IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X
PP. 72-77
www.iosrjournals.org

A Review on - Experimental Investigation of Process Parameters in EDM Process

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Abstract: *Electrical discharge machining(EDM) is one of the nontraditional machining process based on thermo electric energy between the work piece and an electrode. In this process the material removal is occurred electro thermally by a series of successive discrete discharge between electrode and work piece. This paper presents a review of research work carried out for Aluminum material worked on Die sink EDM in Powder mixed EDM, EDM in water and Micro EDM..The input parameters consider are current, Pulse on time and Pulse off time whereas output parameters related to surface roughness, material removal rate, and tool wear rate.*

Keywords:*Material removal rate, Tool wear rate, Surface roughness.*

I. INTRODUCTION

Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. EDM is mainly used to machine difficult to- machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive. EDM Machining process is a non traditional method to produce any types of cavity in the any type of material. Using the different tool material, the performance of EDM can be improved

II. Principle Of Edm

The work piece and electrode are separated by a gap, called spark gap(0.005 to 0.05mm) and a suitable dielectric slurry which is non-conductor of electricity, is forced through this gap at a pressure of about 2kgf/cm2.When a proper voltage is applied the dielectric breaks down and electrons are emitted from cathode and the gap is ionized Avalanche of electrons takes place with collection of more electrons in the gap consequently the resistance drops causing electric spark to jump between the work piece and the tool Each electric discharge causes a focused stream of electrons to move with a very high velocity from the cathode towards anode and their collision with the consequently develop local rise in temperature the tune of 100000C sufficient enough to melt a part of the work piece metal.

- ***Types Of Edm***

Basically, there are two different types of EDM:

1) Die-sinking
2) wire-cut.

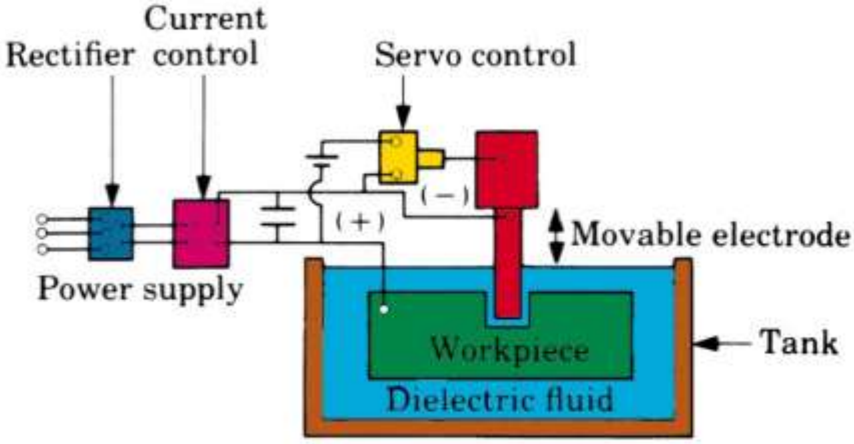

Fig1. PRINCIPLE OF EDM

1) Die-Sinking Edm

In the Die sink EDM, two metal parts submerged in an insulating liquid are connected to a source of current which is switched on and off automatically depending on the parameters set on the controller. When the current is switched on, an electric tension is created between the two metal parts. If the two parts are brought together to within a fraction of an inch, the electrical tension is discharged and a spark jumps across. Where it strikes, the metal is heated up so much that it melts. Sinker EDM, also called cavity type EDM or volume EDM consists of an electrode and work piece submerged in an insulating liquid such as, more typically, oil or, less frequently, other dielectric fluids. The electrode and work piece are connected to a suitable power supply. The power supply generates an electrical potential between the two parts. As the electrode approaches the work piece, dielectric breakdown occurs in the fluid, forming a plasma channel, and a small spark jumps.

2) WIRE-CUT EDM

Such type of EDM sometimes called travelling wire EDM. Electrical discharge wire cutting is a process that is similar in configuration to band swing except in the case of WEDM the saw is a wire electrode of small diameter Material removal is affected as a result of spark erosion as the wire electrode is fed through the work piece In most cases, horizontal movement of the worktable, is controlled by CNC Wire-cutting EDM is commonly used when low residual stresses are desired, because it does not require high cutting forces for removal of material. If the energy/power per pulse is relatively low (as in finishing operations), little change in the mechanical properties of a material is expected due to these low residual stresses, although material that hasn't been stress-relieved can distort in the machining process. Due to the inherent properties of the process, wire EDM can easily machine complex parts and precision components out of hard conductive materials.

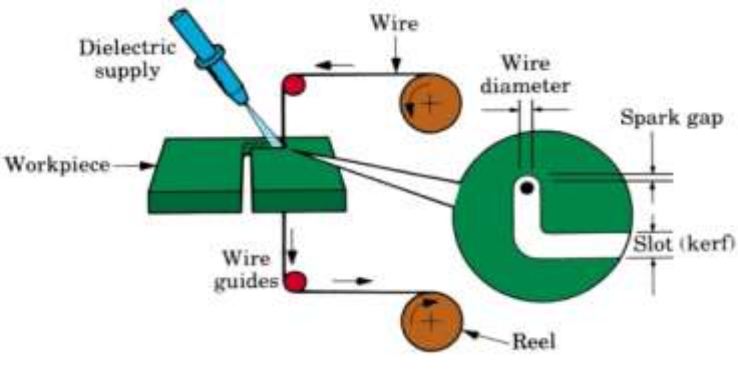

Fig.2 Wire Cut EDM

II. INDENTATIONS AND EQUATIONS (METHODOLOGY)

Methodology involves experimentation work carried out.

1) Selection of Tool and Work piece Material.

Owing to the increased development in the field of EDM processes, it has now become essential to figure the best tool for higher Material Removal Rate, Lower Tool Wear Rate and improved Surface Finish. Keeping in mind the following and analyzing the various tool materials taken for experimentation, we have selected the following.

Table 1 Tool and Work piece materials

Three tool Materials	Two work piece material
1. Aluminum (Al Alloy)	1.Aluminum 7075 T6
2. Brass (FC Brass)	2.Aluminum 359
3. Copper (Cu Alloy)	

- **Calculating the Material Removal Rate (MRR)**

Material Removal Rate is always intended to be higher for efficient machining of the work pieces. Where, weight in gm, time in minutes and density in gm/cc.

$$MRR = \frac{(\text{weight before machining}) - (\text{weight after machining})}{(\text{Time duration}) * (\text{Material density})} \quad \ldots\ldots\ldots (1)$$

- **Calculating Tool Wear Rate (TWR)**

Tool Wear Rate is always intended to be lower for reduction in tool replacement costs

$$TWR = \frac{\text{weight before machining} - \text{weight after}}{\text{Time duration}} \quad \ldots\ldots\ldots\ldots (2)$$

IV. Figures and Tables

The following figure shows the experiment carried out on the aluminum work piece

Fig.3.Machined Aluminium Workpiece

Table 2. Experimental values

Sr.No	Current (A)	Pulse ON time(µs)	Pulse OFF time(µs)	MRR (mm3/min)	TWR (mm3/min)	Ra (µm)
1	10	11	5	3.754	0.13	4.329
2	10	55	7	10.451	0.178	4.329
3	10	95	9	15.006	0.244	4.329
4	18	11	7	21.256	0.147	4.329
5	18	55	5	32.412	0.274	10.928
6	18	95	9	35.43	0.323	8.484
7	26	11	9	25.452	0.24	4.588

Table 3 Literature Reviews

Name of author	Year	Material		Input parameters	Output parameters	Findings
		TOOL	**W/P**			
Sushil Kumar Choudhary	March 2014	copper	Alum**in um**	Polarity, discharge, voltage, Gap Voltage, Peak Current, Average Current, Pulse on Time, Pulse off time, Pulse Frequency.	MRR,SR	Vibration, rotary and vibro-rotary mechanism makes the equipment simple and increases the material removal rate, provide better surface finish ejection from work piece. Better circulation of dielectric fluid and debris removal from work piece**.**
Daniel M. Madyira	July 2015	Brass	aluminu m	Pulse on Time, Pulse off time,	MRR,SR	To determine the fracture toughness of 7075-T6511 aluminum alloy this had been pre-cracked using WEDM**.** In addition, the effect of the WEDM process on the micro structure of the material is also evaluated.
Andrea Gatto, Elena Bassoli and Luca Iuliano	2010	Steel	Aluminu m	Pulse on Time, Pulse off time,	MRR,SR	The performance of HSM and EDM on aeronautical Aluminum alloys 7050, 7075 and 2219 are studied, with the aim to provide technological know-how for moulds production. In both cases the machining performance is evaluated in specific tests through a multistage approach: measurements of the macroscopic process outputs are merged with the investigation of mechanisms at a microscopic level.
NurSherilLok eBintiIzwan, ZhujianFeng, JigarBimalPat el, and Wayne Nguyen Hung*	2015	Steel	Brass	Pulse on Time, Pulse off time,	MRR,SR	This study investigates the material removal rate (MRR) in die sinking electrical discharge machining. (EDM). Hollow electrode for effective flushing was used on four different engineering alloys: aluminum, brass, high strength steel and high strength low alloy steel.
Dr. SumathyMuni amuthu	April - 2017	Copper	Aluminu m	Pulse on Time, Pulse off time,	MRR,SR	After reviewing the papers in relative to the metal matrix composite machining EDM with respect to the input process parameters, it is concluded that the metal removal rate and the tool wear rate increases with the decrease in the weight percentage of the additional material, or with the increase in the discharge current intensity and the pulse ON time.

ShivaniYadav Manoj Kumar Gaur	May 2016	Copper	Aluminum	Pulse on Time, Pulse off time,	MRR,SR	From the past researches the optimization of EDM mainly considered with the effect on MRR and TWR. These factors not only control the noise factors during experimentation but also affect the productivity of any small scale as well as large scale firms.
Lijo Paula, LibiKoraha	2016	Copper	Aluminum	Electrode	Electrolyte	The tool life also improved with cooling in pulse DC. The heat affected zone in pulse DC lower than DC, due to short pulse duration, with intermittent cooling than DC.
Wang Yuangang, Zhao Fulinga,	Sep - 2008	Copper	Aluminum	Pulse Supply	Voltage	A wear-resist electrode for micro-EDM has been theoretically analyzed and experimentally investigated. The results prove that Cu-ZrB2 composite coating electrodes have better corrosion resistance than pure copper electrodes.
RyotaToshimitsua, Akira Okadaa,, RyojiKitadab and Yasuhiro Okamotoa	2016	Chromium Powder	Aluminum	Discharge Current – 1.6A, Voltage-90V	Spark Corrosion	Chromium containing layer can be formed on the EDM finished surface by using a chromium powder mixed fluid. Small surface roughness can be obtained by EDM finishing in CrPMF when the stirring of CrPMF is sufficient.
Macedoa F. T. B.*, Wiessnera M., Hollenstein C., Kustera F., Wegenera K.	2016	Copper	Aluminum	Voltage, Current, Pulse Duration, Electric field	Spark Discharge	Plasma of discharges in air is mostly composed of Cu species from the electrodes due to the vacuum breakdown Mechanism. The dimensions of the plasma are restricted to the tool electrode borders and its interaction with the work piece tends to be concentrated in small spots, generating relatively large craters not very spread over the surface.

III. Conclusion

After studying all the research papers we have found that, the Vibration, rotary and vibro-rotary mechanism makes the equipment simple and increases the material removal rate, provide better surface finish ejection from work piece. Better circulation of dielectric fluid and debris removal from work piece. And the optimization of EDM mainly considered with the effect on MRR and TWR. These factors not only control the noise factors during experimentation but also affect the productivity of any small scale as well as large scale firms. The tool life also improved with cooling in pulse DC. The heat affected zone in pulse DC lower than DC, due to short pulse duration, with intermittent cooling than DC. And also to determine the fracture toughness of 7075-T6511 aluminum alloy which had before-cracked using WEDM. In addition, the effect of the WEDM process on the microstructure of the material is also evaluated.

IV. Acknowledgements

It is our proud privilege and duty to acknowledge the kind of help and guidance received from several people in preparation of this review paper. It would not have been possible to prepare this report in this form without their valuable help, cooperation and guidance. We express sincere gratitude to our guide, Prof M.U Gaikwad, Assistant Professor- Department of Mechanical Engineering, JSPM, NTC, Pune for guiding us for this review paper and in carrying out experimental work. The numerous discussions with him were extremely helpful. Last but not the least, we wish to thank our parents for constantly encouraging us and for providing support.

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