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# ANALYTICAL INVESTIGATION OF VARIABLE PARAMETERS ON CUTTING EFFECT OF STAINLESS STEEL IN EDM

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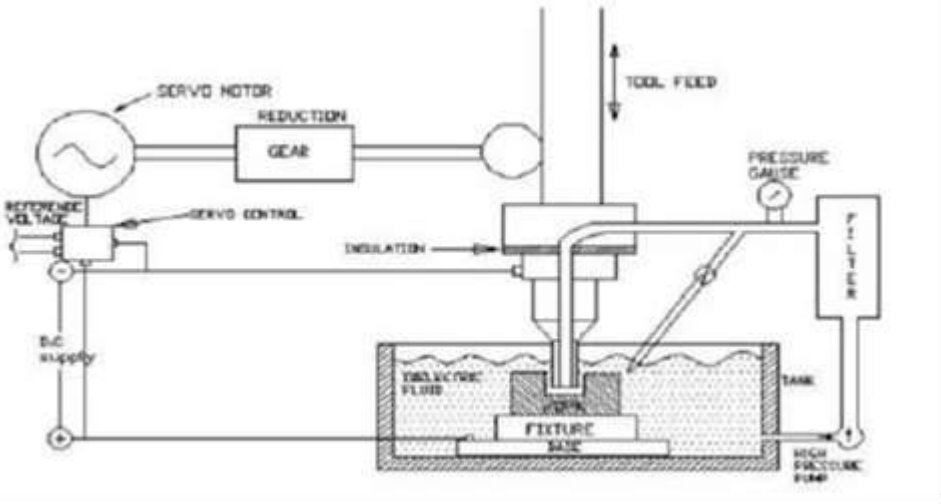
## ABSTRACT

EDM has become an important and cost-effective method of machining extremely tough and brittle electrically conductive materials. It is widely used in the process of making moulds and dies and sections of complex geometry and intricate shapes. The work piece material selected in this experiment is AISI 304 Stainless steel taking into account its wide usage in industrial applications. In today's world 304 stainless steel contributes to almost half of the world's production and consumption for industrial purposes. The input variable parameters are current, pulse on time and duty cycle. Taguchi method is applied to create an L27 orthogonal array of input variables using the Design of Experiments (DOE). The effect of the variable parameters mentioned above upon machining characteristics such as Material Removal Rate (MRR), Surface Roughness (SR) and Overcut (OC) is studied and investigated. The tool material is copper

## I. INTRODUCTION

The erosive effect of electrical discharges was first studied by an English scientist, Joseph Priestley in 1770.However it was not until 1943 when two scientists from Russia invented the EDM process. In the process of utilizing the erosive effects of an electrical discharge, they created a controlled process for machining of materials. Electrical Discharge Machining, commonly known as EDM is a non-conventional machining method used to remove material by a number of repetitive electrical discharges of small duration and high current density between the workpiece and the tool. In this process the material is removed from the workpiece due to erosion caused by rapidly recurring electrical spark discharge between the workpiece and the tool electrode. There is a small gap between the tool and the workpiece. The workpiece and tool both are submerged in dielectric fluid, commonly used are EDM oil, deionized water, and kerosene.




***Experimental Setup***

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## II. LITERARTURE REVIEW

B.S. Reddy et al. [1] carried out a study on the effect EDM parameters over MRR, TWR, SR and hardness. Mixed factorial design of experiments and multiple regression analysis techniques had been employed to achieve the desired results. The parameters in the decreasing order of importance for; MRR: servo, duty cycle, current and voltage.

M.M. Rahman et al. [2] investigated the effect of the peak current and pulse duration on the performance characteristics of the EDM. The conclusions drawn were: the current and pulse on time greatly affected the MRR, TWR and SR, the MRR increases almost linearly with the increasing current

I. Puertas et al. [3] carried out results which showed that the intensity and pulse time factor were the most important in case of SR while the duty cycle factor was not significant at all.

Tomadi et al. [4] investigated the machining of tungsten carbide with copper tungsten as electrode. The full factorial design of experiments was used for analyzing the parameters. In case of SR, the important factors were voltage and pulse off time while current and pulse on time were not significant.

B. Bhattacharyya et al. [5] observed that peak current and pulse on time significantly influenced different criteria of surface integrity such as surface crack density, surface roughness and white layer thickness.

## III. MATERIALS and METHEDOLOGY

The experiments were conducted using the Electric Discharge Machine, model ELECTRONICA - ELECTRAPLUS PS 50ZNC (die sinking type) the polarity of the electrode was set as positive while that of workpiece was negative. The dielectric fluid used was EDM oil (specific gravity-0.763).

**Selection of the workpiece**

AISI 304 Stainless Steel is one of the most widely used materials in all industrial applications and accounts for approximately half of the world's stainless steel production and consumption. Because of its aesthetic view in architecture, superior physical and mechanical properties.

**Tool Design**

The tool material used in Electro Discharge Machining can be of a variety of metals like copper, brass, aluminium alloys, silver alloys etc. The material used in this experiment is copper.

**Mechanism and Evaluation of MRR**

MRR is the rate at which the material is removed the workpiece. Electric sparks are produced between the tool and the workpiece during the machining process. Each spark produces a tiny crater and thus erosion of material is caused.

The MRR is defined as the ratio of the difference in weight of the workpiece before and after machining to the density of the material and the machining time.

**Mechanism and Evaluation of Surface Roughness**

Surface Roughness is the measure of the texture of the surface. It is measured in |im. If the value is high then the surface is rough and if low then the surface is smooth. It is denoted by Ra. The values are measured using Portable style type profilometer, The arithmetic mean of three readings is taken as the final value.

**Mechanism and Evaluation of Overcut**

It is the measure of cut produced exceeding the diameter of the tool. The impression created while EDM process is generally slightly larger than the original diameter of the tool electrode. This is because the spark is generated from along the side of the tool and hence erosion takes place in that direction also. OC is calculated as half the difference of the diameter of the hole produced to the tool diameter

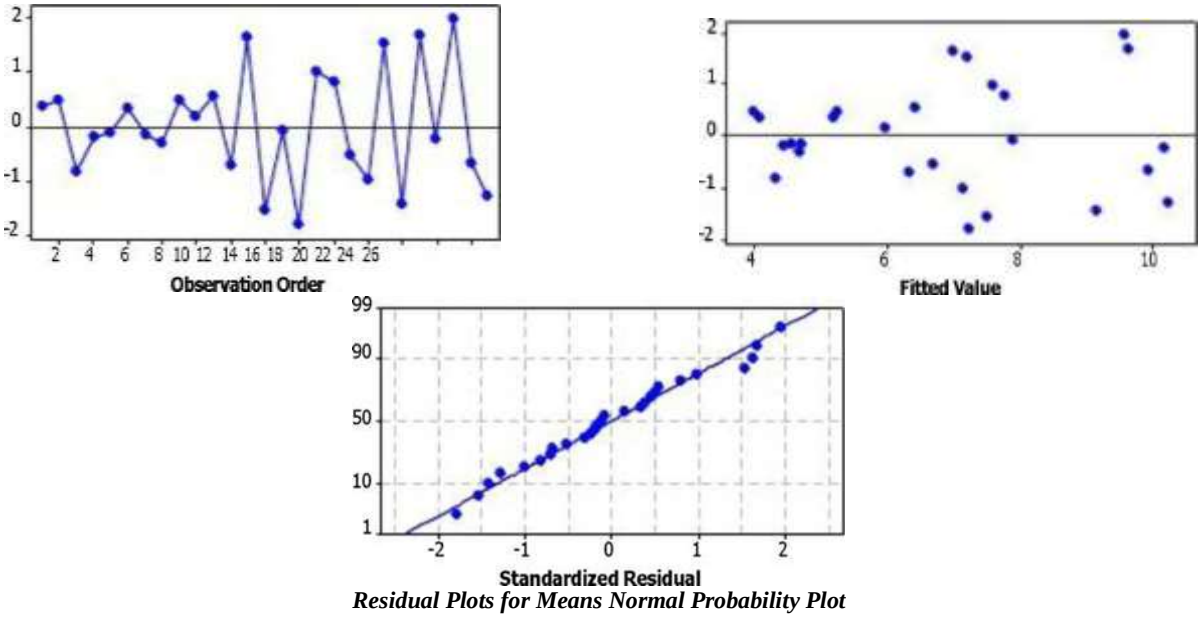
**Design of Experiments Analysis**

Genichi Taguchi developed some statistical methods to improve the qualities of manufactures goods known as Taguchi methods. This design provides a potential and efficient method for designing different products that can operate consistently over a wide range of conditions. Minitab provides both static and dynamic response

experiments. The design of experiments is used to find the best combination of input variables in an orthogonal array.

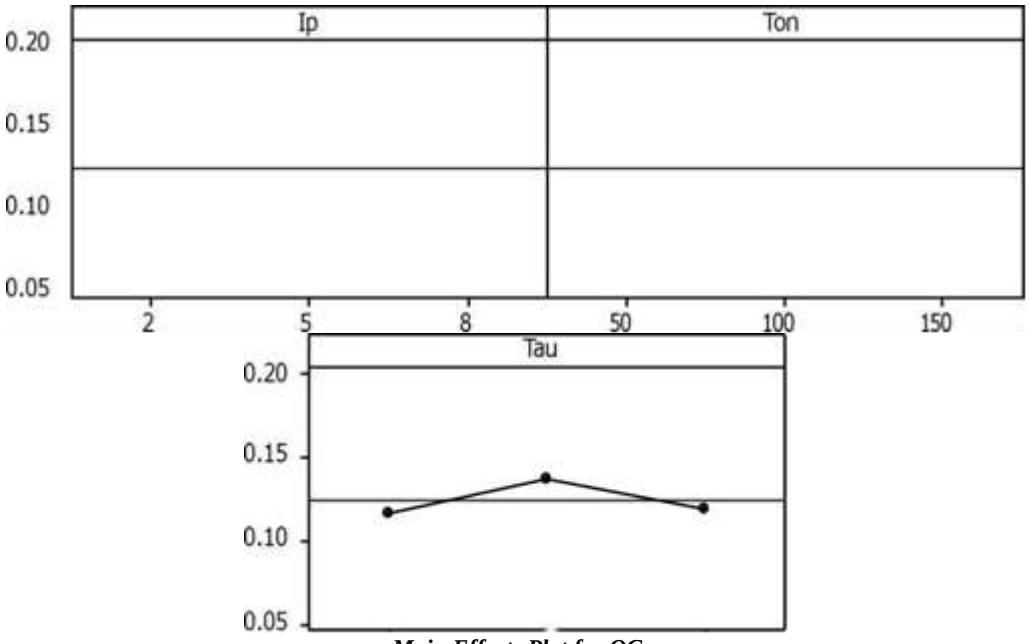
In this experiment the input parameters considered are current, Ton, and t. Since three factors are chosen the design becomes a 3 level 3 factorial Taguchi design. L27 orthogonal array was chosen for the experiments to be conducted.

## IV. RESULTS AND CONCLUSION




***Residual Plots for Means Normal Probability Plot***

1. For MRR the most significant factor was found to be peak current followed by pulse on time and the least significant was duty cycle. The MRR increased nonlinearly with the increase in current. For Ton the MRR first increased till 100 |is and then decreased. With increase in duty cycle, MRR increased insignificantly.




***Main Effects Plot for OC***

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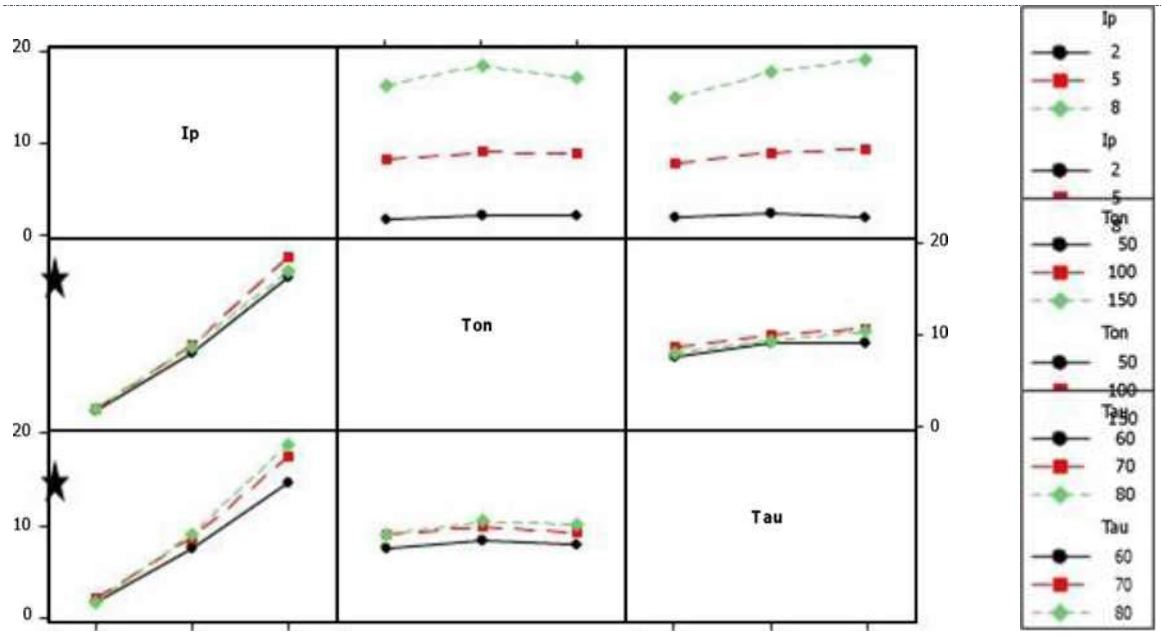


***Interaction Plot for MRR***

2. For SR the most significant factor was again current followed by pulse on time and lastly the duty cycle. SR increased significantly with the increase in current in a nonlinear fashion. For increase in pulse on time SR increased up to 100 |is and then there was no significant increase. In case of duty cycle, SR first increased up to 70% and then started to decrease.
3. For OC the most significant factor was current followed by pulse on time and duty cycle respectively. OC increased along with the increase in current. For increase in pulse on time, OC increased linearly. Finally for duty cycle, OC increased but only up to 70% and then started decreasing.

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