I admit that have read this work and to my opinion this work was adequate from the aspect scope and quality to the meaning award of Bachelor of Mechanical Engineering (Structure&Material)

Signature: .....

Supervisor Name: .....

Date: .....

A STUDY OF FLAW ENTRAPMENT EFFICIENCY IN PENETRANT TESTING

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CONFESSION

"I admit this report is my produce work self except summary and passage which each of it I already telling his resource".

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DEDICATION

For beloved father and mother

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I wish to record sincere appreciation to the supervisor, Puan Zakiah Bt. Abd. Halim on her guidance and impetus given throughout undergo this Projek Sarjana Muda.

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ABSTRACT

The penetrant testing are one of non destructive testing methods for detecting discontinuities that are open to the surface such as cracks, seams, laps, cold shuts, laminations, through leaks, or lack of fusion and are applicable to in-process, final, and maintenance examination. The penetrant testing can be effectively used in the examination of nonporous, metallic materials, both ferrous and nonferrous, and of non metallic materials such as glazed or fully densities ceramics, certain nonporous plastics, and glass. A flaw is a defect, fault, or imperfection. The Flaw Entrapment Efficiency is the ability of penetrant to indicate the indication.

ABSTRAK

Penguji ketembusan adalah satu kaedah pengujian yang tidak memusnahkan untuk mengesan ketakberterusan yang adalah terbuka di permukaan yang retak, berkelim, pusingan, tutup sejuk, lamina, kebocoran, atau kekurangan lakuran adalah boleh digunakan untuk dalam proses dan peperiksaan penyenggaraan. Penguji ketembusan boleh menguji dengan berkesan dalam peperiksaan tak berliang, bahan-bahan berlogam, ferus dan bukan ferus, dan bahan-bahan yang tidak berlogam. Sebagai contoh seramik ketumpatan, sesetengah plastic yang tidak berliang dan kaca. Satu kecacatan dalah satu kerosakan atau ketidaksempurnaan. Kebolehan penyerapan sesuatu kecacatan adalah kebolohan penembusan untuk menunjuk sesuatu tunjukan.

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PT	=	Penetrant Testing
UT	=	Ultrasonic Testing
NDT	=	Non-Destructive Testing
NDE	=	Non-Destructive Evaluation
R&D	=	Research and Development
3D	=	3-Dimension
PSM I	=	Projek Sarjana Muda I
mm	=	Millimetre
s	=	Seconds
%	=	Percentage
CNC	=	Computer-Numerical-Control
°F	=	Degree Fahrenheit
ASTM	=	American Standard Testing and Material

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CHAPTER I

INTRODUCTION

1.1 Background

Penetrant Testing (PT) is a non-destructive testing (NDT) method used to reveal defects which reach the surface of non-porous materials. The defects such as cracks, porosities, cleavages and leaks in steel, cast iron, plastics, ceramics, etc and other non-porous materials must be detected so that the material can be used safely without no doubt. The materials failures occur because these defects reach dangerous proportions such that remaining parts of the materials could not withstand the stress they are subjected to, thus become ductile or brittle fractures.

The first way to classify the penetrant is was the type of penetrant. There are two types of penetrant that commonly used which is fluorescent and liquid dye penetrant. Fluorescent penetrant use a dye much more sensitive to smaller flaw than penetrants used in PT. This is because of the nature of the fluorescent penetrant is applied. With its brilliant yellow glow caused by its reaction with ultraviolet radiation, fluorescent dye sharply contrast with the dark background. Liquid dye penetrants are typically red in colour and represent the lowest sensitivity.

The second way in which penetrants are classified is the method by which the excess penetrant is removed from the test surface. The penetrants are either water washable, solvent removable or post-emulsifiable. Water washable penetrants contain an emulsifier that allows the penetrant to be rinsed off using low-pressure water spray; sometimes a water-dampened towel is used. Solvent removal penetrant requires a solvent to remove the excess penetrant from the surface. Post-emulsifiable penetrants are removed by adding an emulsifier after the penetrant dwell time. By combining the characteristic of these two classifications, six different types of penetrant can be used.

When sensitivity is the primary consideration for choosing a penetrant system, the first decision that must be made is whether to use fluorescent penetrant or visible dye penetrant. Fluorescent penetrants are generally more capable of producing a detectable indication from a small defect. Also, the human eye is more sensitive to a light indication on a dark background and the eye is naturally drawn to a fluorescent indication.

Liquid penetrant inspection can only be used to inspect for flaws that break the surface of the sample. Some of these flaws are fatigue cracks, quench cracks, grinding cracks, overload and impact fractures, porosity, laps, seams, pin holes in welds and lack of fusion or braising along the edge of the bond line.

Under certain conditions, the visible penetrant may be a better choice. When fairly large defects are the subject of the inspection, a high sensitivity system may not be warranted and may result in a large number of irrelevant indications. Visible dye penetrants have also been found to give better results when surface roughness is high or when flaws are located in areas such as weld.

The Flaw Entrapment efficiency is the ability of penetrant to form an indication large enough to be detected. There are several factors that influenced the efficiency. There are volume of defect, length of defect, contaminants, penetrant dye and method of processing. For volume of defect factor, the size of indication reflects the volume of penetrant entered the defect. The larger the discontinuity which is its depth or width, the more penetrant it will hold. It also will present more indication. Then, the length of defect is the continuity of affect volume of penetrant. It will strongly affect the visibility of indication. Very fine defect has insufficient width and it will reduce the ability of human eye to detect indication usually. The defect can only be located when the defect has sufficient length.

The fine and clean discontinuity and wide and contaminated discontinuity will affect the penetration of penetrant. The In-service inspection will encounter the defects that contaminated with oil, water and corrosion products. The contaminated will reduce the volume available for penetration. It also fades the dye visibility if the contaminated is from acidic and alkaline. The heat and prolonged exposure under the ultraviolet light will cause the penetrant lose their intensity.

Then, the type of dye penetrant also affects the Flaw Entrapment efficiency. The different type of dye penetrant will affect the sensitivity of penetrant visibility in terms of brilliance and intensity of the dye color. For example, the sensitivity between the visible dye penetrant and fluorescent penetrant. Fluorescent penetrant has more sensitivity than visible dye penetrant. The dye penetrant with different concentration within a classification will affects the sensitivity level. Alteration of concentration can be made and will affect the ability of penetration of penetrant. It also will affect the Flaw Entrapment efficiency.

Lastly, the affect of Flaw Entrapment efficiency is method processing the specimen. The dip and drain method will allows more unstable element of penetrant

to evaporate during dwell time. It can be solve by increase the concentration the remaining penetrant.

1.2 Problem Statement

In PT, a liquid with wetting characteristic is applied to the surface of a component under test. The penetrant "penetrates" into surface breaking discontinuities via capillary action and other mechanism. It is important to ensure that the penetrant is fully penetrates in the discontinuities before excess penetrant is removed from the surface and a developer is applied to pull trapped penetrant back the surface. Therefore, the investigation of penetrability of the liquid penetrant is required in order to optimize the PT capabilities.

1.3 Objective

This research is used to investigate the Flaw Entrapment Efficiency in PT and differentiate the effect of penetrability by different size of discontinuities and steel material which is mild steel and aluminium.

1.4 Scope

The research is focused on the principle of Flaw Entrapment Efficiency in PT. Then, the research continue with develop the artificial surface defect by using machining process. It is followed by developing the experimental procedure on detection the surface defect. Subsequently is to differentiate the effect of penetrability by different size of defect and different material.

CHAPTER II

LITERATURE REVIEW

It is possible to evaluate the properties of failed component by two main type of test which is non-destructive and destructive test. Non-destructive test used to defect flaws and control dimension. Destructive test are used to determine certain properties such as tensile strength, fatigue and creep strength. Lebowitz, C.A (1997) said that, nondestructive testing is the development and application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure and evaluate flaws.

Larson, B. (2002) notice that the penetrant materials, the inspection technique, the process control procedure, the human factors and the sample and flaw characteristics can effect the penetrant inspection. Nowadays, the penetrant materials are more refined than the kerosene and whiting that used by the inspector at old days. The penetrant materials at the moment are manufactured carefully to produce the level of sensitivity desired by the inspector. In penetrant inspection, the inspection done by the human called the inspector. The inspection is usually performed visually and, therefore, all the factors that affect visual inspection will affect liquid penetrant inspection.

In Symposium on Principle of Penetrant Methods, Carson, H.L (1957) said that, for penetrant inspection, the flaw can only be detecting only at the surface of the material or have some opening at the surface. Cracks are the most important defects in any specimen, and it is imperative that a penetrant method of defect detection should be capable of revealing every surface crack which exists.

Schnurmann, R. (1957) discussed that modern penetrate methods divide by two simple principle. First principle, the fluorescent penetrant to make the flaw more clear and the second principle are depends on the spreading liquid in the flaw. Both of this principle is not really important but the speed and simplicity of application are more important.

In penetrant testing, there are many categories of liquid penetrant that can determine the flaw on the material surface. There are dye penetrant, fluorescent penetrant and dual purpose. According to Halmshaw, R. (1989), he said that the penetrant testing only effective for surface crack detection and surface breaking flaws detection. Cracks of opening width less than two micrometers can be detected, but little other quantitative data has been published. Generally, the fluorescent penetrants provide the highest sensitivity, as the developer enhances the fluorescence. However, contaminants can reduce the performance much more seriously than with the dye penetrant. The post-emulsifier systems are thought to produce higher sensitivity than water-washable systems.

According to Moles, M. (2007), the current state of non-destructive evaluation (NDE) are highly uneven because the technology is applied to everything from welds and assemblies to corrosion and materials characterization, in industries ranging from aerospace and defence to heavy machinery and medical devices. As a result, the number of equipment manufacturers is relatively large. New developments have been based largely on electronics, especially for computer-aided techniques such as ultrasonic and digital radiography. The digital-based technologies are penetrating the older analogue-based markets because data and setups can be saved, results are more reproducible, and the instruments are more reliable. The trend for five years ahead the market is similar to today. The same NDE techniques will probably still be dominant. Advanced NDE techniques that are under development in research and

development (R&D) today should start to be commercially available in five years. Major interest will be in more expensive technologies that do the job faster, better, cheaper, with smaller equipment. The trend for twenty years ahead, he predicts that digital will be dominant, due to capability and cost. Then, the same major non-destructive evaluation will be dominant but more functional technologies will developed.

CHAPTER III

METHODOLOGY

Methodology is where method of research and theory about the research are being done. Before begining the research, flow chart is used to plan the work. The flow chart is important to make our research run smoothly. The work can be done systematically without any problem and every work that being done can see clearly the flow with using the flow chart as illustrated in Figure 3.1.

In this research, it starts with review the topic with supervisor. In this step, meeting with supervisor is really important to get clearly info with this project. Then, with the supervisor guidance, method used is chosen and identify the parameter will be used. In this research, the method will be used to fabricate the test specimen is using milling machine. The parameter to identify in this research is the flaw entrapment efficiency based on different penetrant type and size of discontinuities. Then, the test sample is design. The test sample is design using 3-Dimension (3D) drawing software which is CATIA. Afterwards, the test sample is fabricated using the wire cut EDM machine. After the test sample is finished fabricate, the test sample need to be tested. The test will be conducted using liquid penetrant. Within the test, the test analysis will be done. If the experimental test is not achieved its objective,

the experimental test will be redo. But, if the experimental test is achieved its objective, discussion and documentation about the experimental test will be done.