A REVIEW ON THE PROCESS PARAMETERS OF ELECTRO DISCHARGE MACHINING TECHINQUE

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ABSTRACT: **Electrical Discharge Machining (EDM) is a controlled metal-removal process which is used to remove the metal by means of electric spark erosion. In this process an electric spark is used as the cutting tool to cut (erode) the workpiece to produce the finished part to the desired shape. There are various EDM process parameters (variables) on which the machining performances depends. These parameters are polarity, peak current, pulse on time, pulse off time and flushing pressure which are being reviewed in this paper. New techniques and modifications has also been reviewed briefly. Polarity describes which side of the spark gap is positive or negative. Polarity can effect speed, finish, wear, and machining stability. Peak current is the most important parameter in EDM process and it is amount of power used in discharge machining. Pulse on time (P ON) is the time period during which machining is takes place. Pulse off time (P OFF) is the time during which re-ionization of dielectric takes place and lastly flushing pressure which helps in removal of the metal particles (chips) from the working gap.**

***KEYWORDS*: P ON, P OFF, EDM, MRR, SR, Taguchi method.**

I. INTRODUCTION

Among the various non-convectional machining methods, electric discharge machining (EDM) is one of the most extensively used non-convectional material removal process. In 1943, the soviet scientist Lazarenko announced the construction of the first EDM. They discovered the effect of an electrical discharge and developed a controlled method of machining. EDM is a thermoelectric process in which the heat energy of spark is used to remove material from the workpiece. Duration of each spark is very short. The entire cycle time is usually few micro-seconds (μsec). A brief classification of non conventional process is given below.

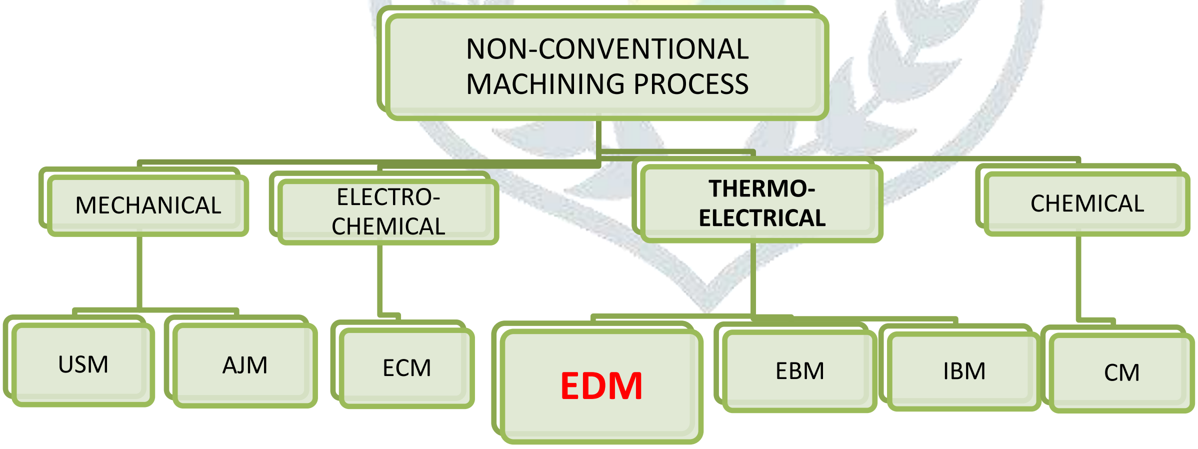

Fig. 1 Various Types of Non- Conventional Machining Processes

Working Principle of EDM

The principle of EDM is to use the eroding effect of controlled electric spark discharges on the electrodes. The metal-removal process is performed by applying a pulsating (ON/OFF) electrical charge of high-frequency current through the electrode to the workpiece. This erodes very tiny pieces of metal from the workpiece at a controlled rate. It is thus a thermal erosion process. The sparks are created in a dielectric liquid, generally water or oil, between the workpiece and an electrode, which can be considered as the cutting tool. There is no mechanical contact between the electrodes during the whole process. Since erosion is produced by electrical discharges, both electrode and workpiece have to be electrically conductive. Figure 2 shows the mechanical and electrical set up and electrical circuit for electro discharge machining. A thin gap about 0.025mm is maintained between the tool and work piece by a servo system. Both tool and work piece are submerged in a dielectric fluid kerosene/EDM oil/deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases.

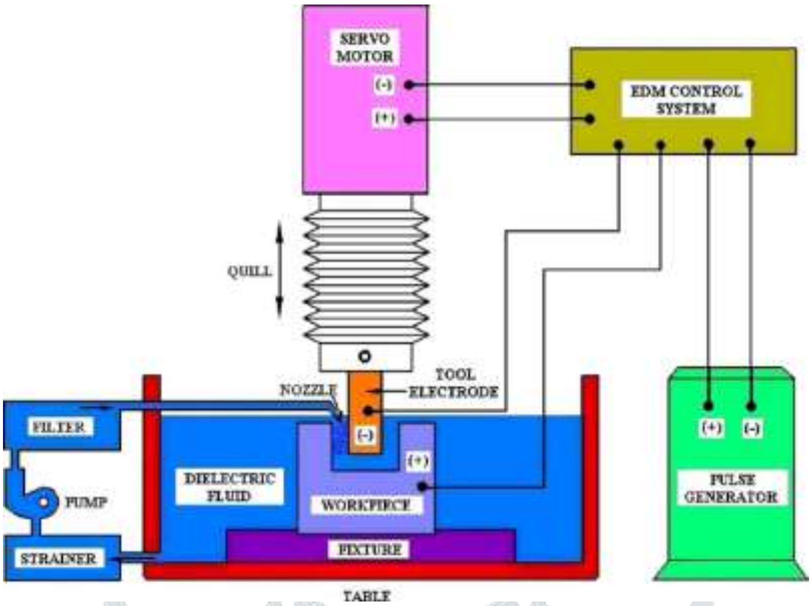

Fig. 2 Setup of Electric Discharge Machining [M. S. Sohani et. al (2009)]

II. LITERATURE SURVEY

Mohri Naotake (1995) studied that with synthetic consideration of electrode wear phenomena in electrical discharge machining. Time dependance of an electrode shape was observed through on-the machine measurement. While the electrode wears at the edge portion in the beginning of machining, it grows at the flat portion in the longitudinal direction. In the stationary state of machining, the wear rate of an electrode is affected by the materials of work piece. Taking account of the precipitation of turbostratic carbon on the electrode, the presence of catalyst in the work piece material is considered. The turbostratic carbon on the surface of electrode prevents the electrode from spark erosion in EDM.

Lonardo P.M. et al. (1999) studied that the most important parameters of EDM are the removal rate, the electrode wear, accuracy and surface texture. In this paper the influence of electrode material, flushing, electrode dimension, depth of cut and planetary motion on EDM performance is discussed. An experimental analysis was carried out on a Cr, Mo, V steel for die casting by using both copper and graphite electrodes. Roughing and finishing operations were considered, by adopting for each condition the parameters commonly recommended in industrial production. The observed results show the importance of electrode material, injection flushing and geometry of cutting on removal rate, electrode wear and surface quality.

Wang Che Chung et al. (2000) studied the optimization of the blind-hole drilling of Al_2O_3/6061Al composite which is done using rotary electro-discharging machining by using Taguchi methodology. Experimental results confirm that the revised copper electrode with an eccentric through-hole has the optimum performance for machining from various aspects. Three observed values, MRR, EWR, and SR, verify this optimization of the machining technique. In addition, seven independent parameters are chosen as variables in evaluating the Taguchi method and are categorized into two groups: (1) electrical parameters, e.g., polarity, peak current, pulse duration, and powder supply voltage, and (2) non-electrical parameters, e.g., rotational speed of the electrode, injection flushing pressure of the dielectric fluid, and the number of eccentric through-holes in the electrode. Furthermore, either the polarity or the peak current most prominently affects the MRR, SR or EWR amongst all of the parameters, whereas none of the non-electrical group has an equal affect.

Yu Z.Y. et al. (2002) studied that it is difficult to drill high aspect ratio through holes and complex shaped blind holes using micro EDM. The debris concentration in the narrow discharge gap causes abnormal discharges leading to excessive electrode wear and lower machining precision. In micro EDM, the electrode size is too small for internal flushing. This paper presents a new approach for effective self-flushing using planetary movement. Through micro holes with an aspect ratio of 18 have been drilled. This approach is also demonstrated by drilling blind noncircular micro holes with sharp corners and edges. The process performance characteristics are analyzed under different machining conditions.

Puertas et al. (2003) studied that the optimum selection of manufacturing conditions is very important in manufacturing processes as these ones determine surface quality and dimensional precision of the so-obtained parts. Thus, it is necessary to know, in advance, properties relating to surface quality and dimensional precision by means of theoretical models which allow to do some predictions taking into account operation conditions such as gap, dielectric fluid, penetration speed, etc. Manufacturing materials with non-conventional processes such as electrical discharge machining, shows really important aspects to study from the point of view of materials science, heat transmission, mechanics and manufacturing processes optimisation.

Luis C.J. et al. (2005) studied the material removal rate (MRR) and electrode wear (EW) study on the die-sinking electrical discharge machining (EDM) of siliconised or reaction-bonded silicon carbide (SiSiC). The selection of the above-mentioned conductive ceramic was made taking into account its wide range of applications in the industrial field: high-temperature gas turbines, bearings, seals and lining of industrial furnaces. This study was made only for the finish stages and has been carried out on the influence of five design factors: intensity supplied by the generator of the EDM machine (I), pulse time (ti), duty cycle (η), open-circuit voltage (U) and dielectric flushing pressure (P), over the two previously mentioned response variables. This has been done by means of the technique of design of experiments (DOE), which allows us to carry out the above-mentioned analysis performing a relatively small number of experiments.

Shibayama T. et al. (2006) studied the improvement of machining characteristics of electrical discharge machining of deep slots using a tool electrode which has micro holes for jetting dielectric liquid over the working surface. The tool electrode was made by the diffusion bonding of two copper plates, over an interface on which micro grooves for jetting the dielectric fluid were formed using electrolyte jet machining. Use of the newly developed tool electrode was found to shorten the processing time and improve machining accuracy significantly compared with the conventional solid tool electrode.

Kiyak M. et al. (2007) studied the influences of EDM parameters on surface roughness for machining of 40CrMnNiMo864 tool steel (AISI P20) which is widely used in the production of plastic mold and die. The selected EDM parameters were pulsed current (8, 16 and 24 A), pulse time (2, 3, 4, 6, 12, 24, 48 and 100 μs) and pulse pause time (2 and 3μs). It was observed that surface roughness of workpiece and electrode were influenced by pulsed current and pulse time, higher values of these parameters increased surface roughness. Lower current, lower pulse time and relatively higher pulse pause time produced a better surface finish.

Masuzawa Takahisa et al. (2008) studied that Jet flushing is the most popular type of flushing for EDM. However, it is usually applied with the nozzles fixed at positions which are decided on the basis of the operator's experience. In this paper a dynamic jet flushing method with moving nozzles that sweep along the outline of the EDM gap. Experimental result clarify the effectiveness of this method on the precision of machining. A method for calculating the debris distribution in the gap is proposed as well. The result of calculations success fully displays the debris status with various types of jet flushing, showing the superiority of the sweeping jet method.

Jahan M.P. et al. (2011) studied the capability of machining intricate features with high dimensional accuracy in hard and difficult-to- cut material, which has made electro discharge machining (EDM) process as an inevitable and one of the most popular non-conventional machining processes. The objective of this paper is to provide a state of the art in the field of EDM and micro-EDM of tungsten carbide and its composites. The review begins with a brief introduction on the EDM and micro-EDM processes. The research and developments in electro discharge machining of tungsten carbide are grouped broadly into conventional EDM of tungsten carbide, micro-EDM of tungsten carbide and current research trends in EDM and micro-EDM of tungsten carbide. The problems and challenges in the area of conventional and micro- EDM of tungsten carbide and the importance of compound and hybrid machining processes are discussed. A summary of the future research directions based on the review is presented at the final section.

Jiang Yi et al. (2012) studied that small-hole EDM has a problem of debris evacuation from the narrow gap between the electrode and workpiece. The presence and difficulty in evacuating the debris formed during an erosion process limit the achievable aspect ratio. To address the problem of debris accumulation, a pulse generator, which is able to shut off harmful pulses and to apply high discharge energy pulses, is developed. A FPGA chip is used as the master controller for the determination of pulse discharge status and MOSFET switching. A series of experiments are carried out to examine the machining performance by shutting off harmful pulses and applying high discharge energy pulses. The experimental results show that the efficiency of small-hole drilling is improved and the aspect ratio is increased.

Kumar Sandeep (2013) studied the unconventional electro thermal machining process used for manufacturing geometrically complex or hard material parts that are extremely difficult-to-machine by conventional machining process. The process involves a controlled erosion of electrically conductive materials by the initiation of rapid and repetitive spark discharges between the tool and work piece separated by a small gap of about 0.01 to 0.50. This gap is either flooded or immersed in a dielectric fluid. The controlled pulsing of direct current between the tool and the work piece produces the spark discharge. The paper reviews the vast array of research work carried out within past decades for the development of EDM. The study is mainly focused on aspects related to surface quality and metal removal rate which are the most important parameters from the point of view of selecting the optimum condition of processes as well as economical aspects. It reports the research trends in EDM.

R.S Jadoun et al. (2014) studied that in recent years, EDM researchers have explored a number of ways to improve EDM Process parameters such as Electrical parameters, Non-Electrical Parameters, tool Electrode based parameters & Powder based parameters. This new research shares the same objectives of achieving more efficient metal removal rate reduction in tool wear and improved surface quality. The paper reviews the research work carried out from the inception to the development of die-sinking EDM, Water in EDM, dry EDM, and Powder mixed electric Discharge Machining within the past decade and also briefly describing the Current Research technique Trend in EDM, future EDM research direction.

Tarun Modi et al. (2015) studied that EDM is more economical non convectional machining process. It is used widely used on small scale as well major industries. EDM process is affect by so many process parameter which are electrical and non electrical. In this project work the rotating tool is used to improve the Metal removal rate (MRR) and to observe its effect on surface finish. Taguchi's method is used as a design of experiments and response surface methodology for analysis and optimization. The machining parameters selected as a variables are pulse off time, pulse on time, servo voltage. The output measurement include MRR and surface roughness.

III. **CONCLUSION**

The present review paper gives a study on various machining parameters of EDM. From literature review, it has been observed that, there is lot of work is being done using different parameters but majorly peak current, P ON and P OFF done on various work pieces which are difficult to be machined by conventional machining. Optimization is also done basically using Taguchi method and other techniques such as Grey Relational Analysis, Surface Response Methodology etc. Various modifications like pulse generator is also being used to remove debris using a FPGA chip. Finally, it is concluded that materials that are difficult to be machined by conventional machining, can be easily machined by non- conventional machining i.e.by using Electro Discharge Machining process. Lastly comparisons of output parameters like EWR, SR, MRR had also been done on the basis of the machining done with the help of different electrodes. Several researches have been conducted to improve these output parameters for better results.

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