UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SURFACE ROUGHNESS OF SMALL THICKNESS IN EDM DIE SINKING MACHINE

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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I hereby, declared this report entitled "Surface Roughness of Small Thickness in EDM Die Sinking Machine" is the results of my own research except as cited in references.

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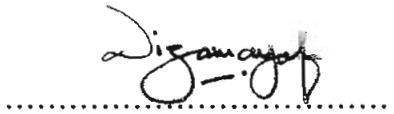
APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the Degree in Bachelor of Manufacturing Engineering (Process). The member of the supervisory committee is as follow:



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ABSTRAK

Objektif projek ini adalah untuk mengoptimumkan parameter mesin “Electrical Discharge Machining Die Sinking” untuk menghasilkan keadaan permukaan yang licin untuk keratan yang nipis dan mengkaji permukaan untuk Die Sinker ini. Pemesinan dikenakan bahagian yang kecil dan jitu adalah rumit kerana kewujudan daya mekanikal yang tinggi dalam kebanyakan proses mungkin merosakkan bentuk itu. Kajian ini, mengkaji parameter mesin seperti “Discharge current, pulse on time, pulse off time and circuit voltage” untuk mengukur keadaan permukaan yang licin. Didalam kajian ini, full factorial design digunakan untuk mereka eksperimen dan akan dijalankan sebanyak 16 kali dengan memanipulasikan pembolehubah yang telah dipilih. Dengan menggunakan “Design Experiment Full Factorial ”, faktor yang memberi kesan ke atas permukaan yang baik ialah arus. Daripada kajian yang dibuat, apabila arus rendah kekasaran permukaannya tinggi.

ABSTRACT

The objective of this project is to optimize the machining parameters in die sinking electrical discharge machining in order to able the best parameter to get surface roughness via small thikcness in Die Sinker Electric Discharge Machine (EDM). Otherwise in machining process of a small and precision part is problematic due to the presence of high mechanical force in most of the manufacturing processes. Throughout the study, the significant machining parameters such as discharge current, pulse on time, pulse off time and circuit voltage will be investigated to measure the surface roughness. Full factorial design is used to design the experiment and relate the input variables to the reponse variables. A design with 16 experimental runs is generated by manipulating the selected generated in the design matrix will be used. By using a Design of Experiment of Full factorial, the result show that peak current are most the significant parameter effect surface roughness in small thickness EDM Die Sinking. It show when peak curent lower, the surface roughness fos small thickness in EDM is increase and in fine finish . The other parameter also give effect in this study but not to significant. From this study, the surface roughness is important to increase a quality for one sample or product.

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DEDICATION

To my beloved father Zulkefli B Ahmad, my mother Radziah Bt Harun, my sister Nurshazana and my brother Muhammad Faiz and Muhammad Farhan, for giving me constant support ,love strength, confidence and guidance that I could not do without.

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ANOVA	-	Analysis of Variance
EDM	-	Electro Discharge Machine
R_a	-	Surface Roughness
IP	-	Peak Current

CHAPTER 1
INTRODUCTION

1.1 Background of the Project

Electrical Discharge Machining (EDM) is a controlled metal-removal process that is used to remove metal by means of electric spark erosion. In this process an electric spark is used as the cutting tool to cut (erode) the workpiece to produce the finished part to the desired shape. The metal-removal process is performed by applying a pulsating (ON/OFF) electrical charge of high-frequency current through the electrode to the workpiece. This removes (erodes) very tiny pieces of metal from the workpiece at a controlled rate.

This project will study and do analysis on surface roughness via thin section for Die Sinker EDM machine. Surface roughness in EDM depends on the accuracy of electrode and if the correct current is used, very fine finish can be obtained. When high current applied, its produce large sparks and makes large work piece craters. If low current applied, a small sparks are produced which create small craters. The sparks in this process erode away the electrode, thus changing its geometry and adversely affecting the shape produced and its dimensional accuracy.

The project will broadly involve a few tasks such as developed a parameter and find the good result in surface roughness of this work piece.

1.2 Problem Statement

Surface roughness is more important in accuracy by tolerance. If their tolerance is high the surface roughness of the workpiece not in a good condition. Otherwise, surface roughness was effect the safety for the user if have a burr at the workpiece or product. 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. The careful finishing of components can lead to longer life, improved efficiency and other benefits.

In molding or stamping industry, surface roughness values are an important consideration to increase a quality of product. In this industry, it produces a variety of design in terms of shape, width, thickness and length. After the product was produce, the most important to continuous the process is surface finish for any type of thickness or shape. So, the value of surface roughness must be a considered.

The problem is when the value of surface roughness increase in a small thickness. Thus, investigation to determine the best parameter to produce good surface roughness for small thickness is really essential using a Die Sinker EDM machine.

Investigate the parameter to produce a good surface.

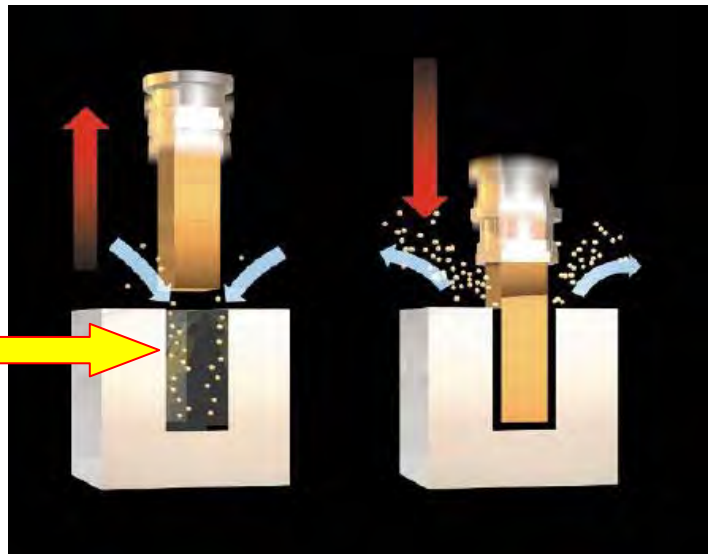

Figure 1.0 : Process in Die Sinking

1.3 Objectives

The objectives of this study were:

i. To investigate the surface roughness for small thickness in Die Sinker Electric Discharge Machine (EDM).
ii. To identify which parameter influenced a surface roughness of a small thickness shape in Die Sinker EDM
iii. To investigate the cutting conditions (peak current, pulse on time and circuit voltage.)
iv. To be able to appreciate the quality of the result product.

1.4 Scope

This research project will focus primarily on the surface roughness via small thickness in 0.4mm of work piece that use mild steel as a material and copper as electrode for Electric Discharge Machine (EDM). In addition, is to justify a best parameter that we want to use to get a best fine finish. Otherwise, to get a higher surface finish and a lower roughness in EDM Die Sinker when apply a certain value of parameter.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter reviewed various study and analysis result and findings from previous researcher's research. Most of the review was based on Die Sinker EDM machine and problem statement for this project.

2.2 Die Sinking EDM

In the Sinker EDM Machining process, two metal parts submerged in an insulating liquid are connected to a source of current which 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. Sinker EDM, also called cavity type EDM or volume EDM consists of an electrode and workpiece submerged in an insulating liquid such as, more typically, oil or, less frequently, other dielectric fluids. These sparks usually strike one at a time because it is very unlikely that different locations in the inter-electrode space have the identical local electrical characteristics which would enable a spark to occur simultaneously in all such locations. These sparks happen in huge numbers at seemingly random locations between the electrode and the workpiece. As the base metal is eroded, and the spark gap subsequently increased, the electrode is lowered automatically by the machine so that the process can continue uninterrupted. Several

hundred thousand sparks occur per second, with the actual duty cycle carefully controlled by the setup parameters.(Shailesh Kumar Dewangan, 2010)

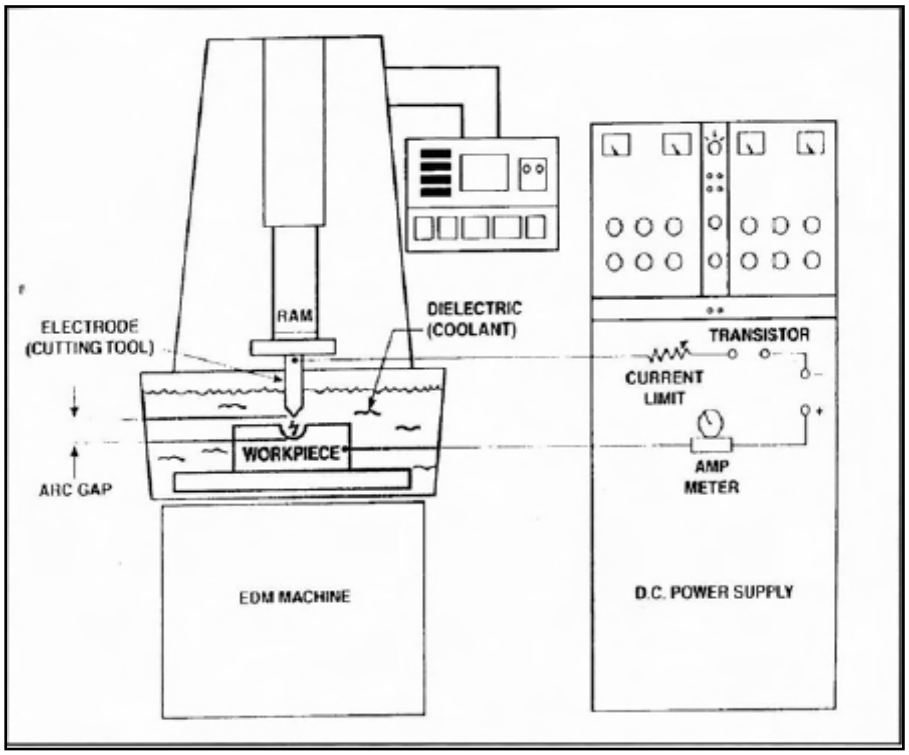

Figure 2.1: Ram -type EDMs plunge a tool, shaped to the form of the cavity required, into a workpiece (Krar, etal, 1996).

2.3 Working Principle in Die Sinker

Die Sinker EDM uses spark erosion to removal metal. Its power supply generates electrical impulse between the work piece and the electrode. A small gap between the electrode and the work piece allows flow dielectric oil. When sufficient voltage is applied, the dielectric oil ionizes and controlled sparks melt and vaporize the work piece.

The pressurized dielectric oil cools vaporized metal and removes the eroded material from the gap. A filter system cleans the suspended particles from the dielectric oil. The oil goes through a chiller to remove the generated heat from the spark erosion process. This chiller keeps the oil at constant temperature which aids in machining

accuracy. It also sparks erosion process. However it produces the sparks along the surface of a formed electrode.

A servo mechanism maintains the gap between the electrode and the work piece. The servo system prevents the electrode from touching the work piece. If the electrode were to touch the work piece it would create a short circuit and no cutting would occur. (REDM Complete EDM Handbook IND, 2006). In die sinking EDM process the parameter was use to make the machine operate and effect the result end the process.

2.4 Machining Parameter in Die Sinking EDM

In this study, peak current, voltage, pulse-on time and pulse-off time were selected as the process parameters to determine their effect to the MRR, EWR, surface roughness and surface hardness of the tool steel. (Shailesh Kumar Dewangan, 2010)

2.4.1 Important Parameter in EDM Die Sinker

(a) Spark On-time (pulse time or Ton): The duration of time (μs) the current is allowed to flow per cycle. Material removal is directly proportional to the amount of energy applied during this on-time. This energy is really controlled by the peak current and the length of the on-time.

(b) Spark Off-time (pause time or T off): The duration of time (μs) between the sparks. This time allows the molten material to solidify and to be wash out of the arc gap. This parameter is to affect the speed and the stability of the cut. Thus, if the off-time is too short, it will cause sparks to be unstable.

(c) Arc gap (or gap): The Arc gap is distance between the electrode and work piece during the process of EDM. It may be called as spark gap. Spark gap can be maintained by servo system (fig no.-1).

(d) Discharge current (current Ip): Current is measured in amp Allowed to per cycle. Discharge current is directly proportional to the Material removal rate.

(e) Duty cycle (τ): It is a percentage of the on-time relative to the total cycletime. This parameter is calculated by dividing the on-time bythe total cycle time. The result is multiplied by 100 for the percentage of efficiency or the socalled duty cycle .

(f) Voltage (V): It is a potential that can be measure by volt it is also effect to the material Removal rate and allowed to per cycle. Voltage is given by in this experiment is 50 V.

(g) Diameter of electrode (D): It is the electrode of Cu-tube there are two different size of diameter 4mm and 6mm in this experiment. This tool is used not only as a electrode but also for internal flushing.

(h) Over cut – It is a clearance per side between the electrode and the work piece after the marching operation.

2.5 Design of Experiment for Surface Roughness in Die Sinking EDM

In this paper, a study was carried out on the influenceof the parameters such peak currrent, power supply voltage,pulse on time and pulse off time. The surface quality that wasinvestigated in this experiment was surface roughness usingperthometer machine. Material removal rate (MRR) andelectrode wear (EW) in this experiment was calculated by usingmathematical method.The variables parameters are have great effects to the machining performances results especially to the material removal rate (MRR). (Shailesh Kumar Dewangan, 2010)

There are two major groups of parameters that have been discovered:

1) Non-electrical Parameters
    a. Injection flushing pressure
    b. Rotational of speed electrode

2) Electrical Parameters

a. Peak current

b. Polarity

c. Pulse duration

d. Power supply voltage

2.6 Electrode

The electrode is the main part of the EDM process, which is connected to the DC power source and is immersed, in the die electric fluid. Electrode materials must, therefore have the following characteristics.

1. Be good conductors of electricity and heat.
2. Be easily machined to shape at a reasonable cost
3. Produce efficient metal removal from the work piece
4. Resist deformation during the erosion process
5. Exhibit low electrode (tool) wears rates.

In EDM a relatively soft graphite or metallic electrode can be used to machine hardened steel or carbide. The EDM process always produces a cavity slightly larger than the electrode and because of the overcut; the electrode must be made a little smaller than the actual size required. (Kaminski and Capuano, 2003)

Electrode materials generally used can be classified as follow:

- Metallic material: electrolytic copper, tellurium or chromium copper, copper tungsten, brass, tungsten, steel, zinc and zinc alloys, tungsten carbide, aluminium.
- Non metallic material : Graphite
- Combination of metallic and non-metallic materials: Copper graphite.