Experimental investigation and multi objective optimization for wire EDM using Taguchi's method

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Abstract- Composite materials and alloys have increased applications in many industries because of their good mechanical characteristics such as strength to weight; stiffness to weight, corrosion resistance, fatigue and thermal expansion compared with metals. Due to its capability for automation is a unique feature fulfilling the expectations of modern manufacturing? EDM is an easy machining process controlled by a large number of processes such as the pulse duration; discharge frequency and discharge current intensity. Any low variations in the parameters can affect the machining performance beyond the expectations. Selection of machining conditions for improved machining performance has great importance during EDM. In this work the effect of working with piece thickness and many other process variations such as highest peak current, time, and other characteristics as cutting rate, surface finish cum roughness. Taguchi method deals with an orthogonal has been used for doing experiment and research results. An experimental cum mathematical model is developed between process factors and responses as all factors considering. In this paper a novel work is done for minimization of machining work for the various machining processes.

***Key Words*: Optimization, Taguchi's method used for surface roughness and analysis of variance.**

1. INTRODUCTION

Electrical discharge machining (EDM) is a well known MRP used to produce components of intricate shapes, quality and profiles as required in today's scenario. It is considered as an ease of work of the EDM process that uses the electrodes to initialize and sparking processes. Apart from this EDM it utilizes a moving wire electrode which is made of slim copper, brass or tungsten in the range of diameter 0.05–0.3 mm, which is capable of achieving very small corner radii. During the EDM processes materials with samples are eroded and developed the various stresses during machining. In addition, the EDM process is capable to machine the high strength including temperature resistive (HSTR) and diminished the geometrical shapes and changes occurring in the machining of hard to machine materials. General applications of 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.

1.1 PURPOSE

As per todays demand for modern era, accurate modelling method such as ANN can be used for interconnecting the input parameters and machining performance characteristics. Optimized set of parameters for more thicknesses of work piece can be obtained using different boundary conditions. Replication of various experiments and methods of working can be performed to increase the accuracy. Experiments can be performed with wider range of input parameters as variables. Various machining parameters can be tried out for its result accuracy and verification of results.

2. WORK PIECE MATERIAL

In this the sample used for the experimentation of AISI D3 tool steel .As per requirement AISI D3 is high carbon-high chromium steel developed for applications high resistance2wear or to abrasion process and for resistance a high pressure rather than to sudden shocks. Because of these qualities and its non-deforming properties, AISI D_3 is unsurpassed for die work on long production runs. In the experiment the oil-hardening steel which hardens to a great depth to better result? The production from a die after each grind is uniform. As the impact strength is relatively low, by proper adjustment of tool design and heat treatment process. In this experiment a steel piece as sample has been used for punche and dies on quite a heavy material being used.

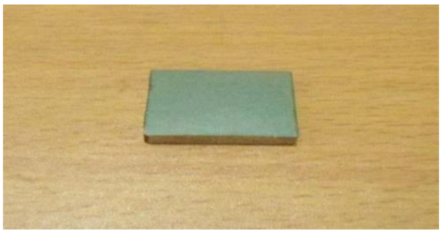


Figure -1: Work piece

Table -1: Mechanical Properties of Die Steel D-3

Density (g/cm³)	Melting point (ºC)	Yeild strength (MPa)	Elastic modulu (GPa)	Possion's Ratio	Hardness
7.87	1421	470	190	0.28	18 HRC

Table-:2 Chemical composition of the work piece material (DIE STEEL D-3) by weight

Material	Fe	Ni	Mn	Cr	C	Si	Cu	V	Mo
% Composition	84.23	0.078	0.388	12.80	2.12	0.227	0.036	0.046	0.021

3. EXPERIMENTAL DESIGN METHODOLOGY

In this the experiments are conducted over the samples are being used for testing and measurements of surface roughness by using Taguchi's methods are being used, and results are obtained for establishements of prior studies. In this experimental work an array force with all experiments for design almost identical experiments and samples has done. In this Taguchi's method various results are analysed as statistical methods to achieve one or more of the below mentioned objectives:

1. To established the best or the optimum state for a product or a process.
2. To estimate the contribution of various parameters and relation with other parameters
3. To estimate the response under the optimum condition as per required for better surface finish and smoothness.

The best conditions are recognized by studying the main effects of the parameters. The main effects of it indicate the general trends of influence of each parameter and process. The knowledge of contribution of individual parameters is a key in deciding the nature of control to be established on a production process. Taguchi suggests two different routes to carry out the analysis. First, the standard approach, where the outcome of a single run is achieved. The second approach of Taguchi's method appeals for multiple runs is to use for signal-to-noise ratio (S/N) for the same work in the analysis as done experimentally.

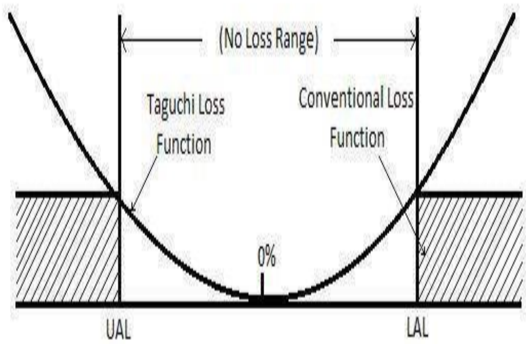
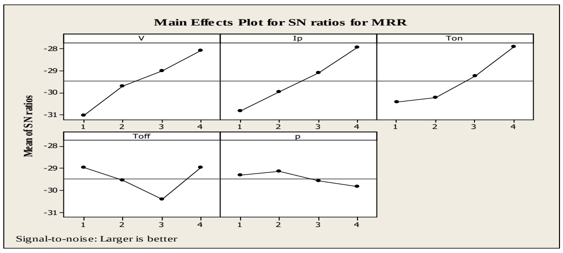
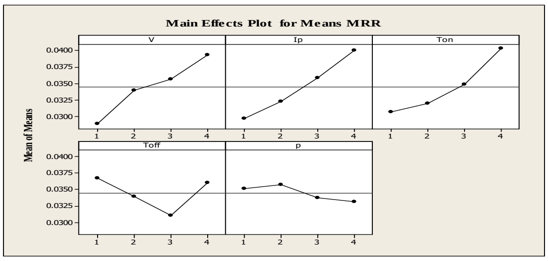


Figure -2: **The Taguchi and conventional quality loss function**

4. RESULT AND DISCUSSION

In this study an attempt has been made to find not only the effect of work piece thickness while several other process parameters and other over different machining performance characteristics such as cutting rate, surface roughness, wire wear ratio but also, an optimized set of parameters for the work piece thickness is done. All of the obtained 35 set of parameters for each work piece thickness are non-dominated to each other; it means that no machining characteristic can be further improved without worsening the other machining characteristic. In the present work the experiments are analysed on Minitab statistical software in the lab and thus S/N values are obtained for the surface finish and its analysis for future work and prospective to work over it.EDM process is analysed and used by using Taguchi's method for better surface finish of the samples which are used in its experiments





- After optimization highest cutting rate 9.6242 mm^2/min (surface roughness-3.31 µm and wire wear ratio-0.061576), lowest surface roughness 0.99 µm (cutting rate-4.8765 mm^2/min and wire wear ratio-0.023119) and lowest wire wear ratio 0.02146 (cutting rate-6.0325 mm^2/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 during experimentation.
- All of above three results show the effectiveness of using controlled NSGA II for multi-objective optimization.
- On performing confirmation experiments on some of obtained set of parameters it was observed that for cutting rate error %age varies from 2.612 to 7.213, for surface roughness varies from 3.238 to 8.256 and for wire wear ratio varies from 3.01 to 7.022.

5. CONCLUSIONS

More accurate modelling method such as ANN can be used for interconnecting the input parameters and machining performance characteristics. Optimized set of parameters for more thicknesses of work piece can be obtained using different boundary conditions. Replication of experiments can be performed to increase the accuracy. Experiments can be performed with wider range of input parameters. Different machining parameters can be tried out.

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