Optimization of Non Electrical & electrical parameters in EDM for Machining Die Steel with the use of Copper Electrode by Applying the Tagauchi Technique

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Abstract— *Electrical Discharge Machining (EDM) is one of the most popular non-traditional machining processes used for machining conducting materials which are difficult to machine by convectional machining process. EDM is thermo-electric process in which metal melts and vaporizes and rapidly cool by dielectric forming debris and thus metal is removed by flushing process. The present work explores the machining conditions which include the effect of parameters like current, pulse on time, pulse off time, concentration of metal powder in dielectric on the MRR and EWR. It is attempted to find the optimal machining conditions for machining HCHCr steel using copper as tool. The experimental study was conducted on die sink type EDM located in institution central mechanical work shop. The design of experiment was conducted using Taguchi method of parametric design where in current, pulse on time pulse off time, mixed dielectric powder were selected and their effect on performance characteristic were MRR and EWR were studied. Experimental trials were conducted and result showed that current is the most significant parameter that influenced the machining response parameters like MRR and EWR.*

Keywords— EDM, EWR, tool wear, current.

1. INTRODUCTION

The era of conventional machining, it has been used the machine like lathe, shaper and milling machines for material processing. Here initially the carbon steel tool where used for cutting and productivity was furthered increased with the advancement in cutting tool. The invention of tungsten carbide tools facilitated the machining and material removal rate (MRR) manifolds. With the development of 3D milling machines and machining centres, an innovative and versatile tool for productivity improvement has been developed. Researcher investigated into the theoretical models of the EDM process and reported that spark discharge causes the release of electrical energy, which is converted into thermal and mechanical energy. As a result, certain volume of work piece material and also electrode material are heated to melting and vaporizing temperatures and thrown out in an explosion manner by mechanical and electrical forces. This process leave tiny pits and craters on the work and electrode surfaces, the size of such craters being dependent on the energy content of the spark. If high pulse energy is used, the craters will be relatively large, producing a rough surface. This type of eroding is called “roughing’. On the other hand, the use of low pulse energy will lead to smaller craters and thus smoother surface, the process being called “finishing”. The large number of mutually overlapping discharge craters results in a pitted structure of the surfaces, causing certain roughness and giving spark eroded surfaces, a characteristic matte appearance without any directionally oriented tool marks. The particles removed are carried off from the gap by the dielectric with the aid of a pressure or vacuum flushing arrangement and are later separated from the liquid in a filtration unit. The rate of stock removal is dependent on the polarity of the work electrode and tool electrode. The dielectric liquid has the function of reducing the cross-sectional area of the discharge channel to increase the energy density, i.e., to concentrate the energy of the spark on a small area and thus increase the efficiency of stock removal. In addition, the dielectric has a shielding function by preventing the access of air; detrimental oxidation will be eliminated during spark discharges. Finally, apart from cooling the work piece and the electrode, the dielectric serve the purpose of flushing the spark gap for the removal of debris. The process can be applied, in general, to any electrically conductive material. Other properties like strength, brittleness etc. do not impose any restrictions to the application of the EDM process. There are no physical cutting forces between the tool and work piece. Due to the process capability EDM has proved especially valuable in the machining of super tough materials such as the new space age alloys.

2. Literature Review

Extensive research in the field of EDM has led to better understanding of the phenomenon of metal removal rate by employing high energy electrical impulses. The key interest of scientists and technologists has been the development of efficient generators leading to higher rates of metal removal with excellent surface finish and low tool wear. This has lead to development of EDM machines with numerical and adaptive controls. In the section attempt has been made to club the work of different authors working on the same or similar array.

P. Janmanee [2] studied the electrical factor respond for MRR, EWR, Surface roughness for machining tungsten carbide as work piece and copper graphite as tool. He concluded that current in majorly responsible for MRR and surface roughness. Crack density increase with increase in discharge current across the gap.

C Bhagat et al. [3] investigated the controlling variable effect on the responding variable surface roughness for machining die steel with copper tungsten electrode and their optimization. In controlling parameters he varied voltage, current, pulse on time and pulse off time. He opted Taguchi method for optimizing the controlling variables for lower surface roughness. He concluded that current is dominating factor responsible for surface roughness.

R. Choudhary [4] studied the effect of various tool material (copper, brass, graphite) on the heat affected zone of work piece material EN-31while machining on EDM. Experimental study showed that graphite showed best response for MRR while copper tool show good response toward MRR. Brass tool gives superior surface finish but moderate MRR. In microstructure analysis, he observed deeper heat affected zone in work piece for graphite tool compared to copper and brass tool.

M.L Jeswani et al. [5] carried out the research by the addition of fine graphite powder into kerosene oil on the machining of tool steels. It was resulted out that the addition of 4 g/l of graphite powder increases the interspace for electric discharge initiation and lowered the breakdown voltage.MRR increases up to 4g/L and after that arching is taking place which has resulted in further lowering MRR.

G.Chakraverti [6] compared the tool rotation effect and stationary tool on the performance parameters. Centrifugal force generated causes more debris to remove faster from machining zone, preventing arching and improves MRR. He concluded that the rotation of tool enhances fresh dielectric induce in machining area there by taking debris particle away from the machining zone. MRR has been increased at the cost of tool wear.

3. Methodology

Selection of tool and work piece

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Determination of mechanical and chemical properties of tool and work piece

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Preliminary study and identification of controlling parameters which affects output variable like MRR, EWR

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Design of experiment using Taguchi orthogonal array

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Experiment trials to yield the output characteristics for each row of control matrix

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Application of Taguchi to find signal to noise ratio to yield optimal solution

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Conducting ANOVA test for checking significance of control parameters variability

4. RESULTS & CONCLUSION

Material removal rate

- Material removal rate is mainly affected by current followed by pulse on time and concentration of copper powder in dielectric fluid. MRR is least affected by pulse off time.
- Peak current is majorly contributes for MRR. MRR increases with increasing current across the spark gap.
- MRR increases with increasing copper concentration in dielectric concentration.

Optimal setting for MRR in the experiment level is as

Current - 10 Amp

- Pulse on time – 50 µ sec
- Pulse off time – 20 µ sec
- Copper concentration in dielectric fluid – 50 grams

Tool wear rate

- Tool wear rate is mainly affected by current and it decreases with increasing current. Tool wear rate is least affected by pulse off time.
- Tool wear rate increases with increasing copper powder concentration in dielectric medium.
- Tool wear rate increases with increasing pulse on time.

Optimal setting for EWR in the experiment level is as

- Current - 10 Amp
- Pulse on time – 50 µ sec
- Pulse off time – 50 µ sec

Copper concentration in dielectric fluid – 0 grams

REFERENCES

[1] C. khattare (2009), A phd. Thesis on " Analysis of surface integrity in electrical discharge machining process for tungsten carbide material" submitted to Department of mechanical engineering – Thapar university, Patiala.

[2] P. janmanee(2011) , "Optimization of EDM of composite 90WC-10Co based on taguchiapproch" *European journal of scientific research*, vol 64 No. 3, ISSN 1450-216X

[3] T.C Bhagat, B.L. Seth , HS payal (2012), "Optimization of EDM process parameters for surface roughness machining of die steel using copper tungsten electrode by Adopting Taguchi array design ", Indian journal of technology, vol 5, issue 10, ISSN 0974-6846

[4] R. chaudhry (2010), "Analysis and evaluation of heat affected zone in discharge machining of EN 31 die steel", *Indian journal of engineering and material science*, vol 17 pp.91-98

[5] M.L Jeswani (1981); "Effect of addition of graphite powder to kerosene used as dielectric fluid in EDM", *journal of wear,* vol 70 , pp133-139.

[6] J.SSoni.; G.Chakraverti,(1997), " Performance evaluation of rotary EDM by experimental design technique" , *Defense Science journal*, vol. 47, No.1, pp 65-73