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A Review Of Edm Using Taguchi Method process Parameters On MRR (Metal Removal Rate)

M.Tech. Scholar Mohit Kumar, Dr. Anil Kumar (Prof.)
Dept. of Mechanical Engg
Rajshree Institute of Management and Technology
Bareilly, UP, India

Abstract- Electrical discharge machining (EDM) is a non-traditional material removal process developed in late 1940s has now become the most important technology in manufacturing industries. Taguchi technique has been applied for design of experiments with three input factors and their trinity levels utilizing L9 orthogonal array. The nine specimens were machined with different electrodes material where AISI 304 stainless steel had been used as a workpiece with kerosene as dielectric fluid. The major aim of this study is the evaluation to choice the principle specifications of electrical discharge machining with the assist of Taguchi technique and utilizing Minitab program in condition of material removal rate and electrode wear rate. The variance conditions examined during production the research on electrical discharge machining would be the electrodes material, current and work piece thickness. The effect of each parameters and excellent performance variables will be achieve by means of ANOVA examination and conformed by investigation to enhance method.

Keywords- ANOVA examination, Minitab program, variance conditions etc.

I. INTRODUCTION

Electric Discharge machining (EDM) is a thermo-electrical process used to machine precise and intricate shapes on the tough metals such as ceramics, maraging steels, cast-alloys, titanium which are widely used in defense and aerospace industries.

Electrical energy is used to generate electrical sparks and material removal mainly occurs due to localized melting and vaporization of material which is carried away by the dielectric fluid flow between the electrodes. The performance of this process is mainly influenced by many electrical parameters like, current, voltage, polarity, and pulse on time, pulse of time, electrode gap and also on non-electrical parameters like work and tool material, dielectric fluid pressure.

All these electrical and non-electrical parameters have a significant effect on the EDM output parameters like, Metal Removal Rate (MRR), Tool Wear Rate (TWR) and Surface Roughness (SR). MRR OFF time in EDM process to identify the optimal sets for material removal rate, wear rate on tool and surface roughness on Mild Steel IS 2026 using copper electrode with L9 orthogonal array and analysis with Taguchi GRA. D. C. Chen (et al) utilized the Taguchi design to optimize the EDM process parameters for machining A6061- T6 aluminum alloy.

Advantages of Edm

- Complex shapes that would otherwise be difficult to produce with conventional cutting tools.
- Extremely hard materials can be machined to very close tolerances.
- Very small pieces where conventional cutting tools may damage the part from excess cuttingtool pressure.
- There is no mechanical contact between tool and the work piece. Therefore delicate sections andweak materials can also be machined without any distortion.
- A good surface finish can be obtained.

- Very fine holes can be easily drilled by using EDM machine.

Disadvantages of Edm

- The slow rate of material removal.
- Reproducing sharp corners on the work piece is difficult due to electrode wear.
- Specific power consumption is very high.
- Power consumption is very high.
- Excessive tool wear occur during machining.
- Electrically non-conductive materials can be machined only with specific setup of process.
- The additional time and cost used for creating electrodes for sinker EDM.
- Potential fire hazards associated with use of combustible oil based dielectrics.

II.REVIEW OF LITERATURE

A study conducted was by B. Singh and M. Singh et al[1] to find the effect of pulsed current on material removal rate, electrode wear, surface roughness and diameteral overcut in corrosion resistant stainless steels viz., 316 L and 17-4 PH. The materials used for the work were machined with different electrode materials such as copper, copper-tungsten and graphite. It is observed that the output parameters such as material removal rate, electrode wear and surface roughness of EDM increase with increase in pulsed current. The results reveal that high material removal rate have been achieved with copper electrode whereas copper-tungsten yielded lower electrode wear, smooth surface finish and good dimensional accuracy.

The study of T. Rajmohan et al [2] investigated the influence of EDM parameters on EWR, MRR and ROC while machining of AISI D3 material with a copper electrode. The parameters considered were pulse-on time (Ton), peak current (Ip), duty factor (t) and gap voltage (Vg). It is found that the MRR is mainly influenced by peak current where as other factors have very less effect on material removal rate. Electrode wear rate is mainly influenced by peak current and pulse on time, duty cycle and gap voltage has very less effect on electrode wear rate. Peak current has the most influence on radial overcut then followed by duty cycle and pulse on time with almost very less influence by gap voltage

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A.A. Khan and S.E. Saifuddin [3] conducted experiments and found better machining performance was obtained generally with the electrode as the cathode and the work- piece as an anode and it was observe that for high MRR main process parameters are peak current, pulse ontime ,pulse off time, whereas for electrode wear were mainly influenced by peak current and pulse on time. Surface quality was mainly influenced by peak current. As far as tool shape configuration concerned best tool shape for higher MRR and lower TWR is circular, followed by square, triangular, rectangular, and diamond cross sections.

N. Arunkumar et al [4] studied the effect of control factors (i.e., current, pulse on time, pulse off time, fluid pressure) for maximum material removal rate (MRR) and minimum electrode wear rate (EWR) for EDM of hard material Stainless steel 316 with copper as cutting tool electrode. In this paper both the electrical factors and non electrical factors has been focused which governs MRR and EWR. Paper is based on Design of experiment and optimization of EDM process parameters. The technique used is Taguchi technique which is a statistical decision making tool helps in minimizing the number of experiments and the error associated with it. The research showed that the Pulse off time, Current has significant effect on material removal rate and electrode wear rate respectively.

P. Sharma, S. Singh, D.R. Mishra, [5] of surface characteristics of Fe-Mn-Al alloy analyzed by means of the atomic force microscopy (AFM) technique and concluded that the higher discharge energy caused more frequent melting expulsions, leads to deep and large crater formation on surface of work, resulting in a poor surface finish.

R. Boora and V. Singla [6] optimized the machining parameters in the EDM machining of C-C composite using Taguchi method. The process variables affects electrode wear rate and MRR, according to their relative significance, are gap voltage, peak current and pulse on time respectively.machined XW42 tool steel and concluded that material removal rate with Cu electrode is greater than graphite electrode. He also concluded that Cu is suitable for roughing surface while graphite is suitable for finishing surface.

A. Thillaivanan, P. Asokan [8] using parameters such as pulse current and pulse duration and concluded that electrode material has an obvious effect on the white layer thickness, the material removal rate, surface roughness and electrode wear are increasing with process parameters.

P. janmanee et al [9] conducted experiments by experimental design methodology and found that a fewer number of experiments are required to find optimum result and the surface roughness equation shows that the current intensity is the main influencing factor on roughness.

Lodhi, B. K., & Agarwal, S. [10] on WC/5ni Composites Using Response Surface Methodology concluded that the MRR is maximum for all compositions. As the percentage of nickel increases the thermal conductivity of the composition increases since the nickel material is easily removed from the surface of the parent material. So the MRR increases with percentage of nickel. The surface roughness increases with increase in current and flushing pressure irrespective of %Ni. The optimum Ra values decreased with increasing electrode rotation.

Durairaj, M., Sudharsun, D et al [11] aimed of investigation to shed a light on the relation and dependence between the material removal process, identified in the evaluation of material removal rate (MRR) and tool wear ratio (TWR), and some of the most important technological parameters (i.e., open voltage, discharge current, pulse width and frequency), in order to experimentally quantify the material waste produced and optimize the technological process in order to decrease it.

Dabade, U. A., & Karidkar, S. S. [12] studied aspects related to surface quality and metal removal rate which are the most important parameters from the point of view of selecting the optimum condition of processes as well as economical aspects. It reported the research trends in EDM.

Lajis, M. A., Radzi, H et al [13] stated the feasibility of using Electrical Discharge Machining (EDM) as a means of machining carbon fiber composite materials. Machining was performed at various currents, pulse durations and with different tool materials and polarities and they concluded that it is entirely feasible machine carbon fiber composite materials by EDM process. Copper electrodes prove to be better than graphite electrodes in terms of tool wear and surface finish. Positive polarity should be used for machining carbon fiber composite materials in order to achieve a low tool wear ratio.

III.PROBLEM FORMULATION

On the basis of above study parameters peak current (Ip), pulse off time (Toff) and pulse on time (Ton) are selected for this work to analyze the material removal rate, tool wear rate and Surface roughness using machining parameters selected as Ip, Ton and T off using Taguchi L9 orthogonal array.

(a) To find influence on MRR with Ip, Ton and T off.
(b) To find influence on TWR with Ip, Ton and T off.

IV.METHODLOGY

Taguchi Method

Taguchi has developed a methodology for the application of designed experiments, including a practitioner's handbook. This methodology has taken the design of experiments from the exclusive world of statistician and brought it more fully into the world of manufacturing [24]. His contributions have also made the practitioner work simpler by advocating the use of fewer experimental designs, and providing a clear understanding of the variation nature and the economic consequences of quality engineering in the world of manufacturing. Taguchi introduces his approach, using experimental design for:

(a) Designing products/processes so as to be robust to environmental conditions.
(b) Designing and developing products/processes so as to be robust to component variation.
(c) Minimizing variation around a target value. This philosophy of Taguchi is broadly applicable.

He proposed that engineering optimization of a process or product should be carried out in a three step approach i.e. system design, parameter design and tolerance design. In system design the engineer applies scientific engineering knowledge to produce a basic functional prototype design. In the product design stage the selection of the materials, components, tentative product parameter values etc. are involved.

Since system design is an initial step, functional design may be far from optimum in terms of quality and cost. The objective of parameter design is to optimize the setting of process parameter value for improving performance characteristics and to identify the product parameter values under the optimal process parameter values. In addition, it is expected that the optimal process parameter values obtained from the parameter design are insensitive to the variation of environmental conditions and other noise factors. Therefore, the parameter design is the key step in Taguchi method of achieving high quality without increasing cost. Basically, classical parameter design developed by Fisher is complex and not easy to use especially, a large number of experiments have to be carried out when the number of process parameters increases.

To solve this task, the Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only. A loss function is then defined to calculate the deviation between the experimental values and desired values. Taguchi recommends the use of the loss function to measure the performance characteristic deviating from the desired value. The value of the loss function is further transformed into a signal-to-noise (S/N) ratio.

Usually there are three categorize of performance characteristic in the analysis of the S/N ratio that is the lower-the-better, the higher-the-better, and the nominal- the –better. The S/N ratio for each level of process parameter is computer based on the S/N analysis.

Regardless of the category of the performance characteristic, the larger S/N ratio corresponds to the better performance characteristic. Therefore, the optimal level of the process parameter is the level with the highest S/N and ANOVA analysis, the optimal combination of the process parameters can be predicted. Finally, a confirmation experiment is conducted to verify the optimal process parameters obtained from the parameter design. The Taguchi method is adopted to obtain optimal machining performance in the die sinking.

1. Larger is better (maximum): S/NLB = -10 log ((1/n) Σ (1/yi ^{2}))
2. Smaller is better (minimum): S/NSB = -10 log ((1/n) Σ yi ^{2})

Where, n is the number of observations or repetitions of a trial and y is the observed data. Notice that these S/N ratios are expressed on a decibel scale. We would use S/NT if the objective is to reduce variability around a specific target, S/NL if the system is optimized when the response is as large as possible, and S/N'S if the system is optimized when the response is as small as possible. Factor level that optimizes the appropriate S/N ratio is optimal.

The use of parameter design of the Taguchi method to optimize a process with multiple performance characteristics includes the following steps:

(a) Identify the performance characteristics and select process parameters to be evaluated.
(b) Determine the number of levels for the process parameters and possible interactions between the process parameters.
(c) Select the appropriate orthogonal array and assignment of process parameters to the orthogonal array.

V.CONCLUSION

From literature review related to single and multi objective optimization process parameters of electric discharge machining and its modified versions using Taguchi method and grey relational analysis from 2003 to 2018 following observations are made.Taguchi method helps to find out optimum level of process parameters to get optimum value of each response variable i.e. MRR, Ra etc. individually. The major advantage of the Taguchi method is that it helps in the improvement of product quality by giving results close to the mean of targeted value rather than a value within statistical specified limit. Taguchi method is the easy, straightforward and simple tool for optimization.

Another advantage is that improvement in productivity with cycle time reduction. The orthogonal array also helps for the reduced number of experiments conducted for a particular number of process parameters having a specific number of levels. The main limitation of the Taguchi method is that results getting from Taguchi method are only relative. Taguchi method not exactly specifies which parameter has the maximum effect on the performance characteristics value. The orthogonal array does not investigate particular variables

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combination because of that this method is not capable to give a relationship between those variables.

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REFERENCES

[1]. B. Singh and M. Singh, "The Performance of Different Electrode Materials in Electric Discharge Machining (EDM) Inconel 600", Proceeding of 12th IRF International Conference of Mechanical Engineering, India, pp. 68-71, 2014.

[2]. T. Rajmohan, R. Prabhu, G. Subba Rao and K. Palanikumar, "Optimization of Machining Parameters in Electrical Discharge Machining (EDM) of 304 Stainless Steel", International Conference on Modeling, Optimization and Computing, Procedia Engineering, Vol. 38, pp.1030-1036, 2012.

[3]. A.A. Khan and S.E. Saifuddin, "Wear Characteristic of Copper and Aluminum Electrodes during EDM of Stainless Steel and Carbide", International Conference of Mechanical Engineering, pp. 28-30, 2005.

[4]. N. Arunkumar, H .S. A. Rawoof and R. Vivek, "Investigation on the Effect of Process Parameters for Machining of EN31 (Air Hardened Steel) By EDM", International Journal of Engineering Research and Applications, Vol. 2, Issue 4, pp. 1111-1121, 2012.

[5]. P. Sharma, S. Singh, D.R. Mishra, "Electrical Discharge Machining of AISI 329 Stainless Steel Using Copper and Brass Rotary Tubular Electrode", International Conference on Advances in Manufacturing and Materials Engineering, Vol. 5, pp. 1771-1780, 2014.

[6]. R. Boora and V. Singla, "Comparison of Different Electrodes Used in EDM for En31 Workpiece", International Journal of Enhanced Research in Science Technology and Engineering, Vol. 3, Issue 8, pp. 192- 200, 2014

[7]. Thillaivanan, P. Asokan, K.N. Srinivasan and R. Saravanan , "Optimization of Operating Parameters for EDM Process Based on the Taguchi Method and Artificial Neural Network", International Journal of Engineering Science and Technology, Vol. 2, Issue 12, pp. 6880-6888, 2010.

[8]. P. janmanee(2011) , "Optimization of EDM of composite 90WC10Co based on taguchi approch" European journal of scientific research, Vol 64 No. 3, ISSN 1450-216X

[9]. Lodhi, B. K., & Agarwal, S. (2014). Optimization of machining parameters in WEDM of AISI D3 Steel using Taguchi Technique. Procedia CIRP, 14, 194-199.

[10]. Durairaj, M., Sudharsun, D., & Swamynathan, N. (2013). Analysis of process parameters in wire EDM with stainless steel using single objective Taguchi method and multi objective grey relational grade. Procedia Engineering, 64, 868-877.

[11]. Dabade, U. A., & Karidkar, S. S. (2016). Analysis of response variables in WEDM of Inconel 718 using Taguchi technique. Procedia Cirp, 41, 886-891.

[12]. Lajis, M. A., Radzi, H. C. D. M., & Amin, A. K. M. N. (2009). The implementation of Taguchi method on EDM process of tungsten carbide. European Journal of Scientific Research, 26(4), 609-617.