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Study of Pulsed DC Power Supply Parameters for Micro-EDM

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ABSTRACT: The selection of power supply is one of the most critical aspects to take into consideration in the many manufacturing process. This paper describes about the development of pulsed dc power supply that essential in the micro EDM. The micro EDM is the electro-thermal process that depends on discharge energy through a specific dielectric in order to supply heat to the work piece. A pulsed discharge occurs in small gap between the work piece & the electrode with removal of unwanted material from work piece through the process of melting. The pulsed dc current causes the heating of the dielectric, work piece & electrode. A pulsed dc power supply provides the electric discharge with controls for voltage, current, frequency, duty cycle & polarity.

KEYWORDS: Micro EDM, pulsed dc power, discharge, spark.

I.INTRODUCTION

From the introduction of EDM in the market there is continuous development of pulsed dc power supply & its parameters. In conventional EDM, the current level is high as well as the voltage required. As a result of high current, electrode gets melted & there is welding of work piece & electrode. There are problems of stray arcing. But in micro EDM uncontrolled discharge cannot be allowed. Thus different power supply is required for micro EDM. Pulsed dc power supply is the critical component in the micro EDM for achieving the required parameters of accuracy, finish & size of micro holes. The purpose of power supply is to convert the alternating current into a unidirectional direct current required to produce the spark and also effectiveness of the EDM is determine by the type of power supply used.

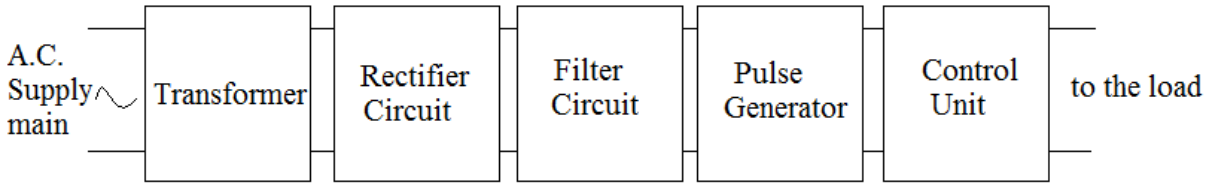

Fig. 1 General block diagram of pulsed dc power supply

A series of electrical pulses generated by power supply unit is applied between work piece and tool electrode. In the event of spark discharge, there is a flow of current across the tool electrode-workpiece gap. The energy content of a single spark discharge can be expressed as a product of $T_{ON} \times Ip$. Energy contained in a tiny spark discharge removes a fraction of workpiece material, leaving behind a small crater on the workpiece surface.

In EDM, the repetitive cycles of spark discharge results in bulk material removal of workpiece. During this process, fraction of material is also removed from the tool electrode called as electrode wear. Better workpiece material removal and low tool electrode wear can achieve by using appropriate power supply. By increasing the spark energy, one can achieve increase in material removal rate but not so good surface finish. By lowering the spark energy, one can obtain better surface finish. To achieve optimum result of material remove rate and surface finish, the power supply parameters should be properly set [9].

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In order to controlled pulse ON time & peak current, the power supply has developed to achieve surface quality of wire EDM [7]. Some power supplies have developed transistor type isopulse generator and servo feed control for improvement of machining parameters of micro-EDM [2]. To achieve desired output current during pulse ON time and during pulse OFF time, a EDM power supply based on series-parallel resonant converter has developed to control switching frequency [8,6]. However to obtain stable machining, improve power supply characteristics should be employed in micro-EDM.

II.PRINCIPLES OF POWER SUPPLY

The basic principle involved in this process is the conversion of electrical energy into heat energy. This heat energy heats the job material and metal is removed from the job. This heat energy has to be controlled if the end results like metal removal rate or electrode wear rate are to be controlled. To control heat energy one has to control the electrical energy applied across the electrode and workpiece through the electrical parameter like current and ON time which is supplied by pulsed dc power supply.

In general the electrical energy per pulse is increased naturally material removal rate increases and so also the surface roughness and electrode wear. The electrical energy is directly proportional to the dc current flowing through the gap and the duration for which current flowing. Thus electric energy is to be controlled through electric parameter of power supply is the key point in micro EDM.

For easy operation one should know the basic variables of power supply required in micro EDM to be selected while machining. Proper knowledge of these variables is advantageous in achieving the desired result. Following table gives the variables available in power supply and final results required from the machine:

Sr. No.	VARIABLES	END RESULTS
1	Current	Metal Removal Rate
2	ON Time	Electrode Wear
3	OFF Time	Surface Finish
4	Gap Voltage	Over Cut

Table 1 Variables of power supply and their end result

Thus the four electrical parameter given on power supply (viz. ON Time, Current, OFF time, Gap Voltage) used to control the end results.

III. POWER SUPPLY PARAMETERS

i) Peak Current (Ip) – This is for selection of pulse peak current.

Range: 0 to 50A (in steps 0, 0.5, 1, 1.5, 2,…….… 50A)

Increase in Ip value will increase in pulse discharge energy, which in turn can improve metal removal rate. For higher value of Ip, gap condition may become unstable with improper combination of T_{ON} and Pulse duty cycle. As and when the discharge condition becomes unstable one must reduce the Ip value.

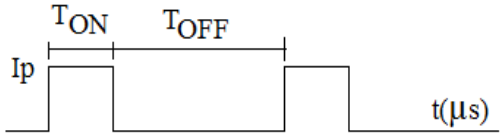

Fig. 2 Current waveform during sparking

ii) Pulse ON time (T_{ON}) – During this period the voltage is applied across the electrode and workpiece.

Range: 0.5, 0.75, 1, 1.5, 2,…….., 4000 (in µsec).

T_{ON} and Peak Current (Ip) determines together with average gap voltage the discharge power and has effect on the surface roughness, overcut and undersize. Single pulse discharge energy increases with increasing T_{ON} period resulting

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it higher cutting rate and reducing tool wear. But higher value of discharge energy with improper combination of T_{ON}, Ip and duty cycle may cause arcing or instability.

iii) Pulse Duty Cycle (Ƭ) – This is to vary the pulse off time in terms of pulse duty factor in steps. Higher the Ƭ, lower is pulse off time i.e. T_{OFF} and higher is the machining efficiency. With higher value of Ƭ, there is number of discharges in a given time, resulting in increase in material removal rate. Using lower value of Ƭ may cause slightly increase in percentage tool wear and also reduce machining efficiency.

Duty cycle = $\frac{Ton}{Ton+Toff}$

iv) Gap Voltage (V) – This is the actual value of gap voltage in between workpiece and electrode.
Range: 50 to 300 (in volt).
Low value of gap voltage can give rise to increase in removal rate. However very low value has arcing tendency. Higher value of gap voltage can increase overcut values and result in reducing removal rates.

IV. REQUIREMENTS FROM THE POWER SUPPLY

Initial requirement from the power supply is small in size and light in weight so that it can portable. Also as the gap distance between workpiece and electrode may vary load changes from open-circuit to short-circuit condition. This is the basic requirement from the power supply used in micro EDM that limiting both the load current under open-circuit condition and short-circuit condition.

During machining, due condition like poor flushing, gap condition deteriorates and sometimes may even lead to arcing. An unintentional happening of this kind can be avoided by taking proper care while machining.

V. CONCLUSION

In this paper, an overview of electrical parameter, peak current (Ip), pulse ON time, pulse duty cycle, gap voltage of pulsed dc power supply are being discussed. These studies of different parameters are done based on previous and recent research on power supply used in micro EDM. This paper focuses on different electrical parameter of pulsed dc power supply. This paper is essential for further development of pulsed dc power supply to fulfil the requirement of micro EDM process.

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