UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CARBON NANOFIBERS ASSISTED CONVENTIONAL EDM ON STAINLESS STEEL

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

by

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I declare that this thesis entitle "carbon nanofibers assisted conventional EDM on stainless steel" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is notconcurrently submitted in candidature of any other degree.

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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 of Bachelor of Manufacturing Engineering (process) with Honours. The member of the supervisory committee is as follow:

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ABSTRACT

The correct selection of manufacturing conditions is one of the most important aspects to take into consideration in the majority of manufacturing processes and, particularly, in processes related to Electrical Discharge Machining (EDM). This study was to identify the Electrical Discharge Machining (EDM) machine using powder mix in dielectric fluid give the effect on conductive material. The conductive material selected is stainless steel. The grade of stainless steel is AISI 304. AISI 304 is an austenitic type. The austenitic types feature adaptability to cold forming, ease of welding, high temperature service, and, in general, the highest corrosion resistance. AISI 304 has lower carbon to minimize carbide precipitation. It is less heat sensitive than other 18:8 steels. Used in high-temperature applications. Model machine Electrical Discharge Machining (EDM) use for this study is SODICK AQ35L to machine the AISI 304. After finish Electrical Discharge Machining (EDM) process, the workpiece will be checked the material removal rate (MRR) and tool wear rate (TWR) with precise digital balance machine.

ABSTRAK

Pemilihan keadaan yang betul dalam pembuatan adalah salah satu aspek yang paling penting untuk diambil kira dalam kebanyakan proses pembuatan dan , terutamanya , dalam proses yang berkaitan dengan Pemesinan Nyahcas Elektrik (EDM) . Kajian ini adalah untuk mengenal pasti kesan Pemesinan Nyahcas Elektrik (EDM) yang menggunakan campuran serbuk didalam cecair dielektrik ke atas bahan konduktif. Bahan konduktif dipilih adalah keluli tahan karat. Gred keluli tahan karat adalah AISI 304. AISI 304 adalah satu jenis austenit . Jenis austenit menampilkan keupayaan menyesuaikan kepada sejuk membentuk, kemudahan kimpalan , perkhidmatan suhu tinggi, dan, secara amnya , ketahanan kakisan yang tertinggi. AISI 304 mempunyai karbon yang lebih rendah untuk mengurangkan pemendakan karbida . Ia adalah kurang haba sensitif daripada keluli yang lain. Ia digunakan dalam aplikasi suhu tinggi. Model mesin Pemesinan Nyahcas Elektrik (EDM) yang digunakan untuk kajian ini adalah SODICK AQ35L untuk memesin AISI 304. Setelah selesai proses Pemesinan Nyahcas Elektrik (EDM), bahan kerja akan diperiksa kadar pembuangan bahan (MRR) dan penggunaan alat kadar (TWR) dengan mesin keseimbangan tepat digital.

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DEDICATION

For my beloved family:

Abdul Rahman Bin Hj Othman (father)

Maziah Binti Abdul Rahman (mother)

Syarfienaz Binti Abdul Rahman (sister)

Muhammad Najib Bin Abdul Rahman (brother)

And

BMFP's Students

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LIST OF ABBREVIATIONS

EDM	-	Electrical Discharge Machine
MRR	-	Material Removal Rate
TWR	-	Tool Wear Rate
RA	-	Surface Roughness
PMEDEM	-	Powder Mix Electric Discharge Machining

CHAPTER 1
INTRODUCTION

This chapter explains the background, the problem statement, objective, and the scope of the study.

1.1 Background

Electrical discharge machining (EDM) is a process where metal erosion heat produced for a series of repeated electrical discharge among the cutting tool serve as a conductive electrode and the workpiece, in presence of a dielectric fluid. This release happens in the gap voltage among the electrodes and the workpiece. The heat vaporizes the release of particles from the workpiece material, which is then washed from the gap with continuous flushing of dielectric fluid. Electrical Discharge Machining (EDM) is a machining process electrical conductive materials by using precisely controlled sparks that occurred between the electrode and the workpiece in the presence of dielectric fluid (Jameson, 2001).

Carbon Nanofibers has excellent mechanical properties such as high tensile strength and high elastic modulus, and thermal conductivity and high electrical. Research into the practical applications of carbon nanofibers has been actively pursued, and metal composite nanosized materials is promising new materials that offer innovative functions. According to (Jong et al., 2007) carbon nanofibers (CNFs) have been intensively investigated for various applications nanoelectronics because of their unusual properties, good stability and high aspect ratio. develop flat panel display, to a source of light and back light unit is as an example of the many efforts. carbon nanomaterials often have to cut, leveled, and illustrated patterns for wider use. This research will study on the feasibility of carbon nanofibres in the EDM process for cutting the conductive materials. The carbon nanofibers will be mixed into the oil during the process.

1.2 Problem statement

The electrical discharge machining (EDM) is one of the major manufacturing processes widely applied in die and mold making industry to generate deep and three-dimensional, requiring high precision, complex shapes and high surface finish. Traditional machining technique is often based on the material removal using tool material harder than the work material and is unable to machine them economically (F. L. Amorim, 2004).

Stainless steel is one of the hard materials. Normally for cutting hard material like stainless steel, milling machine with high speed steel tool or ceramic tools will be use (S.Thamizhmanii, 2011). Previously, electrical discharged machine (EDM) also has been used in the machining of stainless steel with no powder mixture. However, its machining efficiency is still considered low with poor surface finish (Singh Jaspreet, 2013). Therefore, in this study, carbon nanofiber assisted EDM on stainless steel is proposed in order to improve the EDM machinability of silicon carbide.

1.3 Objective

The objectives of this study are:

a) To study feasibility of carbon nanofibers in the electrical discharge machine (EDM) process for stainless steel.
b) To investigate the effect of carbon nanofibers on material removal rate, tool wear rate, spark gap and surface finish of stainless steel.

1.4 Scope

In this experiment, electrical discharged machine (EDM) die sinking was used to produce the hole at the workpiece. Material for workpiece was stainless steel and material for electrode was cooper. In this experiment, different concentration of carbon nanofiber were used to get the material removal rate (MRR) and tool wear rate (TWR), surface roughness for workpiece and the spark gap between workpiece and electrode. Carbon nanofiber was mixed in the dielectric fluid.

CHAPTER 2

LITERATURE REVIEW

Chapter 2 was presents the literature review on EDM die sinking and related subjects. It will give some to get the information about EDM die sinking. Journals research, books, printed or online conferencing products are the main source of guidance projects. This section will include the machining operation, parameters, advantages, application and others. Literature review section work as references, to provide information and guidance.

2.1 History

English scientists have discovered an EDM Machining early as the 1770s. Electrical Discharge Machining not take full advantage of until 1943 when Russia scientists study how the effects of erosion can be controlled and the technique used for machining. When it was originally observed by Joseph Priestly in 1770, EDM Machining was very imprecise and riddled with failures. In the mid 1980s, the EDM techniques were transferred to a machine tool. This migration more widely available and appealing over traditional machining processes made from EDM (Khairul, 2008).

2.2 Electrical discharge machine (EDM)

Electrical Discharge Machining (EDM) is a machining technique known for over fifty years. Now it is a non-traditional machining processes most widely used, especially for producing injection mold and die, for the large production of objects are very common.EDM also can produce with finished parts such as items with unique shapes cut and tools. A large number of industrial sites using EDM among them such as automotive, electronics, internal appliances, machinery, packaging, watches, aeronautics, toys and surgical instruments (L'obtention, 2006).

EDM is a thermal process in which the metal erosion produced by a series of repeated electrical discharges between the cutting tool acts as a conductive electrode and the work piece, in front of a dielectric fluid. This release occurs in the gap voltage between the electrodes and the work piece. The heat vaporizes the release of particles from the work piece material, which is then clean from the abyss with continuous flushing of dielectric fluid.

Electro Discharge Machining or EDM is a machining method normally used for hard metals or material that would be difficult to machine with conventional techniques. One serious limitation, which is EDM only can contact with materials that flow the electrically or conductive material. Electrical Discharge Machining (EDM) is particularly well-suited for cutting complex outlines or delicate cavities that would be hard to produce with a grinder, an end mill or other cutting tools. Metals that can be process with EDM include cast alloy, hardened tool-steel, titanium, carbide, inconel and kovar(Ghaffari, 2008).

EDM can also know as "spark machining" because it eliminates metal by creating a rapid series of repetitive electrical discharges. These electrical discharges are passed between an electrode and the part of metal that want to be machined. The small quantity of material that is eliminating from the work piece willflush away with a nonstop flowing fluid. The cycling discharges create a set of successively deeper craters in the work piece until the final shape is finish.

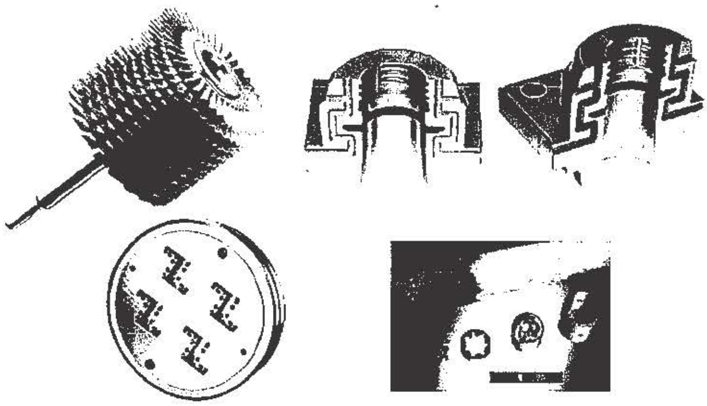

Figure 2.1 - Examples of parts machined with EDM: high speed turbine and mold for the screw thread of PET bottles, produced by die-sinking; die for manufacturing plastic cladding and micro-parts, produced by wire-cutting (Ghaffari, 2008).

2.2.1 Main type of EDM

a) Wire EDM

In wire-cut EDM, wire electrodes are continuously metal (diameter 0.1 mm common, generally brass, steel or copper), that cutting of the workpiece while in the program Deionized water was used as the dielectric, injected directly around the wire. The wire was able to achieve very small the cutting corners. Wearing was smaller problem than the death-bound, because the wire is continuously eroded replaced with a new one because the passage of wires (Kumar, 2010).

Where the electrode is copper wire coming from the spool and fed through the upper and lower diamond guides and then discarded after use. The wire is controlled by a CNC controler that allows you to program the path for the wires to travel together as a super precision saw band. Diameter size of wire from 0.0120 to 0.0008 inches.

This form of EDM is most accurate and is able to hold size well under 0.0001 inches.

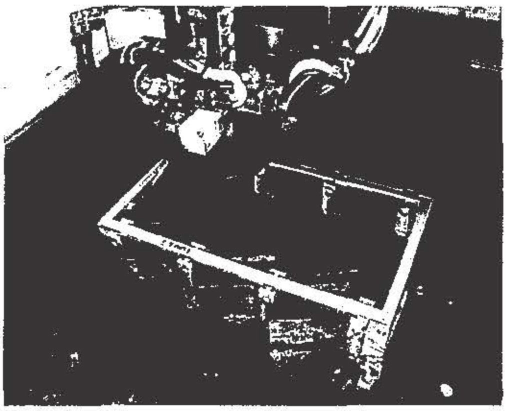

Figure 2.2 - Wire Cutting Process (Kumar, 2010).

b) Sinker EDM

In EDM bound to die, the electrodes are formed and will result in a negative into a workpiece. The wear has been very low; to keep the original shape is not modified electrode during the whole machining process. The asymmetry in the rate of material removal is thus important for the die-bound. The electrodes are generally in copper or graphite, and the dielectric is oil (Kumar, 2010).

Where the materials of electrode is machined shapes made from such as graphite, copper or copper tungsten and the machine use this form to erode the inverse of the workpiece. This process was also accurately and generally used to burn the mold cavity where the electrodes start of the final set and used to erode cavities in the mold which is then used to make thousands or even millions of parts.

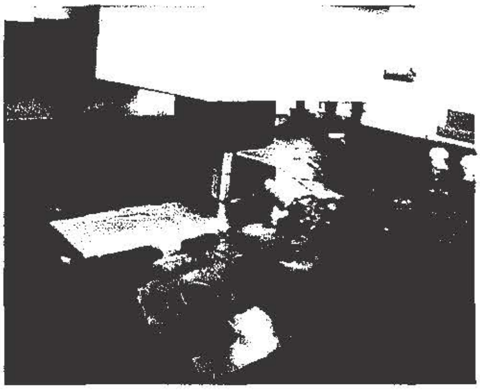

Figure 2.3 - Die Sinking Process (Kumar, 2010).

- Die-sinking EDM is mainly used to produce injection molds whereas the main application of wire-cutting EDM is the production of steel cutting dies and extrusion dies.

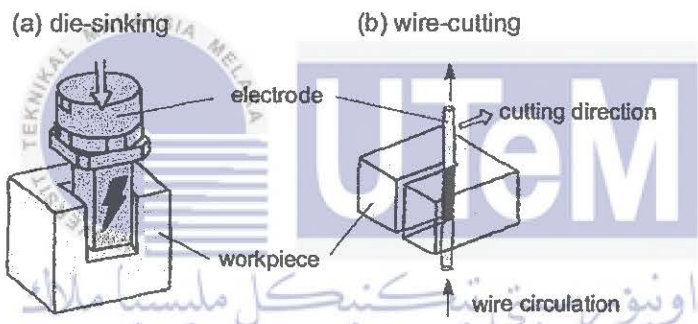

Figure 2.4 - Main Type of EDM: Die Sinking and Wire cutting (Kumar, 2010).

2.2.2 Principle of EDM

Thermal erosion is a corrosive effect of controlled electric spark discharge on the electrodes which is there are the principle of EDM. Sparks was created in a dielectric fluid, generally oil or water, between the electrode and the workpiece, which can be considered as a cutting tool. There is no mechanical contact between the electrode and the workpiece during the entire process. Since the erosion produced by the electric discharge, the two electrodes and the workpiece must be electrically conductive.

Therefore, machining process consists in continuously removing small amounts of material of the workpiece, melting or evaporating during discharge (L'obtention, 2006).

Figure 2.5 gives a simple explanation of the process of erosion caused by the release of a single EDM. First, the voltage applied between the electrodes. Ignition voltage is 200 V. The breakdown of dielectric is usually initiated by moving the electrode toward the work piece. This will increase the electric field in the gap, until it reaches the required value for the damage. Location fraction typically between the closest point electrode and the workpiece, but it also depends on the particles present in the gap. When a fault occurs, the voltage drops and rises during sudden. Attendance at possible at this stage, because the dielectric has been ionized and a plasma channel was created between the electrode.

Discharge current then maintained, guaranteeing constant bombardment of ions and electrons in the electrode. This will cause intense heating the workpiece material (but also the electrode material), quickly establishing small groups on the surface of molten metal. A small amount of vaporized metal can also be directly caused by heating. During discharge, plasma channel expands. Therefore, the radius of the molten metal pool increases with time. The distance between the electrode and the workpiece during discharge is an important parameter. It is estimated that about 10 to 100 μm (increasing gap with increasing discharge current).

At the end of the discharge, current and voltage are shut down. The plasma implodes under the pressure imposed by the surrounding dielectric. Consequently, the molten metal pool is strongly sucked up into the dielectric, leaving a small crater at the work piece surface (typically 1-500 μm in diameter, depending on the current).

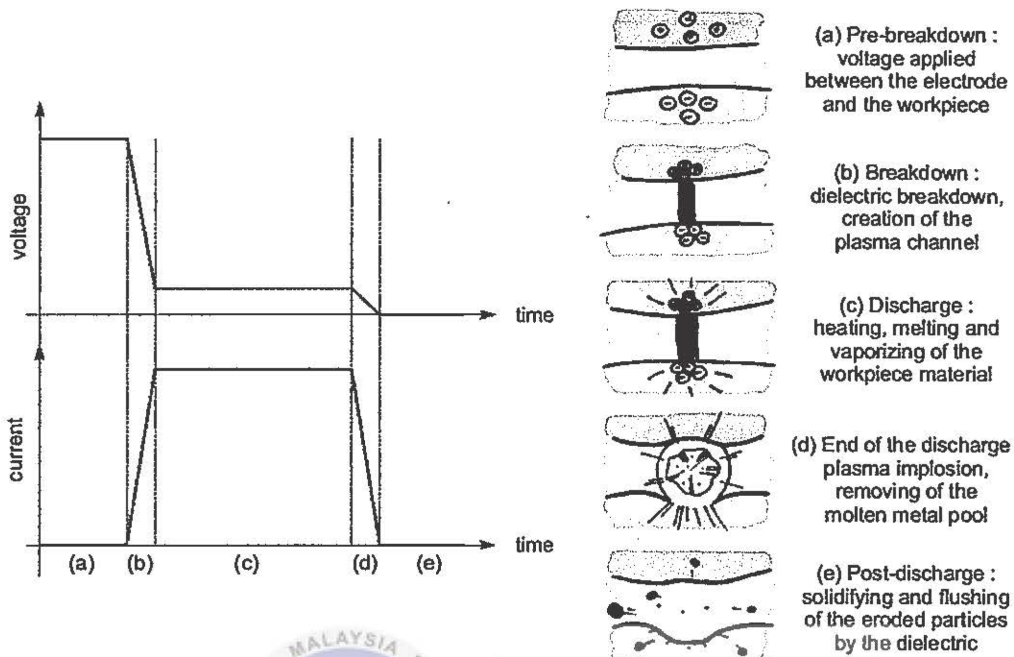

Figure 2.5 - Principle of EDM process (L'obtention, 2006).

Dielectric fluids play an important role in the whole process: it cools the electrode, it guarantees a high plasma pressure and the high energy producing molten metal when the plasma collapses, it reinforces the molten metal into small spherical particles, and it will also get rid of these particles . Post-release is actually a crucial stage, where the electrode gap is cleared of particles removed for the next release. If the particles stay in the gap, the electrical conductivity increased dielectric fluid, which leads to poor control of machining processes and the quality poor. To improve the flow of particles, the dielectric usually flows through the gap. In addition, the movement of the electrode can be pulsed, typically every second, carried out a great retreat. Pulsing movement also increases the cleaning, on a larger scale, by the dielectric "fresh" into the abyss.

Material removal rate can be asymmetrically distributed between the electrodes (wear) and a piece of work (erosion). Asymmetry is mostly due to the different of electrode material. But it also depends on the polarity of the electrodes, the discharge duration and time of discharge. Note that by convention, called the positive pole when the electrode