UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Electrode Tool Wear Analysis under Various Cutting Parameters in the Die Sinking Electrical Discharge Machine (EDM)

Thesis submitted in accordance with the requirements of the
Universiti Teknikal Malaysia Melaka for the Degree of
Bachelor of Manufacturing Engineering (Manufacturing Process)

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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ELECTRODE TOOL WEAR ANALYSIS UNDER VARIOUS CUTTING PARAMETERS IN THE DIE SINKING ELECTRICAL DISCHARGE MACHINE (EDM)

ZARIYANTI BTE PAIJOO

UNIVERSITI TEKNIKAL MALAYSIA, MELAKA

APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

…….

Main Supervisor

(Official Stamp & Date)

DECLARATION

I hereby, declare this thesis entitled “Electrode Tool Wear Analysis under Various Cutting Parameters in the Die Sinking Electrical Discharge Machine (EDM)” is the results of my own research except as cited in the reference.

Signature	:	……
Author’s Name	:	ZARIYANTI BT PAIJOO
Date	:	16 MEI 2007

ABSTRACT

The EDM removes workpiece by an electrical spark erosion process. The shape of the electrode determines the shape of the workpiece owing to the electrode being sunk into the workpiece. Electrode wear is a serius drawback in EDM process, this is because each spark discharge removes material not only from the workpiece but also from the electrode. Therefore, proper selection of the machining parameters can result in better machining performance, for example EWR, MRR and Surface Roughness. The rate of electrode tool wear depends on a number of factors associated with the EDM process such as Current, Voltage and Jump Speed. This thesis investigate the EWR and characteristic of electrode wear under several machining parameters (current, voltage and jump speed) of copper electrode. The DOE were used to find the significant machining parameter that most influence the EWR. Experimental result indicates that IP (Current) and V (Voltage) were the most significant factor that effect the EWR.

ABSTRAK

EDM adalah pemesinan nyahcas electrik yang membuang permukaan benda kerja melalui proses hakisan oleh percikkan api. Bentuk elektrod akan menentukan bentuk benda kerja disebabkan oleh electrod yang diukir ke dalam benda kerja. Kehausan electrod adalah salah satu kelemahan di dalam proses pemesinan EDM, ini kerana setiap percikkan api akan membuang bahan bukan sahaja dari benda kerja tetapi juga daripada elektrod. Oleh itu, pemilihan parameter yang sesuai dapat menghasilkan prestasi pemesinan yang baik, sebagai contoh kadar kehausan elektrod, kadar pemindahan bahan dan juga kekasaran permukaan. Kadar kehausan elektrod bergantung kepada beberapa faktor penting yang berhubung dengan proses EDM seperti arus elektrik, voltan dan lompatan kelajuan. Kajian ini tertumpu kepada kadar kehausan elektrod dan ciri-ciri kehausan yang terdapat pada elektrod di bawah beberapa parameter pemesinan iaitu arus elektrik, voltan dan lompatan kelajuan .Analisis daripada eksperimen ini akan ditentukan dengan menggunakan kaedah DOE untuk mendapatkan parameter pemesinan yang mana ia boleh mempengaruhi kadar kehausan elektrod. Keputusan daripada eksperimen akan menunjukkan bahawa arus elektrik dan voltan memainkan peranan penting serta memberi kesan terhadap kehausan elektrod.

DEDICATION

Especially dedicated to my parent, brothers and sisters

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LIST OF ABBREAVIATIONS, SYMBOLS AND SPECIALIZED NOMENCLATURE

A	-	Ampere
ANOVA	-	Analysis of variance
C	-	Carbon
CMM	-	Coordinate measuring machine
cm	-	Centimeter
DOE	-	Design of experiment
EW	-	Electrode Wear
Fe	-	Ferum
In	-	Inch
IP	-	Current
Js	-	Jump Speed
k	-	Factor
m	-	meter
Max	-	maximum
Min	-	minimum
Mn	-	Manganese
MPa	-	Mega pascal
MRR	-	material removal rate
min	-	minute
mm	-	millimeter
Ni	-	Nickle
OA	-	orthogonal array
Si	-	Silicon
SS	-	Sum of square
V	-	Volt
y	-	average

µm	-	micrometer
µin	-	microinch
µs	-	microsecond
Ω	-	ohm
µΩm	-	micro ohm meter
µΩ/cm	-	micro ohm per centimeter
%	-	percent
°C	-	degree celcius
-	-	low
+	-	high

CHAPTER 1
INTRODUCTION

1.1 Introduction

EDM is a non-traditional machining process based on removing material from a part by means of a series of repeated electrical discharges between a tool, called the electrode and the part being machined in the presence of a dielectric fluid. At present EDM is a widespread technique used in industry for high-precision machining of all types of conductive materials such as: metals, metallic alloys, or even some ceramic material of any hardness.

In the electrical discharge machining process, the shape of the electrode determines the shape of the workpiece owing to the electrode being sunk into the workpiece. However, electrode wear takes place during the electrical discharge machining process. This is because each spark discharge removes material not only from the workpiece but also from the electrode. Therefore, the study of electrode wear is important to ensure the required dimensional accuracy and geometry of the workpiece can be achieved.

The rate of electrode tool wear depends on a number of factors associated with the EDM process such as current, voltage, jump speed, spark gap, polarity, electrode material etc. The shapes of electrode tool wear can be characterized depending upon the different machining parameters. This change in shapes of the tool electrode causes defects in the workpiece which even more pronounced effects when it comes to micromachining.

1.2 Background of the Problem

Electrical discharge machining (EDM) is rapidly becoming an important manufacturing process for machining hard metals and alloy used in the aerospace, tool and dies industries, manufacturing of mould and to produce the complex shape, which required high precision and dimensional accuracy. As been stated, the shape of the electrode will determine the shape of the workpiece or final product. Therefore, the study of electrode wear is important to ensure the required dimensional accuracy and geometry of the workpiece can be achieved.

Hence, this project will analyzed the characteristic and rate of electrode wear under several parameters machining such as current, voltage and jump speed using copper electrode.

1.3 Objectives

The purposes of this project are to:

i. To characterize the mechanism and morphology of tool wear according to current, voltage and jump speed.
ii. To determine the electrode tool wear rate within different machining parameter.
iii. To find the significant machining parameter that most influences the electrode tool wear using orthogonal array approach.

1.4 Scopes

Several approaches are used throughout the project. According to the objectives, the selected scopes of the project are:

i. To understand the EDM die-sinking machining process.
ii. To find the electrode tool wear rate of EDM die-sinking process.
iii. To analyze the type of electrode tool wear under various parameters (current, voltage, jump speed) using Coordinate Measuring Machine (CMM) and Image Analysis Microscope.
iv. To find the significant machining parameter that influences the rate of tool wear using Orthogonal Array approach.

1.5 Important of the Study

The study of electrode wear is important to ensure the required dimensional accuracy and geometry of the workpiece is meet. Beside that, the result from this study will help to estimate the electrode reliability under various machining parameter.

1.6 Expected Result

Optimistically at the end of this project, the main effects of the EDM parameter that influences the rate of electrode tool wear can be obtained.

CHAPTER 2
LITERATURE REVIEW

2.1 Electrical Discharge Machining (EDM)

Electrical discharge machining, commonly known as EDM, is a process that remove metal by means of electrical spark erosion. Machining is performed by the action to removes electrically conductive material by means of rapid, repetitive spark discharges from a pulsating dc power supply with dielectric flowing between the work piece and the tool. The shaped tool (electrode) is fed into the workpiece under servo control. A spark discharge then breaks down the dielectric fluid. The frequency and energy per spark are set and controlled with a dc power source. The servo control maintains a constant gap between the tool and the workpiece while advancing the electrode. The dielectric coil cools and flushes out the vaporized and condensed material while reestablishing insulation in the gap. Figure 2.1 (circle figure) is shown the spark discharge from a pulsating dc power supply with dielectric flowing between work piece and tool (electrode). (Krar, 1996)

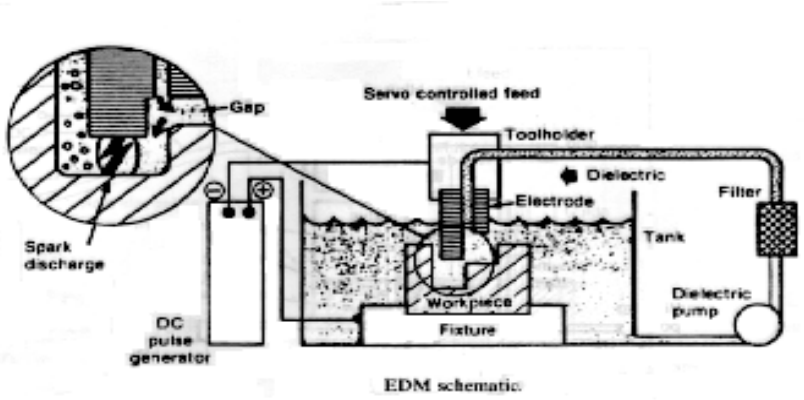

Figure 2.1: A controlled spark discharge removes a very small particle between workpiece and electrode (circle figure). (George Tlusty, 1999)

Beside that, the Electrical Discharge Machining (EDM) technique is applicable to a wide variety of conductive materials irrespective of their mechanical properties, e.g their hardness, strength or toughness, etc. further more, since no direct contact occurs between electrode and workpiece, the EDM process is suitable for the machining of brittle materials such as ceramic and for those materials which are not really machined using traditional machining method.

The recent development in the field of EDM have progressed due to the growing application of EDM process and the challenges being faced by the modern manufacturing industries, from the development of new materials that are hard and difficult to machine such as tool steels, composites, ceramics, supper alloys, hastalloys, nitralloy, waspalloy, nemonics, carbides, stainless steel, heat resistant steel, etc, being widely used in die and mould making industries, tools and die industries, aerospace, aeronautics and nuclear industries. (Shankar, 2004)

2.2 Die-Sinking EDM

The EDM die-sinking as shown at figure 2.2, has a cutting tool (electrode) shaped to the form of the cavity, mounted in the ram of the machine. The electrically conductive workpiece is fastened to the machine table below electrode. The DC power supply produces a series of short, high frequency electrical arc discharges between the electrode and the workpiece. The action removes (erodes) tiny particles of metal from the workpiece and as the process continues, the electrode reproduces it's from in workpiece. (Krar, 1996). Figure 2.3 below is also shown the schematic diagram of EDM machining process.

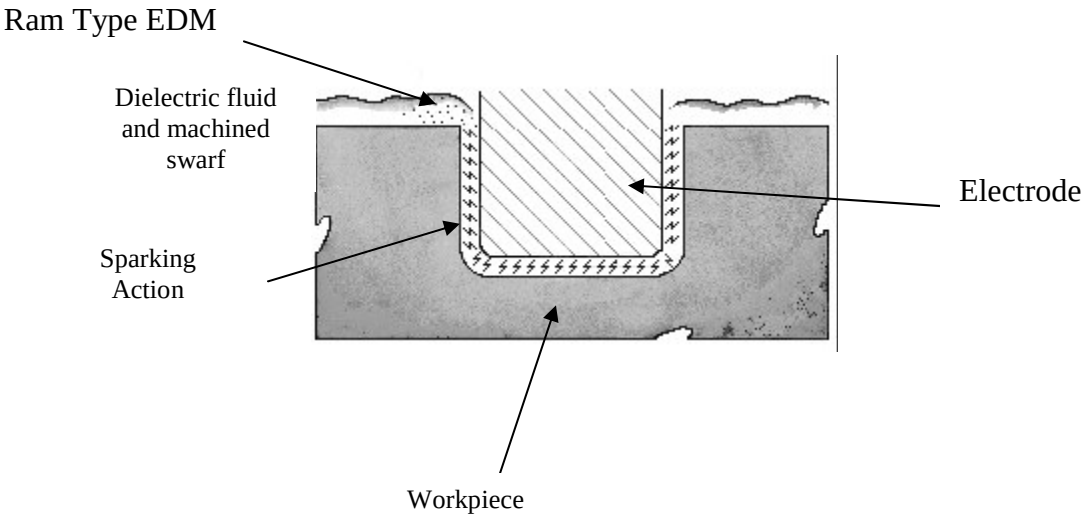

Figure 2.2: A cutting tool (electrode) shaped to the form of the cavity (George Tlusty, 1999)