International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

Analysis of Effect of Cutting Parameter of Wire Electric Discharge Machining on Material Removal Rate and Surface Roughness: A Review

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Abstract - *Wire electrical discharge machining process has been established as a non-conventional thermoelectric machining technique to machine the materials which are a conductor of electricity. The mechanism of material removal is same as the common EDM process. The cutting tools are electric sparks, which have been set up and controlled with the help of a generator. Because the wire electrode is not quite touching the workpiece the electrical charge has produced to a voltage that permits it to cross the gap between electrode and workpiece. the objective of this study is to analyzed influence of various input factors on material removal rate, surface roughness value (Ra) by using response surface methodology (RSM) technique and develop Artificial neural network(ANN) model.*

Key Words: Material Removal Rate (MRR), Key word2 surface Roughnes(R_a), Artificial neural network(ANN), response surface methodology(RSM),wire cut electric discharge machining(WEDM).

1. INTRODUCTION

Wire electrical discharge machining process is a non-conventional thermoelectric machining technique to machine the materials which are a conductor of electricity, which is also called electro-erosion machining process. The mechanism of material removal is same as the common EDM process. The cutting tools are electric sparks, which have been set up and controlled with the help of a generator. Because the wire electrode is not quite touching the workpiece, the electrical charge has produced to a voltage that permits it to cross the gap

Between electrode and workpiece, and zaps off a tiny bit of the workpiece. The dielectric fluid is used to cools down the cutting zone but also wash away the eroded particles between wire electrode and workpiece to restrict them from being obstacles for the next spark. In case of Wire EDM, wire cannot be reused , therefore, it is difficult to control the wire wastage and cost of wire.

EN24 alloys steel is difficult to cut by the conventional machining process. It, however, is essential to find a productive and competent machining technique for EN24 alloys. For machining electrically conductive materials, wire EDM is pioneered as a vigorous, dynamic and precise technique. Parameters' details and procedures provided in machine manufacturer's manual have not contained enough information for machining new materials and different profiles desired by researchers or production engineer.

The sophisticated software adjusts the gap and various parameters in the generator of machine in real time to develop sparks controlled carefully. Sparks with less energy develops less heat; which results in smaller heat-affected zones. A lot of research is being performed by many researchers for investigating the influence of wire EDM on the material removal rate, surface integrity of nickel alloys regarding recast layer and HAZ. EDM includes the fabrication of the stamping cum extrusion tools and dies, gauges, prototypes, ships, aircraft and medical parts with grinding wheel form tools as its samples to work with and inspite of it there are various other applications.

2. REVIEW OF LITERATURE

Pradeep Singh, Arun Kumar Chaudhary, Tirath Singh, Amit Kumar Rana[1] Has studied EN8 materials and its Output parameter dimensional deviation and input parameters are wire feed, pulse off time and servo voltage. Taguchi method was used to optimize the parameter. MINITAB-17 software was used to get optimum values for the test and a confirmation experiment was done for validating the results. The experiment was carried out on EUROCUT MARK II machine, The electrode wire material was brass-copper, Diameter of wire was 0.25 mm. Dielectric fluid used was low conductivity water. Electrode wire was continuously feed through the feeding mechanism. Work piece was a block of EN8 Steel with Dimension 200×100×21(in mm) From the above given dimensions, small pieces were cut. Dimensions of each piece were 5×5×21. and result can be drawn on the basis of optimization is that, Increasing the wire feed rate decreases the dimensional deviation, Increasing the pulse off time initially dimensional deviation increases and further it decreases, Increasing servo voltage decreases dimensional deviation, out off all three parameters, servo voltage has the greatest effect on dimensional deviation and is followed by pulse off time, and wire feed in that order.

Kapil Kumar, Pushpendra Kumar, Shant Kumar Jain, Sachin Kumar[2] work on effect of process parameter like highest peak current, time, and other characteristics as cutting rate and surface finish, Taguchi method has been used for experiment and research results. wider range of input parameters can be tried out for its result accuracy and

result verification . AISI D3 tool steel sample is used. After optimization the result become highest cutting rate 9.6242 mm2/min (surface roughness-3.31 µm and wire wear ratio-0.061576), lowest surface roughness 0.99 µm (cutting rate-4.8765 mm2/min and wire wear ratio-0.023119) and lowest wire wear ratio 0.02146 (cutting rate-6.0325 mm2/min and surface roughness-1.10 µm) for 5 mm thickness has been obtained, which is far more better than highest cutting rate 5.673 mm 2/min, lowest surface roughness 1.56 µm and lowest wire wear ratio 0.034 obtained.

Somvir Singh Nain, Dixit Garg, Sanjeev Kumar[3] has find out that MRR increase with increase in pulse-on-time, wire tension and peak current and decrease with increase in servo voltage, pulse-off-time and wire feed. Surface roughness increase with increase in pulse-on-time, peak current and wire tension significantly and surface roughness decrease with increase in servo voltage and pulse-off-time. Waviness increase with increase in pulse-on-time and wire feed significantly and decrease with increase in servo voltage and pulse-off-time significantly. The entire three models are significant for surface roughness, waviness and material removal rates of WEDM on Udimet-L605. But linear regression and ANN-linear regression model presents better result in contrast to the nonlinear regression model. Overall the linear regression model presents better result in contrast to ANN-linear regression model.

S.Banerjee,B.Panja,S.Mitra[7] examined the influence of process parameter pulse on time(T_{on}),pulse off time(T_{Off}),Wire feed (W_f) and Gap voltage(v) of WEDM on MRR of EN47 spring steel also described significance and interaction of process parameter by ANOVA method the CNC operated wire cut EDM (Model name – WT 355) of JOEMARS was used for this work. The Taguchi orthogonal array is successfully used to optimize the process parameter viz. Author has found that the ANOVA result indicates that pulse on time is the most influencing parameter whereas pulse off time and gap voltage are quite remarkable parameter to control the MRR and finally he conclude that the optimal condition is 26% greater than that developed with the initial condition.

G.Ugrasen, H.V.Ravindra, G.V.Naveen Prakash[9] has study process parameter like pulse on time, pulse off, current and bed speed. HCHCr is use as a work piece material. spark gap between wire and work piece is 0.02 mm, Molybdenum wire having diameter 0.18 mm was used as electrode. pulse on time in the range of (20,28µs),pulse off (4,8µs),current (4,6A) and bed speed (30,40µm/s) is used. the experiment were performed on CONCORD DK7720C four axes CNC WED machine. DOE such as TAGUCHI methodology L27 orthogonal array is used the variable measure for the analysis are surface roughness, volumetric material rate and accuracy. it was found that the control factor pulse on is having more effect on output measure.

U.A. Dabade, S.S. Karidkar[8] has analyse the machining condition for MRR , surface roughness , cutting width and dimentional deviation. Inconel 718 as work peace material with dimension 120×100×16 mm is used. Zinc coated brass wire of 0.25 mm diameter is used as a tool electrode. The pulse on time with (108,124 µs), pulse off time (40,60µs), peak current (70,230 A) is used, DOE such as TAGUCHI methodology L8 orthogonal array. The experimental analysis is carried out using minitab 16 software. After experimental analysis it was observe that pulse on time is the most influential factor for all the response variable such as MRR, surface roughness.

T Singh, J P Misra, B Singh[5] Has illustrates the MRR of Al 6063 alloy by WEDM process. The experimental study has been carried out after designing it with the help of Box-Behnken design technique of response surface methodology and this technique is used to explore the effects of input process parameters on measure of process performance. Based on the experimentation and analysis, it can be concluded that pulse-on time, pulse-off time, and servo voltage have significant effect on response parameter while, the effect of peak current is found insignificant. It was found that MRR increases with increasing pulse-on time, whereas the response parameter decreases with increasing pulse-off time and servo voltage. An empirical model has been developed to provide a guideline to the potential users of WEDM of Al 6063 alloy.

M.Manjaiah, Rudolph F.Laubscher, Anil Kumar [12] has investigate effect of pulse on time, pulse off time, servo voltage and wire feed on AISID2 steel material, MRR and surface roughness are the output measure. Taguchi L_{27} orthogonal array of DOE is used. zinc-coated brass wire of 0.25 mm diameter electrode is used. ECOCUT Wire EDM under power plus mose machine is used for experiment. the pulse on time in the range of (110,130µs),pulse off time (30,42µs),servo voltage(20,60V),wire feed(2,6m/min) is used foe experiment. has concluded that pulse on time and servo voltage are the most significant parameter affecting on MRR and R_a.

Sheril cyriac, Prof.Sharos[10] has experimentally study and optimization of wire EDM on EN24 steel material. workpiece size of 40×50×25mm,specimens of 4×4×25 mm are cut from the main work piece. pulse on time in the range of (35,50µs),pulse off time (9,15µs), current(2,5A),speed (200,215mm/min) are selected as a input process parameter.DOE such as Taguchi's L16 orthogonal arrays is used. The output measure surface roughness is measure by using Mitutoyo surface roughness tester SJ-410.for statistical analysis ANOVA is used. it is concluded that current has major influence on surface roughness and speed has least influence.

3. CONCLUSIONS

The identification of effect of Wire EDM process parameter on the output measure is essential. from the literature reviewed the effect of process parameter are follow.

1. The pulse on time is most significant parameter affecting on MRR.

2. The surface roughness increased when peak current and pulse on time is increase, pulse off time is not having much impact.

3. the pulse on time is the most influencing parameter whereas pulse off time and gap voltage are quite remarkable parameter to control the MRR.

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