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EXPERIMENTAL INVESTIGATION ON ELECTRICAL DISCHARGE MACHINING (EDM) OF STAINLESS STEEL ALLOY MATERIAL USING HEXAGONAL COPPER ELECTRODE FOR IMPROVING GEOMETRICAL ERRORS

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INTRODUCTION

UNCONVENTIOANLMACHININGPROCES:

An unconventional machining process (or non-traditional machining process) is a special type of machining process in which there is no direct contact between the tool and the work piece. In unconventional machining, a form of energy is usedtoremoveunwantedmaterialfromgivenworkpiee .If such materials are machined with the help of conventional machining processes, either the tool undergoes extreme wear (while machining hard work piece) or the work piece material is damaged (while machining brittle work piece)

BASED ON THE TYPES ENRGY USED: Mechanical Energy based Unconventional Machining Processes (e.g. Abrasive Jet Machining Water Jet Machining).Electro- Chemical energy based Unconventional machining process (e.g. Electrochemical Grinding)Chemical Energy based Unconventional Machining Processes (e.g. Chemical Machining).Thermo-electrical (or Electro-thermal) Energybased Unconventional Machining Processes (e.g. Plasma Arc Machining).

TYPES OF UNCONVENTIONAL MACHINING PROCESS:

- ✓ Abrasive Jet Machining(AJM)
- ✓ Water Jet Machining (WJM)
- ✓ Ultrasonic Machining(UM)
- ✓ Electron Beam Machining(EBM)
- ✓ Laser Beam Machining(LBM)
- ✓ Electro-Chemical Machining(ECM)
- ✓ Electro-Chemical Grinding(ECG)
- ✓ Electrical Discharge Machining(EDM)
- ✓ Die Sinking EDM.
- ✓ Wire Cut EDM.

ELECTRICAL DISCHARGE MACHINING (EDM):PRINCIPLE OF EDM:

Electrical Discharge Machining (EDM) is a controlled metal-removal process that is used to remove metal by means of electric spark erosion. In this process an electric spark is used as the cutting tool to cut (erode) the work piece to produce the finished part to the desired shape. The metal- removal process is performed by applying a pulsating (ON/OFF) electrical charge of high-frequency current through the electrode to the work piece. This removes (erodes) very tiny pieces of metal from the work piece at a controlled rate.

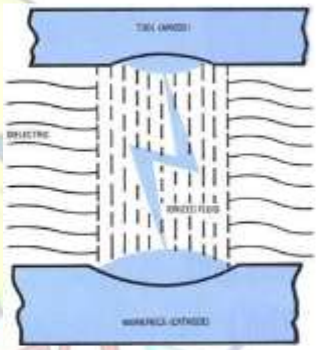

Figure 1.1 Tool and Work piece Spark Gap.

EDM spark erosion is the same as having an electrical short that burns a small hole in a piece of metal it contacts. With the EDM process both the work piece material and the electrode material must be conductors of electricity.A pre shaped or formed electrode (tool), usually made from graphite or copper, is shaped to the form of the cavity it is to reproduce. The formed electrode is fed vertically down and the reverse shape of the electrode is eroded (burned) into the solid work piece.A continuous-travelling vertical-wire electrode, the diameter of a small needle or less, is controlled by the computer to follow a programmed path to erode or cut a narrow slot through the work piece to produce the required shape.

Conventional EDM

In the EDM process an electric spark is used to cut the work piece, which takes the shape opposite to that of the cutting tool or electrode. The electrode and the work piece are both submerged in a dielectric fluid, which is generally light lubricating oil. Servo mechanism maintains a space of about the thickness of a human hair between the electrode and the work, preventing them from contacting each other.EDM is the thermal erosion process in which

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metal is removed by a series of recurring electrical discharges between a cutting tool acting as an electrode and a conductive work piece, in the presence of a dielectric fluid. This discharge occurs in a voltage gap between the electrode and work piece.

machining Characteristic: MRR, SR and EWR.

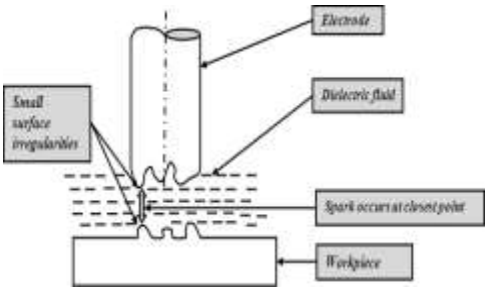
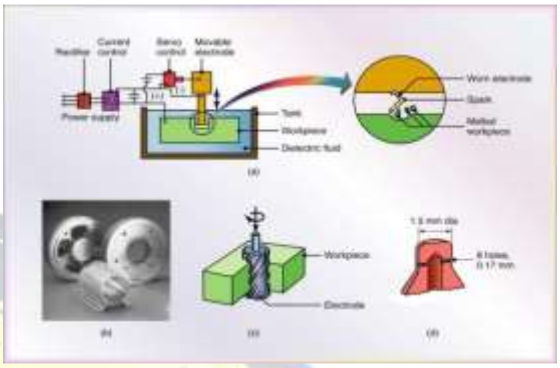


Figure 1.3 Sparking process

Basically, this characteristics' Parameters such as work piece polarity, pulse on time, duty factor tage, discharges current and dielectric fluid. Proper selection of the machining parameters can obtain higher material removal rate, better surface roughness, and Lower electrode wear ratio.



This Figure 1.4 EDM process

(a) Schematic illustration of the electrical-discharge machining process. This is one of the most widely used machining processes, particularly for die- sinking applications.

(b) Examples of cavities produced by the electrical- discharge machining process, using shaped electrodes. Two round parts (rear) are the set of dies for extruding the aluminium piece shown in front.

(c) spiral cavity produced by EDM using a slowly rotating electrode similar to a screw thread

(d) Holes in a fuel-injection nozzle made by EDM; the material is heat-treated steel.

DIE SINKING ELCTRICAL DISCHARGE MACHINING:

Prevents broken drills to prevent complications in drilling that traditional drilling that traditional drilling can't avoid due to improper control of torque conditions. Torque conditions don't exist in EDM because the electrode never touches the work piece; hence, broken drills become a thing of the past. Straight holes are produced because EDM drilling utilizes a non- contact process that avoids drifting in drills.EDM drilling machines are programmable so precision is guaranteed and automation is enjoyed for convenience.

DISADVANTAGE OF DIE SINKING EDM:

- ✓ It is only the Distilled water can be used and the other dielectric fluid not used.
- ✓ Due to the high electrode wear, the depth of blind holes is difficult to control.
- ✓ Considerable electrode wear results from die sinking EDM drilling. For Example, a two inch (51mm) depth can wear the electrode two inches (51mm) or more.

COMMON APPLICATION OF DIE SINKING EDM:

Coolant holes in hardened machine tool bits for taps, end mills, and drills.

Removal of broken drill bits and taps

Placement of holes too small/difficult for conventional drilling

Burr free holes.

LITERATURE REVIEW

Literature review is one of the scope studies. It works as guide to run this analysis. It will give part in order to get the information about electrical discharge machine (EDM) and will give idea to operate the test. From the early stage of the project, various literature studies have been done. Research journals, books, printed or online conference article were the main source in the project guides. This part will include almost operation including the test, history, machining properties and results. History of the electrical discharge machine (EDM) will be story little bit in this section. Literature review section work as reference, to give information and guide base on journal and other source in the media.

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FIGURE 3.4 CO ORDINATE MEASURING MACHINE (CMM)

3.7.3ANGULARITY:

Parallismwere measured with accuracy 4.5 microns as shown in figure 3.4.WORK PIECE MATERIAL: STAINLESS STEEL ALLOY TOOL MATERIAL: TRIANGLE

S.NO.	Parameters	Level 1	Level 2	Level 3
1	**Current (amp)**	15	16	17
2	**Pulse on Time(µs))**	10	11	12
3	**Pulse off Time (µs)**	6	7	8
4	**Dielectric Pressure (kg/cm²)**	24	25	26

WORKPIECE WEIGHT		**ELECTRODE WEIGHT**		**MACHINING TIME**
Before machining (g)	**After machining (g)**	**Before machining (g)**	**After machining (g)**	**min sec**
18.80	18.41	29.45	29.38	3.91
18.41	18.00	29.38	29.25	3.5
18.00	17.62	29.25	29.17	3.95
17.62	17.19	29.17	29.08	5.4
17.19	16.77	29.08	28.94	3.98
16.77	16.42	28.94	28.87	3.58
16.42	15.99	28.87	28.78	6.25
15.99	15.61	28.78	28.69	4.43
15.61	15.28	28.69	28.58	4.23

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RESULTS AND DISCUSSION

To find the material removal rate, tool wear rate, wear ratio, machining time, geometrical tolerance of Stainless Steel alloy steel.

DIE SINKING EDM FACTOR AND LEVEL OFSTAINLESS STEEL ALLOY MATERIAL

Table 4.1 Die sinking EDM factor and level of Stainless Steel Alloymaterial (Hexagonal copper Electrode)

INPUT PROCESSES PARAMETERS

Work piece material: stainless steeltool **material: hexagon**

TABLE 4.2Tabulation for input parameters

MACHINING TIME AND WEIGHING

TABLE 4.3Tabulation for Machining Time and Weighing

GEOMETRICAL TOLERANCE

TABLE 4.4 : TABULATION FOR GEOMETRICAL TOLERANCE

Ex. no	**Current (amp)**	**Pulse on time (μ sec)**	**Pulse off time(μ sec)**	**Dielectric pressure(kg/cm^2)**	**Spark gap voltage(v)**
1	15	10	6	24	
2	15	11	7	25	
3	15	12	8	26	
4	16	10	7	26	
5	16	11	8	24	
6	16	12	6	25	60 – 75
7	17	10	8	25	
8	17	11	6	26	
9	17	12	7	24	

WORK PIECE MATERIAL: STAINLESS STEELTOOL

CALCULATION ANALYSIS OF MATERIAL REMOVAL RATE:

WORK PIECE MATERIAL: STAINLESS STEEL

TOOL MATERIAL: HEXAGON
MATERIAL REMOVAL RATE (MRR):
Calculation of Material Removal Rate (MRR) for Stainless Steel Alloymaterial using pentagon electrode

$$MRR = \frac{\text{work pice weight for before machining} - \text{work pice weight for after machining}}{\text{machining time}} \text{ (g/min)}$$

$$MRR\ (g/min) = \frac{18.80-18.41}{3.91} = 0.0997\ (g/min)$$

$$2.\ MRR\ (g/min) = \frac{18.41-18.00}{3.5} = 0.1171\ (g/min)$$

$$3.\ MRR\ (g/min) = \frac{18.00-17.62}{3.95} = 0.0962\ (g/min)$$

$$4.\ MRR\ (g/min) = \frac{17.62-17.19}{5.4} = 0.0796\ (g/min)$$

$$5.\ MRR\ (g/min) = \frac{17.19-16.77}{3.98} = 0.1055(g/min)$$

$$6.\ MRR\ (g/min) = \frac{16.77-16.42}{3.58} = 0.0977\ (g/min)$$

$$7.\ MRR\ (g/min) = \frac{16.42-15.99}{6.25} = 0.0688(g/min)$$

$$8.\ MRR\ (g/min) = \frac{15.99-15.61}{4.43} = 0.0857\ (g/min)$$

$$9.\ MRR\ (g/min) = \frac{15.61-15.28}{4.23} = 0.0780\ (g/min)$$

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CALCULATION ANALYSIS OF TOOL WEAR RATE:

TOOL WEAR RATE (TWR):

Calculation of Tool Wear Rate (TWR) for Stainless Steel Alloymaterial using pentagon copper electrode

TWR=

$$\frac{\text{tool weight for before machining} - \text{tool weight for after machining}}{\text{machining time}}$$

(g/min)

TOOL WEAR RATE

1. TWR (g/min) $=\frac{29.45-29.38}{3.91}=0.0179$ (g/min)

2. TWR (g/min) $=\frac{29.38-29.25}{3.5}=0.0371$ (g/min)

3. TWR (g/min) $=\frac{29.25-29.17}{3.95}=0.0202$ (g/min)

4. TWR (g/min) $=\frac{29.17-29.08}{5.4}=0.0166$ (g/min)

5. TWR (g/min) $=\frac{29.08-28.94}{3.9}=0.0351$ (g/min)

6. TWR (g/min) $=\frac{28.94-28.87}{3.58}= 0.0195$ (g/min)

7. TWR (g/min) $=\frac{28.87-28.78}{6.25}=0.0144$ (g/min)

8. TWR (g/min) $=\frac{28.78-28.68}{4.43}=0.0203$ (g/min)

9. TWR (g/min) $=\frac{28.69-28.58}{4.23}=0.0260$ (g/min)

4.7 CALCULATION ANALYSIS OF WEAR RATIO:

WEAR RATIO

Calculation of Wear Ratio for Stainless Steel Alloymaterial using pentagon copper electrode

$$\text{WEAR RATIO} = \frac{\text{MATERIAL REMOVAL RATE}}{\text{TOOL WEAR RATE}}$$

1. Wear Ratio $= \frac{0.0997}{0.0179} = 5.569$

2. Wear Ratio $= \frac{0.1171}{0.0371} = 3.156$

3. Wear Ratio $= \frac{0.0962}{0.0202} = 4.762$

4. Wear Ratio $= \frac{0.0796}{0.0166} = 4.795$

5. Wear Ratio $= \frac{0.1055}{0.0351} = 3.005$

6. Wear Ratio $= \frac{0.0977}{0.0195} = 5.010$

7. Wear Ratio $= \frac{0.0688}{0.0144} = 4.777$

8. Wear Ratio $= \frac{0.0857}{0.0203} = 4.221$

9. Wear Ratio $= \frac{0.0780}{0.0260} = 3.00$

4.8 MAIN EFFECTS OF MRR OF STAINLESS STEELMATERIAL

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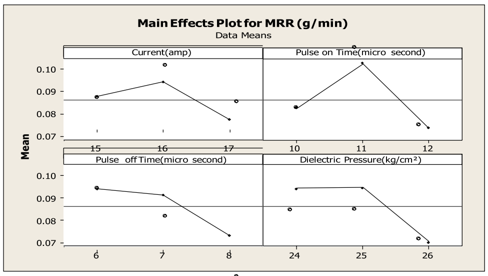

Figure 4.1Main Effects of MRR of Stainless Steel Material

Figure shows the effect of parameters on material removal rate (MRR) of Stainless Steel alloy using copper hexagon electrode. Maximum MRR is obtained at current level 2-16(amp),pulse on time level 2-11(micro second),pulse off time level 1-6(micro second),dielectric pressure level 2-25(kg/cm^2)

MAIN EFFECTS OF TWR OF STAINLESS STEEL ALLOY MATERIAL

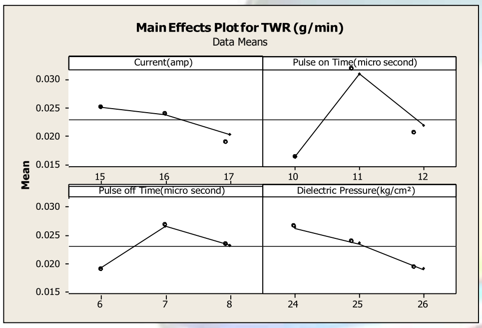

Figure 4.2Main Effects of TWR of Stainless Steel Alloy Material

Figure shows the effect of parameters on tool wear rate (TWR) of Stainless Steel alloy using copper hexagon electrode. Minimum TWR is obtained at current level 3-17(amp),pulse on time level 1-10(micro second),pulse off time level 1-6(micro second),dielectric pressure level 3-26(kg/cm^2).

MAIN EFFECTS OF WEAR RATIO OF STAINLESS STEEL MATERIAL

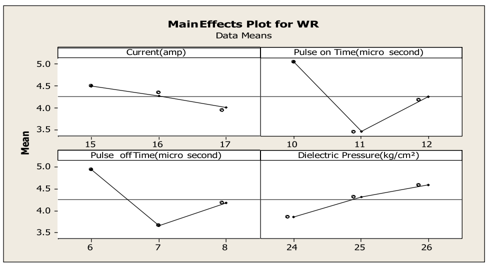

Figure 4.3 Main Effects of Wear Ratio of Stainless Steel Material

Figure shows the effect of parameters on wear ratio (WR) of Stainless Steel alloy using copper hexagon electrode. Minimum WR is obtained at current level 3-17(amp),pulse on time level 2-11(micro second),pulse off time level 2-7(micro second),dielectric pressure level 1-24(kg/cm^2).

4.11 MAIN EFFECT OF GEOMETRICAL TOLERANCE

4.11.1 ANGULARITY 1

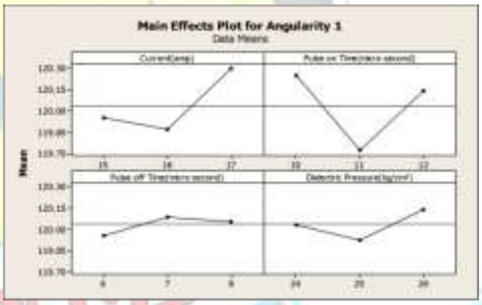

Figure 4.4Main Effect of Geometrical Tolerance for Angularity 1

Figure shows the effect of parameters on angularity of Stainless Steel alloy using copper hexagonelectrode.Minimum angularity 1 is obtained at current level 2-16(amp),pulse on time level 2-11(micro second),pulse off time level 1-6(micro second),dielectric pressure level2-25(kg/cm^2).

4.11.2 ANGULARITY 2

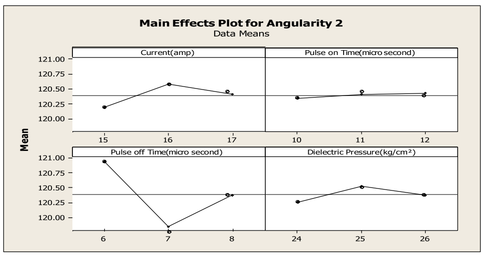

Figure 4.5Main Effect of Geometrical Tolerance for Angularity 2

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Figure shows the effect of parameters on angularity of Stainless Steel alloy using copper hexagonelectrode.Minimum angularity 2 is obtained at current level 1-15(amp),pulse on time level 1-10(micro second),pulse off time level 2-7(micro second),dielectric pressure level1-24(kg/cm^2).

4.11.3 PARALLELISM1

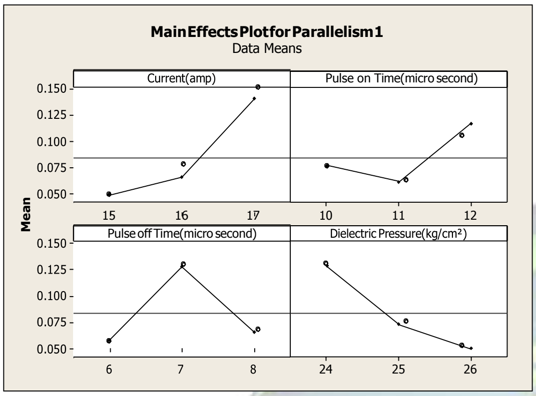

Figure 4.6 Main Effect of Geometrical Tolerance for Parallelism 1

Figure shows the effect of parameters on parallelism of Stainless Steel alloy using copper hexagon electrode.minimum parallelism 1 is obtained at current level 1-15(amp),pulse on time level 2-11(micro second),pulse off time level 1- 6(micro second),dielectric pressure level3- 26(kg/cm^2).

4.11.4 PARALLELISM 2

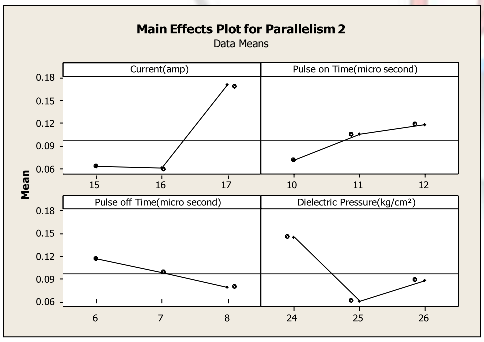

Figure 4.7Main Effect of Geometrical Tolerance for Parallelism 2

Figure shows the effect of parameters on parallelism of Stainless Steel alloy using copper hexagon electrode. Minimum parallelism 2 is obtained at current level 2-16(amp),pulse on time level 1-10(micro second),pulse off time level 3-8(micro second),dielectric pressure level 2-25(kg/cm^2).

4.12 MAIN EFFECT OF MACHINING TIME

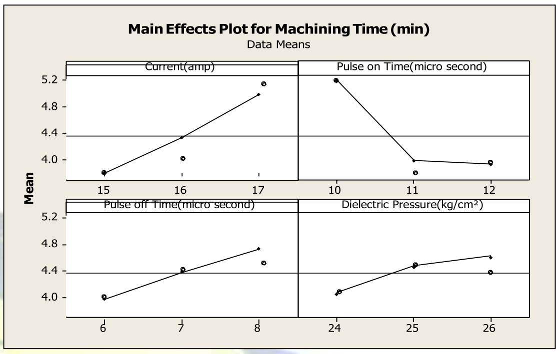

Figure 4.8Main Effect of Machining Time

Figure shows the effect of parameters on machining time of Stainless Steel alloy using copper hexagon electrode. Minimum machining time is obtained at current level 1-15(amp),pulse on time level 3-12(micro second),pulse off time level 1-6(micro second),dielectric pressure level 1- 24(kg/cm^2).

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WORKPIECE

Figure 4.9Workpiece Material

TOOL PHOTO

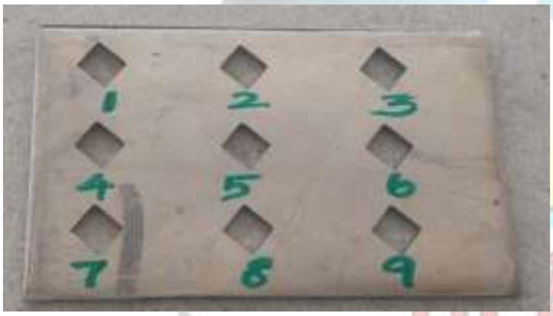

Figure 4.10Tool Material

CONCLUSION

In this paper, review of EDM research work related to MRR improvement has been presented along with some insight into the basic Electric Dischargemachining (EDM) process MRR mechanism. The major research development resulting in improvement in material removal rate (MRR) &Reduction tool wear is summarized.

EDM is now more economical non convectional machining process. It is used widely used on small scale as well major industries. EDM process is affect by so many process parameter which are electrical and non-electrical. In this project work the rotating tool is used to improve the Metal removal rate (MRR) and to observe its effect on surface finish. I am using Taguchi's method as a design of experiments and response surface

methodology for analysis and optimization. The machining parameters selected as a variables are pulse off time, pulse on time, servo voltage.

- When current increases, the MRR also increases. The higher thecurrent, intensity of spark is increased and results in high metalremoval rate.

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- When the current is increased, surface roughnessis also increased. When pulse-on-time increases, the MRR isdecreased.
- The three main significant factors affecting the value of the MRR are the current (I_P), pulse on time and the pulse off time. Form results, MRR hasbeen increases with increase current (Ip), pulse on time (µs) and decrease of pulse off time (µs). MRR increasing with increases pulse off time.
- The three main significant factors affecting the value of the EWR are the current (I_P), pulse on time and the pulse off time. Form results, EWR has been decreases with decrease current (Ip), dielectical pressure (kg/cm^2). The value of EWR decreases with decrease of pulse on time. However, EWR decreases with increase the pulse off time.
- The two main significant factors affecting the geometric tolerance of parallelism are the current (I_P), dielectical pressure (kg/cm^2). Form results, parallelism has been minimum with decrease of current (Ip), increase of dielectical pressure (kg/cm^2).
- The two main significant factors affecting the geometric tolerance of angularity are the current (I_P), dielectical pressure (kg/cm^2). Form results, angularity has been minimum with increase of current (Ip), decrease of dielectical pressure (kg/cm^2).

REFERENCE

E. Ferraris a,*, V. Castiglionib, F. Ceyssensc, M. Annonib, B. Lauwers (1)a, D. ReynaertsaEDM drilling of ultra-high aspect ratio micro holes with insulated tools CIRP Annals - Manufacturing Technology 62 (2013) 191–194

A. Krishnamoorthy a,⇑, S. RajendraBoopathy b,

K. Palanikumar c, J. Paulo Davim d Application of grey fuzzy logic for the optimization of drilling parameters for CFRP composites with multiple performance characteristics Measurement 45 (2012) 1286–1296

P. Kuppan& A. Rajadurai& S. Narayanan Influence of EDM process parameters in deep hole drilling of Inconel 718 Int J AdvManufTechnol (2008) 38:74–84

Che Chung Wang*, BiingHwa Yan Blind-hole drilling of Al2O3/6061Al composite using rotary electro-discharge machining Journal of Materials Processing Technology 102 (2000) 90±102

S. Singh and A. Pandey Some Studies into Electrical Discharge Machining of Nimonic75 Super Alloy Using Rotary Copper Disk Electrode JMEPEG (2013) 22:1290–1303

Nun-Ming Liu &Ko-Ta Chiang &Jenn-TsongHorng&Chih-Cherng Chen Modeling and analysis of the edge disintegration in the EDMdrilling cobalt-bonded tungsten carbide Int J AdvManufTechnol (2010) 51:587–598

Y.-F. Tzeng and N.-H. Chiu Two-Phase Parameter Design for the Optimisation of the Electrical-Discharge Machining Process Using a Taguchi Dynamic Experiment Int J AdvManufTechnol (2003) 21:1005–1014

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