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MAPPING CORROSION ACTIVITIES OF VARIOUS CONCENTRATION OF ACIDIC SOLUTION IN A PIPE USING ULTRASONIC TESTING

FARAHILDA BINTI MASEKAM

Laporan ini dikemukakan sebagai
memenuhi sebahagian daripada syarat penganugerahan
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MAY 2008

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor Mechanical Engineering (Structure & Material)"

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ABSTRACT

Conventional method of inspecting the thickness of pipe due to corrosion is using Ultrasonic Testing Thickness Measurements (UTTM). This experiment is to study the corrosion activities in a pipe with using different concentration of acidic. Hydrochloric acid is used as a medium to create corrosion in internal wall of pipe. The hydrochloric acid is a strong acid, since it is fully dissociated in water where is a strong inorganic acid that is used in many industrial processes. The different of concentration of hydrochloric acid in water, 30%, 50% and 70% are used for this experiment. The different concentration of acidic used shown distinguishes of corrosion activities on the internal wall of pipe. The thickness of pipe wall is measured with an Ultrasonic Testing Thickness Measurement method. The results of corrosion activities are presented in C-scan presentation resulted from A-scan readings obtained from Ultrasonic Testing Thickness Measurement method. The C-scan result displays are created using the MATLAB Programming.

ABSTRAK

Ujian Pengukuran Ketebalan Ultrasonik (UTTM) merupakan kaedah yang paling sesuai untuk memeriksa dan menguji ketebalan paip yang disebabkan oleh kakisan. Eksperimen ini dijalankan bertujuan untuk mempelajari dan mengetahui aktiviti kakisan pada paip dengan menggunakan kepekatan asid yang berbeza. Asid hidroklorik digunakan sebagai medium untuk membentuk kakisaan pada permukaan dalam paip. Asid ini bersifat kuat dan meluas digunakan di pelbagai proses perindustrian. Pada eksperimen ini sebanyak tiga jenis kepekatan asid yang berbeza digunakan iaitu 30%, 50% dan 70% kepekatan. Perbezaan kepekatan asid yang digunakan menunjukkna perbezaan aktiviti kakisan pada bahagian dalam dinding paip. Ketebalan dinding paip akan diukur dengan menggunakan kaedah Ujian Pengukuran Ketebalan Ultrasonik (UTTM). Keputusan aktiviti kakisan akan dipaparkan dalam paparan *C-scan* yang ditukar daripada paparan *A-scan* yang diperolehi daripada Ujian pengukuran Ketebalan Ultrasonik dengan menggunakan perisian MATLAB.

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LIST OF SYMBOLS

h	=	height, m
r	=	Radius, m
V	=	Volume, m^3

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CHAPTER 1

INTRODUCTION

1.1 Project

The purpose of this project is to conduct experiment to study the corrosion activities in a pipe using various concentration of acidic solution using Ultrasonic Testing Thickness Measurement (UTTM) method, and to produce a program that models a C-scan presentation of the corrosion activities in the pipe from A-scan presentation obtained from UTTM. The study and data collection of this project will be held at the Universiti Teknikal Malaysia Melaka (UTeM).

1.2 Problem Statement

Corrosion in pipelines is a problem long faced since long time ago. Industrial sector fields grow older and move to more challenging and often aggressive environments, the difficulties presented by corrosion are multiplying. Some pipelines deteriorate slowly, and certain cases pipeline life has been reliably targeted at 70 years or more. Other pipelines have been built which have exhausted their life after 1 year operation. (Nestleroth, 2006).

According to Kucera (1988), CO_2 and H_2S gases, in combination with water, define most of the corrosion problems in oil and gas production. Other problems include microbiological activity and the solids accumulation. The mechanisms of CO_2 corrosion are generally well defined. However, the reality inside a pipeline becomes complicated when CO_2 acts in combination with H_2S, deposited solids, and other environments. H_2S can be highly corrosive, but can, in some cases, form a protective sulfide scale that prevents corrosion. Microorganisms can attach to pipe walls and cause corrosion damage.

On the latest researching by A. Cosham, P. Hopkins, K.A. Macdonald (2007), corrosion can be classified into one of three general categories. There are internal corrosion caused by the produced fluids and gases, external corrosion caused by exposure to groundwater or seawater, and atmospheric corrosion caused by salt spray and weathering offshore. Of these, internal corrosion is the most costly since internal mitigation methods cannot be easily maintained and inspected. Pitting corrosion along the bottom of the pipeline is the primary corrosion mechanism leading to failures in gas pipelines. The common features of this mechanism are:

a. The presence of water containing any of the following; carbon dioxide (CO_2), bacteria, oxygen (O_2), or solids;
b. Pipelines carrying higher levels of free-water production with no means of water removal, i.e. well site separation or dehydration;
c. The presence of fluid traps where water and solids can accumulate;
d. Vapor phase corrosion is a less common mechanism that has also led to failures. Although not specifically addressed in this recommended practice, many of the preventative measures described in this document will also mitigate this mechanism.

Figure 1.0: Internal Corrosion on Pipeline

(Source: http://www.corrview.com/service_03.htm)

On April 2006, in Alaska they had a case about the corrosion in pipelines. On 2nd March 2006 until April 2006 was determined that 201,000 gallons of oil had spread over almost 2 acres of tundra. The leaky pipeline remains out of service while field workers check out corrosion problems. The corrosion on pipelines was detected by the pipeline leak-detection system sound warnings on four straight days in the week leading up to last month's record North Slope oil spill. They found that the 34 inches pipeline that leaked had circumstances that made leak detection become difficult, which including a relatively high level of sediment moving through the pipe along with the oil. They also found the fluctuations in the volume of oil sent was down to the line from a processing plant can mask a potential leaks. Then the corrosion was blamed for causing an almond-sized hole through which the oil escaped. (*Wesley Loy, Anchorage Daily News, April 20, 2006*).

1.3 Objectives

The objectives of this study are:

a. To study the corrosion activities in internal pipe using various concentration of acidic solution.
b. To measure the wall pipe thickness due to corrosion using Ultrasonic Testing Thickness Measurements (UTTM).
c. To produce a program that models a C-scan presentation of the corrosion activities in the pipe from A-scan presentation obtained from UTTM using MATLAB Programming.

1.4 Scope of Study

This study is focused on the internal corrosion in pipelines, where the corrosion is the main problem since a long time ago. This experiment is to study the corrosion activities in a pipe with using a different concentration of acid. Then, the thickness of pipe will be measure with using the Ultrasonic Testing, where every different concentration of acid affects the different corrosion rate. The acid that is used on this experiment is a hydrochloric acid (HCl), and the various concentration of acid that will be used is 30%, 50% and 70% concentration per volume. For one specimen, there have 108 points of thickness need to be measured. The thickness reading taken is doing by weekly from week one until week ten. The results of corrosion activities will be present as a program that models a C-scan from A-scan presentation obtained from Ultrasonic Testing Thickness Measurement (UTTM) method. MATLAB Programming is using to create a C-scan result display.

CHAPTER 2

LITERATURE REVIEW

2.1 Corrosion in Pipelines

According to A. Cosham, P. Hopkins, K.A. Macdonald (2007), corrosion is an electrochemical process where it is a time dependent mechanism and depends on the local environment within or adjacent to the pipeline. Corrosion usually appears as either general corrosion or localizes (pitting) corrosion. There are many different types of corrosion, including galvanic corrosion, microbiologically induced corrosion, alternate current (AC) corrosion, differential soils, differential aeration and cracking. Corrosion causes metal loss. It can occur on the internal or external surfaces of the pipe, in the base material, the seam weld, the girth weld, and/or the associated heat affected zone (HAZ).

According to Bolt R and Owen RW (1999), the internal and external corrosion are together one of the major causes of pipeline failures. Data for onshore gas transmission pipelines in Western Europe for the period from 1970 to 1997 indicates that 17% of all incidents resulting in a loss of gas were due to corrosion.

On the latest researching by Eiber , Miele and Wilson (2002), incident data from the Office of Pipeline Safety in the USA for the year 2001 attributes 29% of incidents in liquid pipelines, and 19% of incidents in gas pipelines due to corrosion. Corrosion in a