NATIONAL TECHNICAL UNIVERSITY COLLEGE OF MALAYSIA

Study of Sharp Corner in Wire - EDM

Thesis submitted in accordance with the requirements of the National Technical University College of Malaysia for the Degree of Bachelor of Engineering (Honours) Manufacturing (Process)

By

Nidzwan Bin Nosbi

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November 2005

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JUDUL: **Study of Sharp Corner in Wire EDM**

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TAJUK: STUDY OF SHARP CORNER IN WIRE EDM

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DECLARATION

I hereby, declare this thesis entitled "Study of Sharp Corner In Wire - EDM" is the results of my own research except as cited in the reference.

Signature	:	
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APPROVAL

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ABSTRACT

EDM is Electrical Discharge Machining, a process by which metal is removed by electrical energy. A spark is discharge from an electrode and vaporizing the metal. In reality, EDM is a very precise method of machining, and is used when a metal is too hard or tough to be machine conventionally. A wire-cut EDM system is composed of a power supply, wire electrode, a dielectric coolant and other ancillary equipment where the technology is rapidly improved.

In order to create an accurate dimension, a proper alignment and consideration must be taken seriously so that the final result can be obtained. Due to the title of the thesis which is "**Study of Sharp Corner in Wire EDM**" a study and experiment regarding to the title must be carried out so that the factor that is affecting the corner accuracy can be determines and analyze.

ABSTRAK

EDM atau Electrical Discharge Machining, adalah proses dimana logam/besi dipotong dengan bantuan kuasa elektrik. Cetusan api yang dihasilkan daripada electrode akan mencairkan logam tersebut. Dalam penggunaannya sekarang, EDM adalah satu teknik jitu dan terbaik dalam pemesinan dimana material logam keras tidak dapat dimesin menggunakan mesin convensional lain. Dalam Wire-EDM pula, sistem yang terlibat adalah seperti bekalan kuasa, Elektrod wayar, cecair penyejuk dan alaltan lain yang terlibat dan perkembangan teknologi ini semakin berkembang dari semasa ke semasa.

Dalam memenuhi kejituan dan ketepatan, beberapa aspek tertentu mesti diambil kira supaya hasilnya dapat diterima. Oleh yang demikian, dalam tajuk "**Study of Sharp Corner in Wire EDM**" pengkajian terpeinci berkaitan factor yang terlibat dalam sudut tajam akan dilakukan dan dianalisisEDM is Electrical Discharge Machining, a process

DEDICATION

For My family:

Mr. Nosbi Bin Abdul Muttalib,

Mrs. Norhayati Bin Aznan,

Norlin bintiNosbi

And

Nazirah Binti Nosbi

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In the name of **Allah S.W.T** the all mighty god, I would like to express my gratefulness because of giving me the opportunity to complete my studies and my final year's thesis. Alhamdulillah, with much guidance and support I manage to complete the thesis and without HIM, I would not have the confidence and strength in order to overcome the obstacle during completing the thesis.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

DC	-	D*irect current*
EDM	-	Electrical Discharge Machine
RPM	-	Revolution per Minute
Vs	-	Versus.
mm	-	Millimeters
in @ "	-	Inch
S	-	Corner Radius
R	-	Radius
Psi	-	Pound Square Inch
µm	-	Micron meter
Ra	-	Surface roughness
F	-	Ferrenheight
°	-	Degree Centigrade.
Π	-	Pai = 3.142.
θ	-	Angle Degree in Radian.

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CHAPTER 1
INTRODUCTION

1.1 EDM: Principles of Operation

EDM or electrical discharge machining was first introduced as a device to cut or split a broken machining tool. Since than, it had become a very useful device with the help of high technology in order to make a revolutionizing tool, mold and other difficult part that need a proper accuracy and precision in dimension. EDM is actually a system comprising two major components, which are a machine tool and a power supply. The machine tool holds a shaped electrode, which advances into the work piece and produces a shaped cavity. The power supply produces a high frequency series of electrical spark discharges between the electrode and the work piece, which removes metal from the work piece by thermal erosion or vaporization until we get the desired pattern. The basic components of an EDM system are illustrated below.

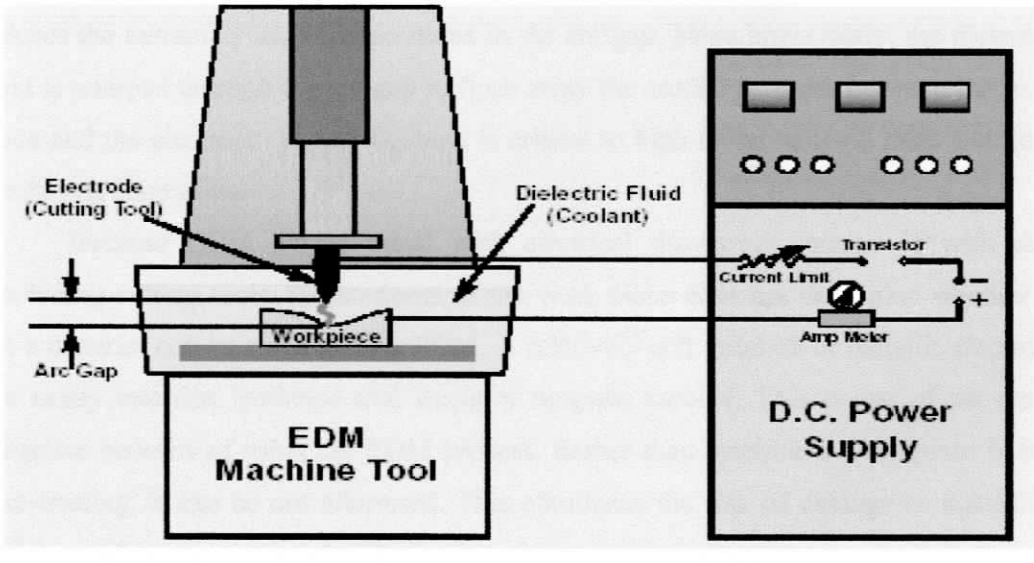

Figure 1.1 (a): Show an illustration of EDM Machine component.

The work piece is mounted on the table of the machine tool and the electrode is attached to the ram of the machine. A DC servo unit or hydraulic cylinder moves the ram (and electrode) in a vertical motion and maintains proper position of the electrode in relation to the work piece. The positioning is controlled automatically and with extreme accuracy by the servo system and power supply. During normal operation the electrode never touches the work piece, but is separated by a small spark gap.

During operation, the ram moves the electrode toward the work piece until the space between them is such that the voltage in the gap can ionize the dielectric fluid and allows an electrical discharge (spark) to pass from the electrode to the work piece. These spark discharges are pulsed on and off at a high frequency cycle and can repeat 250,000 times per second. The spark discharge (arc) always travels the shortest distance across the narrowest gap to the nearest or highest point on the work piece. The amount of material removed from the work piece with each pulse is directly proportional to the energy it contains. Each discharge melts or vaporizes a small area of the work piece surface. This molten metal is then cooled in the dielectric fluid and solidifies into a small spherical particle (swarf), which is flushed away by pressure/motion of the dielectric.

The impact of each pulse is confined to a very localized area, the location of which is determined by the form and position of the electrode. Both the work piece and electrode are submerged in a dielectric fluid, which acts as an electrical insulator to help control the spark discharges.

In EDM, the dielectric fluid also performs the function of a coolant medium and reduces the extremely high temperatures in the arc gap. More importantly, the dielectric fluid is pumped through the arc gap to flush away the eroded particles between the work piece and the electrode. Proper flushing is critical to high metal removal rates and good machining conditions.

Because EDM erodes metal with electrical discharges instead of with chip machining cutting tools, the hardness of the work piece does not determine whether or not a material can be machined by EDM. A relatively soft graphite or metallic electrode can easily machine hardened tool steels or tungsten carbide. This is one of the many attractive benefits of using the EDM process. Rather than machine a work piece before heat-treating, it can be cut afterward. This eliminates the risk of damage or distortion, which could scrap an expensive work piece during heat-treating.

1.2 Wire EDM

EDM wire cutting uses a metallic wire to cut a programmed contour in a work piece. Extrusion dies and blanking punches are very often machined by wire cutting. Cutting is always through the entire work piece. To start machining, it is first necessary to drill a hole in the work piece or start from the edge of the work piece. On the machining area, each discharge creates a crater in the work piece and an impact on the tool. The wire can be inclined, thus making it possible to make parts with taper or with different profiles at the top and bottom. There is never any mechanical contact between the electrode and work piece.

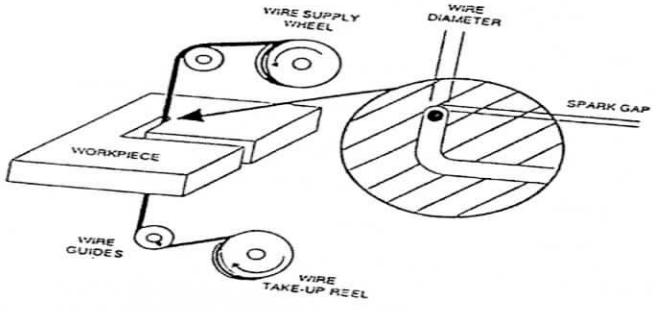

Figure 1.2 (a): Show a basic principal of Wire EDM process.

The wire is usually made of brass or stratified copper, and is between 0.1 and 0.3 mm diameter. Depending on the accuracy and surface finish needed a part will either be one cut or it will be roughed and skimmed. On a one cut the wire ideally passes through a solid part and drops a slug or scrap piece when it is done. This will give adequate accuracy for some jobs but most of the time skimming is necessary. A skim cut is where the wire is passed back over the roughed surface again with a lower power setting and low-pressure flush. There can be from one to nine skim passes depending on the accuracy and surface finish required. Usually there are just two skim passes. A skim pass can remove as much as 0.002" of material or as little as 0.0001".

During roughing (the first cut) the water is forced into the cut at high pressure in order to provide plenty of cooling and eliminate eroded particles as fast as possible. During skimming (accuracy / finish cuts) the water is gently flowed over the burn so as not to deflect the wire.

So it is clear that the basic principles of wire-cut EDM are essentially the same as die sinking EDM, which described above. The major difference is that instead of using an electrode with a complex shape, in wire EDM the electrode is a simple wire, which follows a vertical path through the work piece. Instead of using dielectric oil as in die-sinking EDM, wire EDM uses deionizer water. So in the thesis, I will be studying the factor that affecting the sharp corner in wire EDM process

Figure 1.2 (b): Show a sample of Wire EDM Machine

1.3 Thesis Scope

The title of the thesis is, **Study of Sharp Corner in Wire EDM.** So, for the thesis scope, the studies will determine the effect of various factors in order to get a desired corner, which is accurate in dimension, surface quality.

The scope for the first thesis is to study the factors which effect the corner radius and for the second thesis, it will concentrate on the study and perform an experiment of the stated factor regarding to the surface roughness, cutting speed and parameter that must set in order to get the best corner in Wire EDM machining.

1.4 Objectives of the Thesis

In order to complete the Final Year Thesis, there are some objectives that must be accomplish.

1. Study the basic principle of the Wire EDM operation.
2. Study the factor the usually effect the corner of the cutting work peace.
3. Experimental work in order to get the sharp corner defect
4. Continue the experiment using different variable at the machine such as wire speed and wire tension.
5. Study and measure the surface roughness and accurate dimension of the experiment specimen
6. Determine the suitable parameter that must be set in order to get the accurate dimension and good surface roughness.

1.5 Problem Statement

In order to produce an accurate result regarding to the sharp corner in wire cut, there are several problem that encounter during the cutting process such as: -