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Multi-Response Optimization of EDM Modified Taguchi Method

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ABSTRACT

Taguchi's method has always been a method used to improve the quality of the analyzed processes and products. This research shows an unusual situation, namely the modeling of some parameters, considered technical parameters, in a process that is wanted to be durable by improving the quality process and by ensuring quality using an experimental research method. Modern experimental techniques can be applied in any field and this study reflects the benefits of interacting between the agriculture sustainability principles and the Taguchi's Method application. The experimental method used in this practical study consists of combining engineering techniques with experimental statistical modeling to achieve rapid improvement of quality costs, in fact seeking optimization at the level of existing processes and the main technical parameters.

INTRODUCTION

It has been observed that traditional agriculture, still used on a large scale by Romanian farmers, is currently unsatisfactory and insufficient. The production is met at minimum quotas, sometimes even lacks due to drought and low precipitations, the lack of crop irrigation systems or insufficient ones, the human effort made for sustaining the harvest is immense and the quality of the finite product is poor, the soil is degraded, the fertility is low and there are significant economic losses . Agricultural experiences are all the more necessary as agriculture is more developed and the more numerous and more varied the factors are, because the harmonic intertwining of the factors action produces the maximum productions. Farming experiences are of permanent importance, as new plants varieties and hybrids are developed annually and their production capacity needs to be studied under different technological and environmental conditions. Modern experimental technique allows the simultaneous study, in the same experience of several factors in different combinations and the precise determination of each contribution. Modern experimental technique can be applied in any field and this case study reflects the benefits of the interaction between the principles of sustainable agriculture and the application of experimental research methods, respectively the goals are achieved in a very short time, the working method is fast, simple and does not entail costs, and economic losses are non-existent, thus providing an efficient and lasting agricultural management system. The scenario of EDM machine tool technology as earlier 1960's where it bring to light by an English researcher. However, EDM were not as unreservedly under-taken benefit of until 1941 when Russian researcher experiment that the biting effect of the style should maintained and practice for multi-machining processes. Firstly this was researched by Joseph Priestly ar early's 1770, wire EDM introduce to a work ability methods were assist to structure the metalworking fabrication as present scenario . At mid-1981s, EDM approach was maintaining shifted to a tool.

This changeover helped EDM much effectively mechanism and presenting traditional machining[1]. Electrical Discharge Machining is a effectively material elimination mechanism that is used in order to remove metal by means of electric spark erosion. In this process an electrical spark is employed because the cutting tool to chop (erode) the work piece to supply the finished part to the specified shape. The local temperature rise during the spark is around 10000ºC. A thin gap about 0.025mm is constantly managed for both tool and work material by a servo mechanism presented in Fig 1.1.As work material and tool are aligned during a dielectric field. Oil and De-ionized H2O are examples of liquid di-electric even gaseous di-electric are also useful at mostly area .Typically; tool placed at cathode and work-piece is placed at anode position. At Situation Where the voltage fills difference becomes enough high it required discharges maintained at gap spark at time-interval of 10-12 μs.The EDM process can be used to machine any work material if it is electrically conductive. Material removal depends on mainly thermal properties of the work material instead ofits

strength and hardness. The local temperature rise is quite high, still thanks to very small pulse on time, there's not enough time for the warmth to diffuse and thus almost no increase in bulk temperature takes place. Thus the warmth affected zone is restricted to 2 – 4 μm of the spark crater. Rapid heating and cooling and native heat result in surface hardening which may be desirable in some applications There is an opportunity of taper cut and overcut in EDM, they will be controlled and compensated.

DIELECTRIC FLUID

In EDM process the work piece and electrode are submerged in the dielectric fluid, which is an electrical insulator9 helps to control the arc disengaged. The dielectric fluid, that provides a way of flushing, is pumped through the arc gap. In EDM, material removal mainly occurs due to thermal evaporation and melting. The thermal processing is required to be carried out in the absence of oxygen in order these process are commonly handled to avoid oxidation process which causes improper surface electrical conductivity.

Literature Survey

This chapter introduces the review of research work which is closely related to this thesis work. We first give an overview of the various techniques used for the optimization of manufacturing processes. Then the overview of EDM process optimization based on different dielectric fluid, different geometry of the electrode and work piece material with their conclusion has been discussed. Finally, the problem has been formulated with the critical finding of literature survey.

A literature review is an evaluative report of the knowledge found within the literature associated with the selected area of study. It gives the theoretical base for research and helps to figure out nature of your research. Its aim to review the critical points of current knowledge including substantive found also as theoretical and there foe the methodological contributions to a specific topic. when radius of electrode significantly increases, the MRR increases but EWR decrease [6]. Among the various dielectric fluids used in EDM process, water based dielectric fluid oils as they have good performed and green environmentally friendly [7]. During EDM of Inconel 718 material, typical geometry of the machining holes and solidified material near the hole entry have been observed to achieve the feasibility of micron size hole manufacturing [8].

The pulse current has more effect on EDM multi-performance feature instead of pulse duration. Due to the higher energy density during EDM on Inconel 721 [9]. The experimental investigation of EDM parameters on Inconel 721 using the different geometry of the tungsten carbide electrode with kerosene as dielectric fluid reveals that pulse when required are significantly. characters tic that is required to MRR and reverse to EWR and surface roughness [10]. A comparative analysis of mild steel & aluminium material in the EDM process reveals that low MRR occurs in case of mild steel due its high melting temp. causes poor removal of work material. Electrode undergoes more wear in case of mild steel than aluminium and the wear rate of copper electrode is a smaller amount than that of brass electrode. [11].

Concluding research, it observed there a easy work that which provided with the objective to optimize the multi-response characteristic of EDM process using rotary brass hollow tubular electrode for Inconel 600 and Inconel 718 based on the basic underlying philosophy of Taguchi methodology. Most of the study of EDM process was done to increase MRR and reduced EWR,OC but there was only limited work on tapers of the drill hole using an EDM process. There was no significant work is available for Electrical Discharge Machining using Rotary brass hollow tubular electrode. Several methods were adopted by the researchers to design the experiment and optimization of process parameters of EDM namely desirability approach, gray relational analysis, response surface methodology, Taguchi methodology and hybrid optimization technique but there is only limited work on the optimization technique based on the basic underlying philosophy of Taguchi methodology.

METHODOLOGY

The experimentation is as systematic and scientific approach to manipulate one or more output variables and control or measure the input variables. Data obtained through the experiment are used to calculate the output variables. Every researcher try to conduct trials to obtain maximum and useful data respect to behind the significantly approached.

Experimental Work piece And Their Specification

Modern industry promotes the use of alternative advanced materials (composites, super alloys and ceramics) for establishing design and manufacturing. Therefore, an experiment was performed on Inconel 600 and Inconel 718 that is most widely used Aerospace alloy due to having some typical properties-

Silvery shiny appearance
High toughness and ductility
Good high and low temperature strength
High oxidation resistance
Good corrosion resistance

Inconel 600 is a High nickel alloy having good resistance to oxidation and corrosion at high temperature, extensively used widely different industries.

Inconel 718 is a super alloy having excellent Mechanical properties at elevated temperatures and excellent oxidation resistance up to 980°C typically used in Gas turbine component, Nuclear reactors & pumps, Spacecraft, Cryogenic tanks and liquid fuel Rocket motor components. The typical properties and chemical composition of Inconel 600 and Inconel 718 is given below.

TAGUCHI PHILOSOPHY

Taguchi espoused a superb philosophy for intrernal control within the manufacturing industries. Taguchi method is a scientifically disciplined mechanism for evaluating and implementing improvements in products, processes, materials, equipment, and facilities. Taguchi method is an engineering approach of quality improvement that seeks to obtain a low cost solution to the product design specification based on the requirement of the customer. These improvements are aimed at improving the specified characteristics and simultaneously reducing the amount of defects by studying the key variables controlling the method and optimizing the procedures or design to yield the best results. The method is applicable over a good range of engineering fields that include processes that manufacture raw materials, subsystems, products for professional and consumer markets. In fact, the method can be applied to any process like engineering fabrication computer-aided-design, banking and service sectors etc. Taguchi method is useful for 'tuning' a given process for 'best' results.

Taguchi method divides all problems into 2 categories – Static or Dynamic. While the Dynamic problems have a sign factor, the Static problems don’t have any signal factor. In Static problems,the optimization is achieved by using 3 Signal to Noise ratio (SNR) – smaller the better, larger the better and nominal the best. In Dynamic problems, the optimization is achieved by using 2

SNR - Slope and Linearity. The objective of Taguchi approach is to determine the optimum setting of process parameters or control factors, thereby making the method insensitive to the sources of variations thanks to uncontrollable or noise factors. In this method, main process parameters which influence process results are taken as control parameters and the experiment is performed as per specifically designed orthogonal array.

EXPERIMENTAL SETUP

The experimental work was administered out on EDM model Innovative Automation Product(IAP) 3X-spark with a DC stepper motor which continuously maintaining the constant gap voltage between electrode and workpiece. The photograph represented in 3.2. Machine for table provided of two translational dimension axes to their stroke is 180×170mm. The radius of the electrode can be changed between 0.25 to 2.5 mm in mini steps of 0.15mm as per the to size of the hole.

This machine can also be used as a EDM possessing highest machining current of value 20 A. The Inconel 600 and Inconel 718 were drilled by EDM having Rotary hollow multi tubular electrode of 0.5 mm radius. Reverse polarity have to sustained for electrode and forward polarity for Worktool processed material.

DESIGN OF EXPERIMENT

Efficient experimental design helps to optimize the method and determine factors that influence variability. The primary aim of the Taguchi experiments is to minimize variations in output even though noise is present in the process. Factorial design is easy to construct but can be impractically large. Since it was difficult to perform the experiment based on a full factorial design for all combinations of control parameters so orthogonal array based on new methodology is required to decreases the trials and to reduce work time experiment work. Taguchi orthogonal design often performs better when intermediate number of the process parameter is there with few interactions.

CONCLUSION

An application of the modified Taguchi method to improve the multi-response parameter i.e.MRR, EWR, OC and TA in EDM process of Inconel 600 and Inconel 718 using rotary brass hollow tubular electrode has been reported in this thesis work. The experimental result confirms that this approach is simple, effective and efficient for simultaneous optimization of multiresponse characteristics. From the results of confirmation experiment, it was concluded that the for Inconel 600 MRR is slightly reduced by 4.62% but EWR, OC and TA are reduced by 28.70%, 8.33%, 6.61% respectively. In case of Inconel 718 MRR was improved by 9.86% and EWR, OC and TA reduced by 5.16%, 10.00%, 18.18% respectively, therefore enhancing the quality characteristics of the holes and reducing the EWR. It was evident from the above study that optimization of difficult various performance characteristics can be simplified by this approach.

The experimental error for Inconel 600 and Inconel 718 were found to be 8.64%, 5.10% respectively. The experimental error can be reduced further by increasing the number of experiments or increasing the number of repetitions or considering the interaction among the control parameters. The experimental results are very productive and therefore confirm the success of the experiment. The optimization of EDM process is concerned with maximizing MRR while minimizing EWR, OC and TA that can be achieved simultaneously with a particular combination of control parameters setting. The experimental results obtained can be used in industry in favour of select the highly suitable parameter combination to get the needed quality characteristics of the product. Therefore, the present work successfully evaluated the feasibility of EDM process for Inconel 600 and Inconel 718.From the comparative graphical analysis it was concluded that multi-performance characteristic of Inconel 600 is greatly improved as comparing to Inconel 718. For the same level of control parameters, MRR of Inconel 600 is comparatively higher than that of Inconel 718 because Inconel 718 has low thermal conductivity compare to Inconel 600 that cause the poor heat absorption. For the same level of control parameters, the EWR in case of Inconel 718 is more than that of Inconel 600 because Inconel 718 has low electrical conductivity compare to Inconel 600 that restrict the flow of electrical current during the spark

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