A COMPARATIVE STUDY IN FINDING THE MRR OF H30 AND SS304 MATERIAL IN EDM PROCESS

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ABSTRACT:

In the present paper reviews is conducted of experimental investigations carried out to study the effect of EDM parameters on material removal rate (MRR), electrode wear (EWR), surface roughness (Ra) and dia material overcut in corrosion resistant stainless steels. The non-contact machining technique has been continuously evolving from a mere tool and die making process to a micro-scale application machining alternative attracting a significant amount of research interests and Electrochemical machining (ECM) offers several special advantages including higher machining rate, better precision and control, and a wider range of materials that can be machined.The objective of this paper is to present the results of a study on the effect of the wire electric discharge machining of stainless steel SS-304 and H30 for machining of micro gear. It is observed that for micro gear manufacturing using wire EDM process under the electrical parameters i.e current (ampere), pulse on time (second) and pulse off time (second) defects like pitting, surface oxidation; white layer formation was almost completely removed.

1.0 INTRODUCTION:

EDM is most widely and successfully applied process in machining of hard metals or those that would be very difficult to machine with traditional techniques. The material is removed from the work piece by the thermal erosion process, i.e., by a series of recurring electrical discharges between a cutting tool acting as an electrode and a conductive workpiece in the presence of a dielectric fluid. This discharge occurs in a voltage gap (Vg) between the electrode and work piece. Heat from the discharge vaporizes minute particles of work piece material, which are then washed from the gap by the continuously flushing dielectric fluid This technology is increasingly being used in tool, die and mould making industries, for machining of heat treated tool steels and advanced materials (super alloys, ceramics, and metal matrix composites) requiring high precision, complex shapes and high surface finish. Traditional machining technique is often based on the material removal using tool material harder than the work material and is unable to machine them economically. EDM is one of the most popular non-traditional material removals process and has become basic machining method for the manufacturing industries of aerospace, automotive, nuclear and medical with the increasing demands of high surface finish and machining of complex shape geometries, conventional machining process are now being replaced by non-traditional machining processes.

Wire-cut EDM Wire:

EDM also called electric discharge wire cutting process used for producing two or three dimensional complex shapes using an electro thermal mechanism for eroding the material from a thin single stranded by guide rulers metal wire surrounded by deionized water which is used to conduct electricity. Any hard material can cut by wire EDM process, but the material should have an electrical conductive properties. The electrode wire is commonly made of brass or copper material. The diameter range of wire is 0.5 to 0.25 mm. The wire is wound on a two wire spool which is rotated in the same direction to strand the wire. The speed of wire movement is up to 3 m/min.

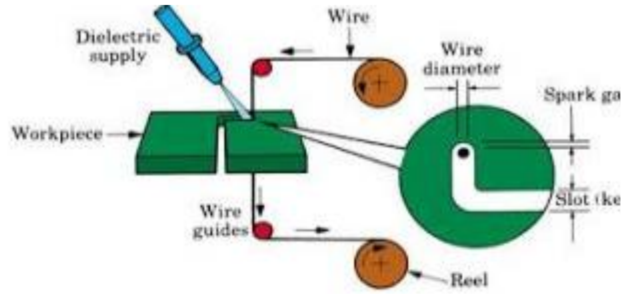


Figure: Wire EDM Machining process

Application of EDM:

- The EDM process is extensively used because of its many advantages over traditional machining. Its chief applications are in the manufacture of press tool and forging dies as well as molds making for injection moulding.
- EDM has also successfully employed for producing intricate and irregular shaped profiles or outline common in tool rooms.
- Small diameter holes in carbide or hardened steel can be machined by tube type electrodes of copper tungsten, using a micro machining attachment.

2.0 LITERATURE REVIEW:

P. srinivasaraoet. al. [1] studied the influence of the most relevant EDM factors over MRR, tool wear rate (TWR), Ra and hardness of ss 304 by copper tool electrode. In order to achieve factorial design of experiments and multiple regressions analysis techniques have been employed to model the previously mentioned response variables by means of equations in the form of polynomials. In the case of MRR, all the design factors are influencing for a confidence level of 95% and arranged in descending order of importance, servo voltage, dutycycle, current and voltage In order to obtain the high value of MRR the workinterval of current, servo and dutycycle (t) should be fixed as high as possible

AsifIqbalet. al.[2] established empirical relations regarding machining parameters and the responses in analyzing the machinability of the SS 304 using copper electrode. The machining factors used were voltage, rotational speed of electrode and feed rate over the responses MRR, EWR and SR. The response surface methodology was used to investigate the relationships and parametric interactions between the three control variables on the MRR, EWR and SR. The developed models show that the voltage and rotary motion of electrode are the most significant machining parameters influencing MRR, EWR and SR

S.Gopalakannanet. al. [3] investigated the effect of pulsed current on material removal rate, electrode wear, surface roughness and diameteral overcut in corrosion resistant stainless steels viz., ss316 L and 17-4 PH. They observed that the output parameters such as MRR, EWR and Ra of EDM increase with increase in pulsed current. The results reveal that high MRR have been achieved with copper electrode whereas copper-tungsten yielded lower electrode wear, smooth surface finish and good dimensional accuracy.

R Thanigaivelanet. al. [4] investigated the effect and parametric optimization of process parameters for electrochemical micromachining (EMM) ofSS 304 using grey relational analysis, by using machining voltage, pulse on-time, electrolyte concentration and tool tip shapes as typical process parameters The experimental results revealed that, the conical with rounded electrode, machining voltage of 9V, pulse on-time of 15ms and electrolyte concentration of 0.35mole/l was the optimum combination for higher machining rate and lesser overcut. The experimental results for the optimal setting showed that there was considerable improvement in the process.

2.0 METHODOLOGY:

In this experiment 304 stainless steel of size 80×50×5 mm3 plate is chosen for conducting the experiment. Grade 304,H30 is the most versatile applications and greatest use of stainless steel, offered in an extensive variety of good products, practices and qualities than any other. It has wonderful welding and forming characteristics. Grade 304 is freely brake or spool molded into a variability of work uses in the manufacturing, construction as well as automobile fields. The austenitic configuration provides these grades brilliant toughness, straight down to lower hotness.Experiments are conducted with straight polarity i.e. electrode is connected with negative terminal of power supply system. The pulsed discharge voltage is applied in various steps. External pressure flushing is used to flush the EDM oil between the spark gap. High Speed Steel is used as a work piece material and a cylindrical shaped copper tool with 6 mm in diameter is used as an electrode. The layout of design of experiment is based on L9 orthogonal array. In this experiment pulse off time, duty cycle, flushing pressure, spark gap and concentration of powder are kept constant 8µs, 6%, 0.3 kgf/cm2, 0.02 mm and 10g/l respectively. A constant spark gap can be maintained with the help of a servo control mechanism. Total eighteen number of experiments are performed out of which nine experiments are conducted by using EDM oil as a dielectric medium and the remaining nine experiments are conducted by using Silicon powder mixed EDM oil as dielectric medium. An electronic weighing machine is used to weigh the work piece before and after experiment for calculation of material removal rate. The capacity of weighing machine is 300 gram and accuracy is 0.001 gram

Selection of tool material:

In this experiment Tungsten carbide rod of 10×100 mm2 used. Tungsten carbide products are famous for their heat resistance, toughness and good machinability. One of the products of tungsten carbide are the solid tungsten carbide rods that are used for cutting dissimilar alloys, cast iron, stainless steel, refractory alloy steel, nickel based alloy, titanium alloy and other nonferrous metals. The solid tungsten carbide rods are offered as a ground and unground with metric or inch standards. These rods possess the features of good wear resistance and corrosion resistance.

Mechanism of MRR:

Mechanism behind material removal of EDM process is based on the conversion of electrical energy to thermal energy that categorized it to electro thermal process. During machining both the surfaces may have present smooth and irregularities causes minimum and maximum gap in between tool and work piece. At a given instant at minimum point suitable voltage is developed produces electrostatic field for emission of electrons from the cathode there electrons accelerated towards the anode

Characteristics of EDM:

(a) The process can be used to machine any work material if it is electrically conductive

(b) Material removal depends on mainly thermal properties of the work material rather than its strength, hardness etc

(c) In EDM there is a physical tool and geometry of the tool is the positive impression of the hole or geometric feature machined

(d) The tool has to be electrically conductive as well. The tool wear once again depends on the thermal properties of the tool material

(e) Though the local temperature rise is rather high, still due to very small pulse on time, there is not enough time for the heat to diffuse and thus almost no increase in bulk temperature takes place.

Table: Specification on EDM

Characteristics	Range
Mechanism of process	Controlled erosion i.e. melting and evaporation aided by cavitation
Spark gap	10 - 125 µm
Spark frequency	200 – 500 kHz
Maximum material removal rate	5000 mm3 /min
Shape application	Micro-holes for nozzles, thin slots, visionless complex craters.

4.0 Experimental analysis:

Experimental works have been undertaken for data collection on the Die Sinking EDM placed in the CNC Laboratory of Tool Room Training Centre, The experiments were conducted on a die-sinking EDM. Its specifications are given in Table. The workpiece material used was stainless steel (SS304). The tool material was H30. Straight polarity was used throughout the experiment. During experiment, there were some parameters which were kept constant throughout. These parameters with their values are given in Table. The dimensions of the tool and electrode The di-electric fluid used was SERVO oil

Optimum cutting parameters:

pulse on time	level
input parameter	2
pulse	3
Duty Cycle	2
Gap Voltage	2

In order to see the effect of process parameters on the MRR, experiments were conducted using L9 OA Performance characteristics chosen for present investigation was material removal rate and surface roughness The value for all 18 specimens with silicon powder and without silicon powder was measured and corresponding data is displayed in Table.

This is due to the fact that, the powder particles form a chain with the effect of electric forces at different places in the sparking zone. The formation of chain helps in bridging the gap between the tool and work piece

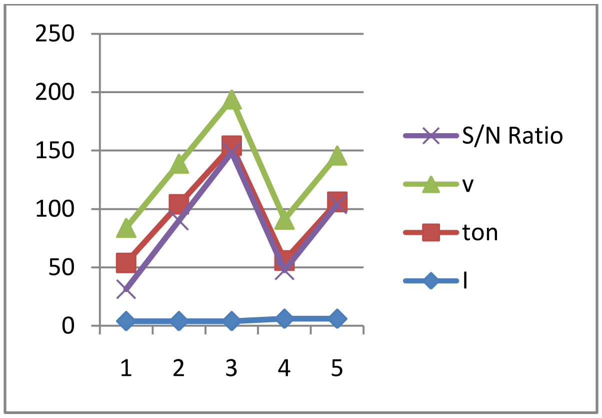
Work material & cutting tool:

In present study, High Speed Steel is used as a workpiece material. The work piece mounted on fixture is shown below in figure2 and a cylindrical shaped H30 having 6 mm diameter is used. Shape of the tool produces the same cavity in the work piece. Using the cylindrical tool, circular hole is produced in the work piece surface.

Figure: H30 material

Experimental cutting results forH30 material:

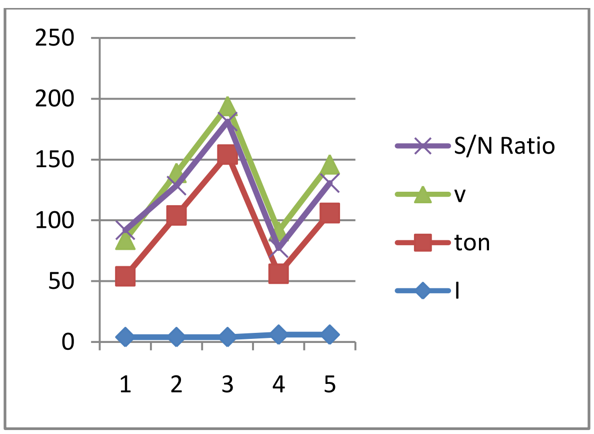
I	ton	v	S/N Ratio
4	50	30	-52.7278
4	100	35	-48.9710
4	150	40	-45.4818
6	50	35	-43.6619
6	100	40	-41.9927



Graph: cutting results for H30 material

Table: Experimental cutting results for SS 304 material:

I	ton	v	S/N Ratio
4	50	30	7.8187
4	100	35	-10.5009
4	150	40	-12.8096
6	50	35	-13.8569
6	100	40	-15.2985



Graph: Experimental cutting results for SS 304 material

From results clearly definite that current is the most effective factor for material removal rate followed by pulse on time and last is the voltage As the value of current and pulse on time increases, the MRR also increase.find out the most significant values of different process parameters like current, pulse on time and voltage to maximize the MRR and to minimize the SR. For this work, a bit of H30 having 140mm in length and 10mm in width is used as a work to study the machining effect on SS 304 work piece material. The experimental design was based on Taguchi technique. It was observed that the copper material was more suitable for electrode material and current was the most effective parameter followed by pulse on time and pulse off time. For all the three electrodes the authors also observed that, increase in current and pulse on time, the overcut also increase and as the pulse off time increases then overcut decreases. Observed the effect of process parameters for electric discharge machining on stainless steel 304 using copper electrode Compressed air was used as dielectric medium. The process parameters selected were discharge current, pulse on time, spindle speed and duty cycle. The layout of design of experiment was based on central composite design (CCD). From results it was concluded that MRR was influenced by discharge current followed by pulse on time and duty factor.

CONCLUSION:

In this investigational experiment on EDM to know the effect of machining outputs taken for consideration are material removal rate and surface roughness of the SS 304 work piece using the solid tungsten carbide tool with side flushing method have been investigated. Both these outputs are important in industrial applications.The process parameters selected were discharge current, pulse on time and flushing pressure. It was observed that, discharge current was the most effective parameter for MRRA constant spark gap can be maintained with the help of a servo control mechanism. EDM as a dielectric medium and the remaining nine experiments are conducted by using An electronic weighing machine is work piece before and after experiment for calculation of material removal rateFrom results clearly definite that current is the most effective factor for material removal rate followed by pulse on time and last is the voltage As the value of current and pulse on time in the MRR also increase

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