a correlation of Sherwood and Reynolds number that can calculate mass transfer coefficients and then relate them to the high-temperature situation where oxides are involved.

Surface characterization techniques will be used to evaluate the surface of a gypsum pellet after successive stages of an experiment. The general surface appearance and colour can be observed visually and the detailed surface roughness and morphology estimated with Scanning Electron Microscopy (SEM), and surface profilometry (Surtronic 25).