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Studies on Wire Selection for Machining With W E D M

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ABSTRACT

The WEDM has been found to have tremendous potential in its applicability in the present day metal cutting industry for achieving improved dimensional accuracy, surface finish, geometric features of work pieces (electrodes, dies etc.). However for successful utilization of process, optimization of various parameters is required for improving the productivity. In this regard an attempt was made to evaluate the best wire both in size and material at rated wire speed and tension. Experimentation was carried out on various work materials using different wire materials, Copper alloy, Molybdenum and Tungsten and sizes ranging from 0.03mmto 0.30mm.The effect of wire material composition were also determined on various cutting parameters and criterion. This work expresses the effects of the wire size, wire material and composition on process parameters like discharge current, gap voltage and criteria like cutting speed, surface roughness and spark gap(cutting off-set required). Present work is useful in selecting best wire and setting the parameters on the machine for high accuracy of cutting.

Keywords:- WEDM, Wire size, wire material, work piece material, cutting parameters

I. INTRODUCTION

The WEDM is the focus of researchers and engineers especially in the field of dies, moulds, precision manufacturing, contour cutting etc. Any complex shape can be generated easily with higher accuracy and surface finish, using CNC WEDM, which is not possible to be achieved by normal EDM process. The scope of development of indigenous software has further strengthened the process technology even in correcting the geometrical and technological data for improving work piece accuracy features .One of the main advantages of this process is that a very small internal corner radius can be achieved because the tool used is a very thin wire. This machine facilitates the manufacturing engineers to cut hard to machine materials with high accuracy, surface finish, close tolerances and contours. The WEDM is a specialized field of EDM, which requires an extensive research. An analysis of effects of various process parameters is required for achieving improved machining characteristics. For the successful utilization of the process with high productivity the role of the wire which is nothing but the tool is to be selected properly. Kevin D et al. [6, 7] studied the wire vibration phenomenon and optimized the wire tension. A.B. Puri, B. Bhattacharyya [8, 9] optimized the wire tension to control the wire lag. I. Cabanesa [10, 11] worked on wire breakage and optimized the parameters for least breakage. The parameters which demand attention for the purpose of analyzing their significant effects on the machining characteristics include wire size, wire material, discharge current, gap voltage, wire tension, wire speed, etc. siva et.al [12,13,14,15] explored mathematical correlation for determining the cutting speed and other vital parameters.

In the present work the effect of wire diameter (size) on cutting speed, spark gap and work material is studied. The influence of wire material is also analyzed to identify which wire is suitable for a particular work material machining.

II. EXPERIMENTATION

The Fig.1 shows the schematic view of the experimental set up. The parameters to be set on machine are determined from the literature are and set on the machine before cutting as mentioned below.

Gap voltage : 80 volts
Machine : ELCUT 234,

Dielectric	: De- ionized water
Dielectric conductivity	: 38 mhos
Wire tension	: 80 N
Wire velocity	: 3.0 m/min
Wire diameter	: 0.03-0.30 mm
Wire material	: Copper alloy, Tungsten and Molybdenum

Graphite work pieces of thickness 2mm to 45mm thickness are cut with "L" and "["slots of 4mm x 6mm size using 0.15mm diameter wire. The machining current is gradually increased to get higher cutting rate and extended for stable machining till wire rupture with un even cutting. The cutting speed is recorded for different machining current values.

The spark gap is measured from the "L" cut slot using microscope. The surface roughness is measured using Talysurf.

The experiments are repeated with wires of diameters 0.2mm, 0.25mm and 0.3 mm. The cutting speed and spark gap values are recorded.

Experiments were conducted on 5mm thick work pieces of Tungsten carbide, graphite, copper, brass and Aluminum using 0.25mm diameter brass with different composition i.e. 64%, 66%, 80%, 85% and 89% copper to study the effect on cutting speed and spark gap.

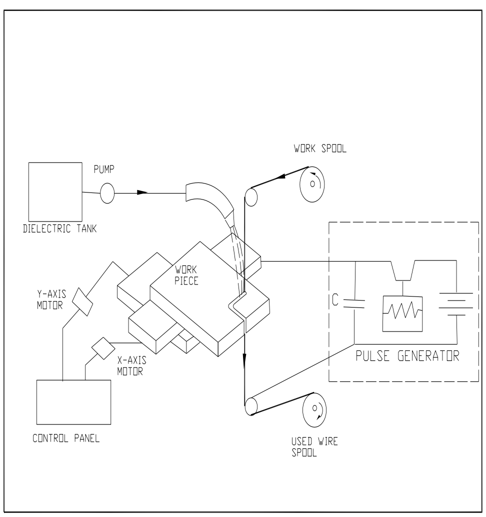

Fig.1 Schematic view of WEDM process

III. RESULTS AND DISCUSSIONS

Experimental studies were performed to observe the influence of the wire size in WEDM on the thickness, work material, cutting speed and spark gap.

Fig.2 shows the variation of cutting speed for various thicknesses of Graphite work piece ranging between 5mm and 45mm with different sizes of wires. The cutting speed is decreasing with increase in work piece thickness. As the thickness increases, the volume of material to be removed will be increasing which requires higher energy. The energy that can be dispensed will be a machine constraint. So the cutting speed will be decreasing with increase in work piece thickness.

The similar nature was observed while machining with different wires of diameter 0.15mm, 0.2mm, 0.25mm and 0.3mm. The cutting speed is increasing with increase in wire diameter.

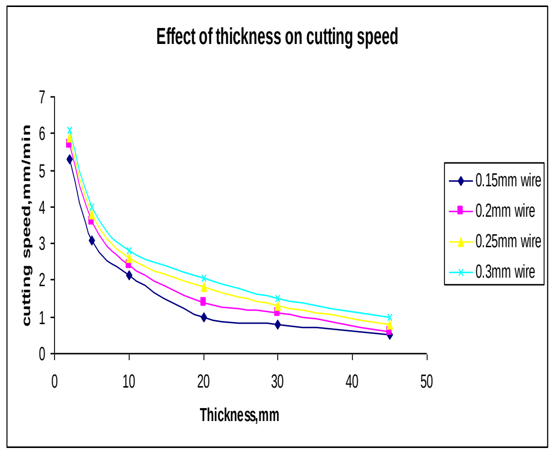

Fig.2 Thickness vs Cutting Speed

The cutting speed for machining Graphite piece of a particular thickness is very low with 0.15mm and high with 0.3mm wire where as it is in increasing order with increase in wire diameter. The current carrying capacity will increase with wire size, which may cause higher material removal.

From the plot it can be evident that the cutting speed for a given work thickness with a particular wire. The rate of increment in cutting speed with wire is good for 0.25mm wire diameter. The variation is very little for 0.30mm. From the results it can be taken as 0.25mm wire is a better option for machining.

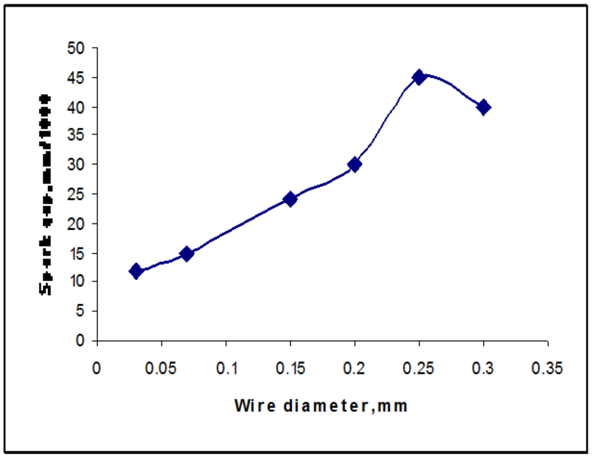

Fig.3 Effect of wire dia. on Spark gap

Fig.3 provides the resulting spark gap in microns when Graphite work piece of thickness 5mm has been machined with various sizes of wires. The figure shows that the spark gap is increasing with the wire size up to 0.25 mm wire diameter and then slightly decreases for 0.30mm diameter wire. The current carrying capacity of the wire will increase with increase with increase in diameter. The spark will jump longer with increase in current. So the spark gap increasing up to 0.25mm wire diameter. But for 0.3mm diameter wire, the current supply may be a machine constraint. The maximum current that can be carried by 0.3mm wire may not be able supply by machine may be a reason for decrement in spark gap. More over gap current is also depends on work piece thickness. Higher current may be able to apply for higher thick work pieces which indicate 0.3mm wire may be useful for work pieces thicker than 45mm.

From the plot the spark gap values can be taken for part programming and machine setting for accuracy in machining.

Fig.4 exhibits the variation of the cutting speeds with respect to various work materials Tungsten carbide, graphite, copper, brass and Aluminum of 5mm size when machined with 0.25mm diameter Cu-Zn alloy wires of 5 different compositions.

It is observed that the cutting speed for tungsten carbide is 1.6mm/min when machined with 64%cu alloy wire. While the cutting speed is lower by small values with other wires. From the plot, it can be understand that 64% copper alloy wire is preferable for machining Tungsten carbide and Graphite.

A similar result is observed for machining Graphite.

Copper, brass and Aluminum are machined with cutting speed values with 89% copper alloy wire.

The conductivity of the wire will be increasing with increase in copper % in the wire. The result envisages that high conductivity work materials require wire with higher conductivity.

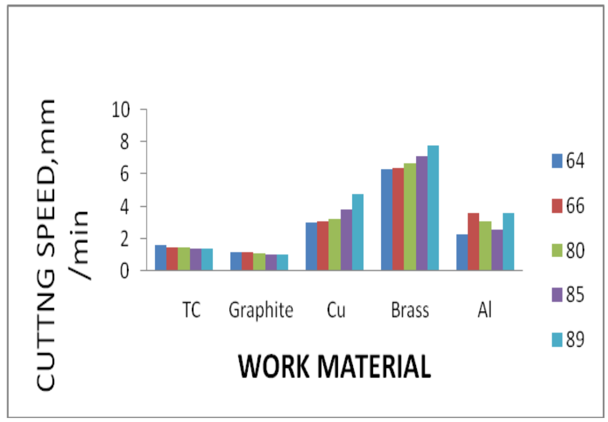

Fig.4 Effect of work material on cutting speed

Fig.5 shows the variation in spark gap values for machining various work materials Tungsten carbide, graphite, copper, brass and Aluminum of 5mm size when machined with 0.25mm diameter Cu-Zn alloy wires of 5 different compositions.

As far as sparkgap is concerned, the wire with 89% cu gives lower overcut for aluminum than others.

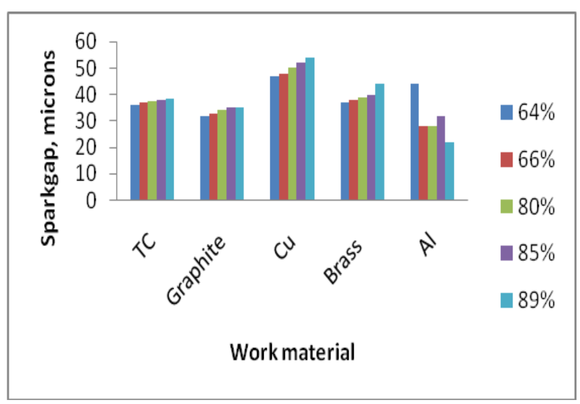

Fig.5 Effect of work material on spark gap

IV. CONCLUSIONS

Based on the limitations of present research, it is obvious that if the material and thickness of the work is known, then one can select the best suited wire based the requirements, like, spark gap and cutting speed. The time of machining can be computed if these parameters are known. The data will be useful in process planning and costing. The optimal wire size should be selected for achieving the controlled criteria yield in WEDM.

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