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# Experimental Analysis of EN 19 Alloy Material on EDM for Improving Geometrical Errors Using Copper Pentagon Shaped Electrode

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**Abstract**

In this research, an investigation and experimental work were carried out on electric discharge machining of EN19 alloy material using copper pentagon shaped electrode. Considering the input process parameters such as Current (amp), Pulse on time (μs) and pulse off time (μs), dielectric pressure (kg/cm$^2$) for machining the effect of this following input parameters on output characteristics like Material Removal Rate (MRR), Tool Wear Rate (TWR), Wear Ratio (WR) and machining time. The investigation was carried out using with $L_9$ orthogonal array based on Design of Experiments (DOE). The effect of each machining parameters on output characteristics were studied independently using main effect plots using Minitab. The most significant factors affecting MRR and TWR of high speed EDM process have been identified as current, pulse on time, pulse off time in dielectric pressure.


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*Keywords:*MRR; WR; TWR; Angularity.

## 1. Introduction

Electric discharge machining process is basically a non-conventional machining process. The non-conventional process familiar in machining hard material and deep holes which cannot be machined by conventional process. The EDM process is also called as spark erosion process or electro-erosion process. In this process, metal is removed by producing powerful electric spark discharge between the tool (Cathode) and workpiece (Anode). This principle is followed in this process. A dielectric fluid is a liquid medium that does not conduct electric current. In EDM process, the tool and work material are submerged in a dielectric solution. The EDM process is well suited for delicate or fragile parts that cannot take the stress of conventional machining. The Electric discharge machining process leaves no burrs. In EDM process dielectric fluid maintains a constant resistance across the spark gap. The tool material generally used as graphite, copper, copper-tungsten, etc. In EDM process it gives good surface finish

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and MRR is higher. The non-conventional machining process gives less tool wear rate (TWR) while comparing to conventional machining process.

**Nomenclature**

| | |
|---|---|
| EDM | Electrical Discharge Machining |
| MRR | Material Removal Rate |
| TWR | Tool Wear Rate |
| SR | Surface Roughness |
| WR | Wear Ratio |

*1.1 Literature Review*

B.Mohan et al (2004) discussed about EDM of Al-Sic metal matrix composites using rotary tube electrode and machining the Al-Sic metal matrix composite gives high MRR using rotating tube electrode. It concluded that can high MRR,EWR,SR gives decrease the diameter of the hole, increasing the volume, high rotational speed and gap[1].Chechungwang and Biinghwayan (2000) determined about the EDM blind-hole drilling in rotary EDM of $Al_2O_3$ composite. The MRR, EWR, SR is increases with help of non-electrical like rotational speed of electrode, injection flushing in EDM blind hole drilling. It concluded EWR, SR is affected by electrical parameter in this process[2].Renjieji et.al (2012) determined about machining SiC ceramic to improve the performance characteristics on ED milling. In this process they concluded SiC ceramic have good characteristics to machining MRR, EWR, SR [3]. E.Ferraris et al.(2013) determined about EDM drilling the shallow holes machined with aqurate ratio. It concluded that micro holes can be done in EDM drilling with aspect ratio. The 120 micro holes with 0.2mm diameter can be machined in 1 hours by EDM process[4]. L.LI et al (2015) determined about the machining characteristics of Inconel 718.They are selected Die sinking and WEDM method. The machinability and surface characteristics of machined surfaces are poor. At the results the new Cu-SiC composite electrode increased the gap and decreases the roughness [5]. M.Aliokka et al(2014) determined about machining of aerospace alloys in EDM process. It concluded that machining hole using different electrode and different material and can get more knowledgeable and automated [6].

Nixon kuruvila and Ravindra H.V (2011) discussed about for parametric influence and optimization of WEDM of hot die steel. In this process they are using Taguchi and Genetic algorithm technique. It concluded the WEDM to optimize of hot die steel to improve MRR, surface finish and productivity when low current and pulse durations[7]. SushantDhar et.al (2007) discussed about a EDM of cast alloys in mathematical modelling. It concluded the aluminium matrix composites can be machined to improve MRR and decrease the TWR and ROC in optimum condition and ROC improve the nonlinear fasion[8]. Fabio N.leao et al.(2005) determined and optimized of Electro Discharge machining with dielectric fluid and electrode material the fast hole can be done. On drilling nickel based work piece using different dielectric fluid and different electrode material,likecopper,brass,water based dielectric fluid and can be obtain 50% better drilling rate and less electrode wear rate.The different electrode used are copper,brass. And water-based dielectric fluid[9]. Chih-Cherng Chen et al(2010) defined about edge disintegration with cobalt-bonded tungsten carbide in RSM method. It concluded the high value of duty factor, discharge current and capacitance is main reason to decrease the disintegration in cobalt-bonded tungsten carbide[10]. LokeswaraRao et.al (2013) established to improve the process parameters in WEDM process. It concluded in this taguchi method, the titanium alloy can be machined the process parameters on MRR, SR effectively[11].

From the literature we have analyzed very limited work pentagon hole and angularity calculation in EDM process. So in this research work was carried out pentagon hole and angularity was measured.

## 2. Materials & Methods

Electric Discharge machine show in Fig.1(b).The copper electrode is used as a tool electrode shown in Fig.2(c).Copper and copper alloys have better EDM wear resistance than brass, but aremore difficult to machine than either brass or graphite.Before machining and after machining of the copper electrode is shown in Fig.2 (b). After machining of the work piece material EN19 shown in Fig.2 (a). And this work is done by $L_9$ orthogonal