UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PROCESS OPTIMIZATION OF EDM CUTTING PROCESS ON TOOL STEEL USING ZINC COATED ELECTRODE WIRE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Process & Technology) with Honours

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (BETP) (Hons.). The member of the supervisory is as follow:

……

(Engr Hanizam Bin Hashim)

ABSTRACT

Electrical Discharge Machining (EDM) is a process of metal machining in which a tool discharges thousands of sparks to a metal work piece. The main purpose of this project is to compare surface roughness of tool steel material using zinc coated brass and brass electrode wires and to recommend the best electrode diameter to machine tool steel work piece material application. There are three objective of this project that needs to be accomplished. Firstly is to compare the surface roughness of tool steel material using zinc coated brass and brass electrode wires. Secondly is to recommend the best electrode diameter to machine tool steel work piece material application. Thirdly is to study the effects of feed rate to the surface roughness. 3 work pieces are machining and 15 readings of surface roughness are taken for every size of diameter of wire. By using the Minitab software, the data in each objective is done. As a conclusion, the best wire for both types is zinc coated brass. Then, the best diameter of wire is 0.10 mm based on their surface roughness result. Next, according to feed rate changed, it is not much a distinction in effect of surface roughness value. In addition, take an over reading on each sample to be a correction if have any error occurred.

ABSTRAK

Electrical Discharge Machining (EDM) adalah satu proses pemesinan logam di mana alat yang melepaskan beribu-ribu percikan api kepada bahan kerja logam. Tujuan utama projek ini adalah untuk membandingkan kekasaran permukaan alat bahan ujian keluli menggunakan zink bersalut tembaga dan tembaga wayar elektrod dan mencadangkan elektrod terbaik untuk mesin alat keluli bahan kerja. Terdapat tiga objektif projek ini yang perlu dicapai. Pertama adalah untuk membandingkan kekasaran permukaan alat bahan keluli menggunakan zink bersalut tembaga dan tembaga wayar elektrod. Kedua adalah untuk mencadangkan garis pusat elektrod terbaik untuk mesin alat keluli bahan kerja. Ketiga adalah untuk mengkaji kesan kadar suapan untuk kekasaran permukaan. Sebanyak 3 keping bahan dan 15 bacaan kekasaran permukaan yang diambil untuk setiap saiz diameter wayar. Dengan menggunakan perisian Minitab, data dalam setiap objektif dilakukan. Kesimpulannya, wayar terbaik untuk kedua-dua jenis adalah zink bersalut tembaga. Kemudian, diameter yang terbaik wayar ialah 0.10 mm berdasarkan keputusan kekasaran permukaan. Seterusnya, berkenaan dengan perubahan kadar suapan, ia tidak banyak perbezaan dalam nilai kekasaran permukaan. Tambahan lagi, mengambil bacaan yang lebih pada setiap sampel adalah untuk membuat sebarang pembetulan jika sesuatu kesilapan berlaku.

DEDICATION

Firstly, dissertation is dedicated to Universiti Teknikal Malaysia Melaka, whose give opportunity in order to complete my case study. It is very helpful with provided good facilities and services while research happened. Secondly, I would like to dedicated to Mr Engr. Hanizam Bin Hashim as supervisor and Mr. Mohd Kamal bin Musa as co-supervisor whose passion for teaching set a new knowledge that can be apply, not only in this research, also can be implement in daily routine. Other than that, technician in Faculty of Engineering Technology (FTK) , those who always gave good co-operation and time in order to completed this research. Lastly this dedication to Mohd Razali Bin Md Yunos whose approved this research and improvised on how to make this research more useful and helpful in industry.

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LIST ABBREVIATIONS, SYMBOLS

ANOM	=	Analysis Of Means
CNC	=	Computer Numerical Control
EDM	=	Electrical Discharge Machine
H0	=	Null Hypothesis
MRR	=	Material Removal Rate
Nc	=	Numerical Control
Ra	=	Surface Roughness
WEDM	=	Wire Electrical Discharge Machining

CHAPTER 1

INTRODUCTION

This chapter basically explains the background, problem statement, objectives and scope on research.

1.1 Project Background

Electrical Discharge Machining (EDM) is a process of metal machining in which a tool discharges thousands of sparks to a metal work piece. A non-conventional process, EDM melts or vaporizes cutting material, leaving little debris and providing a very accurate line. Industry-wide acceptance has led to a wide variety of EDM applications, as it is highly versatile, can cut hard metals, and utilizes a relatively compact amount of workspace.

According to this experiment process, there are some info on electrode material used at the industry such as brass, copper, silver etc. As an information, Brass was one of the first EDM electrode materials. It is inexpensive and easy to machine but it exhibits a higher degree of stiffness and is easier to machine than Copper. Besides, Copper became the metallic electrode material of choice because of the combination of Copper and certain power supply settings enables low wear burning. This electrode material still has a significant disadvantages, it is soft and gummy material to machine or grind. Then, Silver occasionally due to

its superior electrical conductivity, purity and structural integrity. However, due to the cost, Silver is rare to be used. (Kern, 2008)

Based on this project title, the main electrode material is zinc coated wire. It is consists of brass wire electroplated with high purity zinc. The high plating accuracy realizes faster machining speed and also provides a better surface finish on the work piece. The high purity zinc layer formed on the surface of the brass by means of our unique electroplating technology realizes higher machining speed.

By uniformly coating the surface of the wire with zinc, which has good discharge characteristics, it is possible to create a finer discharge compared to when using general brass wire. In the finishing process, improved surface roughness and a better machined profile are obtained, resulting in high cost performance. Almost no copper adheres to the work piece. The zinc coating method is a method of coating by electroplating. It is not a method in which is wire is dipped in molten zinc. A high purity uniform zinc layer can be obtained. The discharge is stable and free of irregularities. Impurities are kept to the minimum, thus preventing deterioration of performance. (Cable, 2012)

This project is conducted to optimize process of EDM cutting on tool steel using zinc coated electrode wire. Other than that, this project also to study about zinc coated on brass wire on EDM cutting process. Then, this analysis will find out the parameter by using proper current, speed travelling and diameter of zinc coated electrode wire.

1.2 Problem Statement

Lately, Brass wire electrode been used in the industry for quite sometimes because its offer low cost and good quality finishing. in recent years, zinc coated brass offer higher cutting speed and performance. (Mms, 2015) However, study in this matter is still insufficient to prove zinc coated brass is better than brass.

1.3 Objective

Based on this problem, the type of wire to be testing is zinc coated brass electrode wire. In addition, this is the objective below:

1. To compare surface roughness of tool steel material using zinc coated brass and brass electrode wires.
2. To recommend the best electrode diameter to machine tool steel work piece material application.
3. To study the effects of feed rate to surface roughness.

1.4 Scope of the Research

The work scope that will involve in this project is the type of wire cut involved is brass and zinc coated brass. To make sure that these will be achieved, the machine of EDM that will be use is Sodick VZ300L. Furthermore, the diameter of the wire electrode is 0.1 mm, 0.2 mm and 0.25 mm. The type of material to be cut or use on this study is tool steel AISI H13. The surface roughness of the material cut will be measured using Mitutoyo SJ-410. At the end of this experiment analysis, the application of EDM will know as much and the diameter of wire electrode of EDM wire cut by zinc coated will be found.

1.5 Outline Of the Report

This project has been divided into five chapters covering the whole our culture in order to achieve the desired objectives. The contents of each chapter have been decided after the information was found. The included content is based on discussions with the supervisor and the information obtained from previous research.

Chapter 1 explains about the project background. Then it followed by objectives of the project, problem statements and scope of the project. Finally, in this chapter explain the outline of the project.

Chapter 2 shows the literature review about the previous work on the wire cut EDM machine. These previous study works as a guidance to perform or build the idea to solve the problems later.

Chapter 3 explains the methodology used in order to solve the problem. Methodology is important because the working progress followed the methodology step and makes it achieve the objective or not.

Chapter 4 explains procedures, results and discussion made after completion of the work done in the lab. All prove of the action that be done need to state in this chapter and attached with the explanation of the action.

Chapter 5 shows the conclusion and recommendation of the project. The conclusion made is based on the findings that get from the action that had been done. Based on what already done, suggestion about another material is stated here in order to go further on this project in future.

CHAPTER 2

LITERATURE VIEW

This chapter basically explains about machinery and equipment used in this project as a guide for studies. Besides, basic information about Wire Electrical Discharge Machining (WEDM) will be tell and how to operate the machine. At early stage of the studies, some gap analysis has been carried out in order to ensure the relevance of this research. All relevant aspect such as current, speed travelling and diameter of electrode wire will be told a little bit in this chapter.`

2.1 Wire Electrical Discharge Machining (WEDM)

The introduction of continuous Wire-EDM to industrial practice in 1969 revolutionised the manufacture of punching, pressing and extrusion tools, and rapidly led to its achieving a monopoly. The process has also gained acceptance in prototype production and in series production e.g. for the aerospace industry. In the Wire-EDM process, the material is removed by means of temporally and spatially discrete discharges which produce local vaporization and melting in association with ejection processes. This enables all electrically-conductive materials to be processed without significant exertion of force, irrespective of their hardness.

Continuous Wire-EDM cutting comprises two successive processing steps. A main cut (high discharge energy) is carried out first, in order to cut out the desired

geometry from the solid material as rapidly as possible, with an allowance for the secondary cuts. Accuracy and surface quality are still unsatisfactory after the main cut. The discharge energy is then gradually reduced during a series of 1-7 secondary cuts, to obtain high accuracy and good surfaces quality.

A volume of work piece has been removed during this short period of spark discharge depends on the desired cutting speed and the surface finish required. Estimated at around 15000 to 21000 Fahrenheit to heat of each electrical spark and erode away a bit of material that is vaporized and melted from the work piece. The chips are flushed away from the cut with a stream of deionised water through the top and bottom flushing nozzles. The heat build-up in the work piece is prevented by deionised water. (Moulton, 2015). Without this cooling system, thermal expansion of the work piece would affect size and positioning accuracy.

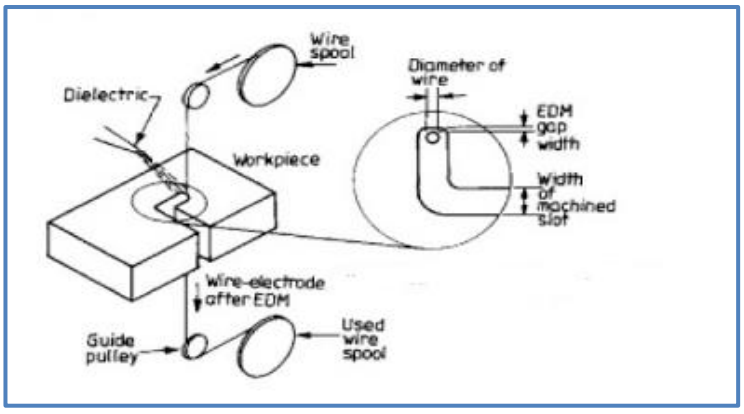

Figure 2.1 : Wire driving and cutting mechanism in WEDM, Source : (W, 2011)

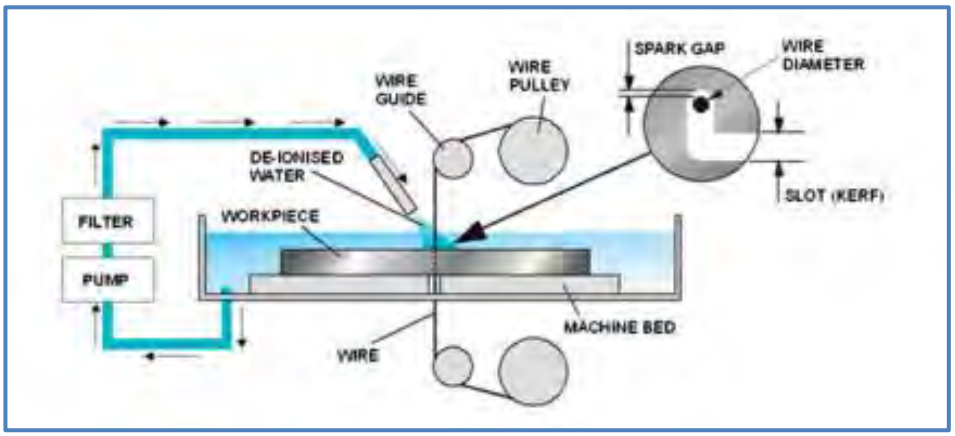

Figure 2.2 : Schematic for WEDM process (Roger, 2014)

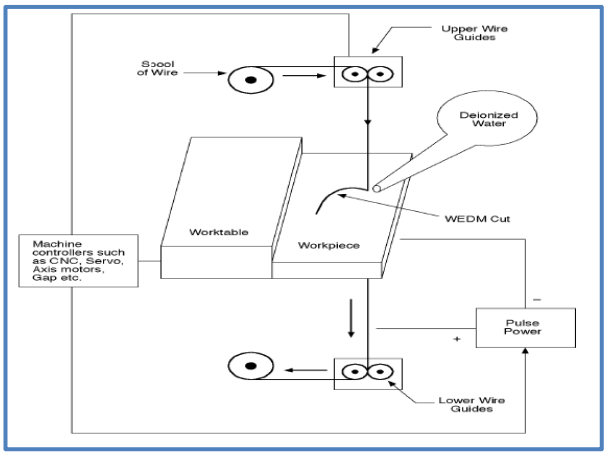

Figure 2.3 : Schematic Diagram For WEDM, (Patnaik, 2006)

2.1.1 Working Principles Of WEDM

Wire Electrical Discharge Machining (WEDM) is non–traditional machining techniques that have high accuracy although complicated shapes especially for the parts that are difficult to be machined. From WEDM can make tools and dies and is an alternative of producing small scale parts with the great dimensional accuracy and surface finish quality. In WEDM, wire is used as electrode that made of thin copper,

brass or tungsten that have diameter 0.05 mm until 0.3 mm which is capable of achieving very small radius of corner. By using mechanical tensioning device, the wire is kept in tension and can reduce to produce inaccurate parts. (Sathiaraj, 2015).

In WEDM, the conductive materials are machined with electrical discharging that will produce sparks between an accurately positioned of electrode wire and the work piece. According to (Cable, 2012), the high frequency pulses of alternating or direct current is discharged from the electrode wire with a small gap or spark through a dielectric fluid. Sparks can be observed and the actual discharging occur more than one hundred thousand times per second and lasting in the range of 1/1000000 of a second or less.

A volume of work piece has been removed during this short period of spark discharge depends on the desired cutting speed and the surface finish required. Estimated at around 15000 to 21000 Fahrenheit to heat of each electrical spark and erode away a bit of material that is vaporized and melted from the work piece. (Moulton, 2015). The chips are flushed away from the cut with a stream of deionised water through the top and bottom flushing nozzles. The heat build-up in the work piece is prevented by deionised water. (Edge, 2015). Without this cooling system, thermal expansion of the work piece would affect size and positioning accuracy.

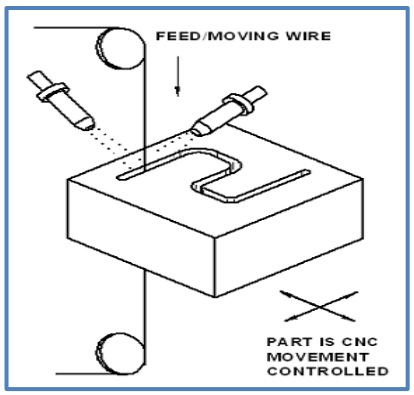

Figure 2.4 : The movement of electrode wire against work piece,
Source: (Edge, 2015)

2.2 Wire Electrode

A variation of EDM is WEDM or electrical discharge wire cutting. In WEDM process, this almost similar to contour cutting with a band saw. The wire travels slowly along a prescribed path and the work piece is cutting with discharge sparks. The wire can cut a work piece as thick as 300 mm and usually being used to make a mould, punches, tool and dies from hard metal. Intricate components for the electronics industries also will be cut. According to (Wukesha, 2014) accessed on 5 May 2014, WEDM is a machine to cut material with a slight wire anode that takes after a customized way. The wires are generally made of metal, copper or tungsten. Zinc or metal covered wires are additionally being utilized. The wire diameter is typically about 0.30 mm for roughing cut and 0.20 mm for finishing cut.

There is no effect on cutting speed even the work piece material is hardness and no physical contact between the wire and part being machined. The important factors in selecting brass and copper are ability to generate an electric discharge, mechanical strength at high temperature, high electrical conductivity and high heat conductivity. The wire also should have sufficient tensile strength and fracture toughness as well as high electrical conductivity and capacity to flush away the debris produces during the cutting. (Wukesha, 2014)

2.2.1 Zinc Coated Brass Wire Electrode

At the Figure 2.5 below shows the structure of Pure Zinc Coated on Brass Wire Core. The brass wire is coated with 100% zinc although the brass contain a little of zinc.