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Dedicated to my beloved parents,

MOHD RAPI BIN ISMAIL

NORMAIZA BINTI ABDUL HALIM

My siblings,

My supervisor,

DR ZAMZURI BIN HAMEDON

And all staffs of Universiti Malaysia Pahang

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ABSTRACT

Electrical discharge machining (EDM) is extremely being used in manufacture of aerospace and automotive parts, also used in development of dies and molds by machining and cut the materials that are strong and hard, which impossible to be machined by traditional machining techniques. However, the main problem of EDM is electrode wear which is mainly caused by debris. In this present study, three types of electrode designs were developed for comparison. The electrode with magnet is used to pull the debris and avoid it from accumulates at the bottom of machined area. Holes also being made at the electrode to improve the flows of debris so that it can be pulled straight away to the magnet inside the electrode. Video measuring system will helps in viewing the zoomed image of electrode so that the wear can be see clearer. Also, electronic balance is used to weigh the weight of electrode to know the amount of electrode wear. Finding from this project show that the electrode with magnet and holes will be more helpful in minimizing the wear of the EDM electrode compared to others.

ABSTRAK

Pelepasan elektrik pemesinan (EDM) sangat digunakan dalam pembuatan bahagian aeroangkasa dan automotif, juga digunakan dalam pembangunan acuan dengan pemesinan dan memotong bahan-bahan yang kuat dan keras, yang mustahil untuk dimesin oleh teknik pemesinan tradisional. Walau bagaimanapun, masalah utama EDM adalah memakai elektrod yang sebahagian besarnya disebabkan oleh serpihan. Dalam kajian ini, tiga jenis reka bentuk elektrod akan digunakan untuk perbandingan. Elektrod dengan magnet digunakan untuk menarik serpihan dan mengelakkan dari berkumpul di bahagian bawah kawasan dimesin. Lubang juga dibuat pada elektrod untuk meningkatkan aliran serpihan supaya ia boleh ditarik terus untuk magnet dalam elektrod. Sistem pengukuran video dapat membantu dalam melihat imej elektrod yang dizum supaya elektrod boleh melihat lebih jelas. Juga, penimbang berat elektronik digunakan untuk menimbang berat elektrod bagi mengetahui jumlah haus elektrod. Apa yang diperolehi daripada projek ini menunjukkan bahawa elektrod dengan magnet dan lubang akan lebih membantu dalam mengurangkan haus elektrod EDM berbanding dengan jenis elektrod yang lain.

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LIST OF SYMBOLS

mm	Millimetre
%	percentage
°C	Degree Celsius
g	gram
K	kelvin
μm	Micrometre

LIST OF ABBREVIATIONS

EDM	Electrical Discharge Machining
VMS	Video measuring system
EWR	Electrode wear ratio
CNC	computer numerical control
MRR	material removal rate
FCC	face-centred cubic

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Electrical discharge machining (EDM) is a non-conventional process for the production of difficult and hard material workpiece that are problematic to machine by conventional machining processes (Kechagias et al., 2008). A chemist from England, Joseph Priestly, discovered the sparks of electrical discharge are able to caused erosive phenomenon. Then, in 1943, two of Russian scientists were invented the EDM process. At 1980, a computer numerical controlled (CNC) electrical discharge machine has been announced in USA (Choundhary & Jadoun, 2014).

EDM also extremely being used in manufacture of aerospace and automotive parts, also used in development of dies and molds (Kechagias et al., 2008). Electrical discharge machining is widely used to machine and cut materials that are tough, strong and hard, which impossible to be machined by traditional machining techniques. Nevertheless, by discharging of controlled sparks at a small gap between the electrode and workpiece (spark gap), the workpiece material being detached through melting and evaporation processes (Pham et al., 2006).

Besides, that different variation of EDM processes can be categorized regarding to the use of dielectric fluids (Leao & Pashby, 2004). Besides, Hydrocarbon oils, such as kerosene or paraffin, are typically being used in die sinking EDM, while deionized water is applied in wire cut and drilling EDM processes as the conductive dielectric mediums. The functions of dielectric fluid is to wash away the remains of material, known as debris, from the spark gap, and

also as a coolant which lower and maintain the temperature of both materials (Prasanna & Husain, 2016).

On the other hand, the range temperature of the plasma channel at the gap of electrode and workpiece is from 8000°C till 10000°C (Santos et al., 2016). Because of the high temperature of electrical sparks, materials that being eroded not just only workpiece, but also the electrode itself. So, the phenomenon of electrode wear is happened and many of research studies have been done by people around the world in order to find ways to improve and reduce wear of electrode.

Eliminating all electrode wears are difficult and quite impossible due to the thermoelectric process which has very high temperature of electrical discharge sparks. Moreover, wear of electrode will rise proportionally to the path of tool electrode and causing in shape changes and inaccuracies (Song et al., 2013).

As to this, research study is done to develop an EDM machine with magnetic field assist to reduce and lower the electrode wear in for machine hard conductive material.

1.2 PROBLEM STATEMENT

In manufacturing sector, there are some factors that have to give attention as important matters, for examples quality, economy and product efficiency. Electrode wear will gives effects to these three main things of the manufacturing industry companies. This is because when electrode wear occurs, the quality of the electrode is not good as before the wear occurs. There will change in shape and size of the electrodes, leading to not efficiency and low quality of products being made. There will be loss to the companies if their customers are not satisfy with their jobs and then reject the product. Besides, if they decide to solve the problem by making new electrodes, it will also costs them lots of money and time for complicated electrode designs.

So, improvement and ways to solve the problem of electrode wear must be done. Actually there were lots of research studies just to reduce wear of electrode in electrical discharge machining (EDM). Based on the previous researches, they still not able to eliminate completely the wear of electrode problem. This is because the wear of electrode occurs due to high temperature of electrical discharge. Other than that, debris also be one of the factors electrode wear to happen.

Debris is the remains of the removal workpiece material that produced in bottom gap between workpiece and electrode. The presence of debris can drastically lower the dielectric fluid breakdown strength (Jia, 2011). As the space is narrow, lots of debris is produced and it is hard to be removed. Debris also can cause increasing of process time as the machine will still try to remove material and attempts to make sure the gap clean and clear. The machining process efficiency and accuracy will be effected if the debris is not being removed in time.

Basically, the accumulation of debris can be cleaned and removed from the spark gap by flushing process (S. F. Miller et al, 2005). Flushing removes debris by blowing the EDM fluid to the workpiece machining area. Other than that, flushing allows the increase of material removal rate (MRR). Unfortunately, the limitation is not all debris being cleared. There still has debris left especially at the bottom of machining area and this will affect the machining efficiency and accuracy of EDM. The inactive pulses such as short circuit will occur because of the remained debris (Teimouri & Baseri, 2012).

This research study focused on improving EDM electrode performance using magnet support at copper electrode.

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