



## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

The conclusions based on the present work are as follows:

- The reduction of hydrogen pressure on a carbon steel tube with time was used to determine the rate of hydrogen transfer through steel tubes with and without oxide films.
- The hydrogen diffusion through a carbon steel tube is reduced by the oxide film formed on both the outside and inside surfaces of the carbon steel tube. The films act as a significant barrier to hydrogen transport.
- Depositing a platinum film on the inside and outside of a carbon steel tube after removing the oxide film eliminated the resistance to hydrogen transfer by the oxide films.
- The diffusion coefficients of hydrogen in carbon steel (ASTM A179) determined in this study varied from  $4.97 \times 10^{-10}$  to  $9.71 \times 10^{-10} \text{ m}^2/\text{s}$  over the temperature range of 180°C-360°C.
- The diffusion coefficient of hydrogen in carbon steel (ASTM A179) was found to follow Arrhenius Law over the temperature range studied.
- The oxide film resistances for the inside and outside tube surface were found to be  $3.17 \times 10^5 \text{ s/m}$  and  $3.85 \times 10^5 \text{ s/m}$ , respectively. This as compared to the experimental tube resistance of  $1.58 \times 10^6 \text{ s/m}$ .
- The reduction of the outside oxide film resistance for plant feeder pipe conditions reduces the resistance to hydrogen transport by 5.21% and 6.18% for 6mm of wall thickness and 5 mm of wall thickness, respectively.

#### 5.2 Recommendations

- Experiments for measuring the hydrogen diffusivity of various types of steel tubes used as the outlet feeder pipes of various CANDU-6 reactors and other

industries are required for a better fundamental understanding of hydrogen transport through pipes which can be measured by a hydrogen effusion probe.

- A test should be made using the Hydrogen Effusion Probe (HEP) in the plant with the outside surface coated with platinum after removing the oxide film.
- Tests should be made on carbon steel tubes with oxide films systematically deposited on the outside of the tube.
- An investigation of deuterium diffusion through CANDU-6 feeder pipe steel should be carried out to better simulate plant conditions undergoing corrosion.
- Other techniques for coating platinum on steel tubes should be studied to achieve a more uniform platinum film on the surface which can be easily applied.
- The Hydrogen Effusion Probe (HEP) developed at CNER should be tested on other commercial applications where corrosion could be monitored by this method.