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STUDY ON CUTTING TOOLS WEAR IN EDM PROCESS

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A thesis report submitted to faculty of mechanical engineering in partial fulfillment of the requirement for the award of Bachelor's degree of Mechanical Engineering (Structure & Material)

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ABSTRACT

Copper electrode with diameter of 10, 20 and 30 mm and mild steel as the workpiece is used in the electro discharge machining (EDM) at two various current of 3A and 6A with the objective of determine the relation between electric current and the wear rate. There are one machining test that is current effect to the cutting process with the time is different. The electrode and workpiece wear rate is obtained by measuring the mass loss percentage. The wear rate can be calculated by using this data. The basics system consists of a shaped tool (electrode) and the workpiece connected to a dc power supply and placed in a dielectric (electrically nonconducting) fluid. When the potential difference between the tool and the workpiece is sufficiently high, a transient spark discharges through the fluid, removing a very small amount of metal from the workpiece surface. The capacitor discharge is repeated at rates of between 50 kHz, with voltages usually raging between 50V and 380V and currents from 0.1A to 500A.

ABSTRAK

Elektrod kuprum dengan diameter 10,20 dan 30 mm dan juga besi tuang sebagai benda kerja digunakan dalam pemesinan discas elektrik (EDM) pada arus elektrik 3A dan 6A dengan objektifnya adalah menentukan perhubungan di antara arus elektrik dengan kadar haus. Terdapat satu ujian dijalankan iaitu kesan arus terhadap proses pemotongan dengan menggunakan masa pemesinan yang berbeza. Kadar haus untuk elektro dan benda kerja diperolehi dengan mengira perubahan jisimnya. Dengan itu, kadar haus dapat dikira dengan data yabg diperolehi. Sistem proses ini adalah elektrod dan benda kerja disambungkan kepada sumber kuasa DC dan diletakkan di dalam bendalir elektrik. Apabila perbezaan potensi di antara elektrod dan benda kerja cukup tinggi, percikan api dihasilkan melalui bendalir itu, mengakis sejumlah kecil besi dari permukaan benda kerja. Percikan ini berulangan dengan kadar di antara 50kHz, dengan voltan biasanya di antara 50V dan 380V dan arus elektriknya 0.1A dan 500A.

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LIST OF SYMBOL

Symbol	Definition
A	Ampere
V	Volt
Hz	Hertz
mm	millimeter
°C	Celsius
s	second
°	Degree
EDM	Electro discharge machining
Δ	Difference
μ	micro
Ω	Ohm
g	gram
cm	centimeter
cal	calorie
W	Watt
K	Kelvin
N	Newton

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CHAPTER 1

INTRODUCTION

1.1 Identification

Machining is the most important process in manufacturing engineering. Machining consist two types, *common* type machining and *non common* type machining.

The example of common type machining is grinding, drilling and lathe. By using the common type machining, the quality of the product produce is very depend on the machine operator skill, type of process use and the type of material. But there are several situations that common type machining cannot apply, one of it is complex shapes like hole with small diameter and oil injection nozzle.

In addition, with the development of the technology nowadays, many new material and alloy have been discovered. So it is need to have new method to improve and increase the quality of metal machining. That's why the usage of the non common type machining is needed to overcome the weakness in common type machining.

The non common type machining is applied especially for mould surface finishing. This method is also limited to several machining parameter, but if the parameter is select properly, the effectiveness of the application from the technical aspect and cost is better then the common type machining.

Electrical Discharge Machining, EDM is one of the non common types machining in manufacturing processes that available for creating complex or simple shapes and geometries within parts and assemblies. EDM works by eroding material in the path of electrical discharges that form an arc between an electrode tool and the work piece. When cutting take place, small portion of metal has been eroded away from the work piece. This whole process is happen in the dielectric fluid.

1.2 Objective

Electro Discharge Machining using NC-EDM machine depend on many types of parameter. Although, this experiment is focus on electrode wear and it rate when the electric current is apply during the machining.

That's why; determine the relation between electric current and the wear rate is the main objective in this project. The wear that happened to the electrode evaluated according to the wear rate. As an addition, the relationship between electrode wear rate and the disposition of work piece rate with the change of the electrode diameter indirectly also observe.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The disposal of material that happen when the workpiece is use at EDM machine is cause by spark erosion. There are many theories that have been suggested to explain the spark phenomena. There are three theories that tried to explain:

1. Electro mechanical theory
2. Thermo mechanical theory
3. Thermo electric theory

2.2 ELECTRO MECHANICAL THEORY

This theory suggests that the work piece material particles become rough because of the concentration of electric field happen. Electric field separates the particles on the work piece after it became higher than the combination force in the work piece material atom gap. This theory denies any thermal effect and EDM process do not brings any effect to the work piece material surface. Although so, the experiment shows lack of evidence to support this theory.

2.3 THERMO MECHANICAL THEORY

This theory suggests that the disposition of work piece when electro discharge machining cause by the melted material that produced by blasting fire. This blasting fire is produce by many electric effect that happened when discharge. But this theory is not supported by the experiment data and fails to give any explanation about the effect of spark erosion.

2.4 THERMO ELECTRIC THEORY

Proving by experiment manage to support this theory. This theory suggest that the disposition of work piece material during electro discharge machining was cause by the production of very high temperature that generated by discharge current. Even this theory was supported; this theory is not accepted entirely because of the difficulty to make interpretation. Until now, this theory is the best among other theory.

We know that when two current-conducting wires are allowed to touch each other, an arc is produced. If we look closely at the point of contact between the two wires, we note that a small portion of the metal has been eroded away, leaving a small crater. Although this phenomenon has been known since the discovery of electricity, it was not until the 1940's that a machining process based on this principle was developed. The EDM process has become one of the most important and widely accepted production technologies in manufacturing industries.

The basics system consists of a shaped tool (electrode) and the workpiece connected to a dc power supply and placed in a dielectric (electrically nonconducting) fluid. When the potential difference between the tool and the workpiece is sufficiently high, a transient spark discharges through the fluid, removing a very small amount of metal from the workpiece surface. The capacitor discharge is repeated at rates of between 50 kHz, with voltages usually raging between 50V and 380V and currents from 0.1A to 500A.

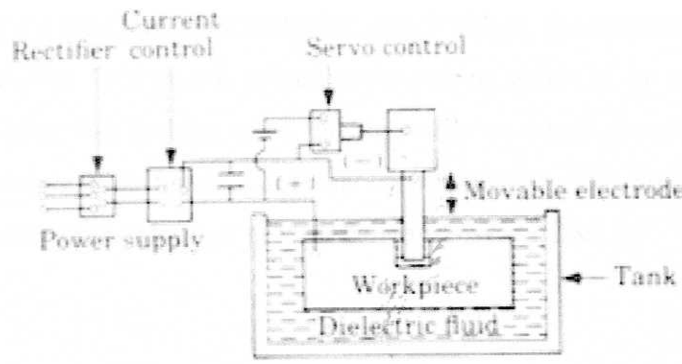

Figure 2.1: Schematic illustration of the electro discharge machining process.

The functions of the dielectric fluid are:

1. Act as an insulator until the potential is sufficiently high
2. Act as a flushing medium and carry away the debris in the gap
3. Provide a cooling medium

The workpiece is fixed within the tank containing the dielectric fluid and its movement is controlled by numerically controlled systems. The gap between the tools is controlled by a servomechanism, which automatically maintains a constant gap.

The most common dielectric fluids are mineral oils, although kerosene and distilled and deionized water are also used in specialized applications. Recent trends involve the use of clear, low-viscosity fluids, these fluids make cleaning easier. The machines are equipped with a pump and filtering system for the dielectric fluid.

2.5 ELECTRODE

Electrodes for EDM are usually made of graphite, brass, copper or copper-tungsten alloy are also used. The tools are shaped by forming, casting, powder metallurgy, or machining techniques. Electrodes as small as 0.1 mm in diameter has been used and the depth-to-hole diameter ratios can range up to 400:1.

Tool wear is an important factor because it affects dimensional accuracy and the shape produced. Tool wear is related to the melting points of the materials involved, the lower the, melting point, the higher the wear rate. Graphite electrodes have the highest wear resistance. Tool wear can be minimized by reversing the polarity and using copper tools, a process called no-wear EDM.

2.6 EDM WORK PRINCIPLE

Electro discharge process is a thermo electric process that erodes away from work piece through the continuing spark between work piece and the cutting tools. This process is happening in the dielectric fluid when the electrode and the cutting tool are sinking in the dielectric fluid. The upper surface of the work piece must at least sink 50mm in the dielectric fluid and this depth must be maintained to avoid fire. The eroded work piece is then flush away by the dielectric fluid.

The electrode has negative polarity and the work piece has positive polarity. Normally electrode has negative polarity because it connected to the direct current power supply. This type of connection gives the electrode negative polarity and positive polarity to the work piece.

The negative charge electrode goes near to the positive charge work piece as near as 0.025mm to 0.050mm. This movement is control by the machine servo motor and the gap is filled with dielectric fluid.

The closer the electrode to the work piece, the higher the potential difference that yield between the electrode and the work piece. When the potential difference is high enough, electron that produced are will ionized the dielectric fluid causing the electron flow increase very high.

The spark produce is aimed at the work piece with high velocity, causing the work piece "melted" and evaporated small piece of the work piece, living a crater at the work piece. The evaporated metal is floating on the dielectric fluid as the metal cloud and then condenses to small particles that must be spurting out quickly. The temperature in this situation is estimated between 8000°C to 16 000°C

The electron will flow from the electrode continuously through the ion path in the dielectric fluid to the work piece. The electron flow non stop until the potential between electrode and the work piece is unable to maintain where the voltage is drop to 20V and at this time the discharge process will stop. At this stage, the dielectric fluid once again will be discharge. The voltage will increase and this process repeated. This repetition process can reach up to 100 000 times per second.

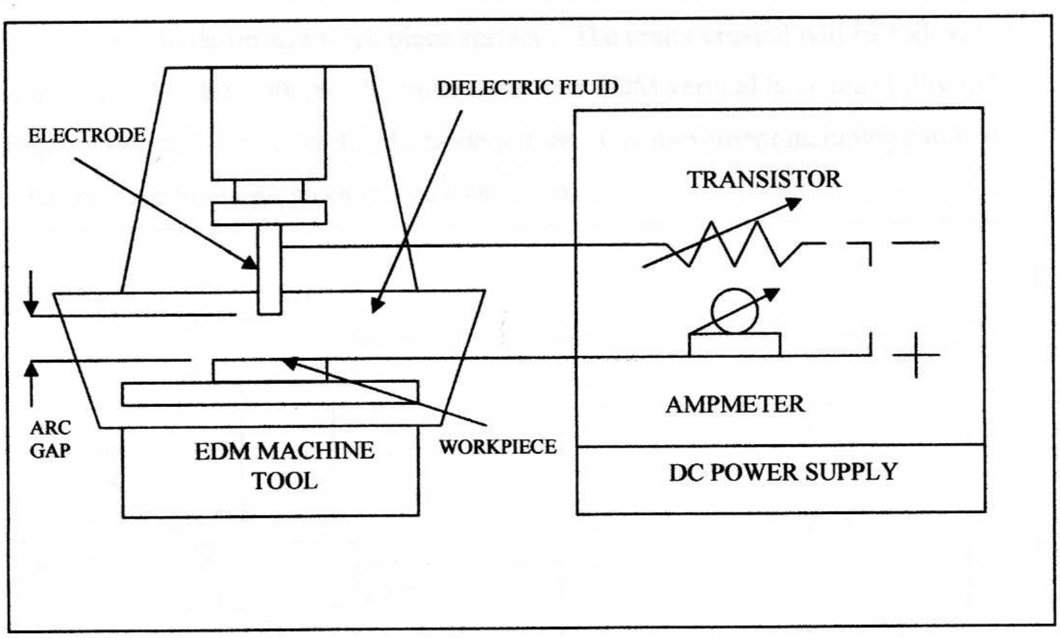

Figure 2.2: Shows the EDM basic system.