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Influence of Duty Factor of Pulse Generator in Electrical Discharge Machining Process

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Abstract

Electrical discharge machining (EDM) is highly utilized in manufacturing sectors owing to its ability to machine high strength materials with complex shape. The pulse duration of the pulse generator highly determines the machinability in such process. Since the duty factor can characterize the pulse duration, it is very essential to analyze its effect on machinability in the process. In the present study, an endeavor has been made to investigate the influence of duty factor on surface morphology of machined stainless steel using EDM process. From the experimental results, it has been inferred that modified pulse generator approach could provide better surface finish due to its ability to produce tiny cracks.

Keywords: EDM, Spark, Duration, Duty factor, Pu**lse**

INTRODUCTION

Electrical Discharge Machining is used to machine materials of high hardness by creating high speed electrical discharges between the tool and the work piece as shown in Figure .1 [1]. The discharge duration is controlled by a signal generator. It is needed to modify the pulse generator circuit to enhance the process mechanism [2]. The machining can be improved by alternative switching capabilities of the signal generator. In the present study, an attempt has been made to design and fabricate modified transistor pulse train generator to enhance performance measure of an EDM process [3]. The modification has been proposed by adopting different duty factor during various machining conditions. In conventional EDM machine different machining operations like rough machining, pre-finishing, finishing cycle are done. In rough machining, high MRR is obtained [4].The MRR is gradually reduced in pre-finishing and reached lower value of MRR during the finishing cycles. It can result in finer surface quality. Hence it is necessary to utilize the different machining cycles to the machining job with higher surface finish with considerable MRR[5].The machining cycle with different set of instructions have to be given to the system for performing a single job. This will increase the production time with good surface finish. A signal generator is developed to produce different sets of signals to the amplifier unit during the machining period without stopping the operation. This can be achieved by changing the pulse width of the signal so rough machining cycle and the finishing cycle can be executed by the alternative switching capability of the signal generator [6-8].

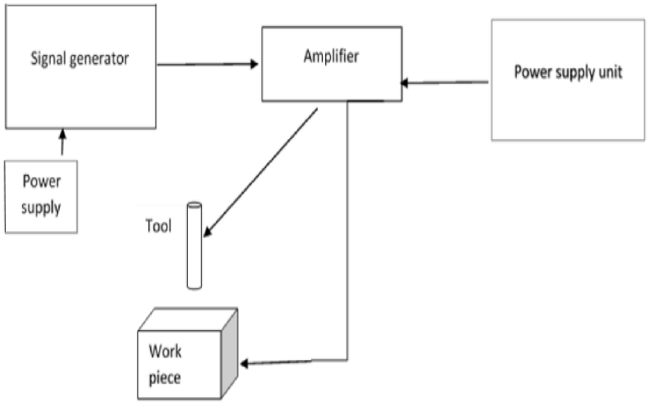

Figure 1: control schematic of basic EDM setup

From the literatures, it has been observed that only little attention has been given for analyzing the effect of duty factor on machining characteristics in EDM process. Hence the present investigation has been carried out. In the present study, an attempt has been made to design and develop a circuit which should be capable of switching the electrical energy under various duty factor in EDM process.

EXPERIMENTS AND METHODS

In the present study a signal generator has been developed in order to implement different pulse width during the machining process. Four different signals have been proposed i.e. A1(0.8), A2(0.6), A3(0.4), and A4(0.2) for conducting the experiments as shown in Figure 2. This approach can be performed by adopting the suitable duty factor based on serial

reading values from the voltage sensor. At each stage of the machining process the appropriate signal can be selected by the controller. The amplified signal is applied between the tool and the workpiece in the presence of a dielectric medium to produce the sparking. The controller has been designed to shift duty cycles under the various process of the cycles as that of A1 has the longest duty cycle whereas the A4 has the shortest duty cycle. When A1 signal is selected, the ON time is more than the OFF time which leads to high material removal rate (MRR) and low surface finishing. Finally A4 which has low ON time with high OFF time lead to low MRR and a better surface finish. The net effect of this machining approach has resulted in higher MRR with better surface finish which can enhance the machinability of EDM process.

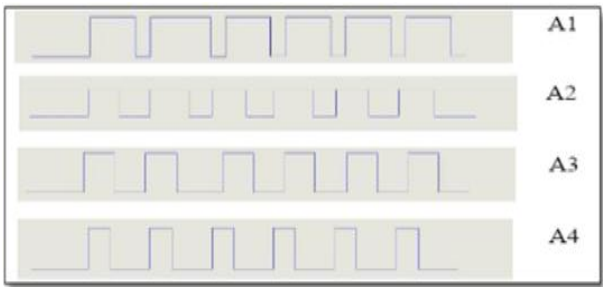

Figure 2: Signals with different duty factor

The opto-coupler has been provided between the signal generator and the power amplifier to prevent reverse currents from damaging the controller as shown in Figure.3. In the amplifier module four IRF540N MOSFET have been connected in parallel for reducing the heating effect of switching device when high current is flowing through it. The additional heat sink has also connected to reduce the heat further.

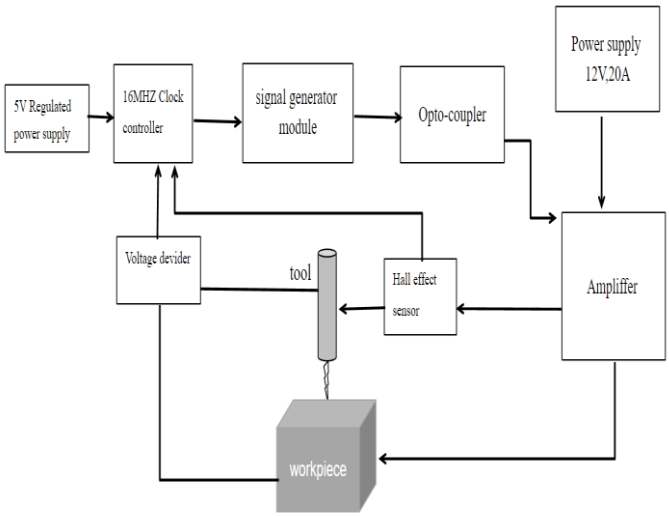

Figure 3: Schematic diagram of modified pulse generator

A hall effect current sensor has to be connected to identify the initiation of the sparking process. The current flow level has been sent to the controller through the analog port. The constant distance between the tool and the workpiece has been maintained using a voltage divider across the machining zone. The values have been sent to the controller. The surface morphology of the machined workpiece with different approach of pulse generator has been evaluated using optical microscope.

RESULTS AND DISCUSSION

The experimentation has been done with modified approach based pulse generator and existing constant duration pulse generator. Table1 shows the process variables of the machining process. The EDM setup has been designed and fabricated to experiment on various factors pulses with different pulse widths are applied across the tool and work piece with a constant frequency. The effect of duty factor on surface morphology using different approaches of pulse energy generator in EDM process. The experiments have been conducted with existing pulse generator which can able to supply the energy with 0.8 duty factor as constant.

Table1: Selection of Process variables

Process variables	**Description**
pulse generator	modified pulse generator
tool	Brass with negative polarity
Work piece	AISI 202 Stainless steel with positive polarity
Dielectric medium	De-ionized water
Flushing pressure	2 bar
Flushing type	Fully submerged

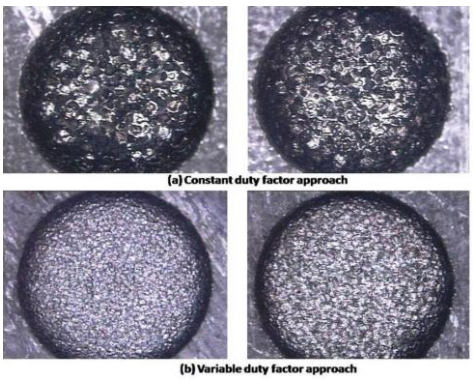

Figure 4: Effect of duty factor on surface morphology in EDM process.

However the modified pulse generator has been designed to deliver the higher energy under higher duty factor during the initial stage of the process. Then the value of duty factor is gradually reduced to reach lower duty factor during the finishing stage. The higher duty factor can produce higher material removal and lower surface quality. Nevertheless the lower duty factor can produce lower material removal with good surface quality [9]. Hence the present approach of duty factor modification has been proposed. The surface quality is characterized by the spark energy developed during the machining. Since the spark energy is determined by duty factor, it has produced considerable influence on determining the surface quality [10]. Figure 4 shows the effect of duty factor on surface morphology in EDM process. It has been observed that variable duty factor pulse generator has produced better surface morphology owing to its ability of delivering lower spark energy during the machining process. However the constant duty factor pulse generator has produced rough surface morphology due to its ability of delivering constant spark energy throughout the machining process.

CONCLUSION

With the view of enhancing the performance of EDM pulse generator, an experimental investigation has been conducted with modified approach. The modified pulse generator has been designed and developed and its performance has been compared with existing pulse generator. It has been inferred that modified pulse generator approach can produce better surface finish due to its ability to produce tiny cracks.

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