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Optimization of Process Parameter in Electrical Discharge Machining

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***Abstract*: This is the non-traditional machining process. The high surface finish of the material is required. more complex shape of material is required. Wire EDM is one of the non- traditional machining processes. Surface roughness and kerf width are of crucial importance in the field of machining processes. This paper uses the Grey relational theory and Taguchi optimization technique, in order to optimize the cutting parameters in Wire. EDM for D3 steel material. The best surface finish is achieved by minimum kerf width.**

Minimum kerf width is the material removal of the material. 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. For each experiment surface roughness and kerf width was determined by using contact type surf coder and video measuring system respectively. By using multi objective optimization technique grey relational theory, the optimal value is obtained for surface roughness and kerf width and by using Taguchi optimization technique, optimized value is obtained separately. Additionally, the analysis of variance (ANOVA) is too useful to identify the most important factor.

***Keywords*: Discharge Machining**

1. Introduction

WEDM is based on Electrical Discharge Machining Process, which is also called electro- erosion machining process. When the gap voltage is sufficiently large (i.e. reaches the breakdown voltage of dielectric fluid), high power spark is produced, which increase the temperature about 10,000 degrees Celsius. By this way the metal is removed from the work piece. D3 stainless steel is used as a work piece. Stainless Steel 304 is a nickel and chromium based alloy, which is widely used in valves, refrigeration equipment, evaporators, cryogenic vessels due to their exceptional corrosion resistant, high ductility, non-magnetic and it retains solid phase up to 1400 degree Celsius. The chemical composition of the work material is shown in table 1.

Brass wires are alloys of copper and zinc possesses reasonable conductivity with high tensile strength when compared to the copper wires. In this experiment, brass wire having 65% of copper and 35% of zinc is selected as a tool due to its properties, availability and low cost. The gap between the wire and work piece usually ranges from 0.025 to 0.075 mm and is constantly maintained by a computer controlled positioning system [1]. The selection of optimum machining parameters in WEDM is an important step [2, 3]. Taguchi Optimization technique is single parameter optimization based on the signal to noise ratio. Grey relational analysis is applied to optimize the parameters having multi-responses through grey relational grade. Furthermore, a statistical analysis of variance (ANOVA) is performed to see which process parameters are statistically significant [4]. The material is use D3 steel material is proved in this chart. The eight type of test has taken of the D3 steel type of material.

Table 1
Chemical composition of the work material

Test	Test Result	Unit
Carbon	2.14	%
Silicon	0.30	%
Manganese	0.43	%
Phosphorous	0.028	%
Sulphur	0.030	%
Chromium	11.09	%
Tungsten	0.11	%
Vanadium	0.074	%

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2. Design of experiments

Taguchi Technique is applied to plan the experiments [5]. Orthogonal arrays were introduced in the 1940s and have been widely used in designing experiments [6]. It is used to reduce the number of experiments needed to be performed than the full factorial experiment. Based on the machine tool, cutting tool and work piece capability, the process parameters and the level for the process parameters were selected.

Table 2

	Unit	Level 1	Level 2	Level 3	Level 4
Gap voltage	V	40	45	50	55
Pulse on time	Us	4	6	8	10
Pulse of time	Us	4	6	8	10
Wire feed	Mm/ min	2	4	6	8

Taguchi proposed to acquire the characteristic data by using orthogonal arrays, and to analyze the performance measure from the data to decide the optimal process parameters. The designed combination of input parameters and its corresponding surface roughness and kerf width

3. Taguchis optimization method

Optimization of process parameters is the key step in the Taguchi method to achieve high quality without increasing cost [7]. However, originally Taguchi method was designed to optimize single performance characteristics [8]. According to Taguchi method, the S/N ratio is the ratio of Signal to Noise where signal represents the desirable value and noise represents the undesirable value. The response Ra and Kf reported in Table 3, which is used to calculate the Signal to Noise Ratio (S/N) using the equation (1). The experimental results are now transformed into a signal-to-noise (S/N) ratio [9]. Since surface roughness and kerf width is desired to be at minimum, so Lower the Better characteristic is used for S/N ratio calculation. The optimal setting would be the one which could achieve lowest S/N ratio [10]. The S/N Ratio for the experiments conducted.

4. Conclusion

Experimental investigation on wire electrical discharge machining of D3 stainless steel has been done using brass wire of 0.25 mm. The following conclusions are made on optimization method, the optimized input parameter combinations to get the minimum 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 µs pulse on time, 6 µs pulse off time.

Based on the Grey relational analysis, the optimized input parameter combinations to get both the minimum surface roughness and the nominal kerf width are 50V gap voltage, 2mm/min wire feed, 4 µs pulse on time and 4 µs pulse off time. The Analysis of Variance resulted that the pulse on time has major influence on the surface roughness (µm) and kerf width (mm) in both the Taguchi optimization method and Grey relational analysis. The objectives such as surface roughness and kerf width are optimized using a single objective taguchi method and multi objective grey relational analysis and the same has been validated with the experimental results.

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