UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PROCESS OPTIMIZATION FOR DIE MANUFACTURE: EDM DIE SINKING

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

By

MOHD IRWAN BIN JAINUDIN
B051010074
890102-01-6239

FACULTY OF MANUFACTURING ENGINEERING

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I hereby, declared this report entitled “Process Optimization for Die Manufacture: EDM Die Sinking” is the results of my own research except as cited in references.

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Date	: 23rd June 2014

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) (Hons.). The supervisor is as follow:

………………………………

(Supervisor)

ABSTRAK

Pemesinan nyahcas elektrik (EDM) adalah salah satu proses pemesinan tidak tradisional berdasarkan tenaga termo-elektrik antara bahan kerja dan elektrod. Dalam proses ini, pembuangan bahan berlaku melalui satu siri bantuan elektro -termal antara elektrod dan bahan kerja. Prestasi proses ini, sebahagian besarnya , bergantung kepada bahan elektrod itu. Pemesinan nyahcas elektrik (EDM) adalah satu kaedah pemesinan yang paling popular untuk menghasilkan acuan kerana keupayaannya untuk menghasilkan bentuk-bentuk rumit dan memesin bahan-bahan keras . SKD11 merupakan bahan yang sangat biasa digunakan kerana ia tahan kakisan . Semasa membuat eksperimen bahan elektrod , arus dan masa nadi hidup diambil sebagai pembolehubah untuk kajian kadar pembuangan bahan dan kekasaran permukaan. Dua bahan elektrod yang berbeza kuprum dan tembaga telah digunakan. Dengan menggunakan kaedah Taguchi , Campuran Design L18 pelbagai ortogon telah dipilih dan tiga peringkat yang sepadan dengan setiap pembolehubah diambil. Eksperimen telah dijalankan sebagai satu set eksperimen direka dalam tatasusunan ortogon. Percubaan ini telah dianalisis dengan menggunakan perisian Minitab. Dari hasil analisis ini, elektrod merupakan parameter paling berpengaruh untuk kekasaran permukaan. Selain itu, arus merupakan pengaruh paling besar dalam menentukan kadar pembuangan bahan. Daripada analisis ini, persamaan mengoptimumkan untuk kedua-dua kekasaran permukaan dan kadar pembuangan bahan telah diperolehi.

ABSTRACT

Electrical Discharge Machining (EDM) is one of the Non-Traditional Machining processes, based on the thermo-electric energy between the workpiece and the electrode. In this process, material removal occurs by a series of electro-thermal relief between successive discrete electrode and the workpiece. The performance of the process, to a large extent, depends on the Electrode material. Electrical Discharge Machining (EDM) is a most popular machining method to manufacture dies, punches and press tools because of its capability to produce complicated, intricate shapes and to machine hard materials. SKD11 is a very commonly used material due to its property of resistant to corrosion. During experimentation, electrode material, current and pulse on time were taken as variables for the study of material removal rate and surface roughness. Two different electrode materials copper and brass were used. Using Taguchi method, Mixed Design L18 orthogonal array has been chosen and three levels corresponding to each of the variables are taken. Experiments have been performed as per the set of experiments designed in the orthogonal array. These experiments were analyzed by using Minitab software. From the result of analysis, electrodes were finding a most influent parameter for a surface roughness. Brass electrodes were found that give lower value than copper. Lowest value that gives while using Brass electrode is 1.53μm, which lower than using copper electrode that gives a value of 2.71μm. While current is the most influent parameter that affects the material removal rate. When current is 30A, its give more MRR than 10A and 18A. From this analysis also found the optimize equation for both surface roughness and material removal rate.

DEDICATION

Especially dedicated to my parent, brother, sister and also my friend.

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A special thanks to my supervisor, Dato' Prof. Dr. Abu b. Abdullah for this supervision in doing this project. I greatly appreciate his consistent encouragement, advice and invaluable guidance throughout the project.

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CHAPTER 1
INTRODUCTION

1.1 Background

Electrical discharge machining (EDM) is a non-traditional manufacturing process based on removing material from a part by means of a series of repeated electrical discharge between tools called the electrode on the part being machined in the presence of an electric fluid. At present, EDM is widespread technique used in industry for high precision machining of all types of conductive materials such as metals, metallic alloys, graphite, or even some ceramics material of any hardness (C.J. Luis et al.2005). In tool die and mould making industries, EDM is commonly used for machining heat treated tool steels materials.

EDM also manufacturing process based the erosion of metals sparks discharges. Shaped tool or known as electrode and the workpiece are the basics EDM system which connected to a DC power supply and place in a die electric. The sparks in this process erode away the electrode, thus changing its geometry and adversely affecting the shape produced and its dimensional accuracy. Tool (electrode) wear is thus an important factor which is related to the melting point of the electrode of the materials involved.

EDM has a high capability of machining the accurate cavities of dies and moulds. Nevertheless, electrode wear occurs during EDM process leading to a lack of machining accuracy in the geometry of workpiece. Furthermore, electrode wear imposes high costs on manufacturers to substitute the eroded complicated electrodes by new ones for die making. In order to increase the machining efficiency, erosion of the workpiece must be maximized and that of the electrode minimized in EDM process (H. Zarepour et al. 2007).

Normally, EDM is capable of machining geometrically complex or hard material component, that are precise and difficult to machine. These studies will investigate the performance of different electrode Materials on SKD11 workpiece with EDM process. The electrode materials were graphite, copper and Brass. The influences of some machining parameters such as pulsed current, pulse time, pulse pause time, voltage, dielectric liquid pressure and electrode material have been examined. This investigation will be done through a several experiments between electrode and workpiece to identify an effect of process parameter. The response factors that want to observe is more to surface roughness (Ra) and material removal rate (MRR).

1.2 Problem Statement

This study is focusing on following questions:

a) What is the most suitable electrode for machining of SKD11 material between Cooper and Brass electrode that gives best result of surface roughness using same parameter?
b) What is the machining parameters for each type of electrode (peak current and pulse-on time) that influence the surface roughness (R_a) and material removal rate (MRR)

1.3 Objectives

The objectives of this project are:

a) To investigate the most suitable electrode to machining SKD11 material between copper and brass electrode.
b) To study effect of surface roughness (Ra) and material removal rate (MRR) when using different type of electrode.
c) To study the parameter that will be optimized to get optimum result in surface roughness (Ra) and material removal rate (MRR)

1.4 Scope of Work

In order to get the best result, this experiment must be focused to the following issue:

i. Parameters to be studied include type of electrode, peak current and pulse on time (ON).
ii. Machining SKD11 material with using copper and brass electrode.
iii. Surface integrity need to be investigated includes surface roughness (Ra) and material removal rate (MRR).

CHAPTER 2
LITERATURE REVIEW

2.1 Machining

Machining is a material removal process in which a sharp cutting tool is used to mechanically cut away material so that the desired part geometry remains. The most common application: to shape metal parts. Machining is the most versatile and accurate of all manufacturing processes in its capability to produce a diversity of part geometries and geometric features. (M. P. Groover, 2002)

Machining is a term that covers a large collection of manufacturing processes designed to remove unwanted material, usually in the form of chips, from a workpiece. Machining is used to convert castings, forgings, or preformed blocks of metal into desired shapes, with size and finish specified to fulfil design requirements. Almost every manufactured product has components that require machining, often to great precision. Therefore, this collection of processes is one of the most important of the basic manufacturing processes because of the value added to the final product. By the same token, machining processes are often the most expensive. The majority of industrial applications of machining are in metals. Although the metal cutting process has resisted theoretical analysis because of its complexity, the application of these processes in the industrial world is widespread. Machining processes are performed on a wide variety of machine tools (J. T. Black, 1990).

Machining is a general term describing a group of processes that consist of the removal of material and modification of the surfaces of a workpiece after it has been produced by various methods, thus machining involves secondary and finishing operations (Kalpakjian et al., 2010).

According to El-Hofy (2005) harder, stronger and tougher material that frequently used in modern machining practice are more difficult to machine. In modern machining practice, harder, stronger, and tougher materials that are more difficult to cut are frequently used. Nowadays, directed toward the machining process in which the mechanical properties of the workpiece material does not impose any limitations on material removal process. In this case, nonconventional machining techniques came into practice as the possible alternatives in the machine, design complexity, surface integrity, and the need downsizing.

2.2 Traditional Machining

Machining remove certain parts of the workpiece to change them to the final shape. Traditional, also called conventional machining requires the presence of a more powerful tool from the workpiece to be machined. These tools have penetrated the workpiece to a certain depth. In addition, the relative motion between the tool and workpiece are responsible for shaping or generating the desired shape. Traditional machining can be classified according to the machining action of cutting (C) and mechanical abrasion (MA) as shown in Figure 2.1.

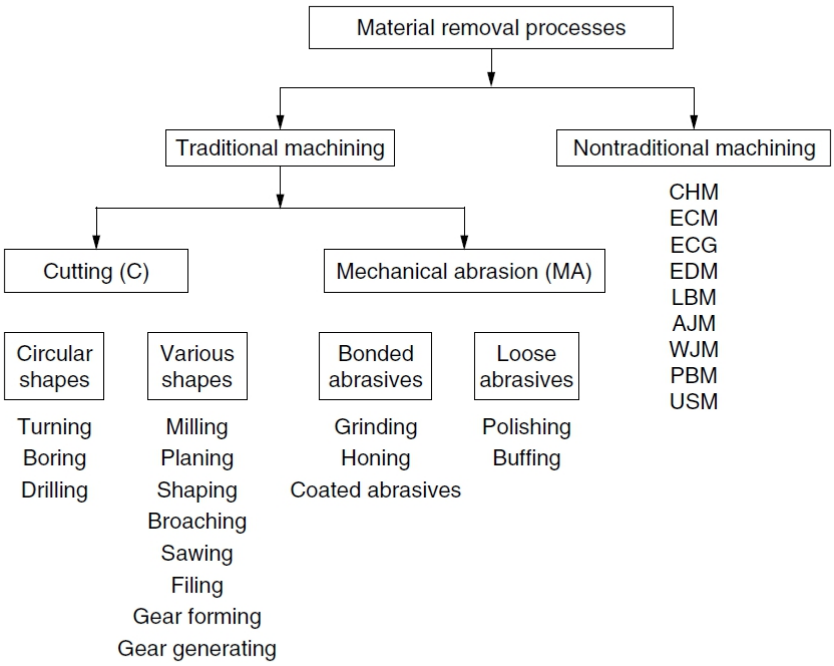

Figure 2.1: Material removal processes. (El-Hofy, 2005)

2.2.1 Machining by Cutting

According to El-Hofy (2005) during machining with cutting, this tool penetrates the workpiece to the cutting depth. A relative motion (main and feed) to determine the geometry of the workpiece is required. In this case, the change resulted in the cylinder, shaping and milling produces flat surface while drilling produce different diameter holes. Tools have the cutting edge geometry is known. Action to cut waste machining allowance in the form of chips, which can be seen with the naked eye. During machining with cutting, the workpiece shape can be produced by forming when the cutting tool has finished workpiece contour. A relative motion is required to produce the chip (main motion) in addition to the tool feed in depth as shown in Figure 2.2a.

The accuracy of the surface profile depends mostly on the accuracy of the form-cutting tool. Surfaces can also be produced by some of the recommendations to achieve the formation of the chip (main motion) and movement participation points along the surface (feed motion). Figure 2.2b provides a typical example of the generation of the cutting surface. Milling the slot, as shown in Figure 2.2c, adopt the shape and cut principles combined generation. (El-Hofy, 2005)

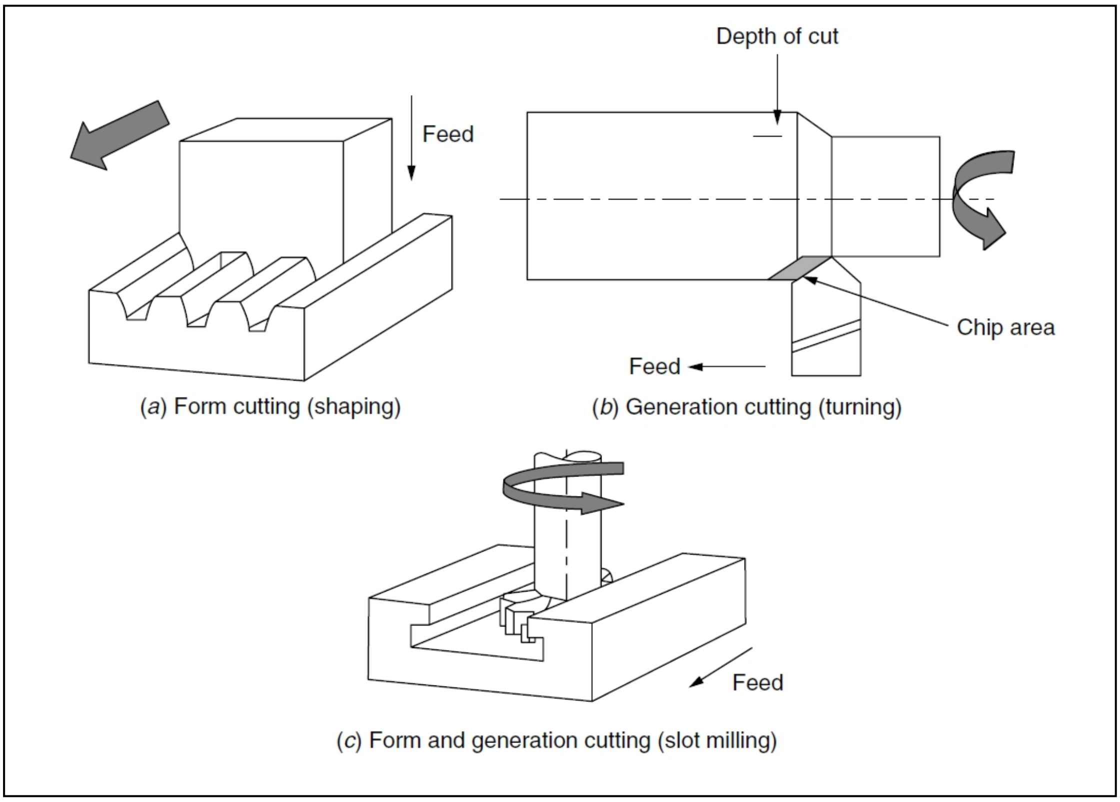

Figure 2.2: Metal cutting processes. (El-Hofy, 2005)

Durability of the workpiece for machining with cutting depends on the temperature generated in the machining zone. Highspeed Hot Machining now recognized as one of the leading manufacturing techniques with high production. As the temperature increases, the strength decreased while the increase in ductility. It is quite logical to assume that the high temperature will reduce cutting forces and energy consumption and increase in material cutting machine. Hot Machining has been working to improve the machinability of glass and ceramic engineering. (El-Hofy, 2005)

El-Kady et al. (1998) claimed that workpiece heating is intended not only to reduce the hardness of the material but also to change the chip formation mechanism from a discontinuous chip to a continuous one, which is accompanied by improvement of the surface finish. Todd and Copley (1997) built a laser-assisted prototype to improve the machinability of difficult-to-cut materials on traditional turning and milling centers. The laser beam was focused onto the workpiece material just above the machining zone. The laser-assisted turning reduced the cutting force and tool wear and improved the geometrical characteristics of the turned parts.

2.2.2 Machining by Abrasion

According to El-Hofy (2005) abrasive machining term usually describes a process in which the provisions issued by various machining hard, angular abrasive particles or grains (also called grits), which may or may not be tied to a definite geometric shape tool. In contrast to metal cutting, abrasive machining, cutting edge individuals are randomly oriented and the depth of involvement (undeformed chip thickness) is small and not equal for all coarse grains at the same time in contact with the workpiece. Cutting edge (abrasive) is used to remove small machining allowance MA action during the finishing process. The material is removed in the form of minute chips, which are invisible in most cases. The MA action is adopted during grinding, honing, and super finishing processes that employ either solid grinding wheels or sticks in the form of bonded abrasives (Figure 2.3a). Furthermore, in lapping, polishing, and buffing, loose abrasives are used as tools in a liquid machining media as shown in Figure 2.3b.

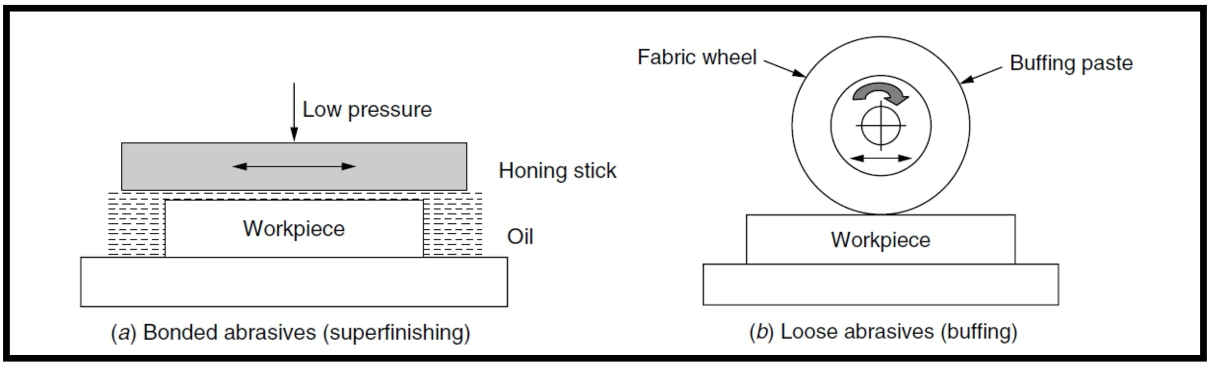

Figure 2.3: Abrasive machining. (El-Hofy, 2005)