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Original Research Article

Performance analysis of iso current pulse generator on machining characteristics in EDM process

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ABSTRACT

Extremely hard materials can be easily machined by Electrical Discharge Machining process due to its thermal erosion nature. In this process, the amount of material removed is directly proportional to the discharge current. Due to the stochastic nature of the thermal erosion process, the discharge current is varied for every applied electrical pulse. It results in different levels of material removal over the material surface during machining process. The volume of the crater is determined by the discharging energy. The variation in the discharging energy produces high surface roughness, which is influenced by discharge current. A constant duration discharge current is needed throughout the process to produce better surface quality. In this research, an iso duration current pulse generator has been proposed to achieve good surface finish. An experimental performance evaluation has been conducted with conventional transistor pulse train generator and modified iso current pulse generator by Taguchi L_{27} orthogonal array design. The machining characteristics have been evaluated for both the pulse generators. It is found the that modified iso duration current pulse generator has produced better surface quality with higher material removal rate than the conventional transistor pulse train generator.

1. Introduction

1.1. Thermal erosion process

Electrical Discharge Machining (EDM) otherwise known as thermal erosion process is one of the non-conventional manufacturing processes, where tool and workpiece does not come in contact with each other during the machining process. This process can produce a crater in any conducting material by thermal energy irrespective of the hardness of the material. Since the EDM process does not involve direct contact between the workpiece and tool such as that of any conventional manufacturing process, there are no vibration problems in such a process. This causes less tool wear compared to the conventional manufacturing processes. In this process, the two conductors i.e. tool and workpiece are separated by an isolating medium. Based on alignment of tool and workpiece, this process can be classified as die sinking and

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wire cutting EDM processes. In die sinker machining, the tool shape is a replica of required profile. In Electrical Discharge Machining, a controlled DC pulse (30–100 V) is applied between the tool and the workpiece separated by small air gap (0.01–0.5 mm) with high frequency (100 kHz–10 MHz). The air gap is filled by a dielectric medium. When the dielectric medium reaches its breakdown voltage, the ionization column is formed between the workpiece and the tool electrode. It leads to the generation of a higher thermal energy in terms of 8000 °C to 12000 °C. Because of the higher thermal energy, the material is melted and vaporized. The melted material in the air gap can be removed by the flushing process. Fig. 1 explains the schematic diagram of a basic Electrical Discharge Machining setup. For improving surface quality in thermal erosion process, many researchers have implemented new techniques with it. Abbas et al. [1] discussed about new trends involved in Electrical Discharge Machining.

1.2. *Need for the research*

Ho and Newman [2] reviewed about research areas involved in the thermal erosion process. It has been reported that very few researches have been done related to the electrical parameters involved in this process. Normally the EDM process utilizes two types of the pulse generators: RC relaxation pulse generator and transistor pulse train generator. Since there is a time lag for charging the capacitor for each cycle of supply, RC relaxation pulse generator can produce low frequency DC pulse only. Due to its low frequency operation, it removes only less amount of material. The high frequency transistor pulse train generator can produce high material removal rate. Han et al. [3] explained about the merits of transistor pulse train generator over RC relaxation pulse generator. Due to the stochastic nature, the EDM process is not having a constant duration discharge current throughout the process. Han et al. [4] discussed about the nature of electrical discharging process and need for iso duration pulse generator. Jahan et al. [5] narrated the demerits of transistor pulse train generator over RC relaxation pulse generator. They concluded that surface finish by RC relaxation generator is better than that of transistor pulse train generator. Due to its higher frequency operating region, transistor pulse train generator can remove more material than RC relaxation generator. But it does not produce good quality surface. This drawback of transistor pulse train generator can be overcome by iso duration current pulse generator. Kuppan et al. [6] found that peak current determines the machining characteristics in EDM process. Tsai et al. [7] concluded that peak current and pulse duration mainly decide the machining characteristics in the EDM process.

Mohan et al. [8,9] proved that the peak current decides the crater volume on the surface. The surface finish depends on the crater volume. The crater volume is determined by the amount of energy delivered per pulse. Muthuramalingam and Mohan [10,11] explained about the influence of iso duration pulse and tool electrode properties in the EDM process. If the duration of the discharge current during machining is constant, the crater volume stays the same. It can produce a good quality surface. Nowicki et al. [12] discussed about the surface finish modification of workpiece using the EDM process. From the literatures, it is found that only few literatures are available in area of altering the pulse shape to enhance the surface quality. In the present study, a modified iso discharge current pulse generator has been proposed and developed for improving the machining characteristics of the EDM process.

2. Pulse generator circuit in thermal erosion process

2.1. *Conventional transistor pulse train generator*

Fig. 2 shows schematic arrangement of transistor pulse train generator. Since the conventional RC relaxation pulse generator gives low material removal rate, the transistor pulse train generator is mostly employed.

The transistor pulse train generator utilizes a high frequency response semi conductor device for the switching operation. Due to its high frequency operation, this pulse generator can produce higher material removal rate. The main drawback of this pulse generator is its ability to produce the random energy discharges. Owing to this ability to produce the random discharge energy levels, the transistor pulse generator

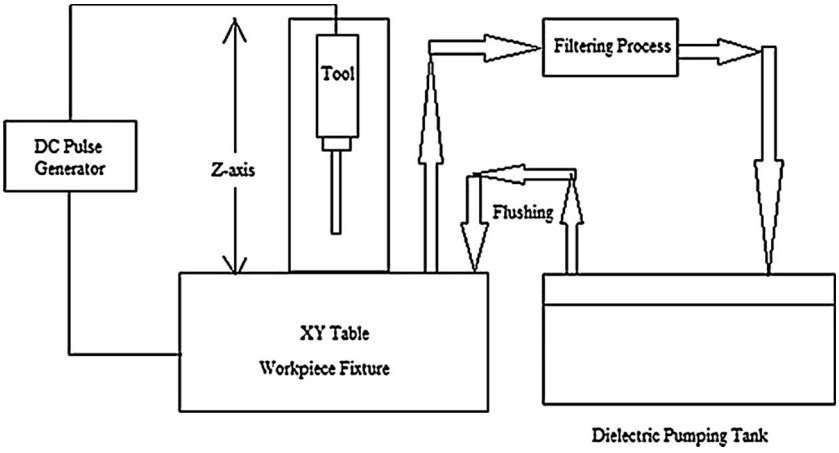

Fig. 1 – Schematic diagram of basic Electrical Discharging Machining setup.