EXPERIMENTAL ANALYSIS AND OPTIMIZATION OF PROCESS PARAMETER OF EDM FOR EN47

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ABSTRACT: The aims of this research work to identify parameters of EN47 spring steel material on EDM machine by applying Copper, Graphite, & Tungsten Carbide Coated Copper electrodes. And pursue the influence of four design factors pulse on (Ton), pulse off (Toff), current (I), and voltage (V), which are the most connected parameters to be controlled by the EDM process over machining specifications such as material removal rate (MRR) and tool wear rate (TWR) and characteristics of surface integrity such as average surface roughness (Ra) and also to quantify them. In this paper the experiments have been conducted by using Taguchi Methodology with the DOE techniques and developed a mathematical model to predict material removal rate & average surface roughness using input parameters such as pulse on(Ton), pulse off (Toff), current (I), voltage (V).

Keywords: EDM, MRR, TWR, Surface Roughness.

INTRODUCTION:
Now-a-days days due to need for high strength materials in sophisticated industries and patronaged by the advances in the field of Materials science, there has been an increase in the availability and use of different machining of materials. EDM is one such process which is widely used to machine electrically conductive materials. EDM is a thermo-electric process in which material remotion takes place through the process of controlled spark generation. It is one of the most popular non-traditional machining processes being used in the industries. [1]

EDM is a thermo-electric process in which material removal takes place through the process of controlled spark generation. It is one of the most popular non-traditional machining processes being used in the industries. EDM is generally used for mould and Die making industry and in manufacturing automotive, aerospace and surgical components. Since there is no mechanical contact between the tool and work piece, therefore frail components can be machined without the risk of damage. [1]

The Surface Roughness plays a very important role for any manufacturing work in order to identify the extent of the surface finish with reference to time and cost. A number of experimental works has been carried out till date for the investigation of the effect of the different parameters over the surface roughness value for different materials. [2]

PRINCIPLE OF EDM

In this process the metal is removing from the workpiece due to erosion case by rapidly recurring spark discharge taking place between the tool and workpiece. Show the mechanical setup and electrical setup and electrical circuit for electrode discharge machining. A thin gap about 0.025mm maintained between the tool and workpiece by servo system shown in Fig.1. Both tool and workpiece are submerged in a dielectric fluid. Kerosene/EDM oil/deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases.

Fig.1 setup of Electrical discharge machining

The tool is of cathode and workpiece is anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 10 of microseconds.
EXPERIMENTAL SET-UP

A. Selection of the Work Material: EN 47 Spring Steel of 160 mm dia and 12mm thickness.

Electro Discharge Machining is able to do machining of hard material component such as heat treated tool steels, composites, super alloys, ceramics, carbides, heat resistant steels etc with Electro Discharge Machining process. EN 47 steel is medium tensile steel which is supplied in the black hot rolled or it can be in normalized condition.

EN 47 steel has good weld ability and machinability in normalized as well as the hot rolled condition. EN 47 is having huge industrial applications such as gear manufacturing, Leaf spring, train Shokers which requiring more wear resistance and strength.

B. Selection of the Electrode Material:

1) Copper : Size : 10mm dia , 1 Inch length
2) Graphite : Size : 10mm dia , 1 Inch length
3) Tungsten Carbide Coated Copper: Size: 10mm dia, 1 Inch length.
4) Tungsten Carbide Powder

<table>
<thead>
<tr>
<th>Elements</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>3</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.8</td>
</tr>
<tr>
<td>Chromium</td>
<td>15</td>
</tr>
<tr>
<td>Iron</td>
<td>3.5</td>
</tr>
<tr>
<td>Nickel</td>
<td>56.4</td>
</tr>
<tr>
<td>Tungsten</td>
<td>17.3</td>
</tr>
<tr>
<td>Silicon</td>
<td>4</td>
</tr>
</tbody>
</table>

Table no. 3.1 Specification of Electrode

It is capable of machining geometrically complex or hard material components, super alloys, ceramics, carbides, heat resistant steel etc. There are different types of tool material are using the EDM method. And the tool steel contain carbon and alloy steel that are particularly well suited for tools. Various electrode materials used are graphite, copper, copper graphite, brass, zinc alloys, steel, copper tungsten, silver tungsten, tungsten etc., classification of different electrode materials used in Electro Discharge Machining Process. Copper is selected as a tool material of present experimental work.

EXPERIMENTAL WORK

This experimental setup is used for machining of different materials regardless of their hardness. For this experiment the whole work will be carried out on Electric Discharge Machine, model Joemars Machine (die-sinking type) with servo-head (constant gap). Experiments will be conducted using copper and graphite electrodes.

The EDM consists of following major parts:

a) Dielectric reservoir, pump and circulation system.
b) Power generator and control unit.
c) Working tank with work holding device.
d) X-Y table accommodating the working table.
e) The tool holder.
f) The servo system to feed the tool.
Machine Specification
Model: Joemars AZ 50 Machine

Table no. 1. Specification of JOEMARS AZ50 EDM machine

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>SIZE</th>
<th>UNIT</th>
</tr>
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<tbody>
<tr>
<td>X TRAVEL</td>
<td>200</td>
<td>Mm</td>
</tr>
<tr>
<td>Y TRAVEL</td>
<td>350</td>
<td>Mm</td>
</tr>
<tr>
<td>Z TRAVEL</td>
<td>160</td>
<td>Mm</td>
</tr>
<tr>
<td>TANK CAPACITY</td>
<td>200</td>
<td>Ltrs</td>
</tr>
<tr>
<td>MOTOR FOR PUMP</td>
<td>1</td>
<td>H.P.</td>
</tr>
<tr>
<td>POSITIONING RESOLUTION</td>
<td>1</td>
<td>micron</td>
</tr>
</tbody>
</table>

Fig.3 EDM Machine setup

PLAN OF EXPERIMENT
Through this dissertation, effect of different process parameters such as Pulse Duration (Ton) & (Toff), Discharge current (Ip) & Spark Gap (Vg) their effect on machine response characteristics such as Material Removal Rate, Tool Wear Rate and Surface Roughness on EN 47 Spring Steel work piece material using copper, graphite & tungsten carbide coated copper electrode will be investigated.

Table no. 2. Processing Parameters and Machine Responses

<table>
<thead>
<tr>
<th>Input parameter</th>
<th>Output parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Current</td>
<td>Material Removal Rate (mm³/min)</td>
</tr>
<tr>
<td>Spark Gap (Vg)</td>
<td>Tool Wear Rate (mm³/min)</td>
</tr>
</tbody>
</table>
Analysis of Observation OfEn 47 By Copper Electrode:

Analysis of Observation OfEn 47 By Graphite Electrode:

Analysis of Observation OfEn 47 By Tungsten Coated Copper Electrode:
Optimization Of Grey Relational Analysis:

<table>
<thead>
<tr>
<th>SR NO.</th>
<th>Electrode</th>
<th>MRR (mm³/min)</th>
<th>TWR (mm²/min)</th>
<th>Ra (µm)</th>
<th>Grey Relational Grade</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Copper</td>
<td>32.511</td>
<td>4.058</td>
<td>9.12</td>
<td>0.5190</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Graphite</td>
<td>12.352</td>
<td>7.005</td>
<td>6.208</td>
<td>0.4308</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Tungsten Carbide Copper</td>
<td>8.205</td>
<td>3.018</td>
<td>12.125</td>
<td>0.3654</td>
<td>1</td>
</tr>
</tbody>
</table>

Conclusion:
- From the experimentation we found that the Copper Electrode is having higher material removal rate (MRR) 40.49 mm³/min than of the graphite electrode MRR is 30.457 mm³/min & for tungsten carbide coated copper electrode MRR is 13.629 mm³/min.
- Low Tool wear rate of Graphite & Copper Electrode, TWR of both the electrode are same are 0.029 mm²/min.
- Machining from the Graphite electrode obtain better Surface Roughness (Ra) is 2.25 µm, than the Copper (Ra is 2.33 µm) & Tungsten Carbide Coated Copper Electrode (Ra is 7.81 µm).
- Based on the experiment, the effect of selected input parameter on the output parameter like MRR, TWR, Ra are studied.

REFERENCE
[7] Thiruppathi K, Panneerselvam T, Santosh S “optimization of edm parameters using taguchi method and grey relational analysis for mild steel is 2026”.