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Performance analysis and process optimization of EDM parameters on Inconel 600 with copper electrode

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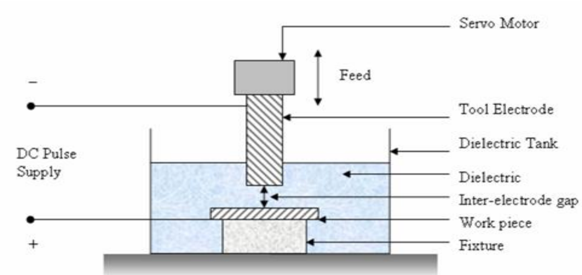
***Abstract*— In recent years, numerous developments in micro-EDM focus on the fabrication of micro-holes, micro-tools and micro components. Although micro-holes are formed by different manufacturing methods, micro-EDM proves to be one of the most promising manufacturing technologies. Even though, micro-EDM is found to be capable of manufacturing micro-holes regardless of hardness, the study on quality and integrity of discharge machined surface is shown important as it has a significant impact on the product performance. Since an electrode with micro features is employed to cut its mirror image in the work piece, it is necessary to investigate the machining efficiency of the electrodes used. Furthermore, to improve the machining efficiency, it is momentous to consider the effect of various influencing input and output parameters. In this project, a series of experiments were conducted with copper electrode as a tool and Inconel steel as work piece to machine small depth on the work piece. The combination of gap voltage, Ampere setting were new line considered for maximum Material Removal Rate (MRR), Surface Roughness (SR), constrained circularity error and overcut. The main aim was to identify the electrode which could enhance the production of quality of impression and to have a significant contribution for modern industrial requirements. . Current investigation on EDM process is a ANOVA optimization technique applied on the most effective process parameters i.e. Ampere rating, sparking voltage while machining**

***Index Terms*— Material removal rate, surface roughness, ANOVA, Ampere rating.**

I. INTRODUCTION

1.1 Electric Discharge Machining

Electric discharge machining is a thermo-electric non-traditional machining process. Material is removed from the work piece through localized melting and vaporization of material. Electric sparks are generated between two electrodes when the electrodes are held at a small distance from each other in a dielectric medium and a high potential difference is applied across them. Localized regions of high temperatures are formed due to the sparks occurring between the two electrode surfaces. Work piece material in this localized zone melts and vaporizes. Most of the molten and vaporized material is carried away from the inter-electrode gap by the dielectric flow in the form of debris particles. To prevent excessive heating, electric power is supplied in the form of short pulses. Spark occurs wherever the gap between the tool and the work piece surface is smallest. After material is removed due to a spark, this gap increases and the location of the next spark shifts to a different point on the work piece surface. In this way several sparks occur at various locations over the entire surface of the work piece corresponding to the work piece-tool gap. Because of the material removal due to sparks, after some time a uniform gap distance is formed throughout the gap between the tool and the work piece. Thus, a replica of the tool surface shape is formed on the work piece as shown in Figure 1.1. If the tool is held 3 stationary, machining would stop at this stage. However if the tool is fed continuously towards the work piece then the process is repeated and more material is removed.



II. EDM PROCESS

THEORIES OF MATERIAL REMOVAL

The removal of material in electrical discharge machining is based upon the erosion effect of electric sparks occurring between two electrodes. Several theories have been forwarded in attempts to explain the complex phenomenon of "erosive spark". The following are the theories

ELECTRO-MECHANICAL THEORY

This theory suggests that abrasion of material particles takes place as a result of the concentrated electric field. The theory proposes that the electric field separates the material particles of the work piece as it exceeds the forces of cohesion in the lattice of the material. This theory neglects any thermal effects. Experimental evidence lacks supports for this theory.

THERMO-MECHANICAL THEORY

This theory suggests that material removal in EDM operations is attributed to the melting of material caused by "flame jets". These so - called flame jets are formed as a result of various electrical effects of the discharge. However, this theory does not agree with experimental data and fails to give a reasonable explanation of the effect of spark erosion.

THERMO-ELECTRIC THEORY

This theory, best-supported by experimental evidence, suggests that metal removal in EDM operations takes place as a result of the generation of extremely high temperature generated by the high intensity of the discharge current.

GENERAL EXPERIMENTAL SETUP

Two electrodes were machined to a cylindrical shape of 14 mm diameter and 50mm length. A plate of 200 mm ×60 mm size and thickness 18 mm of OHNS die steel was taken. It was subjected to a standard hardening cycle and it has a hardened at the range of 40 to 45 HRC.

One surface of the work piece was then ground on a surface grinder to remove surface irregularities and minor scaling. The hardness of this surface was measured on Rockwell Hardness Tester C scale using a diamond cone. After mounting the work piece and one of the electrodes on the machine, the depth of machining was set at 25mm. The work piece was machined with 15 A discharges current and other standard machine settings. The time of machining was recorded in minutes and final weights of the work piece were taken. The machining cycle was repeated for the next value of discharge current. Similarly, the observations were made for the other two electrodes.

For each electrode material, the effect of variation in discharge current was studied on output parameters, namely, material removal rate (MRR), machined surface roughness. Surface roughness readings were taken on the bottom surface of the machined cavity. Surface roughness was measured on Surf test equipment giving Ra value in microns

EDM APPLICATIONS

This section discusses some of the applications of EDM commonly found in the industry. It also includes other experimental interests providing a feasible expansion of EDM applications.

Heat-treated materials

In some applications, EDM has replaced traditional machining processes such as the milling of heat-treated tool steels. Milled material has to be within an acceptable hardness range of less than 30–35 HRC with ordinary cutting tools. However, EDM allows tools to be treated to full hardness before machining, avoiding the problems of dimensional variability, which are characteristic of post-treatment.

Since EDM does not induce mechanical stresses during machining, it provides an additional advantage in the manufacture of intricate products carried out several successful experiments involving an electrode of 50 μm diameter and a multi-electrode for the batch production of micro-parts. The proposed method significantly reduces the production time and costs of fabricating both the electrodes and parts

III. WORK MATERIAL

INCONEL® alloy 600 – A Ni-Cr-Fe alloy with résistance to stress-corrosion cracking and caustic corrosion, and with high-temperature strength and oxidation-resistance. Used for chemical and petrochemical processing, nuclear and automobile engineering and thermal processing. Available as billet, rod and bar, flat products, seamless, tubing and wiring.

MACHINING PARAMETERS (GENERAL)

Sparking Voltage (V)	V80±5%
Discharge Current (A)	15,11,10,8,7,6,5,4
Servo Control	Electro Mechanical
Polarity	Normal (Electrode – Positive)
Dielectric fluid	Commercial Grade Kerosene
Flushing side	Flushing with Pressure
Work piece Material	Inconel 600

PROCESS PARAMETERS AND THEIR LEVELS

S.no	Pulse ON time	Current	voltage
1	100	30	20
2	150	40	24
3	200	50	28

Optimal level values for roughness from graph

Process parameters	Levels	Roughness response values	S/N response values(db)
A	3	5.464	-14.72
B	2	5.633	-15.01
C	1	5.814	-15.24

IV. MACHINING OBSERVATIONS

Sample	Flushing ressure /cm^2	Pulse on time µs	Discharge current A	Gap voltage v	RA Micron	Machining time minutes	MRR
1OR A	2.5	100	30	20	5.185	44	0.172273
2 OR B	2.5	100	40	24	5.879	31	0.227419
3 OR C	2.5	100	50	28	8.118	22	0.382273
4 OR D	2.5	150	30	24	5.440	24	0.315833
5 OR E	2.5	150	40	28	5.394	53	0.147925
6 OR F	2.5	150	50	20	6.630	36	0.129444
7 OR G	2.5	200	30	28	5.866	62	0.13371
8 OR H	2.5	200	40	20	5.627	42	0.180476
9 OR H	2.5	200	50	24	4.899	58	0.162241

V. CONCLUSIONS

In this study, the Taugchi technique and ANOVA were used to obtain optimal EDM parameters in the drilling of INCONEL STEEL under sink EDM conditions. The experimental results were evaluated using ANOVA. The following conclusion can be drawn .As a result of the Taugchi experimental trials, it was found that the type of gap current were the most significant factor improving the surface roughness with contribution percentage of 56.83% respectively. The optimum control factor for both Machining time A1 B3 C2 (Pulse on time100 Gap current 50 Gap voltage24)

REFERENCE

1. Guu Y.H. et al, (2003) 'Effect of electrical discharge machining on surface characteristics and machining damage of AISI D2 tool steel', Materials Science and Engineering, Vol 358, pp37-43.

2. Guu, Y.H.(2001) 'AFM surface imaging of AISI D2 tool steel machined by the EDM process', Applied Surface Science, Vol242, pp 245–250.

3. Pecas, P, et al. (2008) 'Electrical discharge machining using simple and powder-mixed dielectric: The effect of the electrode area in the surface roughness and topography', journal of materials processing technology, vol 200, pp250–258.

4. Kansal, H.K, et al., (2005) 'Parametric optimization of powder mixed electrical discharge machining by response surface methodology', Journal of Materials Processing Technology, vol169, pp427–436.

5. Prabhu.S, et al (2008) 'Analysis of Surface Characteristics of AISI D2 Tool Steel Material Using Carbon Nano Tube', International journal of nanotechnology and application, Vol 2, No 2-3,Pp 107-122.

6. Prabhu.S, et al (2008) 'Nano surface generation in grinding process using carbon nano tube with lubricant mixture', International journal of nanotechnology and application, Vol 2, No 2-3, Pp 149-160.