STUDY OF PROCESS PARAMETER OF WIRE ELECTRIC DISCHARGE MACHINING: THE REVIEW

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ABSTRACT

Wire EDM is a variation of the Electric Discharge Machining and is commonly known as wire-cut EDM. In WEDM, material is eroded from the work material by a series of discrete sparks occurring between the work piece and the wire which is generally act as electrode, separated by a stream of dielectric fluid. Dielectric fluid commonly used is deionized water which is act as coolant and flushes the debris away. Work piece is generally electric conductive. It can machine anything that is electrically conductive regardless of the hardness, from relatively common materials such as tool steel, aluminum, copper, and graphite, to exotic space-age alloys including Inconel, titanium, carbide, polycrystalline diamond compacts and conductive ceramics. This papers shows the detailed analysis of process parameters

Keywords: Wire, Process, Parameters, Water.

INTRODUCTION

In WEDM process, the tool i.e. wire is moved in the programmed path and material is removed from the workpiece accordingly. The electrically conductive materials are cut by WEDM process by the electro-thermal mechanism. Material removal takes place by a series of discrete discharges between the wire electrode and workpiece [1]. These discharges cause sparks and result in high temperatures instantaneously, up to about 10000° C. These temperatures are huge enough to melt and vaporize the workpiece metal and the eroded debris cools down swiftly in working liquid and flushed away. WEDM is a non-conventional process and is very widely used in tool steels for
pattern and die making industries. The process is also used for cutting intricate shapes in components used for the electric and aerospace industries. The figure 1 shows the process of wire electric discharge machining

Figure 1: shows the process of Wire electric Discharge Machining [Source, [3]

2. PROCESS PARAMETERS OF WEDM [4]

1. Electrical Parameters
   a) Pulse duration or pulse on time
   b) Pulse interval or pulse off time
   c) Servo voltage
   d) Peak current
   e) Gap voltage

2. Electrode Wire
   a) Wire size
   b) Wire material
   c) Wire tension
   d) Wire feed

3. Dielectric Fluid
   a) Dielectric flow rate
   b) Dielectric conductivity

4. Workpiece Related Parameters
   a) Workpiece material
   b) Workpiece size
Electrical Parameters

a) **Pulse duration**: Pulse duration, also called pulse on time, is expressed in micro seconds. During the pulse on time, the voltage is applied in the gap between workpiece and the electrode thereby producing discharge. Higher the pulse on time, higher will be the energy applied there by generating more amount of heat energy during this period. Material removal rate depends upon the amount of energy applied during the pulse on time.

b) **Pulse Interval**: Pulse interval, also referred as Pulse off time, is also expressed in micro seconds. This is the time between discharges. Off Time has no effect on discharge energy. Off Time is the pause between discharges that allows the debris to solidify and be flushed away by the dielectric prior to the next discharge. Reducing off Time can dramatically increase cutting speed, by allowing more productive discharges per unit time. However, reducing Off Time, can overload the wire, causing wire breakage and instability of the cut by not allowing enough time to evacuate the debris before the next discharge. [5]

c) **Servo Voltage**: Servo voltage acts as the reference voltage to control the wire advances and retracts. If the mean machining voltage is higher than the set servo voltage level, the wire advances, and if it is lower, the wire retracts. When a smaller value is set, the mean gap becomes narrower, which leads to an increase in number of electric sparks, resulting in higher machining rate. However, the state of machining at the gap may become unstable, causing wire breakage.

d) **Peak Current**: Peak current is the amount of power used in discharge machining and is measured in unit of amperage. The current increases until it reaches a preset value during each pulse on time, which is known as peak current. Peak current is governed by surface area of cut. Higher peak current is applied during roughing operation and details with large surface area.

e) **Gap Voltage**: Gap voltage, also called open circuit voltage specifies the supply voltage to be placed on the gap. Greater the gap voltage, greater will be the electric discharge. If the gap voltage increases, the peak current will also increase. In some WEDM machines both of these factors show machining voltage.

1. **Electrode Wire [2]**

a) **Wire Size**: The wire diameter shows the wire size. The wire is usually made of brass or stratified copper, and is between 0.02 and 0.33 mm diameter. Larger the diameter larger the width of cut.

b) **Wire Material properties**:
   - It should be electrically conductive.
   - It should have good machinability, thus allowing easy manufacture of complex shapes.
   - It should have low erosion rate or good work to tool wear ratio.
   - It should have low electrical resistance.
   - It should have high melting point.
   - It should have high electron emission.
c) **Wire Tension:** If the wire tension is high enough the wire stays straight otherwise wire drags behind. Within considerable range, an increase in wire tension significantly increases the cutting speed and accuracy [7]. The higher tension decreases the wire vibration amplitude and hence decreases the cut width so that the speed is higher for the same discharge energy. However, if the applied tension exceeds the tensile strength of the wire, it leads to wire breakage.

d) **Wire Feed rate:** As the wire feed rate increases, the consumption of wire as well as cost of machining will increase. Low wire speed will cause wire breakage in high cutting speed.

2. **Dielectric Fluid**

The dielectric fluid and the flushing there of perform following functions [6]

- To insulate the gap before a large amount of energy is accumulated and to concentrate the discharge energy to a small area (insulator).
- To recover a desired gap condition after the discharge by cooling the gap and deionizing (cooling).
- To flush away the debris of the work piece removed by spark (flushing medium).

a) **Dielectric flow rate:** Dielectric flow rate is the rate at which the dielectric fluid is circulated. Flushing is important for efficient machining. Flushing pressure is produced from both the top and bottom nozzles.

b) **Dielectric Conductivity:** Lower electrical conductivity of the dielectric results in a higher metal removal rate.

3. **Workpiece Related Parameters**

a) **Workpiece Material:** The specific physical, metallurgical, and electrical properties of the work piece material also influence the process of wire electric discharge machining. For material processed by EDM or WEDM, the initial surface condition affects the results. A low melting point in the material increases the MRR and improper heat treatment of the metal results in distortion, breakage of the die and punches while machined by WEDM [2]

b) **Workpiece Thickness:** In the WEDM process, cutting speed decreases as the thickness of the work piece increases. But in the WEMD it is considered that the thicker the work piece, the faster is the cut, all other factors being equal. In any EDM operation, every pulse does not produce a spark. However, the longer length of wire electrode in a thicker work piece provides more opportunities for the spark to occur. This makes the process more efficient for a thicker work piece[3].

**CONCLUSION**

EDM is a non-conventional process based on removal of unwanted material in the form of debris from a job piece by means of a chain of recurring electrical discharges (created by electric pulse generators in micro seconds) between a tool called electrode and the work material in the presence of a dielectric fluid( like kerosene and distilled water). The wire electric discharge Machinig is As EDM Wire Erosion cuts in an exceptionally straight, true and parallel manner, multiple parts can be produced through stacking sheet materials and cutting many components at the same time.
REFERENCES


