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Review

A review on influence of electrical process parameters in EDM process

T. Muthuramalingam [a,*], B. Mohan [b]

[a] Department of Mechatronics Engineering, SRM University, Kattankulathur, India
[b] Department of Mechanical Engineering, CEG Campus, Anna University, Chennai, India

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ABSTRACT

Since the thermal energy produced in electrical discharge machining process is due to the applied electrical energy, it is very important to enhance the electrical process parameters to improve the process efficiency. The present study discusses about having an overview of the EDM process, modeling of process parameters, and influence of process parameters such as input electrical variables, pulse shape, and discharge energy on performance measures such as material removal rate, surface roughness and electrode wear rate. This study also discusses about controlling the electrical process parameters, and empirical relationships between process parameters and optimization of process parameters in EDM process. From the review results, it has been observed that the efficacy of the machining process can be improved by electrical process parameters, and only less attention has been given for enhancing such parameters.

1. Introduction

Electrical discharge machining (EDM), otherwise known as thermal erosion process, is one of the non-conventional machining processes, where tool and workpiece do not come into contact with each other during the machining process. The progression of events constituting the process of material erosion from the work surfaces by an electrical discharge machining can be explained in the following way. If an appropriate voltage is developed across the tool electrode (normally cathode) and the workpiece (normally anode), the breakdown of dielectric medium between them happens due to the growth of a strong electrostatic field. Owing to the electric field, electrons are emitted from the cathode toward the anode on the electrode surfaces having the shortest distance between them. These electrons impinge on the dielectric molecules of the insulating medium, breaking these dielectric fluid molecules into positive ions and electrons. These secondary electrons travel along on the same ionization path. This event causes an increase in the electric field strength across the work surfaces and liberates a large number of electrons. It creates an ionized column in the shortest spark gap between the tool electrode and the workpiece, thereby decreasing the resistance of the fluid column and causing an electrical discharge in the shortest distance point between the tool and the workpiece. The

* *Corresponding author*. Tel.: +91 9994872013; fax: +91 4422232403.
E-mail addresses: muthu1060@gmail.com, muthu_456@yahoo.com (T. Muthuramalingam), mohan@mitindia.edu (B. Mohan).
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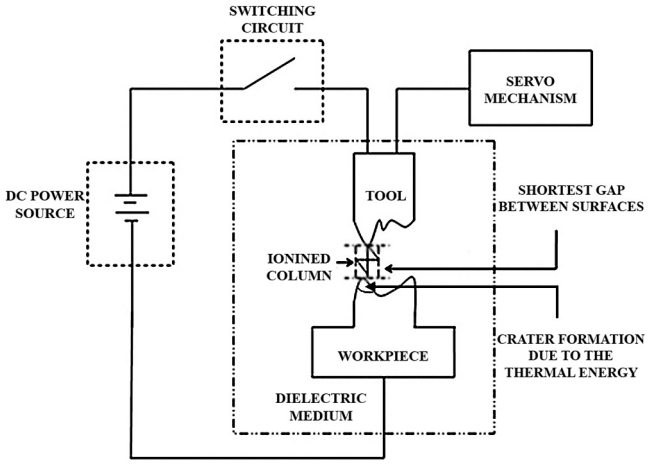

Fig. 1 – Basic mechanism involved in EDM.

enormous thermal energy melts and vaporizes the material from the workpiece, which creates a small crater over the work surface. There happened a collapse of the ionized column with the termination of the electrical energy by means of the switching circuit and then surrounding dielectric fluid occupies its place. The melted debris is removed by the flushing process. The conduction of dielectric medium can be determined by the current, duration and pulse energy [1]. Fig. 1 explains the formation of ionized column in the shortest distance of work surfaces using the EDM process [1].

2. State of art in EDM process

Since the electrical discharge machining process is of with non-linear nature, it requires a lot of improvements on it. Many authors have discussed about the research works for improving process efficiency of the EDM process. The fundamentals of EDM process mechanism and research works carried out from the inception to the development of the die-sinking EDM process within the past decade have been discussed by Ho and Newman [2]. It has been reported and discussed about the EDM researches relating to improve the process performance measures, optimizing the process variables, and monitoring and control of the sparking process. Abbas et al. presented the recent research trends to improve the performance characteristics involved in all the aspects of electrical discharge machining process. They discussed about the need for controlling the process parameters to enhance the machining process efficiency of the EDM process [3]. The development of new technologies for improving the surface quality of workpiece is a significant research area in EDM process. Kumar et al. presented a review on the phenomenon of surface modification by EDM and future trends of its applications [4]. It has been observed that most of the research works concentrated on surface modification using the powder mixed dielectric medium in EDM process. The study of the impact of the electrical process parameters on surface modification of the workpiece has been taken up by very few researchers.

3. Enhancing the performance of pulse generator

Since the electrical energy is supplied to the EDM process informing the DC pulses, the pulse generator needs to be upgraded to improve the performance measures in the machining process. The lower energy pulses enhance the surface finish of the workpiece whereas the higher energy pulses improve the material removal rate.

Jahan et al. conducted a detailed experimental investigation to find out the influence of major operating parameters on surface quality of tungsten carbide with both transistor and RC-type generators in EDM process [5]. It has been proved that RC pulse generator has produced a smoother surface finish than the transistor pulse generator due to its lower discharge energy distribution over the surface of tungsten carbide. Han et al. designed and developed a modified transistor pulse generator with pulse frequency of 1 MHz to produce higher material removal rate than the RC pulse generator in the electrical discharge machining process [6]. They found that the transistor pulse generator has provided two or three times higher machining speed than the conventional RC pulse generator while machining tungsten workpiece with brass electrode.

A pulse generator based on fixed pulse width modulation has been developed by Yan and Liu to generate the high frequency 4.4 MHz and short duration pulse control signals to reduce surface roughness of the workpiece tungsten carbide in the EDM process [7]. From the experimental results, it has been observed that the very low discharge energy pulse applied between tool and electrode has improved the surface quality of workpiece during the machining process. Yan and Chiang discussed about the development and application of a new power supply in wire electrical discharge machining process [8].

A transistor-controlled power supply composed of a low energy discharge circuit has been designed to provide the functions of high frequency and lower energy pulse control. The experimental results have shown that the low peak current has been resulted in better surface finish in EDM process. Muthuramalingam and Mohan discussed about effect of uniform distribution for improving the surface quality using iso current pulse generator in EDM process [9]. Fig. 2 shows the surface quality of workpiece made by three different pulse generators. It has been observed that the iso current pulse generator could produce better surface finish than the conventional pulse generators such as RC pulse generator and transistor pulse generator.

Han et al. designed and developed a new transistor type pulse generator with high frequency response to produce higher erosion rate of the workpiece in the electrical discharge machining process [10]. From the experimental results, it has been observed that the modified transistor pulse generator has produced 24 times higher material removal rate than the RC pulse generator in the EDM process. Yan and Lai presented the development of a fine-finish power supply with high frequency in EDM process [11]. This power supply has been composed with full bridge circuit, two snubber circuits and a pulse control circuit. It has been found that the proposed power supply has