A Literature Review on Effect of Machining Parameters in Wire – EDM

Rutvik A. Shah, Prof. Ankit Darji

P. G. Student (M. E. - Production) 2 Asst. Professor

1 Mechanical Engineering Department

1, 2 LDRP-ITR, Gandhinagar, Gujarat

Abstract—The recent upgradation of newer and harder materials has made the machining task in WEDM quite challenging. Thus for the optimum use of all the resources it is essential to make the optimum use of parameters to get the best output to increase the productivity. Advances in technology have impacted with an increased cutting speed and tight tolerances in WEDM. This paper reviews the various notable works in field of WEDM and magnifies on effect of machining parameters on MRR, kerf width and surface roughness.

Key words: Brass wires, coated wires, MRR, DOE, Surface roughness, ANOVA

I. INTRODUCTION

Wire electrical discharge machining (WEDM) is an indispensable machining technique for producing complicated cut-outs through difficult to machine metals without using high cost grinding or expensive formed tools [9]. Wire-cutting EDM is commonly used when low residual stresses are desired, because it does not require high cutting forces for removal of material.

It can machine anything that is electrically conductive regardless of the hardness, from relatively common materials such as tool steel, aluminium, copper, and graphite, to exotic space-age alloys including hast alloy, wasp alloy, Inconel, titanium, carbide, polycrystalline diamond compacts and conductive ceramics. Parts that have complex geometry and tolerances don't require you to rely on different skill levels or multiple equipments. Most work pieces come off the machine as a finished part, without the need for secondary operations.

II. WORKING PRINCIPLE OF WIRE - EDM

A model of Wire EDM is shown in figure 1. In Wire EDM, the conductive materials are machined with a series of electrical discharges (sparks) that are produced between an accurately positioned moving wire (the electrode) and the work piece. High frequency pulses of alternating or direct current is discharged from the wire to the work piece with a very small spark gap through an insulated dielectric fluid (water). Wire EDM uses a travelling wire electrode that passes through the work piece. The wire is monitored precisely by a computer-numerically controlled (CNC) system.

Many sparks can be observed at one time. This is because actual discharges can occur more than one hundred thousand times per second, with discharge sparks lasting in the range of 1/1,000,000 of a second or less. The volume of metal removed during this short period of spark discharge depends on the desired cutting speed and the surface finish required.

III. LITERATURE REVIEW

S. B. Prajapati, N. S. Patel [1] evaluates the effect of pulse On-Off time, voltage, wire feed and wire tension on MRR, SR, kerf and gap current in Wire EDM. A series of experiments have been performed on AISI A2 tool steel in form of a square bar. Analysis of data optimization and performance is done by Response Surface Methodology (RSM).

Atul J. Patel, Prof. Satyam Patel [2] used Taguchi L9 orthogonal array to find out effects on AISI 304 Stainless Steel of thickness 10 mm in Wire EDM. Input parameters such as pulse On-Off time, wire tension and input power have been used to evaluate their influence on Surface Roughness and Material Removal Rate. Mathematical relations between input parameters and performance characteristics were established by the linear regression analysis method by using MINITAB software.

Rao and Sarcar [3] studied the influence of optimal parameters on cutting speed, surface roughness, spark gap, and material removal rate (MRR). He evaluated the optimal parameters such as discharge current, voltage at rated wire speed and tension for brass electrode of size 5-80 mm. Mathematical relation was developed for cutting speed, spark gap and MRR. Effect of wire material on cutting...
criteria was also evaluated for brass workpiece with four wires of different copper percentages. This study is useful for evaluating cutting time for any size of job and to set parameters for required surface finish for high accuracy of cutting. Mathematical relations are helpful for estimating cutting time, cost of machining, process planning and accuracy of cutting for any size of job within machine range. Results obtained are helpful for quantification of parameters for quality cuts. Also, results are useful in manufacturing wire EDM system for die and tool steel electrodes.

Nihat, Can, Gul [4] investigated on the effect and optimization of machining parameters on kerf and material removal rate (MRR) in WEDM operations. Experimental studies were conducted using different pulse duration, open circuit voltage, wire speed, and dielectric flushing pressure. Importance levels of parameters were analysed using analysis of variance (ANOVA). The optimum machining parameter combination was obtained by using the analysis of signal-to-noise (S/N) ratio. The variation of kerf and MRR with machining parameters is mathematically modelled by using regression analysis method. Objective of minimum kerf together with maximum MRR was performed. The experimental studies were performed on a Sodick A320D/EX21 WEDM machine tool. CuZn37 Master Brass wire with 0.25mm diameter was used in the experiments. As work-piece material, AISI 4140 steel (DIN 42CrMo4) with 200mm × 40mm × 10mm size was used.

From Comparison of Experimental result and ANN predicted result it was found that they were very close and giving very accurate result. The maximum error is 0.14. ANN is powerful technique for prediction of process parameters error was very less. The maximum error is 0.14. ANN is powerful tool of AISI A2 Tool Steel are predicted by using Artificial Neural Network (ANN). ANN was founded a powerful tool for data prediction and it gives agreeable result when compared to full factorial design. All the experiments were conducted on Ultra Cut 843/ ULTRA CUT f2 CNC Wire-cut EDM machine. The size of the work piece considered for experimentation on the wire-cut EDM is 25 mm x 20 mm x 10 mm. Increasing the discharge energy generally increases surface irregularities due to much more melting and re-solidification of materials. Hence, it is found that SR tends to decrease significantly with decrease in IP and TON.

Saurav Datta, Siba Sankar Mahapatra [9] experimented with six process parameters: discharge current, pulse duration, pulse frequency, wire speed, wire tension and dielectric flow rate, to be varied in three different levels. Data related to the process responses viz. material removal rate (MRR), roughness value of the worked surface and kerf have been measured for each of the experimental runs; which correspond to randomly chosen different combinations of factor setting. These data have been utilized to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a function of the aforesaid six process parameters. Predicted data have been utilized for identification of the parametric influence in the form of graphical representation for showing influence of the parameters on selected responses. Predicted data given by the models (as per Taguchi’s L27 (3^6) Orthogonal Array (OA) design) have been used in search of an optimal parametric combination to achieve desired yield of the material removal rate (MRR), roughness value of the worked surface and kerf have been measured for each of the experimental runs; which correspond to randomly chosen different combinations of factor setting. These data have been utilized to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a function of the aforesaid six process parameters. Predicted data have been utilized for identification of the parametric influence in the form of graphical representation for showing influence of the parameters on selected responses. Predicted data given by the models (as per Taguchi’s L27 (3^6) Orthogonal Array (OA) design) have been used in search of an optimal parametric combination to achieve desired yield of the material removal rate (MRR), roughness value of the worked surface and kerf have been measured for each of the experimental runs; which correspond to randomly chosen different combinations of factor setting. These data have been utilized to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a function of the aforesaid six process parameters. Predicted data have been utilized for identification of the parametric influence in the form of graphical representation for showing influence of the parameters on selected responses. Predicted data given by the models (as per Taguchi’s L27 (3^6) Orthogonal Array (OA) design) have been used in search of an optimal parametric combination to achieve desired yield of the material removal rate (MRR), roughness value of the worked surface and kerf have been measured for each of the experimental runs; which correspond to randomly chosen different combinations of factor setting. These data have been utilized to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a function of the aforesaid six process parameters. Predicted data have been utilized for identification of the parametric influence in the form of graphical representation for showing influence of the parameters on selected responses. Predicted data given by the models (as per Taguchi’s L27 (3^6) Orthogonal Array (OA) design) have been used in search of an optimal parametric combination to achieve desired yield of the material removal rate (MRR), roughness value of the worked surface and kerf have been measured for each of the experimental runs; which correspond to randomly chosen different combinations of factor setting. These data have been utilized to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a function of the aforesaid six process parameters. Predicted data have been utilized for identification of the parametric influence in the form of graphical representation for showing influence of the parameters on selected responses. Predicted data given by the models (as per Taguchi’s L27 (3^6) Orthogonal Array (OA) design) have been used in search of an optimal parametric combination to achieve desired yield of the.
process: maximum MRR, good surface finish and dimensional accuracy of the product. Grey relational analysis has been adopted to convert this multi-objective criterion into an equivalent single objective function. The work piece, a block of D2 tool steel with 200 mm × 25 mm ×10 mm size, has been cut 100 mm length with 10 mm depth along the longer length.

IV. CONCLUSION

1) For cutting rate and surface roughness, the pulse ON and pulse OFF time is most significant. The spark gap set voltage is significant for kerf.
2) Increase in Input power, value of surface roughness is increase. Increase in Pulse on time, value of material removal rate is increase.
3) Open circuit voltage was three times more important than pulse duration for controlling kerf, while for MRR, open circuit voltage was about six times more important than pulse duration.
4) Corresponding to minimum value of pulse off time the spark gap decreases with increase in dielectric pressure, whereas the spark gap increases with increase in dielectric pressure corresponding to maximum value of pulse off time.
5) As the machine feed rate increases, the kerf width decreases. Increasing machine feed rate, the MRR will increases simultaneously. Smoother surface can be obtained with low setting of machine feed rate.
6) It is found that SR tends to decrease significantly with decrease in IP and TON.

V. FUTURE SCOPE

For researchers there is wide scope for analysing and developing new technology. Many different types of wire material can be used for machining on a particular material and optimum parameters can be obtained. Also many different work piece materials that can be used for research are Tool Steels, Titanium alloys, EN series, Inconel, Nickel alloys, Aluminium alloys etc.

REFERENCES