

## A Review on Electrical Discharge Machining Tool

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### Abstract

Electrical discharge machining (EDM) is a process under which giving different shapes to hard metal, hole and simultaneously forming. The objectives of this paper work to investigate of various reviews of authors which works on behave during operation with different types of tool material and also investigate influences. This paper elaborates about the manufacturing condition aspects to take into consideration in the majority of process and particularly in process related to Electrical Discharge Machine (EDM). There are the conditions that determine important characteristics such as material removal rate, Electrode wear. By means of the improvement and growths in new machineries, low weight & high strength, high hardness and temperature resistant materials have been advanced for distinctive applications which include aerospace, medical, automobile and more. In the machining of hard and metal matrix composite materials, outdated manufacturing processes are being more and more changed by more non-traditional machining processes which include Electrical Discharge Machining (EDM). This paper provides an important review on different types of EDM processes, elements and parameters of EDM, Also it provides a brief discussion on dielectric fluid and find the effect of influences of process parameter on response and percentage contribution of each factor is determined.

**Key words:** EDM, Electric Discharge Machining, WEDM, TWR and MRR.

**Keywords:** RCA, NCA, Steel, Strength

### 1. Introduction

Electrical discharge machining (EDM) is used to get the desired shape by means of electrical discharge operations. Material removal process has completed due to current discharge between two electrodes.[1,2] In this action dielectric liquid and electric voltage play very important role. As we know that electrical discharge machining operations come under non-conventional machining techniques.[11,13,15] It is mostly used for machining operations on hard metals and for multipart operations,

which are nearly difficult with outdated techniques. [3] The EDM process is remove unwanted material in the form of remains and produce shape of the tool surface as of a metal piece via an electrical eviction trapped between tool and work piece i.e. (cathode and work piece)[3,20] in presence of dielectric fluid. In these machining process tool is attached to negative so it called cathode (polarized electrical device) and work piece is called the anode, because, it is attached to positive. Dielectric fluids are kerosene, transformer oil, distilled water, may be filled.[12,22]

**Types of EDM :** Die-sinking EDM process[13,20]

This process was founded by two Russian scientists, B. R. Butinzy and N. I. Lazarenko in 1943 to find the ways of preventing the erosion of tungsten electrical contacts due to sparking.[3,9] So many times, they were unsuccessful in this task but they found that the erosion was more precisely controlled if the electrodes were immersed in a dielectric fluid[6]. This led them to invent an EDM machine used for working difficult-to-machine materials such as tungsten.

Fig.1 shows mechanism of Die Sinker EDM In this process two electrodes are fitted on their places on the machine parts which is work bench and the tool holder. Both the electrodes must be the electrically conductive. After that both the electrodes are immersed in an insulating liquid dielectric with the help of the pump. The dielectric fluid is the EDM oil/ kerosene / transformer oil[12,22]. Then set the machining parameters on the CNC controller for machining on the work piece to get required shape and the size[20].

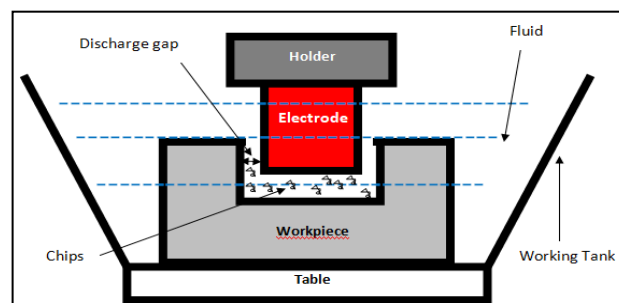


Figure. 1: Mechanism of Die-Sinker EDM[15]

### Wire EDM Process

The wire-cut kind of machine founded in the 1960s for the purpose of making tools (dies) from hardened steel.[3] In this process the tool electrode in form of wire. To avoid the erosion of material from the wire causing it to break, the wire is wound between two spools so that the active part of the wire is constantly changing[9,15,20] Fig.2 shows mechanism of wire EDM. The wire cut EDM process also called electric discharge wire cutting process. It is used for the producing two or three dimensional complex shapes using an electro thermal mechanism for eroding the material from a thin single stranded by guide metal wire surrounded by deionizer water which is used to the conduct electricity.[20,23]

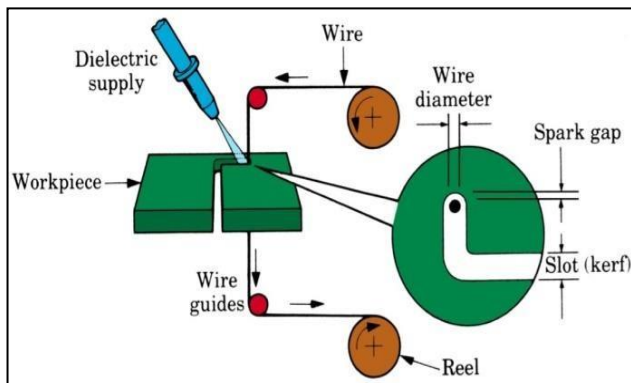


Figure. 2: Mechanism of Wire EDM[13]

## 2. Elements of EDM

- **Work material**-The material of work piece should be electrically conductive.[13]
- **Tool Electrode**-The material of electrode should be highly conductive and arc erosion resistant such as copper or graphite.[9,10]
- **Dielectric Fluid**-The main function of dielectric fluid is to cool, solidify and flush the debris. It also serves as an insulator in between work and tool.[12]
- **Servo system**- The servo system is used to control the work tool gap .It works by receiving signals from gap voltage sensor system in the power supply and control the feed of electrode.
- **Power Supply system**-It is a main important part of EDM ,source to supply of power. [13].

## 3. Experimental Methodology

Parameters of EDM mainly classified into two categories

1. Process parameters [6]
2. Performance measures[13]

### Process Parameters

The process parameters are mainly two types

A..ELECTRICAL PARAMETERS[7,9,13,14],B..NON ELECTRICAL PARAMETERS[7,9,13,14]

- |                      |                          |
|----------------------|--------------------------|
| I. Pulse on time     | I. Flushing              |
| II. Pulse off time   | II. Electrode Lift time  |
| III. Polarity        | III. Workspaces rotation |
| IV. Electrode gap    | IV. Type of Dielectric   |
| V. Gap Voltage       |                          |
| VI. Peak current     |                          |
| VII. Peak voltage    |                          |
| VIII. Pulse duration |                          |
| IX. Pulse waveform   |                          |
| X. Duty factor       |                          |

Pulse on Time(Ton)-pulse on time is the time duration during that the current flows per complete one cycle[14]

Pulse of time(Toff)-Duration of time between sparks is pulse of time.

Peak current-It is amount of power used in EDM and MRR is directly proportional to it.[14]

### Performance Measure

- Material removal rate(MRR)
- Tool wear rate(TWR)
- Surface roughness(SR)
- Wear ratio(WR)
- Surface quality

Material removal rate(MRR):Electrical parameters can be controlled through power supply system among the performance parameters.(MRR) is amount of work piece material remove per machining time.[4,15] The MRR is expressed as the weight of material removed from the work piece over a period of time.MRR is directly proportional to pulse on time.[22,24]

Tool wear rate (TWR): is the amount of material eroded per machining time. It is performance measure for the erosion rate of the tool electrode.[18,22]

Surface Roughness(SR): is used to describe an amplitude feature, which translates to roughness of the surface finish[2]

Wear ratio(WR): is the ratio of tool wear rate to material removal rate [22]

Surface Quality: is used to describe the condition of the machined surface.[2].

## 4. Dielectric Fluid

It is used as a coolant, flushing medium and also a catalyst conductor. It plays very important roles in EDM process. [16] The requirements are

- The dielectric should have compulsory and constant dielectric strength to serve as insulation between tools and the work, till the breakdown voltage is reached.[5]
- It must be de-ionizing speedily afterwards the

spark ejection has taken place.

- It must need small viscosity and a polite moistening ability to provide effective cooling mechanism and remove the swerve particles from the machining gap.
- It should flush out of the element produce during the spark out of the gap. This is the most important purpose of the dielectric fluid. Insufficient flushing can result in arcing decreasing the life of the electrode and increasing of the machining time. [22]
- It should be chemically in neutral, so as not to attack to the tool, job and the movable table or the tank.
- Its flash point should be high so that there are no fire threats.
- It should not release any toxic vapours.
- It should sustain these properties with temperature variation, contamination by working residuals and products of the decomposition.[5]
- It should be economical and easily available in nature.

### 5. Literature Reviews

Year	Author details	Key finding
2021	Vishal Singh et al	This paper provides principle, advantages and limitation of wire EDM process
2021	N.Vats et al	This research study of the effect of various process parameter like pulse on time, pulse off time, wire feed on the performance measure like MRR, Surface roughness and wire wear ratio.
2020	S.Suresh Kumar et al.	This paper provides a detailed study on EDM process parameter, Powder mixed EDM, Electrode material and Electric discharge coating process.
2019	Mohd. Yunus Khan et al	This research paper study on optimization of process and evaluate performance and applicant
2017	V.S.Nimbalkar et al	This paper relevant to a review on EDM for Titanium alloy & their future applications.
2016	Afsana Banu et al.	They provides an important review on different types of E.D.M. process and a brief discussion on machining responses and mathematical modelling.
2014	Sushil Kumar Choudhary et al.	This paper reviews different research work carried out for development of die sinking EDM ,wire cut EDM ,WATER in EDM,powder mixed EDM, DRY EDM. There is a brief detail about components of EDM, Different parameters of EDM, ie. process parameter and performance

		parameters.
2013	Mohammed B Ndaliman et al.	In this paper the surface properties of workpiece Ti-6Al-4V was investigated using two dielectric fluids. It was founded that surface roughness is generally higher in the workpiece machined with urea solution dielectric fluid.
2013	MK .Das et al.	In this paper surface roughness and MRR are optimized using WPCA(weighted principal component analysis) in EDM of EN 31 tool steel.
2010	Anand Pandey et al.	This research paper describes EDM process, process parameters, Hybrid EDM process ie. Powder mixed EDM and ultrasonic assisted EDM
2009	SH.Tomadi et al.	In this paper they find out copper tungsten tool is better for surface finishing of tungsten carbide
2008	P.Kuppan et al.	In this paper experimental analysis of deep hole drilling of Inconel 718 is carried out using EDM process .Low value of pulse on time to be selected for getting better surface finish.
2003	B.Sen et al.	This paper describes detail on two types ,Isoenergetic and Isofrequent power supply in EDM

### Advantages of Electric Discharge Machining

There are following advantages [19] of Electrical Discharge Machining:-

1. During the process there is no physical contact between the tool and workpiece, hence the workpiece is not subjected to contact stresses and even thin section components could be machined without deformation.
2. Complicated cutting profile, internal junctions, pointed and briery angles can be created easily.[21]
3. Readily applicable to electrically conductive materials, physical and metallurgical properties of the work material are not barrier to its application.
4. High degree of surface finish and accuracy could be achieved.
5. Overall rate of production is higher than conventional cutting processes
6. The process can easily be automated.

### Limitations [19] Of Electric Discharge Machining

There are following limitations of Electrical Discharge Machining:

1. Can not be applied to electrically non-conducting materials

2. As compared to conventional machining the overall machining operation is slower
3. Tool wear can limit the degree of accuracy attainable.
4. Normally applicable to small sized jobs.[21]

### EDM Applications

EDM has been successfully applied for the manufacture of tools having complicated profiles. Spark erosion can prove to be economical for the machining of stamping tools, wire drawing and extrusion die, forging dies, intricate mold cavities etc. It has been extensively applied for the machining of exotic materials used in aerospace industries, refractory metals, hard carbides hardenable steel etc.[2]

### 6. Conclusion

In this research paper find there are number of major factors related to EDM processes:

- 1) Resulting foremost conclusions can be stated from review of work in this area that EDM performance is generally evaluated on the basis of TWR, MRR, Ra and hardness.
- 2) In Material removal rate (MRR) from all selected parameters, spark current (I) is the most significant input factor affecting the machining of work piece.
- 3) The performance is affected by discharge current, pulse on time, pulse off time, duty cycle, voltage for EDM.
- 4) For tool wear rate (TWR) from the all selected parameters, spark current (I) is the most significant input factor affecting the machining of work piece followed by spark time and voltage.
- 5) Innovative technology in the EDM is unceasingly progressing to make this procedure further appropriate for the Machining. In the field of manufacturing additional attention is on the optimization of the method by dropping the number of Electrode.
- 6) This paper provides an important review on different types of EDM processes, elements and parameters of EDM, Also it provides a brief discussion on dielectric fluid.

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