CHAPTER 7 CONCLUSIONS AND RECOMMEDATIONS FOR FUTURE WORK

This chapter presents the conclusions and recommendations for future work. The conclusions in this study are divided into subsections with respective to the objectives of this dissertation as follows.

7.1 Conclusions

7.1.1 The Home-built AE sensors

The home-built AE sensors are designed and built based on theory using the soft PZT material. The properties of home-built AE sensors are equivalent to the commercial one. The frequency response of home-built AE sensors is good. The calibration result is shown that the AE_{rms} and air pressure are linearly related. The home-built AE sensors can be applied in the internal valve leakage rate measurement and the uniform corrosion monitoring. The benefit is to minimize the cost of AE measurement systems for applying in the field work.

7.1.2 The Model Formulation

The model formulation is developed based on the theory of relationship between mechanical energy released from source and AE signal. Then this model formulation is applied to measure the internal valve leakage rate and monitor the uniform corrosion. The results show that the model formulation is valid.

7.1.3 The System Calibration

The air jet system calibration is revealed to refer the scale of the sensitivity of the home-built AE sensors and commercial one for measurement the internal valve leakage rate and monitoring the uniform corrosion process. The results show that the sensitivity of the AE sensors can be calibrated using an air jet calibration system (see subsections 7.1.4 and 7.1.5). The AE data can be transfer by this system calibration.

7.1.4 The Internal Valve Leakage Rate Measurement Using AE

The results of the internal valve leakage rate measurement using AE can be summarized as follows:

An air jet is chosen to calibrate the internal valve leakage rate due to the air jet's frequency spectrum being similar to the spectrum of a fluid leak in an internal valve.

Ratios between frequency spectra are constant in the range of 100 – 300 kHz for the home-built sensor and commercial AE sensors (WD and R15), for both the air jet and fluid leakage in internal valve. Therefore the value of AE_{rms} received from each AE sensor can be compared or transferred.

Results received from the three types of AE sensors are compared in the laboratory. It is shown that, based on the equation used to predict leak rate, each of these sensors can be used, and each should exhibit identical results.

The valve leakage rate measurement system is tested in the field where its pressure is higher than in the laboratory setting and the size of valve is different. The prediction of leak rate is close to the actual leak rate.

When any part, for instance an AE sensor or an amplifier, of the valve leakage rate measurement system is changed, the equation used to predict valve leakage rate also changes. The benefit of implementing the relative system calibration method is to reduce the number of experiments required to determine the relation between AE_{rms} and valve's parameters. This new method only requires that a new ratio of spectra be determined to correct the equation.

7.1.5 The Uniform Corrosion Monitoring Using AE

The results of the uniform corrosion monitoring using AE can be summarized as follows:

The wave propagation path affected by the AE signal received from uniform corrosion process is explained and an equation is developed to predict the corrosion rate. The main effects of the energy of the uniform corrosion source are the corrosion rate, the sensitivity of the AE sensor and the signal condition (preamplifier). It is explained through electrical energy from the potentiostat control, which is subsequently converted to read as the uniform corrosion energy.

An equation 6.13 is developed using analysis of the effect of the wave propagation path to forecast the acoustic energy at uniform corrosion. The results obtained from both types of AE sensors are compared in a laboratory and based on this equation, we are able to forecast the uniform corrosion energy using each sensor, with both exhibiting similar results.

When the conditions of uniform corrosion are different, the equation 6.13 can be used to resolve the problem. The benefit of this equation is that it only requires the recalculation of new constants and the recalibration of the sensitivity of the AE sensors. The sensitivity of the AE sensors can be calibrated using an air jet calibration system.

7.2 Contribution to Knowledge

The contribution to knowledge from this research can be summarized below.

Firstly, the model formulation is derived based on the theory to explain the relationship between mechanical energy released from source and AE signal for calibrating the AE sensors. Furthermore, the AE data can be transferred between AE sensors by this model formulation when AE sensors are calibrated by using an air jet.

Secondly, the ratios from transferable system, transfer function, are proved. The result from uniform corrosion monitoring and internal valve leakage rate measurement by using AE showed that these ratios are constant. This means that the ratio can be utilized to transfer or compare the AE data between AE sensors. This is especially useful because the AE data obtained from one AE sensor can be converted to another. The advantage of this ratio, from the relative system calibration method by using an air jet, is to reduce the times and number of experiments when the condition of measurement system is changed.

Finally, the equation for uniform corrosion monitoring by using AE method is derived. This equation explains the effect of the wave propagation path to forecast the acoustic energy at uniform corrosion source. Furthermore, this equation can explain the relationship between AE sensors to compare and transfer the AE data.

7.3 Recommendations for Future Work

In this study, the AE sensors are designed and built using the soft PZT material and a model formulation is developed based on theory to describe the relationship between mechanical energy released from source and AE signal. However, the AE sensors and AE testing system are interesting to develop and apply in the field works. The recommendations for future work are as follows:

- Wireless system of AE sensor to send the AE data.
- Development and fabrication of pre-amplifier for AE sensor.
- Development of power supply for AE sensor (using PZT to generate the electrical energy).
- Software for collecting AE data.