IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# INVESTIGATION OF PROCESS PARAMETERS AND MACHINABILITY ON DIE SINKING EDM FOR INCOLOY 800 WITH DIFFERENT PROFILE ELECTRODE

[1]Savan M. Patel, [2]Prof.Dhaval A. Patel

[1]M.Tech student, [2] Associate Professor

[1]Department of Mechanical Engineering,

[1]Sankalchand Patel Collage of Engineering, Visnagar, Gujarat, India

***Abstract:*** In Electric Spark Machining, choice of manufacturing constraints is a necessary feature. This Electrical Spark Machining is an advanced process in all manufacturing processes. For the manufacturing of sophisticated parts, which require accurate machining that time Electric Discharge Machining used. A super alloy, heat-treated tool steel, ceramics, heat resistance steels etc. which are tough to machining. For this, we use Electric Discharge Machining which also known as Electric Spark Machining. Incoloy alloy set in the group of super stainless steels. The main element of this incoloy alloy is nickel-chromium-iron with other extra copper, molybdenum metal. High solidity at high peak temperature and super resist of erosion is the main feature of incoloy alloy. Vast application of incoloy 800 is like Heat exchangers, Carburising equipments, Heating elements and nuclear steam generator tubing. In our research, we use hollow, flat, convex and concave electrode profile for machining of incoloy 800. MRR and TWR are the parameters we analyze after the experiment.

***Index Terms*** **– Die sinking EDM, Incoloy 800, Copper tool, MRR, TWR, Tool base profile.**

## I. INTRODUCTION

In the Electric Spark Machining, work piece material is removed by a spark which is created by electric power. This spark arises between the work piece and tool constantly. Composite material, super alloys, ceramics, carbides, heat resistant steels etc materials are difficult to machine. Electric Discharge Machine has the capability of a machine to these complex and high strength materials. Die-sinking EDM and Wire-cut EDM are the two types of Electric Discharge Machine.

### 1.1 PRINCIPLE OF ELECTRIC DISCHARGE MACHINE

We show the set-up of the EDM in the below figure. The Electric Discharge Machine principle is simple. There is an electric spark repeatedly discharge between the work piece and tool which outcome in erosion of material from the work piece. Generally, there is a small gap of about 0.025 mm is keep going between the tool and work piece by a servo system appear in fig. 1. In Electric Discharge Machine, there is a dielectric moisture is used. Generally, EDM oil, kerosene and deionized water are used for dielectric moisture in EDM.

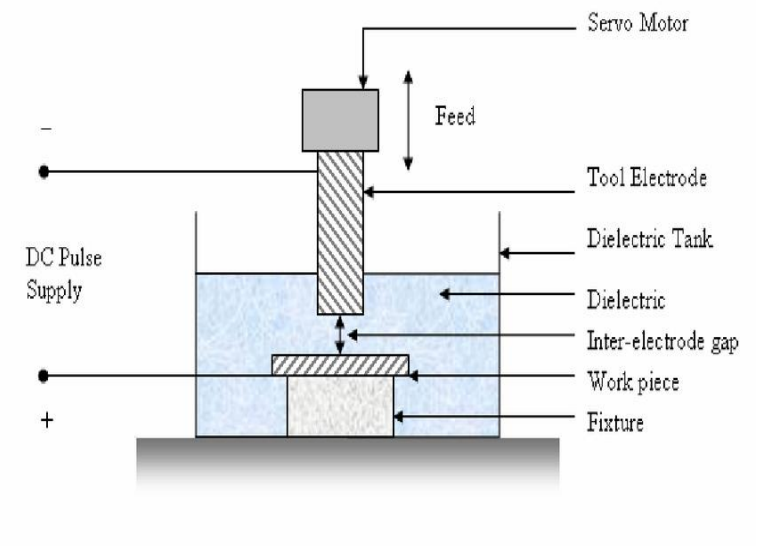


Figure 1 Electric Discharge Machining Set Up

In the EDM, An anode is selected for the work piece and the tool is selected for a cathode. Electric Discharge Machining process requires enough high voltage for starting the process. When voltage supply starts, every 10 microsecond gap spark generates between work piece and tool. The plasma channel produces by interference between electrons and ions. The pressure generates between work and tool by spark discharge. After high pressure and high temperature metal is mollify and removed. In this process, molten metal is removed only slightly. When potential difference eliminates, the plasma channel is pass out. These plasma channels pass out to create shock waves and pressure, which is a formation of undesired metal.

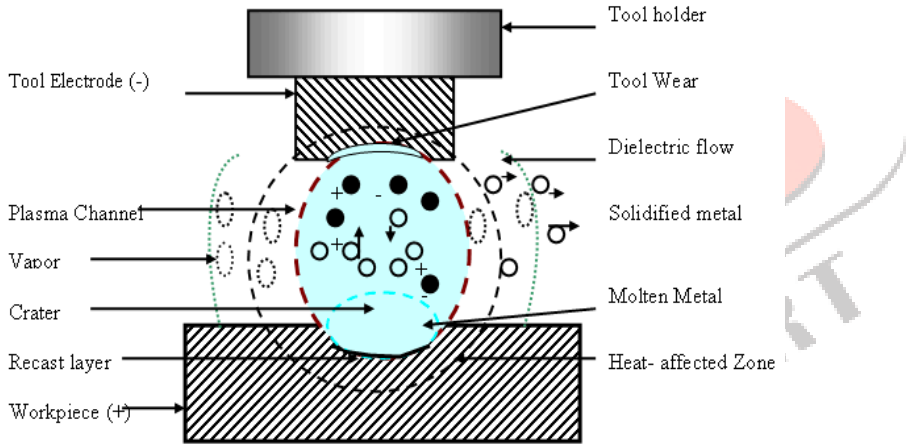


Figure 2 Working principle of EDM process

### 1.2 Application

- EDM is largely used for die and mould manufacturing. EDM is used for making sample and parts of Automobile and Aerospace industries.
- For wire drawing, thread cutting and forging EDM is used.
- Solid materials like tungsten, steel and carbide are machined by EDM.
- Internal thread cutting and helical gear cutting, EDM is used.
- For the drilled of curved holes, EDM is used.
- To attain a high surface finish, EDM is used.
- Fragile material like ceramic is also be machined by EDM.
- At present, EDM is used in medical device, electro optic device, sports and also in R&D Departments.
- Highly complex area and versatile parts where micro level machining require, there EDM is used.
- Precisely extreme edges and corners are machined by EDM.

## II. LITERATURE REVIEW

M. Jagadeeswara Rao et al. For this project Die-sinking EDM is used for machining super alloy material and some analysis techniques were used to discover the variable which has a high influence on the output. In this study, the work piece material is incoloy 800 and the tool materials are copper, graphite and composite electrode CW75. Using L9 orthogonal array and analysis of input parameters like current, pulse on time, pulse off time and flushing pressure over the output parameters like MRR, TWR and SR. The operation was performed in three levels with different machining process parameters. Grey relational analysis optimizes the input data and giving a good output response. Machining was carried out by Taguchi L9 array. To attain higher

material removal rate and lower tool wear rate, finding the best parameters by grey relational analysis. Results shows that current = 16, pulse on time = 150, pulse off time = 20 and flushing pressure = 3.3 are the process parameters for attaining the best output. [1]

M. Manohar et al. In this research, the paper author studied the impact of electrode base profile and its range of impact on machining alloy. In this research also examine the various base profiles of electrode and machine surface. In this study, another selected different types of electrode profile like convex, concave and flat for the analysis. The electrode material is copper and the size is twelve metric linear unit diameters. These three different electrodes base profile radius is 6, 8 and 10 mm. flat and concave base profile electrode result are lower compare to convex base profile for MRR of drilling holes, surface finish and lesser recast layer. The lower radius of the electrode profile result is good in terms of surface finish and ductility because of its small contact size. Concave electrode profile performance is lower compare to the flat profile. When we talk about the tool wear rate, a flat profile tool wear rate is best. After the experiment, we conclude that if we want a low tool wear rate then we use of convex profile for machining. [2]

Narcis Pellicer et al. In this paper, analyze the response parameters like Material removal rate, surface roughness, depth width and slopes with using of a copper electrode as a tool and AISI H13 as a work piece. Also, study the impact of using various types of tool electrode geometry in Die sinking EDM. After the ANOVA analysis author conclude that, when peak current grows MRR and Surface roughness also enlarge. Different profile tools like square and rectangle give a super radial and axial wear ratio. Square and rectangle profiles are the good option for tool design and machining. Pulse of time inequality influence the Material removal rate. [3]

M. Boccadoro et al. In this paper, the author studied EDM drilling machine potentiality for drilling holes in turbine blades. Super alloy materials are used in the turbine blades of a jet engine. In the jet engine, high temperature is created. Internal and outer cooling required drilled holes in super alloy material. For drilling holes in super alloy, Electric Discharge Machine is used. After the conclusion of this process, we find that the value of the recast layer can be lessened. From the accumulation of the process parameters, we find the erosion speed. The erosion speed is 1.6 mm/sec. Tool wear rate is down when MRR is going on 77 mm^3/min. EDM drilling and shaping mixture indicates the probability to provide cooling holes with condenser while electrode is not change. It is found that laser drilling thickness is higher than shaping. The chance of producing cooling holes without changing electrodes in EDM drilling and shaping process is higher. [4]

S. Narayanan et al. In this study, using three different electrodes copper, copper-tungsten and graphite. Investigation was performed on inconel material with this three different electrodes. In this investigation, input parameters are peak current, pulse on time, duty factor and electrode rotational speed and output parameters are MRR, TWR and SR. After the 3.0 mm and 25 mm diameter drilling holes, process data was analyzed by regression analysis method. After the experiment, conclude that when the current is high then MRR will also high in any electrodes. Copper electrodes have effectual MRR with the increasing current after by graphite and copper tungsten electrode. The Tool wear rate is high in the copper electrode compare to the copper tungsten electrode. In the small value of current, the graphite electrode shows the lowest wear rate. It shows that because the TWR decrease whenever pulse on time increase. After the analysis of the result, we show that copper gives us the best result with the recommendation to surface roughness. [5]

## III. EXPERIMENTAL DETAILS

- Machine details – AZ 50 Die-sinking Electric Discharge Machine made by JOEMARS.
- Work piece Material – Incoloy 800 ( 150 × 60 × 3 mm plate )
- Process variables – Peak current (I), Pulse on Time (Ton), Duty cycle
- Response variables – Material Removal Rate (MRR), Tool Wear Rate (TWR)
- Tool material – copper round bar with different base profile like Flat, Hollow, Convex and Concave
- Hollow tool electrodes size – 3.5 mm, 4 mm, 5 mm diameter
- Convex tool electrodes size – 4 mm, 6 mm, 8 mm radius
- Concave tool electrodes size – 4 mm, 6 mm, 8 mm radius


Figure 3 Convex shape copper electrodes

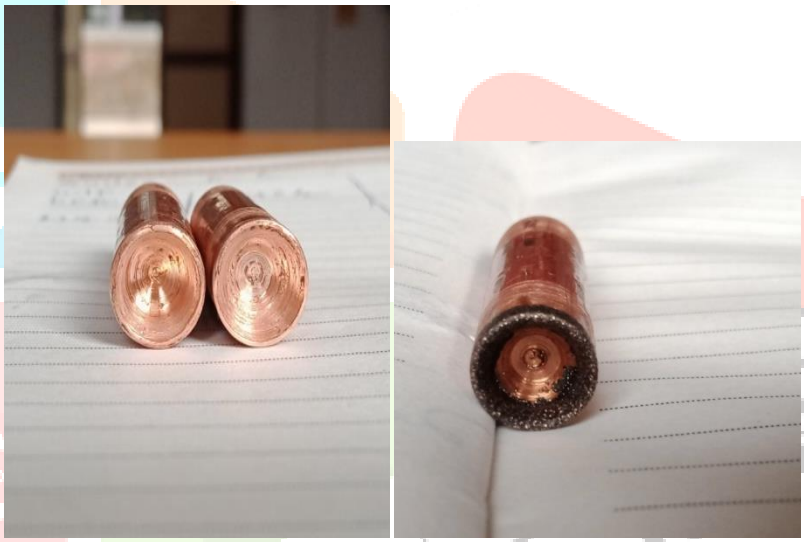

Figure 4 Concave shape copper electrodes

Figure 5 Hollow shape copper electrodes

- Machining parameters

Table 1 Process variables at their levels

| Factors | Parameters | Unit | L1 | L2 | L3 |
|---|---|---|---|---|---|
| A | Peak Current (I) | A | 36 | 43 | 50 |
| B | Pulse on Time (Ton) | μ s | 17 | 48 | 62 |
| C | Duty cycle | - | 0.42 | 0.49 | 0.56 |

From the table 1 we are selected L9 orthogonal array for the experiments. We perform a total of 9 experiments in our operation.

## IV. OUTCOME AND ANALYSIS

Table 2 Data obtained from experimental work

| Exp. No | Peak Current | Pulse on Time | Duty Cycle | MRR | TWR |
|---|---|---|---|---|---|
| 1 | 36 | 17 | 0.42 | 0.426859 | 0.097375 |
| 2 | 3 | 48 | 0.49 | 0.286509 | 0.055539 |
| 3 | 36 | 62 | 0.56 | 0.403475 | 0.0467814 |
| 4 | 43 | 17 | 0.49 | 0.116178 | 0.053714 |
| 5 | 43 | 48 | 0.56 | 0.486807 | 0.102900 |
| 6 | 43 | 62 | 0.42 | 0.673037 | 0.029525 |
| 7 | 50 | 17 | 0.56 | 0.198983 | 0.085053 |
| 8 | 50 | 48 | 0.42 | 0.581774 | 0.0453226 |
| 9 | 50 | 62 | 0.49 | 0.709266 | 0.129229 |

- **ANOVA ANALYSIS**

ANOVA Analysis is the method for analysis in our EDM process. ANOVA analysis is the quantitative method used for finding the percentage beneficiation of the separate element. In our experimental analysis, which elements require for management is find with ANOVA analysis. In this approach, data are not directly examined. This ANOVA analysis gives us contention of control and noise element. By analyzing the literature and quantity of variations, a strong controlling environment can be forecast. MINITAB19 software is used for this ANOVA examination. In MINITAB software, we create effect plots. This effect shows the difference of separate feedback with three parameters i.e. peak current, pulse on time and duty cycle. X and y axes shown in plots. X axes is for the utility of separate process variables and y axes for the response variables. These effect plots are used to find the best design environment to find a best surface finish.

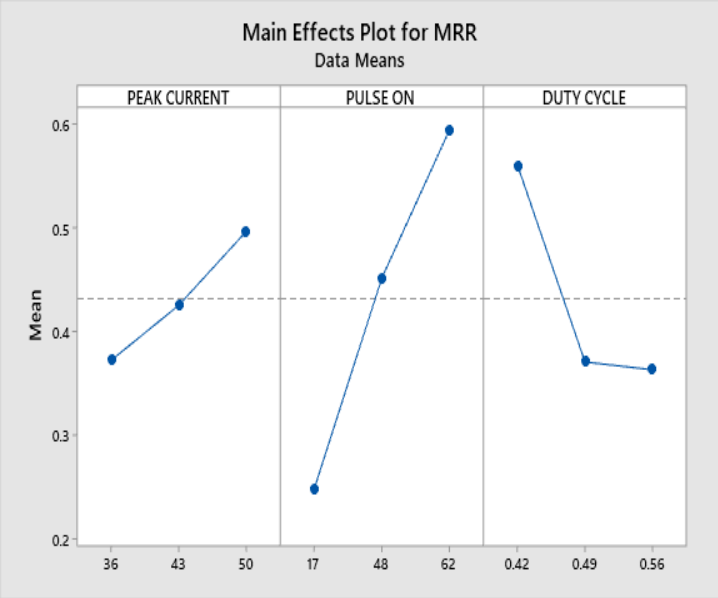


Figure 6 Main effect plot for MRR

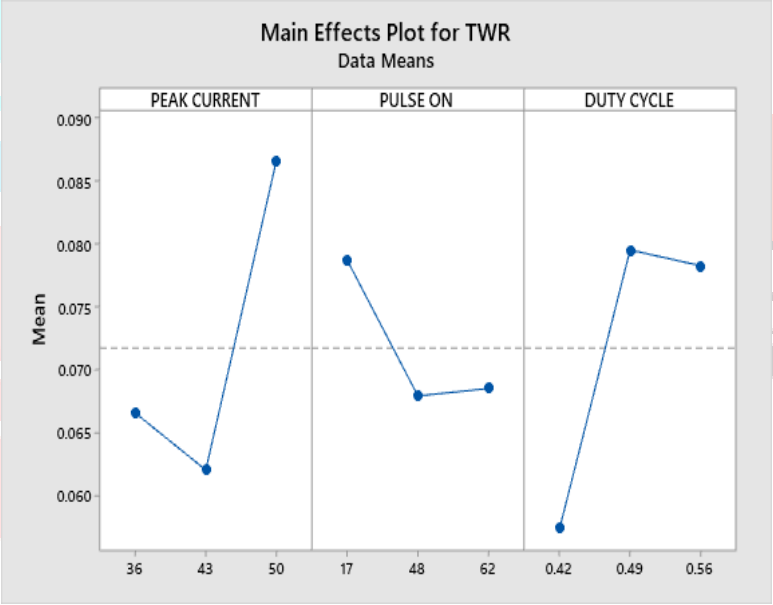


Figure 7 Main effect plot for TWR

- **GREY RELATIONAL ANALYSIS**

Grey relational analysis is also known as the grey relational generation. The first step of this analysis is normalized operation data in zero to one range. After normalizing the data next step is to calculate the grey relational coefficient to signify the link between real process data and demand data. After that find a grey relational grade by sum of grey relational coefficient communicate the pick out feedback. Different analysis procedure converts into single response procedure analysis by this approach with grey relational grade. The excellent variable mixture is assessed by increase the average grey relational grade.

For the creation of grey relation, normalized statistics keep in touch to lower-the-better standards can be demonstrated as:

$$Xi(k) = \frac{\max \mathrm{yi(k)} - \mathrm{yi(k)}}{\max \mathrm{yi(k)} - \min \mathrm{yi(k)}}$$

Normalized data indicate for Higher-the-better (HB) standards as:

$$Xi(k) = \frac{\mathrm{yi(k)} - \min \mathrm{yi(k)}}{\max \mathrm{yi(k)} - \min \mathrm{yi(k)}}$$

Pre processed order deliberate for grey relational co efficient as:

$$\S i(k) = \frac{\min\Delta + \theta\max\Delta}{\Delta \mathrm{i(k)} + \theta\max\Delta}$$

Grey relational analysis, analyze the parameter and give us the best value for Material removal rate and Tool wear rate. According to Grey relational analysis best value for experiment is peak current – 43 A, Pulse on time – 17 µ.s and Duty cycle – 0.49 µ

After the analysis of the result, we find a best value for final experimental investigation. In the final investigation, we are using different base profile electrodes like hollow, convex and concave for machining of incoloy 800. After the final investigation we conclude that convex base profile electrode having better result compare to concave and hollow electrode. 4 mm radius convex profile electrode had minimum time for drilling hole.

## V. CONCLUSION

Our investigation main goal is to discover the best parameter value by using various base profile electrodes for drilling hole on incoloy 800. The result of our investigation study as below:

- In EDM machining always want to obtain greater MRR value, so peak current must always be kept high for higher MRR value.
- Material removal rate influence by pulse on time with some determined span. After that pulse on time does not influence MRR as much as peak current influenced MRR.
- During the process, we conclude that flushing pressure and flushing technique plays an important role in response parameters like Material removal rate and Tool wear rate.
- Conclusion of our main investigation shows that, for drilling convex profile electrode is more desirable compared to hollow and concave profiles electrode.

## REFERANCES

[1] M. Jagadeeswara Rao, Riyaz Uddein Sheikh and K. Buschaiah, “Grey Relational Analysis of EDM Process Parameters For Incoloy 800” ICETE 2, 476 – 482

[2] M. Manohar, T. Selvaraj, D. Sivakumar, Shibu Gopinath and Koshy M George, “Experimental Study to Assess the Effect of Electrode Bottom Profile while Machining Inconel 718 through EDM Process” Procedia Material Science 6, 92 – 104

[3] Narcis Pellicer, Joaquim Ciuranaand, “Tool Electrode Geometry and Process Parameters Influence On Different Feature Geometry and Surface Quality in Electrical Discharge Machining of AISI H13 Steel” Springer Science Business Media, LLC

[4] M. Boccadoro, M. Kliuev, R. Perez, W. Dalbo and F. Kuster, “EDM Drilling and Shaping of Cooling Holes in Inconel 718 Turbine Blades” Procedia CIRP 42, 322 – 327

[5] S. Narayanan, P. Kuppan, R. Oyyaravelu and A. S. Balan, “Performance Evolution of Electrode Materials in Inconel 718 Super Alloy” Springer Verlag London Limited 2007