Optimization of Material Removing Rate EN45 Steel Tool by Electro Discharge Machining

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ABSTRACT

The main aim of this paper is to maximization of MRR in die sinking electro-discharge machining of EN45 material victimization Taguchi technique. EN45 could be an atomic number 25 spring steel with high carbon content. EN45 is employed wide within the motorcar business for leaf springs, truncated round shape springs, coiled springs, and spring plates and plenty of general engineering applications. MRR (Material Removal Rate) is that the life of fabric removal and is set by evaluating the distinction of the initial weight of labour piece to the ultimate weight of labour piece and dividing by machining time. MRR could be a major think about the machining method and customarily it decides the machining time. Considering this short product life cycle, most MRR is often fascinating. so parameters poignant the MRR ought to be recognized and optimized for need results. The experiments conducted supported the L27 Orthogonal array and results were optimized. The experiment is going to be distributed victimization four input parameters viz. peak current (I_p), pulse on time (T_{on}), pulse off time (T_{off}), and voltage (V) with 3 completely different levels. Results or consequences the results of various input parameters and therefore the effect of their combination on MRR determined victimization Taguchi and analysis of variance table. it absolutely was determined that peak current and pulse off time is additional vital issues for MRR.

Keyword: - *Electro Discharge Machining, Taguchi Method, Pulse on, Peak Current, Pulse off, Voltage*

1. INTRODUCTION

Electrical Discharge Machining is a non-conventional Machining process. This is frequently used nowadays due to its various advantages. The main advantage of EDM is there is no contact between tool and work piece which indicates that there is no need for mechanical work and hence no distortion and shape changes of work piece takes place. Since the machining process involves electrical energy hence the work piece should be conductive irrespective of hardness and toughness. EDM process is capable of manufacturing very complex and hard material which can't be a machine by conventional machining process. The principle of EDM process is to convert electrical energy into thermal energy. It is mainly used in the manufacture of mould, die, automotive, aerospace and surgical components etc. In EDM material remove occurs due to melting and vaporization of material and tiny craters appear on the surface of work material. These craters are produced due to the strike of sparks, responsible for material erosion, on the surface of the work piece. During the EDM process work piece and tool are charged with opposite polarity. Generally work piece charged positively and tool negatively. Erosion of positively charged material occurs more as compared to negatively charged material, because electron from negatively charged material (usually tool) strikes at high speed on positively charged material.

2. LITERATURE REVIEW

Vikas et al (2014) carried out the optimization of the MRR for EN41 material based on the four input parameters like the pulse on time, pulse off time, discharge current and gap voltage using Taguchi method. They found out that the current along with the pulse-off time had a larger impact over the MRR followed by some of the interactions between parameters, while the effect of the other parameters were negligible.[1]

Milan Kumar Das et al (2014) carried out the optimization of MRR and surface roughness (Ra) in EDM for EN31 steel tool by using an artificial bee colony algorithm. They used the same four parameters at different level and concluded that MRR and Ra are proportional to pulse on time and discharge current. [2]

Pujari Srinivasa Rao et al (2014) tried to optimize of wire EDM parameters for MRR and surface roughness for aluminium alloy using Taguchi method and observed that the parameters pulse on time, current and gap voltage have a significant effect on MRR and surface roughness. [3]
Rajmohan T.(2012) used the same process on 304 stainless steel by using Taguchi with the same four parameters. He found that current and pulse off time are the most significant parameters on MRR. [4]
Chandramouli S (2014) also studied RENE80 nickel super alloy with aluminium tool by using EDM and Taguchi and found that pulse on time and pulse off time have the same sign on MRR and also concluded that MRR increased with increase in current, and decreased initially with an increase in the pulse on-time and later increased with it. MRR also increased with an increase in pulse off time but did not follow the same pattern for a pulse on time. [5]
K.D. Chattopadhyay (2008) carried out the same optimization method using Taguchi with EN-8 steel with copper as a tool electrode using three parameters Ton, Ip and electrode rotation. He found that decrease in pulse on time, decrease in electrode rotation and increase in peak current, increased MRR. [6]
G Krishna Mohana Rao et al (2008) study the influence of machining parameters on EDM of margining steel. They used three parameters current, pulse on time and duty factor at three levels and concluded that the MRR increased with an increase in current and duty factor while decreased with an increase in pulse on time. [7]

Many more researchers like H. Ramasawmy et al (2001), Raghuraman et al (2013), P.Abinesh et al (2014), Pravin R et al (2012), Ajeet Bergaley (2013), Pardeep Singh et al (2012), A.M. Nikalje et al (2013), E.Aliakbari et al (2012), R.Ramakrishnan et al (2006), S.Aravind Krishnan et al (2013) have worked with different materials and on different non -conventional machining using different parameters to obtain the most optimized value for various desired outputs. From the literature survey, it was under stood that no research work has been reported in EDM of EN45 material to find out the MRR. So, in this study, Taguchi is used for the development of optimization of MRR with four different parameters peak current, pulse on time, pulse off time and voltage. The adequacy of the developed model has been evaluated also by ANOVA test.

3. METHODOLOGY

Four machining parameters like peak current, pulse on time, pulse off time and voltage selected with three levels as shown in Table 1. The experiment was carried out according to L27 orthogonal array as generated by Minitab using Taguchi method. For each experiment values of all four parameters were selected in different combination. If Taguchi technique was not used then there would be 34 = 81 experiments required. But by Taguchi only 27 experiments were conducted. The corresponding values of S/N for each experiment were obtained by using Minitab 16 software.

Input parameters and their levels
Selected input Parameters

Table 1: Process Parameters

Process Parameter	Level 1	Level 2	Level 3
Peak Current (A)	8	16	24
Pulse on Time (µs)	200	300	400
Pulse off time (µs)	2100	2200	2300
Gap voltage(V)	40	60	80

CUTTING TOOL MATERIAL – Copper Cylindrical Tool
WORK PIECE MATERIAL – EN45 Steel Tool
DIELECTRIC MEDIUM - Paraffin oil
Material removing rate was evaluated using the formula

$$MRR = \frac{Initial\ Weight\ of\ Workpiece - Final\ Weight\ of\ Workpiece\ (gm)}{Machining\ Time\ (min)}$$

3.1 Taguchi Method

Taguchi is a method of process of selection of the best combination of input parameters for the optimal value of output. Taguchi helps to reduce variability and find cost-effective robust design. For this experiment Taguchi L27 orthogonal array is used. Taguchi provided total of 27 rows corresponding to each experiment. MINITAB 16 software was used for analysis of the experimental data. In the Taguchi method, the S/N ratio is the measurement of quality characteristics deviating from the desired value. The term signal represents the desirable mean value of the output, and the term noise represents the undesirable value. For the present output i.e. MRR maximum S/N ratio is desirable and hence is considered.

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