A study on Experimental Design and Optimization techniques for EDM Process Parameters

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Abstract Design of Experiments has been used for many of the industries for manufacturing the optimal products by examination of the performances. It can be mainly used for screening, optimization and robustness of the experiments to produce optimal products. It provides the design before the start off the experiment and it can be used for making decision with the help of process knowledge for the provided data. Also it can be used for making analysis of each data on the performance characteristics. One can predict the performances by giving the rank. This paper describes the design of experiments and the optimization techniques handled by various authors.

IndexTerms **–Design of experiments, Optimization, Machining, EDM, Parameters.**

I. INTRODUCTION

In any process, there is n number of factors and m number of outputs. The performances of process get affected by one or more factors. To analyze the performance, one can do the experiments with various levels of factors. Each factor has different levels. There are i number of experiments when there are combination of factors with different levels. It is complex and unfeasible to do all the experiments. To solve this problem, Taguchi developed some sort design to do the experiments. Taguchi formed some standard arrays called orthogonal array for n factors with different levels. By following the array one can do experiments with less number of trials. And from the results of experiments one can find the optimal solution for the process. This paper discusses the design of experiments and the various optimization process handled by various authors.

II. Literature Survey

Prasanna et al. [1] uses Taguchi's grey relational analysis for the multi performance optimization and used regression analysis for mathematical modeling. The author considered spindle speed, feed rate and air pressure for conventional dry drilling of Ti–6Al–4V plate. The performance of small hole has been evaluated through thrust force, overcut, circularity and taper. They have also used ANOVA to study the effects, contribution and significance of process parameters.

Chander Prakash et al. [2] uses a multi-objective particle swarm optimization (MO-PSO) technique to determine the optimal levels of process parameters such as concentration of hydroxyapatite powder (CHA), peak-current (Ip), pulse-on (Ton), and pulse-off (Toff). Surface roughness (SR), thickness of recast layer (RLT), and micro-hardness (MH) were chosen as output responses for hydxroxyapatite (HA) powder mixed electric discharge machining (HAM-EDM) process of bio-degradable MgeZneMn alloy. They have used L27 orthogonal array for the experimental design. Taguchi's methodology integrated with response surface methodology was to develop mathematical model for individual output response characteristics.

Chinmay et al. [5] This author uses utility concept and quantum behaved particle swarm optimization (QPSO) algorithm for optimization of EDM parameters for machining of Inconel 718 by copper, graphite and brass electrodes. They have chosen L27 array for the design and the process parameters are open circuit voltage, discharge current, pulse-on-time, duty factor, flushing pressure and electrode material. Material removal rate, tool wear rate, surface roughness and radial overcut are the performance measures which are to be optimized. Non linear regression analysis was used to develop the model.

Sagar et al. [3] discusses the single and multi-objective optimization of micro EDM drilling of Titanium alloy (Ti6Al4V) by using copper tungsten (CuW) electrode. It uses response surface methodology (RSM) based central composite design (CCD) to analyze the effect of pulse on time, discharge voltage, capacitance and electrode rotation speed on responses such as material removal rate (MRR), side gap measurement and taper ratio. For MRR discharge voltage, capacitance and electrode rotation speed are influencing parameters. The side gap width is influenced by pulse on time, capacitance and electrode rotation speed whereas taper ratio is influenced by pulse on time and capacitance. ANOVA is used to recognize the importance of process parameters.

Sohil et al. [4] uses a new method for multi- objective optimization of EDM machining properties of Mg-RE Alloys. They have used Passing Vehicle Search (PVS) algorithm to obtain 2-D and 3-D pareto fronts for getting the required best possible output variables. They have taken pulse-on (Ton), pulse-off (Toff) and peak current (A) as input parameters. In RSM, Box–Behnken design is used for mathematical modeling of MRR, TWR and roundness of holes by reducing the number of trials. Level diagrams were used to illustrate decision making.

Zhang et al. [6] optimizes the Magnetic Field assisted EDM (MF-EDM) process economically and environmentally using the modified non-dominated neighbor immune algorithm (M-NNIA) method. They have evaluated electrode wear rate (EWR),

energy consumption (SEC), and environmental impacts (including carbon emission and machining noise), using the Taguchi method. The pulse on time (ranging from 100 to 200 ms) and magnetic field intensity (ranging from 0.05 to 0.10 T) are the two factors affecting the performance of MF- EDM. By using M-NNIA, the optimization decreased by 61%, 18% and 21% for EWR, SEC, Carbon emission and machining noise. This MF- assisted EDM offers significant advantages and potential for applications in the sustainable manufacturing field.

III. COCLUSIONS

From the literature survey, many authors used Taguchi's orthogonal array as design plan and uses different optimization algorithm depending upon the single or multi response optimization. From this study, one can infer the knowledge how to plan the experiments before the start of work and optimization techniques from various authors.

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