An Experimental Investigation of WC-EDM during Machining of AISI-52100 steel

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Abstract— Wire EDM is an emerging technology in the field of machining to fabricate very complex products. Wire EDM is a very complex process involving the different process parameters. In the present investigation an optimization of wire EDM has been carried out using Full factorial method. The parameters involved are current, voltage, and wire feed rate are taken as the response criteria. The present work demonstrates optimization of Wire Electrical Discharge Machining process parameters of material as used AISI 52100 alloy steel with multiple performance characteristics such as Material Removal Rate (MRR), kerf width and Surface roughness.

Key words: WEDM, Investigation, Surface Roughness, Kerf Width

I. INTRODUCTION

Electrical discharge machining (EDM) is one of the most extensively used nonconventional, thermo -electric metal removal process which encodes material from the work place by a series of discrete spark between a work and a tool electrode immersed in a liquid dielectric medium. Electrical energy is used directly to cut the material in final shape. Melting and vaporization takes place by electrical discharges. The minute amounts of the work material is then ejected and flushed away by the dielectric medium. The sparks occur at high frequency which continuously and effectively removes the work prices material by melting and evaporation.

Fig. 1: Wire cut edm machine Setup

II. LITERATURE REVIEW

AliVaziniShayana,Reza Azar Afzac, Reza Teimouri [1] been conducted using air as dielectric medium and they took process parameter like pulse on time, pulse off time, gap set voltage, discharge current and wire tension. They measured cutting velocity (CV) surface roughness (SR) and oversize (OS). They experiments were conducted to investigate effects of process parameters on dry WEDM characteristics and find appropriate ranges for each factor. They used design experiments based on response surface methodology (RSM) and analysis of variances (ANOVA).

M.Durairaj, D.Sudharsan, N.Swamynathan [2]. experiment on stainless steel using wire cut EDM.objective of optimization is to attain the minimum kerf width and the best surface quality simultaneously and separately. In this present study stainless steel 304 is used as a work piece, brass wire of 0.25mm diameter used as a tool and di 16, orthogonal array has been used. The input parameters selected for optimization are gap voltage, wire feed, pulse on time, and pulse off time. Dielectric fluid pressure, wire speed, wire tension, resistance and cutting length are taken as fixed parameters. Surface roughness are 40V gap voltage, 2mm/min wire feed, 6 µs pulse on time, 10 µs pulse off time and similarly optimized conditions to get the minimum kerf width are 50V gap voltage, 2mm/min Wire Feed, 4 pulse on time, 6 µs pulse off time.

Brajesh Kumar Lodhi, Sanjay Agarwal.[3] conducted experiment on AISI D3 Steel using L9 Orthogonal Array) Taguchi methodology through wire cut EDM. They were carried out experiments under varying pulse-on-time, pulse-off-time, peak current, and wire feed. Also they were used an orthogonal array, the signal-to-noise (S/N) ratio, and the analysis of variance (ANOVA) to the study the surface roughness. They were determined the effect of various machining parameter such as pulse-on time, pulse off time, peak current and wire feed for surface roughness. They were found that the pulse on time and current have influenced more than the other parameters considered in this study. • Result shows that the errors associated with SR is only 3.042 %. The selection of optimum values is essential for the process automation and implementation of a computer integrated manufacturing system. Thus the optimized condition, not only makes that wedm a more commercially viable process for industrial applications, but also turns a spotlight on WEDM processes a promising field for further advancements.

Kannachai Kanlayasiri, Prajak Jattakul.[4] conducted experiment on determine an optimal cutting condition of dimensional accuracy and surface roughness for finishing cut of wire-EDMed K460 tool steel. The cutting variables investigated in this study encompassed cutting speed, peak current, and offset distance. Box– Behnken design was employed as the experimental strategy, and multiple response optimization on dimensional accuracy and surface roughness was performed using the desirability function. Results showed that both peak current and offset distance have a significant effect on the dimension of the specimen while peak current alone affects the surface roughness. The optimal cutting condition was at 2 A peak current and 772 m offset distance. Since neither dimension nor surface roughness was affected by cutting speed, the speed was thus set at the highest of 5.5 mm/min to maximize the production rate. Confirmation tests on the optimal cutting condition were executed by which all cut specimens were shown to be within the specifications.

Nihat Tosun,Can Cogun, Gul Tosun l. [5] This paper presents an investigation on the effect and optimization of machining parameters on the kerf (cutting width) and material removal rate (MRR) in wire electrical discharge machining (WEDM) operations. The experimental studies were conducted under varying pulse duration, open circuit voltage, wire speed and dielectric flushing pressure. The settings of machining parameters were determined by using Taguchi experimental design method. The level of importance of the machining parameters on the cutting kerf and MRR is determined by 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 modeled by using regression analysis method. The optimal search for machining parameters for the objective of minimum kerf together with maximum MRR is performed by using the established mathematical models.

J.A. Sanchez, J.L. Rodil, A. Herrero [6] the development of enhanced generators that produce more energetic discharges yielding cutting speeds as high as500mm2/min has resulted in stronger forces acting on the wire. These forces, together with the low rigidity of the wire, especially in the cutting of parts of high thickness, are responsible for wire deformation that has a direct influence on the accuracy of the part, mainly on wall-flatness and corners. In this work a study on the corner geometry generated by the successive cuts (roughing and finishing) is present

III. EXPERIMENTAL RESULT

The process parameters include parameters relating to the forming of the wedm as shown in table 1 .

parameters	unit	Level1	Level2	Level3
Current	A^0	90	100	110
voltage	Volt	30	40	50
Feedrate	Mm/sec	5	10	15

Table 1: level s of parameter

IV. ANOVA ANALYSIS

1) According to the analysis done by the MINITAB16 software, if the values of probability are less than 0.05, it indicated that the factors are significant to the response parameters. Comparing the p-value to a commonly used α- level = 0.05, it is found that if the p-value is less than or equal to α, it can be concluded that the effect is significant, otherwise it is not significant. From ANOVA result it is observed that the voltage and wire feed influencing parameter for Material Removal Rate, while the value of p for current is 0.648 which is greater than 0.05 p value so they are not influencing parameter for MRR.
2) From ANOVA result it is observed that all process parameters voltage, current and wire feed are influencing parameter for Surface roughness, the value of p for all reprocess parameters are 0.000 which is less than 0.05 p values. So, it is not influencing parameter for Surface roughness
3) From ANOVA result it is observed that all responses are influencing parameter for kerf width, while the value of p for all process parameter is 0.000, 0.004 and 0.004 which is less than 0.05 p values. So, it is influencing parameter for kerf width.

V. REGRESSION MODEL

The regression equation takes the form of: Response= constant + coefficient (predictor) +… + coefficient (predictor)

MRR = 4.92 - 0.00872 VOLTAGE + 0.00189 CURRENT + 0.0107 WIRE FEED

Surface Roughness= 1.65 - 0.00639 VOLTAGE + 0.00689 CURRENT + 0.0168 WIRE FEED

Kerf Width = 0.401 - 0.000789 VOLTAGE + 0.000594 CURRENT - 0.00128 WIRE FEED

VI. MULTI RESPONSE OPTIMIZATION OF PROCESS PARAMETER

As we know that higher grey relational grade value will give optimum value of MRR, SR and Kerf width. Thus it is revealed that response will be optimum voltage 50, current 110amp, wire feed rate 10 mm/sec

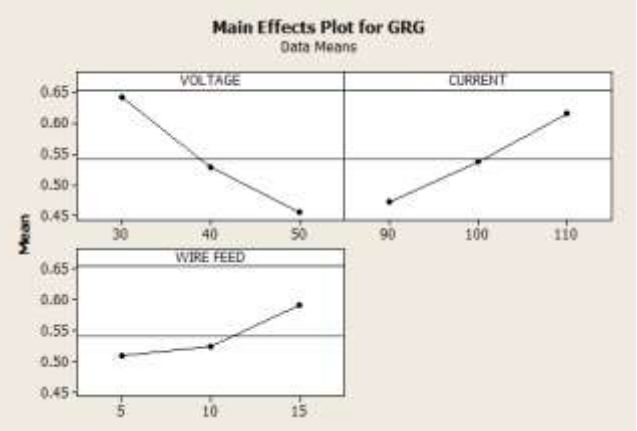

Fig. 2: Main effect of factor on Grey Relational Grade

VII. CONCLUSION

1) The surface roughness increase with increase current from 90 to 110 Amp., when the other two parameter are kept constant as well as surface roughness decrease with increase voltage 30 to 50 volt
2) While studying the effect of the cutting parameters on the kerf width, it was observed that voltage play equally important roles in the effect on the kerf width. The role of the both the current and wire feed given is not crucial to the same extent. The optimum condition for machining to reduce kerf width would be A3 B1 C3. The voltage kept at 50 volt, the current kept at 90 amp. And wire feed are kept 5 mm/sec.
3) The optimum condition for machining to reduce surface roughness would be A3 B1 C1. The voltage kept at 50 volt, the current kept at 90 amp. and the wire feed 5 mm/sec.
4) While studying the effect of the cutting parameters on the surface roughness, it was observed that both the wire feed and current play equally important roles in the effect on the surface roughness. The role of the voltage given is less crucial to the same extent compare to other process parameter.

5) Through use of regression equation, engineer can manipulate range of cutting voltage, current and wire feed for this particular work- material. Also it has been find out and predicted kerf width, material removal rate and surface roughness at any combination of process parameter.
6) The optimal parameter values are at voltage 30 volt, current 110 amp and wire feed 15 mm/sec. At these parameters the values of kerf width, surface roughness and MRR are 0.427 mm, 0.43µm and 5.15 mm3/min respectively.
7) It is shown that the performance characteristics of the wire cut EDM process, namely voltage, current and wire feed improved together by using Grey Relational Analysis

VIII. REFERENCES

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