UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON THE EFFECT OF EDM DIE SINKING PARAMETERS ON THE SURFACE FINISH OF MILD STEEL

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

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 Manufacturing (Process and Technology) with (Hons.). The member of the supervisory is as follow:

…….

Mohd Razali bin Md Yunos

ABSTRACT

Die sinking electrical discharge machining EDM is one of the earliest non-traditional machining processes and has a capability in producing high precision parts. An inappropriate EDM die sinking machining parameter will affects the quality of the surface roughness parts because the spark gap between work piece and electrode are lower. Therefore, this research was conducted to investigate the effect of EDM die sinking machining parameters on surface roughness of mild steel material. The spark gap and peak current were manipulated to find the best combination of EDM machining parameters. The machine surfaced will analysed using surface roughness test and the image of textured are captured by using microscope. At the end of this experiment, it is shown that spark gap and peak current have the maximum influence on surface roughness. When the spark gap was increased, the value of surface roughness decreased which give finer surface structure, and when peak current increase, the value of surface roughness, will be higher and produce the rough surface finish.

ABSTRAK

Electik nyahcas mesin EDM adalah salah satu proses pemesinan moden yang paling awal dan mempunyai keupayaan untuk menghasilkan bahagian dengan ketepatan yang tinggi. Ketidaksesuaian parameter yang digunakan daripada proses EDM akan memberi kesan kepada kualiti bahagian-bahagian kekasaran permukaan kerana sela bunga api di antara bahan kerja dan elektrod adalah lebih rendah. Oleh itu, kajian ini dijalankan untuk mengkaji kesan daripada proses EDM parameter kepada kekasaran permukaan keluli lembut untuk kemasukan sela bunga api. Arus puncak dan jarak percikan akan dikaji untuk mencari kombinasi terbaik parameter pemesinan EDM. Permukaan yang telah dimesin oleh EDM akan dianalisis dengan menggunakan ujian kekasaran permukaan dan imej bertekstur direkod dengan menggunakan mikroskop. Di akhir eksperimen ini, kajian menunjukkan bahawa arus puncak dan jarak percikan memberi impak yang besar pada permukaan keluli. Apabila jarak percikan meningkat, permukaan keluli menjadi semakin licin dan apabila arus puncak meningkat, permukaan keluli menjadi semakin kasar.

DEDICATION

I dedicated this thesis to my beloved parents, Abdol Sukor bin Mad Yasin and Rokiah binti Abdullah who have always been my nearest neighbours and have been so close to me that I found them with me whenever I needed. It is because of their never ending love that motivates me to set higher targets. I also dedicated this dissertation to all my friends and UteM's staff who have supported me throughout the process. I would like to express my deepest gratitude to my supervisor Mr. Mohd Razali bin Md. Yunos, who always be my guider to complete my thesis, to my co-supervisor, Mr. Hairizal bin Osman, to Mr. Khairum bin Hamzah who thelp me out in data analysis, also not to forget to all of the assistant engineer, Mr. Janatul Hafiz bin Basir, Mr. Mohd Azimin bin Ibrahim, Mrs. Norhafizah binti Ishak, and Mr. Zuraini bin Zachariah, who always assist me in machining and data collection time. Last word, I want to thanks to all people who help me directly and indirectly within the time to complete this thesis.

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I would like to thank to my family and my special thanks to all friends that gives support and always company me in making and complete this project.

TABLE OF CONTENT

LIST OF FIGURE

LIST OF TABLE

CHAPTER 1

INTRODUCTION

1.1 Introduction

In order to make the reader understand, there must be an introduction for every kind of report. An introduction also must be written in the excellent way so that the reader will be exited to read more about the report even though they just read the introduction part. In this part, there just a basic information about the project such as problem statement, objective of the project, current situation and project scope. All of this information is written in a summary way, that's because the further information will be written in literature review.

Literature review is one of the scope studies. It works as guide to run this analysis. It will give part in order to get the information about electrical discharge machine (EDM) and will give idea to operate the test. From the early stage of the project, various literature studies have been done and the uses of research journals, books, printed or online conference article were the main source in the project guides. History of the EDM will be story little bit in this section. Literature review section work as reference, to give information and guide base on journal and other source in the media.

For methodology part, it will present the information about process flow of the project. It is the combination of the PSM 1 and PSM 2 process flow. In this chapter, there will be the design of experiment (DOE) for this project, experiment set up, tool preparation, specimen preparation, machining set up, testing the specimen after machining and data analysis using selected method and software. Methodology

session is a part that will make the reader understand the step that been take in order to complete this project.

1.2 Current Situation

EDM die sinking is being use in worldwide now a day. All of the machine has their own parameter that been set by their users. There a place that want to produce a rough surface finish, and another place want to produce a smooth surface finish. The parameter is use depend on the purpose of work. Sometime there a place that misused the parameter, so that it will not get the 100% requirement product. So that why this study is all about, to study the best parameter to be use in order to get the optimum surface finish.

1.3 Problem Statement

The limitations of EDM die sinking is due to the slow rate of material removal. This is because of the gap between electrodes that strike to towards the work piece at one time. Besides that, EDM die sinking involves high power consumption in its process. The process may require high energy power to run each process. In addition, the process of EDM die sinking is affected by the work piece layer. Surface defects are important in term of quality and accuracy of tolerance. The EDM parameter play a vital role in deciding machining characteristics like surface integrity, energy consumption and efficiency of EDM process especially on mild steel material.

Figure 1.1 shows the schematic of EDM die sinking process between electrode and work piece. Two metal parts will be submerged in an insulating liquid that are connected to a source of current and it is switched on and off automatically depending on the parameters set on the controller. When the current is switched on, an electric tension is created between the two metal parts. If the two parts are brought together to within a fraction of an inch, the electrical tension is discharged and a spark jumps across. Where it strikes, the metal is heated up so much that it melts. Innumerable such sparks spray, one after the other (never simultaneously) and

gradually shape the desired form in the piece of metal, according to the shape of the electrode. Several hundred thousand sparks must fly per second before erosion takes place.

In the case of EDM die sinking, the required shape is formed negatively in the metal with a three-dimensional electrode. By superimposed movements in the main axes x, y, c, z, the most varied shapes, indentations and cavities are created, such as cannot in part be achieved by any other machining system.

A value of surface roughness may be specified so that expensive finishing processes are eliminated, thereby reducing costs, or alternatively to improve the mechanical properties of a component. Repeating strike of electrode onto the work piece will give some damaged at material structured inside of work piece.

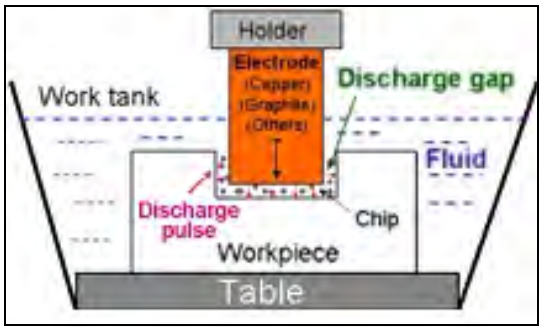

Figure 1.1 Schematic of EDM die sinking process

Source: www.sodick.co.in

1.4 Project Objectives

This project is come out with 4 objectives requirement:

a) To design an appropriate experiment on the mild steel EDM die sinking process.

b) To identify the parameters in EDM die sinking machining.

c) To investigate the effects of EDM die sinking parameters on surface finish and microstructure.

d) To suggest the optimum parameters of EDM die sinking in order to get a required or specified surface finish.

1.5 Project Scope

Scopes for this project is based on objectives that have stated and there are the several scopes that will be carrying out:

a) Focusing on getting the best EDM machining parameters to get the good surface finish of the mild steel.
b) Surface finish of mild steel will be studied using Inverted Research microscope.
c) Material used in this experiment as work piece is mild steel.
d) Material used in this experiment as tool electrode is copper.
e) Machine model is EA12DM.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The electrical discharge machining EDM is one of the major manufacturing processes widely applied in die and mould making industry to generate deep and three-dimensional complex cavities in many different classes of materials under roughing and finishing operations. EDM is the thermal erosion process in which metal is removed by a series of repeated electrical discharges between a cutting tool acting as an electrode and a conductive work piece, in the presence of a dielectric fluid.

The advantages of EDM include machining of machining part that has complex shape. Complex shapes that would otherwise be difficult to produce with conventional cutting tools. Parts with complex, precise and irregular shapes for forging, press tools, extrusion dies, difficult internal shapes for aerospace and medical applications can be made by EDM process. EDM process find application in various fields such as the automotive, medical, aerospace, electrical and electronic industries.

Besides that, extremely hard material does not have to very close tolerances. This is including stainless steel, copper, graphite, and exotic metals that would cause difficulties during conventional machining. Materials of any hardness can be cut as long as the material can conduct electricity (H. Ramasawmy, 2004). The tool does not contact the work piece directly so even delicate materials can be machined using EDM.

The EDM process can be used in two different ways, the first way is a reshaped or formed electrode (tool), usually made from graphite or copper, is shaped to the form of the cavity it is to reproduce. The formed electrode is fed vertically down and the reverse shape of the electrode is eroded (burned) into the solid work piece. During the EDM process the work piece and the electrode are submerged in the dielectric oil, which is an electrical insulator that helps to control the arc discharge. The dielectric oil, that provides a means of flushing, is pumped through the arc gap. This removes suspended particles of work piece material and electrode from the work cavity.

The second way is a continuous-travelling vertical-wire electrode, the diameter of a small needle or less, is controlled by the computer to follow a programmed path to erode or cut a narrow slot through the work piece to produce the required shape. The wire-cut EDM is a discharge machine that uses computer numerical control (CNC) movement to produce the desired contour or shape. It does not require a special shaped electrode, instead it uses a continuous-traveling vertical wire under tension as the electrode. The electrode in wire-cut EDM is about as thick as a small diameter needle whose path is controlled by the machine computer to produce the shape required.

Very small work pieces where conventional cutting tools may damage the part from excess cutting tool pressure. EDM is often used to create prototypes for the aerospace industry. It is also used for creating dies for badges and jewellery. There is no direct contact between tool and work piece. Due of this, the surface of material will not have any adverts effects. Therefore delicate sections and weak materials can be machined without any distortion. In addition, a good surface finish can be obtained where at the end of process no burrs are left in machined surface.

Very fine holes can be easily drilled. EDM can be very useful for small hole drilling, often used in electronics. An interesting application is for removing tools such as drill bits which have broken off inside a work piece. Small hole EDM drilling, also known as fast hole EDM drilling, hole popper, and start hole EDM drilling. Now, small hole EDM machining is used for production work and the drilling speed have been achieved up. Holes can be drilled in any electrical conductive material, weather hard or soft, including carbide.

Discharge occurs when there are voltage gap between the electrode and work piece. Heat from the discharge vaporizes minute particles of work piece material, which are then washed from the gap by the continuously flushing dielectric fluid. The intensity of the electric field in the volume between the electrodes becomes greater than the strength of the dielectric when the distance between the two electrodes is reduced which breaks, allowing current to flow between the two electrodes.

The experiment will be conducted on a material called mild steel. Mild steel are used widely in mould manufacturing because of its properties of good corrosion resistance, excellent polish ability, good wear resistance, good machinability and good stability in hardening. Mild steel is recommended for all types of moulding tools and its special properties make it particularly suitable for moulds. Figure 2.1 shows the example shape of mild steel material used in this project.

Figure 2.1 Mild steel

Source: Steel Ltd catalogue