CHAPTER 1 INTRODUCTION

1.1 Motivation

Acoustic emission (AE) refers to the phenomena of transient elastic waves generated by a sudden redistribution of energy from localized sources within a material. AE is one convenient method that can be used to detect and monitor the structures such as crack or fracture of material (Bailey et al., 1976; Ohtsu and Ono, 1988; Bowles, 1989; Andreykiv et al., 2001), internal valve leakage (Sharif and Grosvenor, 1998; Lee et al., 2004; Kaewwaewnoi et al., 2005; Kaewwaewnoi et al., 2010) and the corrosion process in petrochemical industry (Kudryavtsev et al.,1981; Darowicki et al., 2003; Jirarungsatian et al., 2005; Prateepasen et al., 2006). The transient elastic waves are detected by an AE system that contains sensor usually of piezoelectric (PZT) type, amplifier, filters and AE data acquisition systems (Yan and Jones, 2000; Jones and Yan, 2005). Nevertheless, AE measurement systems are significantly dependent on the acoustic stress wave transmission paths; the location of source and AE sensor (attenuation), the coupling of the AE sensor to the structure surface. The sensitivity of the AE sensor itself can alter levels of AE signal when obtained from the AE source.

It is clear from AE measurement systems that the AE sensor is the main part of AE measurement systems. The sensitivity of the AE sensor is dependent on the natural frequency of PZT and AE source. If the natural frequency of AE sensor is similar to the frequency of AE source, the sensitivity of measurement system is high. Each AE sensor presents a different sensitivity due to its frequency bandwidth response. From this problem, the AE sensors must be calibrated to make the AE energy obtained from the different AE sensors compatible. The most calibration methods of AE measurement only give a qualitative indication of the AE source rather than a quantitative indication of the absolute level of the AE source. Thus AE data can not be transferred between AE sensors and AE measurement systems and it is very difficult to compare the results obtained in different laboratories and on different structures.

Over the past few decades, researchers have proposed several energy sources for AE system calibration, such as an elastic impact induced AE energy source (Yan and Jones, 2000; Raeymaekers and Talke, 2006), a pulsed laser induced AE energy source (Jones and Yan, 2005), an arbitrary function generator induced AE energy source (Theobald et al., 2005), a piezoelectric conical transducer-generated AE energy source (Yan et al., 2002; Yan et al., 2004), etc. Recently, an air jet, a relatively low-cost AE energy source, was applied to single-point tool wear monitoring (Prateepasen et al., 2000). The research concluded that the AE frequency spectrums produced by the air jet and machining were quite similar, and therefore it was possible to convert the AE_{rms} value received from tool wear process into an equivalent air jet pressure value.

In this dissertation, the AE sensor is designed and fabricated using the soft piezoelectric (850) material. An air jet system calibration and the transferable of AE data are presented. Then, a model formulation for the relationship between mechanical energy released from source and AE signal is formulated. Lastly, the AE sensor, the air jet system calibration, the transferable of AE data and the model formulation are applied in the internal valve leakage rate measurement and the uniform corrosion monitoring, respectively.

1.2 Objectives

1. To study and fabricate an AE sensor and create the model formulation for the relationship between mechanical energy released from source and AE signal.

2. To validate the model formulation created in the objective 1 by applying in two practical applications: internal value leakage and uniform corrosion monitoring.

1.3 Scopes

1. Using the soft piezoelectric (850) material to fabricate the AE sensors.

2. Using the air jet system calibration to refer the scale of AE sensors sensitivity.

3. AE sensors are fabricated to measure and monitor the internal valve leakage and the uniform corrosion process, respectively.

4. Using the air from air compressor to simulate the internal valve leakage by incomplete closure of ball valve.

5. The type of corrosion in this dissertation is uniform corrosion.

1.4 Expected Contributions

1. The properties of the home-built AE sensor are equivalent to the commercial one and it can be fabricated in Thailand.

2. A relative calibration method is revealed to refer the scale of AE sensors sensitivity.

3. The transfer technique and model formulation for applying the home-built AE sensor to measure and monitor the internal valve leakage and the uniform corrosion process, respectively.

4. When the testing conditions or measurement systems in the field work are different, the AE data can be useful to analyze.

5. Minimization of the cost of AE testing system for applying in the field work.

6. Development of the knowledge for applying AE testing in the field work to measure the internal valve leakage and monitor the uniform corrosion process.

1.5 Overview of the Dissertation

This dissertation is composed of seven chapters, references, appendixes and curriculum vitae. The chapters are briefly described as follows.

Chapter 1 presents the motivation, the objectives, scopes of this dissertation and the expected contributions.

Chapter 2 deals with the literature reviews.

Chapter 3 introduces and explains the AE testing system, the PZT material, theories of electromechanical, calibration method of AE sensor and the model formulation for the relationship between mechanical energy released from source and AE signal.

Chapter 4 presents the experiment procedures, results and discussions of design and fabrication of AE sensor using PZT material, the air jet system for calibration the sensitivity of AE sensors.

Chapter 5 presents the experiment procedures, results and discussions of the internal valve leakage rate measurement in the laboratory and in the field work. The home-built AE sensor made from chapter 4 is applied to the internal valve leakage rate measurement system. A system calibration is applied, using an air jet as the artificial AE source. A method for transferring information between different AE sensors is also proposed.

Chapter 6 presents the experiment procedures, results and discussions of uniform corrosion monitoring in the laboratory. The home-built AE sensor made from chapter 4 is also applied to the uniform corrosion monitoring. A system calibration is applied, using an air jet as the artificial AE source. The effects of the wave propagation path are explained, and an equation is constructed to explain the effects of the wave propagation path between the output (AE signal from data acquisition device) and input (electrical energy from potentiostat control). The prediction of the acoustic energy at uniform corrosion is presented. A model formulation created from chapter 3 and a method for transferring information between different AE sensors are also proposed.

Chapter 7 gives the conclusions of this dissertation, and proposes ideas for the future research work.

The all research works can be summarized in figure 1.1. The details of each experiment procedure and result are shown in chapter 3, 4, 5 and 6, respectively.

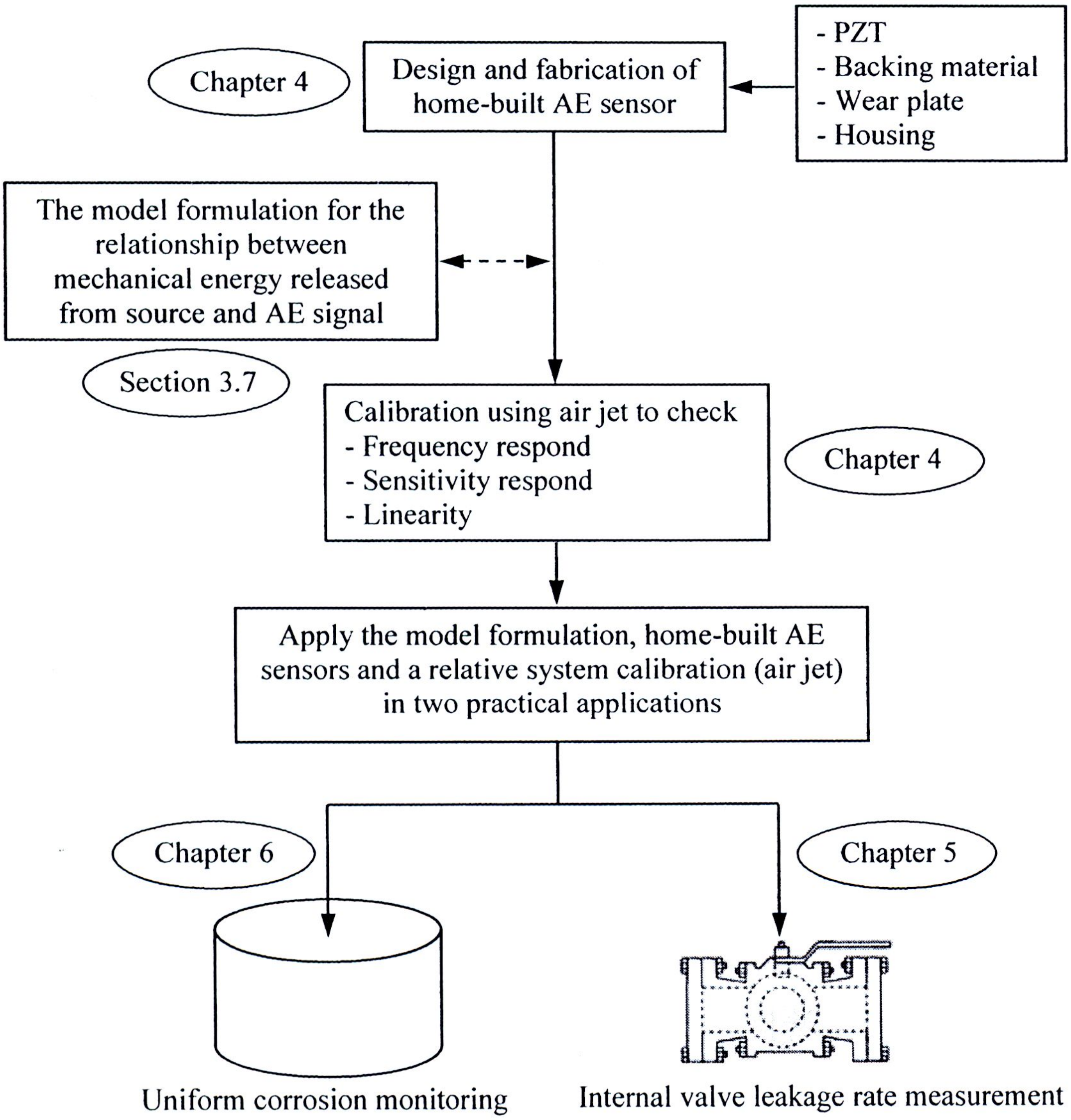

Figure 1.1 A diagram of all research works