CHAPTER I
INTRODUCTION

Since the increase in energy consumption has led to an energy crisis, alternative energy resources have been developed. Nuclear is the one of the most important energy resources used for electric power supply in many countries. The CANDU reactor is the nuclear reactor developed and used for electrical generation in Canada.

In 1996, the CANDU-6 at Point Lepreau nuclear power plant reported several higher than expected corrosions in the piping, especially in the outlet feeder pipes of the primary heat transport system (PHTS). Measurements of the pipe thickness confirmed that the thinning rate of the outlet feeders was accelerated by the high coolant velocity. This phenomenon was considered to be flow-assisted corrosion (FAC). The corrosion rate on the outlet feeders was found to be depended on the coolant velocity raised to power 1.52 (Beshara, 1997). As a result, the mechanism and the effect of FAC on outlet feeder pipes became a significant with respect to CANDU maintenance.

Under operating conditions with the CANDU reactor, the outlet feeder pipes are normally covered by an oxide film formed by oxidation in high-temperature heavy water on the primary coolant side. This film, predominantly magnetite (Fe_3O_4), has resistant properties to inhibit the corrosion of the carbon steel. Therefore, the stability of the magnetite oxide film on the carbon steel is important for reducing the corrosion rate within the feeder pipes.

The purpose of this study is to investigate the velocity effect on the oxide film by varying coolant flow rates in the primary system (5, 10, 20 m/s). After the oxide was formed, its morphology was analyzed by surface characterization techniques using Energy Dispersive X-ray Analyzer (EDX), Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Firstly, the combined results from EDX and SEM were used to determine the morphology and the chemical composition of the oxide film. Lastly, TEM was used to investigate the electron scatter pattern and the depth profile of the oxide film in order to obtain the structure of the oxide film.

In 2002, Lang introduced a relationship between the wall shear stress produced by the high coolant velocity and the corrosion rate of outlet feeder pipe within CANDU reactors. In order to study this relationship, a number of experiments and numerical methods were required to determine the local shear stress at the wall of feeder pipe.

In order to investigate the relationship between local shear stress and FAC, Fluent which is a software to study fluid dynamics was used to simulate the local shear stress in outlet feeder pipes of CANDU reactors. To validate the simulation data, the oxide thicknesses in outlet feeder pipe in Point Lepreau were used as a comparison with the simulated shear stress.