A REVIEW : Optimization of Process Parameter in Wire Electric Discharge Machining (WEDM) For Machining.

Anand R. Patel[1] , Kiran A. Patel[2] , Priyesh N. Santoki[3]

[1]*P.G. Student Production (Mechanical), LDRP-ITR, Gujarat, India*
[2]*Lecturer, Mechanical Engineering, LDRP-ITR, Gujarat, India*
[3]*Ex Assistant Professor, Mechanical Engineering, ACT-VENUS, Gujarat, India*

ABSTRACT

With the exponential growth of manufacturing industries, the need for exotic and advanced material has increased. Wire Electrical Discharge Machining is a non-traditional machining method that is quite successful for machining of Special Steel. WEDM seems to be a better choice as it conforms to easy control and can machine intricate and complex shapes. The present work aims to study the effect of WEDM input parameters like pulse on time, pulse off time, and voltage on the performance measures like cutting rate & gap current. Taguchi method will be employed for the experimental work. The research work is expected to assist in finding out the optimum output parameters that will lead to maximum cutting rate and minimum gap current. Genetic Algorithm will use for optimize the output parameters.

Keyword: - *WEDM, Pulse on time, Pulse off time, Servo Voltage, MRR, SR.*

1. INTRODUCTION

In Wire Electrical Discharge Machining (WEDM), or Wire-Cut EDM, a thin single-strand metal wire is fed through the work piece, typically occurring while in a submerged tank of dielectric fluid or deionized water. This fluid helps to cool the process and flush away the cut material. The Wire EDM process uses electric current to cut conductive materials leaving a smooth surface that requires no further finishing or polishing. This process is used to cut plates and to make punches, tools, and dies from any conductive material, including hard metals that are too difficult to machine with other methods, such as; metal allows, graphite, carbide and diamond. The wire is held between upper and lower diamond guides. The guides move in the (X-Y) plane controlled by a CNC, the upper guide can also move independently in the (Z-U-V) axis, giving rise to the ability to cut tapered and transitioning shapes and can control axes movements. This gives the Wire-Cut EDM the ability to be programmed to cut very intricate and delicate shapes. Wire EDM is commonly used when low residual stresses are desired. Wire EDM has no added residual stress because it has no cutting forces. There is little change in the mechanical properties of a material in Wire EDM due to its low residual stresses. The cutting wire never touches the material, the cutting itself is due to the erosion that occurs when a spark forms between the cutting wire and raw material. A typical Wire EDM process with consist of several passes, moving at various speeds. The first passes are typically fast moving, lower accuracy to remove large amounts of material. Later, skim passes, will retrace the cuts at lower speeds, removing less material but improving the surface quality and accuracy of the cut. If complex cut outs are required, a pre-drilled hole through a raw material can be threaded with a Wire EDM and the machine can begin cutting from there. Applications for Wire EDM include the creation of extrusion dies, blanking punches and metal and tool fabrication.

2. WORKING PRINCIPLE OF WEDM

Wire-cut EDM is typically used to cut plates as thick as 300mm and to make punches, tools, and dies from hard metals that are difficult to machine with other methods. Wire-cutting EDM is commonly used when low residual stresses are desired, because it does not require high cutting forces for removal of material. If the energy/power per pulse is relatively low (as in finishing operations), little change in the mechanical properties of a material is expected due to these low residual stresses, although material that hasn't been stress-relieved can distort in the machining process. Due to the inherent properties of the process, wire EDM can easily machine complex parts and precision components out of hard conductive materials. Wire EDM is an electro-thermal non-traditional

machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. Use electric current and fine wire to cut conductive materials. The cutting typically occurs while the work piece is submerged in deionized water. Deionized water helps to cool the process and flush away the cut material. Cutting wire does not touch the material. Cutting itself is due to the erosion that occurs when a spark forms between the cutting wire and the raw material.

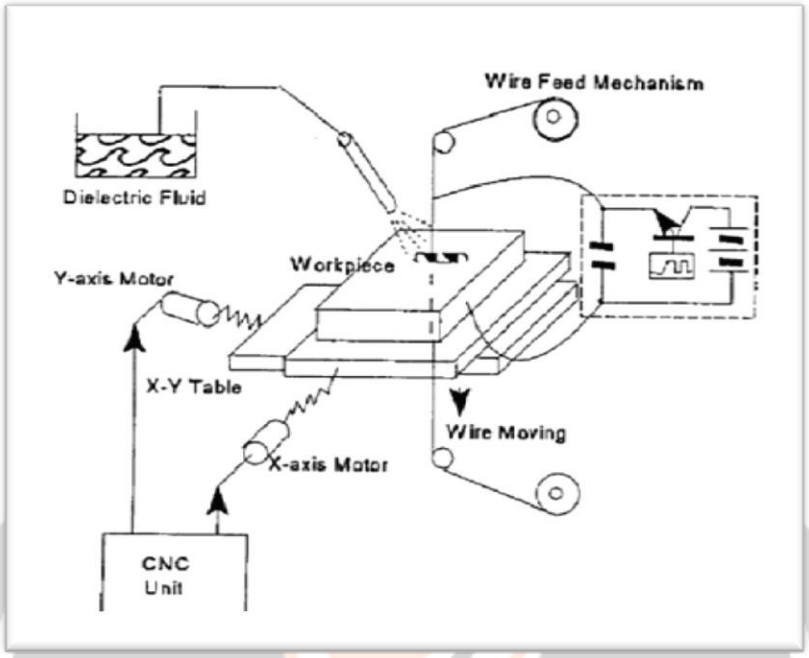

Fig 2.1 Diagram of working of WEDM

3. LITERATURE REVIEW

Vikram Singh , S.K. Pradhan[1] They use Taguchi technique and response surface methodology in machining of AISI D2 Steel. The objective of the present work is to investigate the effects of various WEDM process parameters such as pulse on time, pulse off time, servo voltage and wire feed rate on the Material Removal Rate (MRR), Surface Roughness (SR) and cutting rate. Secondly, to obtain the optimal settings of machining parameters at which the MRR and cutting rate are maximum and the Surface Roughness (SR) is minimum in a range. The experiments were carried out as per design of experiment approach using L27 (34) orthogonal array. AISI D2 steel specimen is machined by using brass wire as electrode and the response surface methodology (RSM) is used for modelling a second-order response surface to estimate the optimum machining condition to produce the best possible response within the experimental constraints. The results from this study will be useful for manufacturing engineers to select appropriate set of process parameters to machine AISI D2 steel.

G.Ugrasen, H.V.Ravindra, G.V.Naveen Prakash, R.Keshavamurthy[2] Estimation of machining performances using MRA, GMDH and artificial neural network in Wire EDM of EN-31. This study on the development of model and its application to estimation of machining performances using Multiple Regression Analysis (MRA), Group Method Data Handling Technique (GMDH) and Artificial Neural Network (ANN). Experimentation was performed as per Taguchi's L'16 orthogonal array. Each experiment has been performed under different cutting conditions of pulse-on, pulse-off, current and bed speed. Among different process parameters voltage and flush rate were kept constant. Molybdenum wire having diameter of 0.18 mm was used as an electrode. Three responses namely accuracy, surface roughness, volumetric material removal rate have been considered for each experiment.

Parveen Goyal, N M Suri, Sanjeev Kumar, Rajesh Kumar[3] They study the surface properties of EN-31 die-steel after machining with powder metallurgy EDM electrodes. A lot of experimentation has been carried out to find the optimum parameters for the EDM process. Researchers have also used powder metallurgy electrodes to study their influence on surface properties and output process parameters. In this paper, powder metallurgy electrodes prepared with different compositions of copper and manganese has been used to machine EN-31 die-steel. Comparisons have been made with copper electrode for microhardness and surface roughness

behavior of workpiece and it has been found that copper-manganese (in weight ratio 70-30) composite electrode shows better results than copper-manganese (in weight ratio 80-20) electrode and copper electrode.

B.P. Mishra, B.C. Routara[4]In which they do experimental investigation and optimisation of performance characteristics in EDM of EN-24 alloy steel using Taguchi Method and Grey Relational Analysis. This investigation addresses exploration of EDM process on EN-24 alloy steel using Taguchi robust design approach and multi Objective Grey Relational Grade with four controllable input parameters such as Pulse on time (TON), Pulse off time (Toff), Peak current (I P) and Flushing pressure for analysis of MRR and Tool wear rate (TWR).The design matrix for experimentation with different treatment conditions are chosen utilising L9 orthogonal array. From detailed study, it is found that different combinations of EDM process parameters are necessary to achieve enhanced MRR and reduced TWR for EN-24 alloy steel. In this study, single objective optimization is established by Taguchi methodology and optimal factor settings for multi objective optimization of two output responses MRR and TWR collectively are identified using Grey relational analysis. Significant contribution of input controllable parameters on output response MRR is also identified statistically.

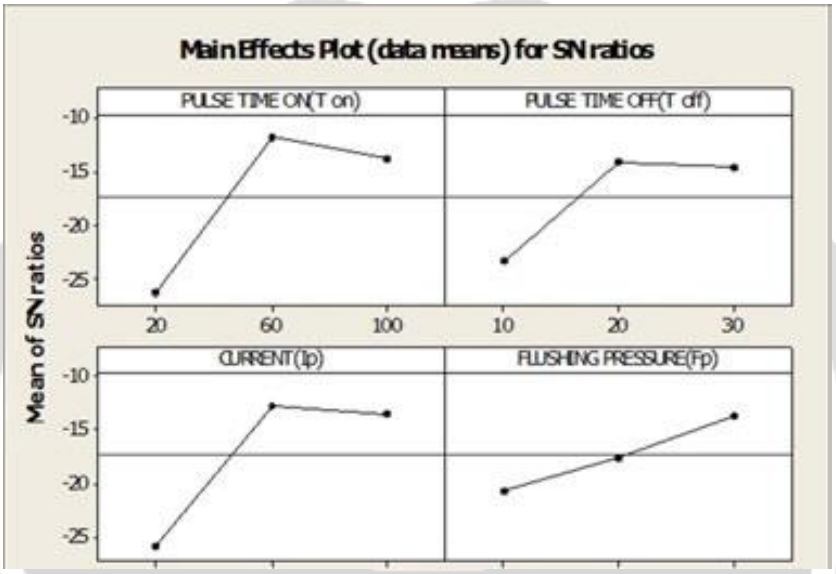

Fig 3.1 Factor Effects plot on S/N ratios for MRR

Sumit Raj, Kaushik Kumar [5] They optimise and prediction of material removing rate in die sinking electro discharge machining of EN45 steel tool. The main aim of this paper is to maximization of MRR in die sinking electro-discharge machining of EN45 material using Taguchi method. EN45 is a manganese spring steel with high carbon content. EN45 is used widely in the motor vehicle industry for leaf springs, truncated conical springs, helical springs and spring plates and many general engineering applications. The experiments conducted based on the L27 Orthogonal array and results were optimized. Experiment were carried out using four input parameters viz. peak current (Ip), pulse on time (Ton), pulse off time (Toff) and voltage (V) with three different levels. The effects of different input parameters and effect of their combination on MRR determined using Taguchi and ANOVA table. It was observed that peak current and pulse off time are more significant factor for MRR.

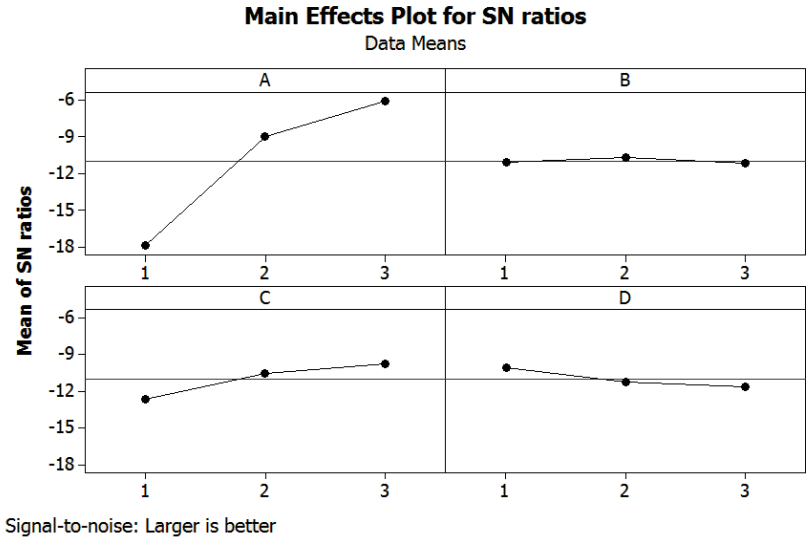

Fig 3.2 Response graph for S/N ratio

Vikas, Shashikant, A.K.Roy and Kaushik Kumar[6] Study about effect and optimization of machine process parameters on MRR for EN19 & EN41 materials using taguchi method. The present work deals with the comparison of the MRR for EN19 and EN41 material in a die sinking EDM machine. The various input factors like Pulse ON time, Pulse OFF time, Discharge current and voltage were considered as the input processing parameters, while the MRR is considered as the output. Optimization using Taguchi method was performed to predict the best combination of inputs towards maximum output. A comparison was done to obtain the effect of these input parameters over the MRR for both the material, and simultaneously the impact of the carbon percentage over the MRR was investigated. It was found that the Discharge current in case of the EN41 material and EN19 material had a larger impact as compare to other processing parameters on the MRR. A relative study of the carbon composition for both the material was also done.

S.Tripathy,D.K.Tripathy[7] In which study of Taguchi method in of preference by similarity to ideal solution (TOPSIS) and Grey Relational Analysis (GRA) have been adopted to evaluate the effectiveness of optimizing multiple performance characteristics for PMEDM of H-11 die steel using copper electrode. The effect of process variables such as powder concentration (Cp), peak current (Ip), pulse on time (Ton), duty cycle (DC) and gap voltage (Vg) on response parameters such as Material Removal Rate (MRR), Tool Wear Rate (TWR), Electrode Wear Ratio (EWR) and Surface Roughness (SR) have been investigated using chromium powder mixed to the dielectric fluid. Analysis of variance (ANOVA) and F-test were performed to determine the significant parameters at a 95% confidence interval. Predicted results have been verified by confirmatory tests which show an improvement of 0.161689 and 0.2593 in the preference values using TOPSIS and GRA respectively. The recommended settings of process parameters is found to be Cp = 6 g/l, Ip =6Amp, Ton = 100 µs, DC = 90% and Vg = 50 V from TOPSIS and Cp = 6 g/l, Ip = 3Amp, Ton = 150 µs, DC = 70% and Vg = 30 V from GRA.

Leera Raju, Somashekhar S Hiremath[8] Electro-Discharge Machining (EDM) is one of the non-conventional machining processes available, in which the material removal takes place due to melting and vaporisation of electrode materials. Micro Electro-Discharge Machining (µ-EDM) is a variant of EDM, is playing an important role in generation of micro features on difficult to machine conducting materials. In this Paper, authors carried out an extensive literature study to give a complete description on µ-EDM process, its requirements, performance and applications. More than fifty papers were referred and the details were categorized into five major areas, namely, experimental setups and its subsystems, experimental studies and optimization methods, generated micro features, modelling and simulation approaches and applications.

G.Ugrasen, H.V.Ravindra, G.V.Naveen Prakash, R.Keshavamurthy[9] Wire Electrical Discharge Machining (WEDM) is a specialized thermal machining process capable of accurately machining parts with varying hardness or complex shapes, which have sharp edges that are very difficult to be machined by the main stream machining processes. This study outlines the development of model and its application to estimation of machining performances using Multiple Regression Analysis (MRA), Group Method Data Handling Technique (GMDH) and Artificial Neural Network (ANN). Experimentation was performed as per Taguchi's L'16

orthogonal array. Each experiment has been performed under different cutting conditions of pulse-on, pulse-off, current and bed speed. Among different process parameters voltage and flush rate were kept constant.

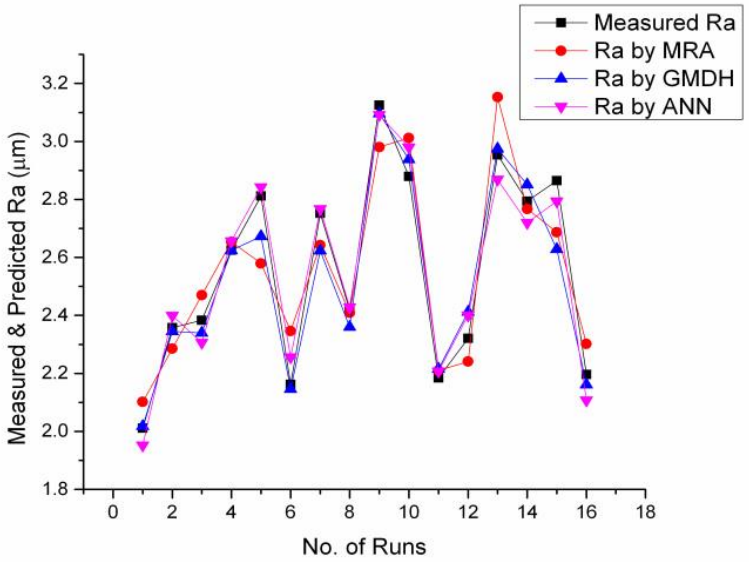

Fig. 3.3 Comparison of measured and predicted surface roughness usnig MRA, GMDH and ANN

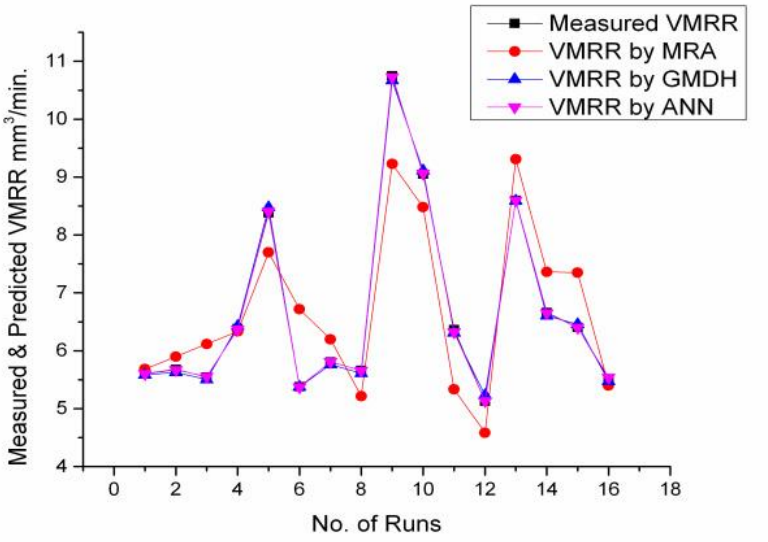

Fig. 3.4 Comparison of measured and predicted VMRR usnig MRA, GMDH and ANN

Rupesh Chalisgaonkar, Jatinder Kumar[10] In this research, input parameters such as pulse on time (TON), pulse off time (TOFF), peak current (IP), wire feed (WF), wire tension (WT), and servo voltage (SV) has been selected for process capability investigation in WEDM process. The process capability index was evaluated for machining characteristics such as machined work-piece dimension (MWD) and surface roughness (SR). Taguchi's approach to experiment design and analysis was utilized to study the influence of machining parameters on the process capability index. Single response optimization was performed for both machining characteristics to find out the parametric setting which could optimize WEDM process capability. Surface integrity aspects such as microstructure analysis of the selected machined titanium samples have also been investigated.

4. OBJECTIVES

- To Study the effect of input variable parameters on performance parameters.
- To get the optimum input & output parameters for selected wire & work piece material.
- To study about the MRR& SR in WEDM & its optimization.

- To find out the problems of wire breaking during machining & its solutions.

5. EXPERIMENTAL SETUP

In industry, designed experiments can be used to systematically investigate the process or the product variables that influence the product quality. In design of experiments, the experimenter is often interested in the effect of some process or investigation. Increasing productivity and improving quality are important goal in any business. The method for determining how to increase productivity and improving quality are evolving. After identify the process condition and product components that influence the product quality, one can have direct improvement efforts to enhance the product's manufacturability, reliability, quality, and field performance.

Planning: Careful planning can help to avoid problems that can occur during the execution of the experimental plan.

Screening: In many process development and manufacturing applications, potentially influential variable are numerous. Screening reduces number of variable by identifying the key variable that affects product quality. This reduction allows focusing on process improvement effort on the really important variables.

Optimization: After identifying the important variables by screening, next step is to determine the best or optimal value for these experimental factors. Optimal factors values depend on the process objective.

Verification: Verification involves performing a follow- up experiment at the predicted best processing condition to confirm the optimization result. Following methods are used in design of experiment.

Fig 5.1 Wire electrical discharge machine

6. CONCLUSIONS

1. Ranges of Wire EDM process parameters have been established based on review of literature and by performing the pilot experiments using one factor at a time (OFAT) approach.
2. The effects of the process parameters viz. pulse on time, pulse off time, servo voltage on response characteristics viz. material removal rate, surface roughness were studied.
3. The optimal sets of process parameters were obtained for various performance measures using Taguchi's design of experiment methodology. The summary results of predicted optimal values of the responses and their confidence intervals (both for confirmation experiment and population).

7. REFERENCES

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