REUSED SUNFLOWER OIL AS DIELECTRIC FLUID FOR ELECTRIC DISCHARGE MACHINING PROCESS

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ABSTRACT

Electro Discharge Machining (EDM) is an incredibly recognizable machining practice among as of unpredictable machining systems for perplexing, complex profiles in “very hard to machine” materials (which are electrically conductive). In EDM, the material ejection of the cathode is obtained through exact controlled electric pulse release, which happens the metals of two anodes into vapors, at the event of the breakdown of the dielectric medium. This exploration work, forms are done to discover the appropriateness of plant seed oils from reused sunflower oil as a dielectric liquid in the EDM procedure. And furthermore checked its reasonableness with EDM oil as alternate dielectric liquid for mechanical application. Electrode Wear Rate (EWR), Material Removal Rate (MRR), Surface Roughness (SR), and Tool Wear Rate (TWR) are the key execution highlights of EDM. The important objective of EDM is to get higher MRR close by achieving the reasonably great surface nature of the machined workpiece. The parameters that achieve the most shocking MRR rely upon the machining surface which is associating with the workpiece and apparatus. Dielectric is the hugest variable for getting brilliant outcomes for the abovementioned - expressed key highlights. These examinations came about that reused sunflower oil is an appropriate dielectric media, the outcomes acquired are great while contrasting and that of EDM oil and furthermore discover the impact of the geology of the workpiece and carbon particles dissolving is checked with SEM investigation for any deviations on work surface

KEYWORDS: Electric Discharge Machine (EDM), Electrode Wear Rate (EWR), Material Removal Rate (MRR), Surface Roughness (SR) & Tool Wear Rate (TWR)

1. INTRODUCTION

In the evolution of human civilization, mechanization followed by automation and then computerization process is also faced the problem of difficult to removal material from very hard materials, this is overcome by the application of non-traditional machining process. The best machining process is EDM process under non-traditional machining process. The material is expelled from the workpiece because of disintegration brought about by quickly repeating electrical sparkle between the workpiece and the cathode with a little gap between them and both are submerged in dielectric fluid (EDM oil, deionized water, and Kerosene oil). This productive technique is based on the repetitive waste management of controlled discharges. Because of its nature of contact, it became a general production process like, efficiency of machining materials, molding, instruments industry, precision industry, consumer industry, and medical field, regardless of their hardness and its specific surface design.

Murahari Kolli[1] studied PH 17-4 SS work piece which has high strength. It is difficult to make machines on conventional machining methods. In this way, the machining of progressive method is utilized. This work outlines a multi-reaction development procedure for controlling the machining properties on the EDM procedure while machining task of work piece. Normal metalworking, synthetic industries and space engineering purpose this
PH 17-4 stainless steel is broadly utilized. Experiments are carried out utilizing four machine responses are I, Ton Toff and V. Output responses are MRR, SR, and TWR were determined. For upgrade the single procedure determinants L9 orthogonal array of Taguchi procedure is utilized. At long last, the GRA entropy strategy is utilized for advancing the multi-function attributes. The reliable effect of policy decisions is did by ANOVA. Kunge et al. [2] studied the impact of EWR and MRR and examine the Cobalt Bonded Tungsten Carbide on the Powder Mixed Electrical Discharge Machining 21(PMEDM). In this procedure, the working liquid is mixed with fine Al particles discharges the homogeneous pulsating energy, due to this shows numerous releasing impacts inside a solitary pulse as input. This examination is done distinctly for the completing stages and has been done considering the four preparing responses: I, Ton, size of grains, and convergence of fine particles of Al. The RSM was utilized to design and examine the trials. The work material erosion by and large increments with an expansion of Aluminum powder fixation. Kunieda et.al, [3] Studied the exhibition of EDM compared to dielectric fluid under a number of specific conditions, i.e., the use of cylindrical terminals with an incredible lean wall (<0.3 mm), tool is connected with polarity of negative charge, planetary/pivot motion of the tool and rapid viscosity air flow The expulsion rate of the material is accomplished by O2 is greater and is accomplished by air (55%) and EDM fluid (21%). The best improvement of EDM by gas as dielectric is the incredibly lesser degree of terminal wear (mostly zero), that is free on pulse length. Using ultrasonic vibrations on the work piece increase the material's expulsion rate of EDM with the gas, as it allows the fluid to flow from the vent into the metal. Izquierdo et al. [4] (2009) the EDM procedure work piece created by emplacement of different releases, occurs through EDM procedure, the distance across of the releases 19 channel and material expulsion proficiency can be assessed utilizing reverse recognizable proof from the consequences of the mathematical model. A unique mathematical model for the reproduction of the EDM procedure was introduced. The profile created by EDM top layer by estimating heat dissipated zone within the work piece utilizing the limited distinction-based methodology by considering the impact of progressive releases. Khalid Hussianat.al, [5] (2018) powder blended EDM is solitary procedure used in EDM to increase the machining characteristics. In this work, Aluminium powder distilled water used as dielectric fluid. Pulses on time, Peak current, aluminium powder composition are varied to optimize the machining of W300 die steel. The experiments are planned using face-centred central composite design machining parameters to obtain high (MRR) and low surface roughness (SR). Empirical models are developed for MRR and utilizing (RSM) to study the effect of process parameter sorting genetic algorithm (NSGA-II) the ideal procedure parameters for achieving extreme MRR and least possible surface roughness generated Dastagiri. M [6] et.al, studied the four info process parameters picked as a part of this strategy are discharge current (IP), pulse on time (T_on), Discharge voltage (V) and Inter-Electrode Gap (IEG). These parameters will be analyzed at three distinct dimensions. By considering MRR, SR, and TWR as yield and estimated for each investigational run. Concentrating on demonstrating MRR is increasing, SR as lower and parallel to lesser TWR of the terminal. Hence, the Heuristic strategy along these lines has been received to conjecture the outcomes referenced.

2. EXPERIMENTATION

A. Selection of Tool and Work Piece

The tool material (electrode) used for this experiment is copper with 10 mm diameter, and the workpiece is taken as harden steel EN-31 (DIN 100Cr6) of 70*70*10 mm size. The mechanical properties of EN-31 are displayed in Table 1.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>7.8 Kg/m³</td>
</tr>
</tbody>
</table>
B. Selection of Dielectric Fluid

Kailas M. Talkit et al., [7] examined the viscosity of Coconut, Sesame, Sunflower, and Soyabean oil by using Redwood Viscometer. Soyabean oil is added with various proportions of sunflower, coconut oil, and sesame oil and measured its viscosity also. Up to 30°C of operating temperature viscosity of vegetable oils is very high. The viscosity of vegetable oils drastically reduced after 80°C. By adding 90% Soya bean with 10% coconut oil showed a superior viscosity than all other combinations of oil mixing. H.M.Wilhelmet.al, [8] did an accelerated thermal ageing test under Oxygen flow rate in a thermo-stabilized bath. Refined vegetable oils viscosities are deliberated with and without adding antioxidants. The Viscosity of sunflower is greater than Soya oil and Rice oil variant at 100°C. Whereas Rice bran oil viscosity was observed very low at the same temperature. Refined Rice bran oil, Soya oils took 2hrs to reach the critical viscosity before adding antioxidants, whereas Rice oil took 10 hrs of ageing.

Normally the dielectric fluids used for EDM are de-ionized water; additives are added in Water, Mineral oils, Kerosene, EDM oils, and transformer oils. Mineral oils are made from hydrocarbon based paraffin crude oils of fossil fuels. As the mineral oils are extracted from hydrocarbon molecules with different molecular structure which is resists degradation behaviors of mineral oil. Due to such phenomenon several researchers used vegetable oils as a liquid dielectric in transformers. Among the attractive factors of vegetable oil, the non-toxicity and highly biodegradable features which ensure low risk to the environment if there is a spillage. The high flash and fire points of vegetable oil ensure more in-service operation safety than mineral oil [9]. Again selection of edible and non edible alternate oils, edible oil usage generates an issue which rises of food security, so the better option is selecting the edible oil in which reused oils are the alternate dielectric fluid. In this research work to the reused sunflower oil (RSO) is considered as dielectric fluid.

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Reused Sunflower Oil</th>
<th>EDM Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>-</td>
<td>Yellowish red</td>
<td>No color</td>
</tr>
<tr>
<td>Odor</td>
<td>-</td>
<td>odd odor</td>
<td>No odor</td>
</tr>
<tr>
<td>Density</td>
<td>Kg/m³</td>
<td>919</td>
<td>820 at 15°C</td>
</tr>
<tr>
<td>Flash Point</td>
<td>°C</td>
<td>200</td>
<td>155</td>
</tr>
<tr>
<td>Fire Point</td>
<td>°C</td>
<td>215</td>
<td>170</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>KV/mm</td>
<td>17</td>
<td>15</td>
</tr>
</tbody>
</table>

C. Experimentation and Discussion

The process Parameters are chosen as input for this work are Current (I), Pulse on time (Ton) and pulse off time (Toff). The output parameters are Electrode Wear Rate (EWR), Material Removal Rate (MRR), Surface Roughness (SR) and Tool Wear Rate (TWR) are considered with three factors and four levels are taken by using Orthogonal Array (OA) of L16
experimentation from Minitab 16.

Table 3: EDM process parameters with its levels

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current (I)</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Ton (μs)</td>
<td>100</td>
<td>200</td>
<td>500</td>
<td>900</td>
</tr>
<tr>
<td>Toff (μs)</td>
<td>100</td>
<td>200</td>
<td>500</td>
<td>900</td>
</tr>
</tbody>
</table>

Figure 1: Comparison of MRR for EDM oil with Reused Sunflower Oil.

Figure 2: Comparison of TWR for EDM oil with Reused Sunflower Oil.

Figure 3: Comparison of EWR for EDM oil with Reused Sunflower Oil.
From fig. 1 the MRR for reused sunflower oil is slightly less than the EDM oil values. The MRR values at the experimentation of 7th trail run, 10th trail run and 12th trail runs are equal values of RSO and EDM oil. But at the trail run of 14th, 15th and 16th shows more MRR for RSO than EDM oil. Fig. 2 shows the TWR for RSO is lesser than the EDM oil, means lesser amount of tool will wear. Which reduces the tool machining cost, increases tool life. The EWR for reused sunflower oil is lesser than the EDM oil as shown in the fig. 3, means the EWR is ratio of wear weight of the tool to the wear weight of the workpiece, compared with EDM oil to RSO. The SR for reused sunflower oil is lesser than the EDM oil in some values as shown in fig. 4.

3. RESULTS AND DISCUSSIONS

SEM images of EDM oil used as Dielectric Fluid is shown in Fig. 5, 6 and 7 with various magnifications are shown below.
EDM oil used SEM images are reveals in fig. 5, 6 and 7 with different magnification ranges. Fig. 5 shows that the more amounts of craters, debris and recast layers are found on the surface, fig. 6 displaysthe lumps of debris, spherical globules, deep craters were found on the surface, fig. 7 shows the spherical globules, deep craters and lumps of debris are found on the surface of the work piece used on EDM oil.

Figure 6: EDM oil SEM images at X500 Magnification.

Figure 7: EDM oil SEM image at X500 Magnification.

Figure 8: SEM image X100 magnification of RSO oil
Fig. 8 and 9 illustrate that spherical globules, deep craters, lumps of metal deposits, recast layer, porous region are found after completion of machining which removes the material deposition is occurred on the work surface due to inadequate cleaning of dielectric fluid. Carbon soot existence is also detected in fig. 5, this is because of the mineral oil which is created from hydro carbon based paraffin crude oils slacken its carbon atoms during erosion of work material at high liquefy temperature and this carbon particles will enter in to the melted work material which change, the work segment properties and the melted work material along these lines contaminate the dielectric liquid.

The International Agency for Research on Cancer (IARC) expressed that, oil based cutting liquids which have heterocyclic and polyaromatic rings are carcinogenic, and contact with it might bring about fatal illnesses like malignancy [11]. Genuine medical problems like malignancy, respiratory issues and hereditary sicknesses are the results of poisonous and less biodegradable slicing liquids when they come to physical contact [12].

4. CONCLUSIONS

The following conclusions were made by using sinker EDM machine with EN 31 workpiece and Copper as electrode, by using RSO and EDM oil as dielectric fluid.

- The machining material removal rate (MRR) reused sunflower oil is almost equal or some values lies on same point that of EDM oil values.
- Tool wear rate also is lesser when compared to that of EDM oil.
- The machine surface since to be cleaner and more fine surface finishing better than compared its superior to that
of with EDM oil. Some values are slightly greater than the EDM oil. Where with moderate level of SR is required then RSO can be used in place of EDM oil.

- With moderate amount of MRR, SR is as application then the RSO will use as alternate for EDM oil.
- The cost of RSO is so much cheaper than EDM oil. RSO can be easily available. Dielectric contamination is also very less compared with EDM oil.
- No Carbon soot formation is observed from SEM images. So the Work piece and tool properties will remains unaltered by using the RSO.

ACKNOWLEDGMENT
The present work is carried out at Centurion University of Technology and Management, India and the authors are thankful to the management for availing the machining facilities of EDM and other testing facilities.

REFERENCES


Impact Factor (JCC): 8.8746  SCOPUS Indexed Journal  NAAS Rating: 3.11
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