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OPTIMIZATION OF PROCESS PARAMETERS FOR THE MACHINING OF INCOLOY 800HT ON EDM

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ABSTRACT
Electrical discharge machining (EDM) have Non-traditional machining processes work on the basis of thermo electric energy between the work piece and the electrode. This type of process, material removal by series of successive discrete electric discharges between electrode and the work piece .The performance of EDM process using different type of electrode material. The Material Removal Rate (MRR), Tool Wear Rate (TWR) and Surface Roughness (SR) are measures for detailed analysis by use of different electrode materials Brass, Copper and Copper Tungsten and work piece material as INCOLOY800HT have employed for the experiments. The dielectric fluid used as EDM Dielectric fluid. Objective of this project is show the best material in terms of higher MRR, lower TWR, and excellent surface finish

INTRODUCTION
EDM process is a developing technology lead to increase machining process and accuracy. Electro Discharge Machining (EDM) is the electro-thermal non-traditional machining process, in this type of process electrical energy is used to generate electrical spark and spark use to remove material due to thermal energy of the spark. EDM is used where machine difficult to- machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries on job-shop basis. Work material to be machined by EDM has to be electrically conductive. EDM Machining process is a non traditional method to produce any types of cavity in the any type of material. Using the different tool material, the performance of EDM can be improved. The experimental Set up of EDM(Fig.1)

Fig. 1 Experimental setup of EDM

1. Electrical Discharge Machine Process
In EDM a potential difference is applied between the tool and work piece. As shown in Fig. 2 (EDM process) both the tool and the work material are conductors of electricity. The tool and the work material are immersed in a dielectric medium. Generally kerosene or deionized used dielectric medium. A gap maintained between the tool and the work piece. Depending upon the applied potential difference and the gap between the tool and work piece, an electric field established. the tool is connected to the negative (Cathode) terminal of the generator and the work piece is connected to positive (Anode) terminal.the electric field is established between the tool and the job, the free electrons on the tool are produce electrostatic forces. the work function or the bonding energy of the electrons is less, electrons would be emitted from the tool (assuming it to be connected to the Negative terminal). that emission of electrons are called cold emission. The “cold emitted” electrons are then accelerated towards the job through the dielectric medium. As they gain velocity and energy, and start moving towards the job, there would be collisions between the electrons and dielectric molecules. Such collision may result in ionization the dielectric molecule depending upon the work function or ionization dielectric molecule and the energy of the electron. the electrons get accelerated, more positive ions and electrons would get generated due to collisions. This cyclic process would increase concentration of electrons and ions in the dielectric medium

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between the tool and the job at the spark gap. The concentration would be so high that the matter existing in that channel could be as “plasma”. The electrical resistance of such plasma channel would be very less. All of a sudden, a large number of electrons will flow from the tool to the job and ions from the job to the tool. This is called avalanche motion of electrons. Such movement of electrons and ions can be visually as a spark. the electrical energy is dissipated as the thermal energy of the spark. The high speed electrons then impinge on the job and ions on the tool. The kinetic energy of the electrons and ions on impact with the surface of the job and tool respectively would be converted into thermal energy or heat flux. Material removal occurs due to instant vaporization of the material as well as due to melting. The molten metal is not removed completely but only partiall . the electrons strike the job leading to crater formation due to high temperature and melting and material removal. Similarly, the positive ions impinge on the tool leading to tool wear. In EDM, the generator is used to apply voltage pulses between the tool and the job. A constant voltage is not applied. Only sparking is desired in EDM rather than arcing. Arcing leads to localized material removal at a particular point whereas sparks get distributed all over the tool surface leading to uniformly distributed material removal under the tool.

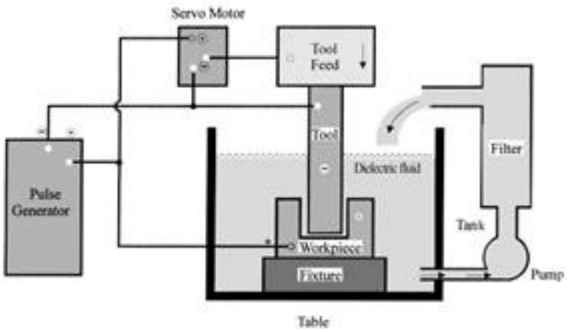

Fig. 2 EDM process

Optimization technique plays important role to increase quality.The Taguchi Method use to analyze optimal process parameter.The Taguchi method primarily uses engineering judgement to decide optimal factor levels for multiresponses ,which increases uncertainty during the decision making process.

2. Electrode Material

Copper Electrode
Ccopper used as an electrode material. It extruded or drawn and then machined to required size and shape, low wear under both Roughing and Finishing operations and has the capacity to remove large amounts of material

Brass Electrode
This is alloy of copper and zinc, Brass does not resist wear ass well as copper or tungsten,but is much easier to machine and can be die-cast.

Copper Tungsten
This is used electrode material in EDM mostly.

3. Work piece Material

Incoloy 800HT Alloy
This type of workpiece used for its strength at high temperatures and its ability to resist carburization ,oxidation, and other types of high-temperature corrosion. Applications include furnace components and equipment, petrochemical furnace cracker tubes,pigtails and headers, and sheathing for electrical heating elements

Composition of INCOLOY800HT ALLOYS(in %)

NICKEL	CHROMIUM	IRON	CARBON	ALUMINIUM	TITANIUM
30	19	39	0.6	0.25	0.25

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EXPERIMENTAL DETAILS

The Experimental work, three factors, each with three levels were selected as controllable variables, a three factor three level central composite rotatable design was selected for conducting the experiments.

Experimental set up

The Experimental work, carried out on a die-sinking EDM machine (SS 50 Spark Generator) of ELECRONICA ZNC India Ltd. Pune, installed at Mechanical Department of Govt. College of Engineering, Amravati, and Maharashtra, India. The EDM machine can be run either on positive polarity or negative polarity. Polarity defines which side of the spark gap is either positive or negative. The straight or normal polarity i.e. tool positive and work piece negative are used for the purpose of obtaining better surface roughness.

Design of experiments

Taguchi orthogonal arrays provide a set of well balance experiment which gives much reduce variance for the experiment with optimum set of control parameter .Minitab 17 software was used to make the design of experiment .based on the degree of freedom of control parameter an L9 Taguchi OA was selected for the present experimental work

Sr. No.	Current(A)	Ton(µs)	T
1	3	50	7
2	3	150	8
3	3	200	9
4	5	50	8
5	5	150	9
6	5	200	7
7	7	50	9
8	7	150	7
9	7	200	8

Total 9 experiment were conducted using Copper, Brass and Copper Tungsten electrodes individually.the value of performance parameter has been calculated using formula followings:
MRR=(Initial weight-final weight)of work piece material/Maching time
EWR=(Initial weight-final weight)of electrode material/Maching time

RESULT AND DISCUSSION

3.1 The response table for MMR, EWR and SR based on experimental and regression analysis are shown in following table.

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For Brass Electrode

#	MRR (Exp)	MRR (Regs)	ERROR	EWR (Exp)	EWR (Regs)	ERRR	SR (Exp)	SR (Regs)	ERROR
1	0.0081207	0.007965	0.0001557	0.014547	0.014041	0.000506	6.6	6.8909	0.2909
2	0.0074034	0.006797	0.0006064	0.011582	0.010361	0.001221	7.5	7.4929	0.0071
3	0.0074162	0.006479	0.0009372	0.010096	0.009431	0.000665	7.7	7.8189	0.1189
4	0.013892	0.015131	0.001239	0.020926	0.023955	0.003029	7.8	7.3575	0.4425
5	0.012670	0.013963	0.001293	0.017515	0.020275	0.00276	8.2	7.9595	0.2405
6	0.011167	0.012049	0.000882	0.015676	0.013885	0.001791	8.3	8.1355	0.1645
7	0.023185	0.022297	0.000888	0.037441	0.033869	0.003572	7.6	7.8241	0.2241
8	0.020792	0.019533	0.001259	0.023881	0.024729	0.000848	8.3	8.2761	0.0239
9	0.018773	0.019215	0.000442	0.023467	0.023799	0.000332	8.4	8.6021	0.2021

For Copper Electrode

#	MRR (Exp)	MRR (Regs)	ERROR	EWR (Exp)	EWR (Regs)	ERRR	SR (Exp)	SR (Regs)	ERROR
1	0.017862	0.016475	0.001387	0.000095	0.000095	0.0000	7.3	6.6605	0.6395
2	0.014272	0.013145	0.001127	0.000041	0.000013	0.000028	7.4	7.3485	0.0515
3	0.009869	0.011315	0.001446	0.000052	0.000071	0.000019	8.4	7.8510	0.549
4	0.032569	0.034135	0.001566	0.000165	0.000177	0.000012	4.5	5.9615	1.4615
5	0.034312	0.030805	0.003507	0.000093	0.000069	0.000024	5.2	6.6495	1.4495
6	0.025575	0.029965	0.00439	0.000193	0.000035	0.000158	6.6	6.2010	0.399
7	0.049432	0.051795	0.002363	0.000352	0.000259	0.000093	6.7	5.2625	1.4375
8	0.052146	0.049455	0.002691	0.000257	0.000175	0.000082	4.5	4.9995	0.4995
9	0.048367	0.047625	0.000742	0.000122	0.000117	0.000005	5.8	5.5020	0.298

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For Copper Tungsten Electrode

#	MRR (Exp)	MRR (Regs)	ERROR	EWR (Exp)	EWR (Regs)	ERRR	SR (Exp)	SR (Regs)	ERROR
1	0.005590	0.004139	0.001451	0.0000136	0.0000129	0.0000007	7.1	7.175	0.075
2	0.012421	0.01732	0.004899	0.0000328	0.0000276	0.0000052	8.4	8.606	0.206
3	0.004499	0.003037	0.001462	0.0000344	0.0000237	0.0000107	9.5	9.830	0.33
4	0.006091	0.005827	0.000264	0.0000964	0.0000832	0.0000132	6.7	7.158	0.458
5	0.037129	0.02665	0.010479	0.0000974	0.0000927	0.0000047	9.2	8.589	0.611
6	0.026699	0.03435	0.007651	0.0000733	0.0000639	0.0000094	7.8	6.762	1.03
7	0.038252	0.03833	0.00019	0.0007806	0.000609	0.0001716	7.6	7.141	0.459
8	0.056879	0.05063	0.006249	0.0005673	0.000423	0.0001443	5.3	5.521	0.221
9	0.052699	0.05368	0.000981	0.0001327	0.000164	0.000032	5.9	6.745	0.845

Regressin Analysis : Based on the experimental data gathered, statistical regression analysis enabled to study the correlation of process parameters with the MRR, EWR and SR.

Optimal Result.

Taguchi's signal to noise ratio is applied in this work to improve the performance characteristics such as MRR, TWR and SR on the Inconel800HT alloy during EDM process. Since the Taguchi method is suitable for single objective function the multi-objective task was fulfilled by taking in consideration the optimum values obtained from the SN ratio.The conclusion of this work are summarized as follows

For Brass Electrode

Sr.no	Ip	T-on	t	Value from SN ratio	Value from regression equation	% error
1.MRR	7	50	9	0.0229	0.0222	2.97
2.TWR	3	200	7	0.0076	0.0073	2.94
3.SR	3	50	7	6.68	6.89	3.02

For Copper Electrode

Sr.no	Ip	T-on	t	Value from SN ratio	Value from regression equation	% error
1.MRR	7	50	7	0.0519	0.0524	1.01
2.TWR	3	150	8	0.0000021	0.0000022	4.76
3.SR	5	150	8	4.5	4.6	2.2

For Copper Tungsten Electrode

Sr.no	Ip	T-on	t	Value from SN ratio	Value from regression equation	% error
1.MRR	7	150	7	0.061	0.063	4
2.TWR	3	200	8	0.00021	0.00020	2.8
3.SR	7	50	7	5.13	5.107	0.5

Result obtained from validation experiment

The results obtained from the regression analysis giving the optimum value of the process input parameter for machining were used for performing the validation experiment in order to know whether the values obtained

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from the regression analysis give optimum result practically or not. The experiment was carried out using only copper as the electrode since from the regression analysis the result obtained for the best electrode was copper electrode. The reading from this experiment and the regression analysis is compared and the errors in the obtained values are shown below.

	Validation experiment Values	Regression values	%error
MRR	0.0531	0.0519	2.26
TWR	0.00000221	0.0000021	4.82

CONCLUSION

The optimum values obtained from the regression analysis was checked by performing the experiment again only for the copper electrode which was concluded as the best electrode from the regression analysis and the values were recorded as shown in the above Table Thus from the Regression analysis and the validation experiment it can be concluded that the best electrode for the purpose of machining the Inconel800HT alloy is copper electrode.

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REFERENCES

1. *V.Muthukumar, N. Rajesh, R. Venkatasamy, A. Sureshbabu , N. Senthilkumar, "Mathematical Modeling for Radial Overcut on Electrical Discharge Machining of Incoloy 800 by Response Surface Methodology", International Conference on Materials Processing and Characterization (ICMPC 2014), Procedia Materials Science 6,pp. 1674 – 1682, 2014*
2. *V.B.Chaudhari, S.S.Soni, A.B.Pandey," Parametric Study Of Incoloy 800 (Super Alloy) In Dry-EDM", International Journal of Advance Research In Science And Engineering, Vol. No.3, pp.382-389, 2014*
3. *Muthu Kumar V., Suresh Babu A., Venkataswamy R.,Raajenthiren M.,"Optimization of the WEDM parameters on machining Incoloy 800 super alloy with multiple quality characteristics", International Journal of Engineering Science and Technology, Vol. 2 (6), pp. 1538-1547, 2010*
4. *Om Prakash Sahani, Rajneesh Kumar, Meghanshu vashista," Effect of Electro Discharge Machining Process Parameters on Material Removal Rate", Journal of Basic and Applied Engineering Research, Volume 1, No 2, pp. 17-20, 2014*
5. *Ashok Kumar,1kuldeep Singh Bedi,2Karaj Singh Dhillo, 2Rashpal Singh," Experimental Investigation of Machine parameters For EDM Using U shaped electrode of EN-19 tool steel", International Journal of Engineering Research and Applications, Vol. 1, Issue 4, pp.1674-1684*
6. *M-G. Her and F.-T. Weng," Micro-hole Machining of Copper Using the Electro-discharge Machining Process with a Tungsten Carbide Electrode Compared with a Copper Electrode" International Journal of Advance Manufacturing Technology, vol 17, pp 715–719, 2001*
7. *Oguzhan Yilmaz & M. Ali Okka," Effect of single and multi-channel electrodes application on EDM fast hole drilling performance", International Journal of Advance Manufacturing Technology, pp. 185–194, 2010*
8. *Dinesh Kumar, Naveen Beri, Anil Kumar," Study Of Overcut During Electric Discharge Machining Of Hastelloy Steel With Different Electrodes Using The Taguchi Method", International Journal Of Advanced Engineering Technology, Vol 2, Pp. 306-312, 2011*
9. *Mustafa Ay & Ulaş Çaydaş & Ahmet Hasçalık,"Optimization of micro-EDM drilling of inconel 718 superalloy", International Journal of Advance Manufacturing Technology, vol 66, pp. 1015–1023, 2013*
10. *K. Wang, H.L. Gelgele, Y. Wang, Q. Yuan, M. Fang, A hybrid intelligent method for modelling the EDM process, International Journal of Machine Tools & Manufacture ,vol 43, pp..995–999.2003*
11. *M.L. Jeswani, Effects of the addition of graphite powder to kerosene used as the dielectric fluid in electrical discharge machining, Wear 70 (1981) 133–139.*

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12. *Kansal, H.K., Singh, S., Kumar, P., 2005, "Parametric optimization of powder mixed electrical discharge machining by response surface methodology." Journal of Materials Processing Technology, Vol. 169, No. 3, pp. 427–436, 2005*
13. *Parmod Malhotra, Amit Kohli," Performance Study of Electrical Discharge Machining With H-11 Tool Steel Using One Variable at a Time Approach",International Journal for Science and Emerging Technologies with Latest Trends", vol 12, pp.15-20, 2013*
14. *M. Durairaj, D. Sudharsun, N. Swamynathan," Analysis of Process Parameters in Wire EDM with Stainless Steel using Single Objective Taguchi Method and Multi Objective Grey Relational Grade" Procedia Engineering, vol 64, pp. 868 – 877, 2013*
15. *Jahan et al, "Development, Modeling, and Experimental Investigation of Low Frequency Work piece Vibration-Assisted Micro-EDM of Tungsten Carbide", Journal of Manufacturing Science and Engineering, Vol 132, 2010*
16. *Ravindranadh Bobbili a , V. Madhu a & A. K Gogia," Effect of Wire-EDM Machining Parameters on Surface Roughness and Material Removal Rate of High Strength Armor Steel", Materials and Manufacturing Processes,vol 28, pp 364–368,2013*