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COMPARISION OF THE MACHINING CHARACTERISTICS ON ELECTRICAL DISCHARGE MACHINING BETWEEN TUNGSTEN CARBIDE AND AISI H13

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ABSTRACT

Electrical Discharge Machining is a process for shaping hard metals and forming deep and complex shaped holes by arc erosion in all kind of electro-conductive materials. The objective of this research is to study the influence of operating parameters of EDM of tungsten carbide and AISI H13 on the machining characteristics. The effectiveness of the EDM process with tungsten carbide and AISI H13 is evaluated in terms of the Material removal rate, the relative wear ratio and the surface finish quality of the work piece produced. High material removal rate, low relative wear ratio and good surface finish are conflicting goals, which cannot be achieved simultaneously with a particular combination of control setting. The higher discharge current, the faster is the machining time. Material removal rate and surface roughness of the workpiece are directly proportional to the discharge current intensity. This study confirms that there an optimum condition of precision machining of tungsten carbide and AISI H13 although the condition may vary with composition of the materials, the accuracy of the machine and other external factors.

INTRODUCTION

Electrical discharge machining utilizes rapid, repetitive spark discharges from a pulsating direct-current power supply between the workpiece and the tool submerged into a dielectric liquid [1]. There is no physical cutting force between the tool and workpiece.EDM has prove especially valuable in the machining of the super tough ,electrically conducting materials such as the new space-age alloys. It is being used extensively in the plastic industry to produce cavities of almost any shape in metal moulds. Although the application of EDM is limited to the electrically conductive workpiece materials, the process has capability of cutting of these material regardless of their hardness and toughness. during the EDM process, the main machining output parameters are the material removal rate (MRR), tool wear ratio (TWR) and surface roughness (Ra) of the workpiece. It is desirable to obtain the maximum MRR with minimum TWR and surface roughness for AISI H13 [5] and the machining characteristics are the material removal rate, relative wear ratio and surface roughness for tungsten carbide so, the conclusion from the study may drive is, For all electrode materials, the material removal rate increases with increasing peak current. At the low range of peak current, the relative wear ratio decrease with the peak current for copper electrodes.

EXPERIMENTAL SET-UP AND PROCEDURE

The workpiece material used in this study was AISI H13 tool steel. Prior to EDM processing, the workpiece was cut in a cylindrical shape with a length of 20 mm and a diameter of 20 mm. The main mechanical and physical properties of such workpiece material at different temperatures are given in Table 1.

Table 1 Mechanical and physical properties of AISI H13

Temperature [°C]	Density [kg/dm3]	Specific heat [J/(kg·K)]	Electrical resistivity [Ω·mm2/m]	Modulus of elasticity [N/mm2]	Thermal conductivity [W/m·K]
20°C	7.80	460	0.52	215×103	24.30
500°C	7.64	550	0.86	176×103	27.70
600°C	7.60	590	0.96	165×103	27.50

A series of experiment on EDM of tungsten carbide was conducted on a Roboform 40 electrical discharge machine to examine the effects of input machining parameters such as the gap voltage, peak current,and workpiece surface roughness. In the tests, the machining characteristics, i.e., the output variables, namely Material removal rate, relative wear ratio and surface roughness. The workpiece material properties of tungsten carbide is shown in Table 2.

Table 2 Workpiece material properties of Tungsten Carbide

Density	Hardness	Melting point	Tensile strength	Compressive strength	toughness
15.1 g/cm^3	HRA 87	2597°c	179 kg/mm^2	410 kg/mm^2	50kg/mm^2

The tool material was forged commercial pure copper with the main properties given in Table 3. The experiments were performed on a diesinking EDM machine (CHARMILLES ROBOFORM200) which operates with an iso-pulse generator.

Table 3 Physical properties of copper electrode

Physical properties	Thermal conductivity [W/m·K]	Melting point [°C]	Boiling temperature [°C]	Specific heat [cal/g·°C]	Specific gravity at 20°C [g/cm3]	Coefficient of thermal expansion [×10-6 (1/°C)]
Copper	380.7	1083	2595	0.094	8.9	17

RESULTS AND DISCUSSION

Comparision of effect of peak current on tungsten carbide and AISI H13

The effect of peak current on material removal rate is shown in Fig. 1a for pulse duration 12.8, 25, 50, 100 and 200µs. At all values of pulse duration, the material removal rate increases with the intensity of discharge current up to 48A and then decreases when machining with higher current.

The effect of discharge current on the relative wear ratio is shown in Fig. 1b. In the testing range from 16 to 64A, the relative wear ratio decreased slightly with discharge current up to about 24A, and then started to increase at a more gradual rate. The optimum peak current on the basis of the relative wear ratio for tungsten carbide took place at about 24A, and with this current setting the relative wear ratio is minimum at all setting of pulse-on time.

The effect of peak current on surface roughness is shown in Fig. 1c. The surface roughness of tungsten carbide workpiece resulting from EDM increases with the discharge current and ranges from R_a = 1.9µm at 16A to R_a = 3.7µm, at 64A. It is shown that the lower the current, the finer will be the surface texture. The machining rate is proportional to the current intensity. However, high amperage generally requires large machining areas, and produces greater surface roughness.

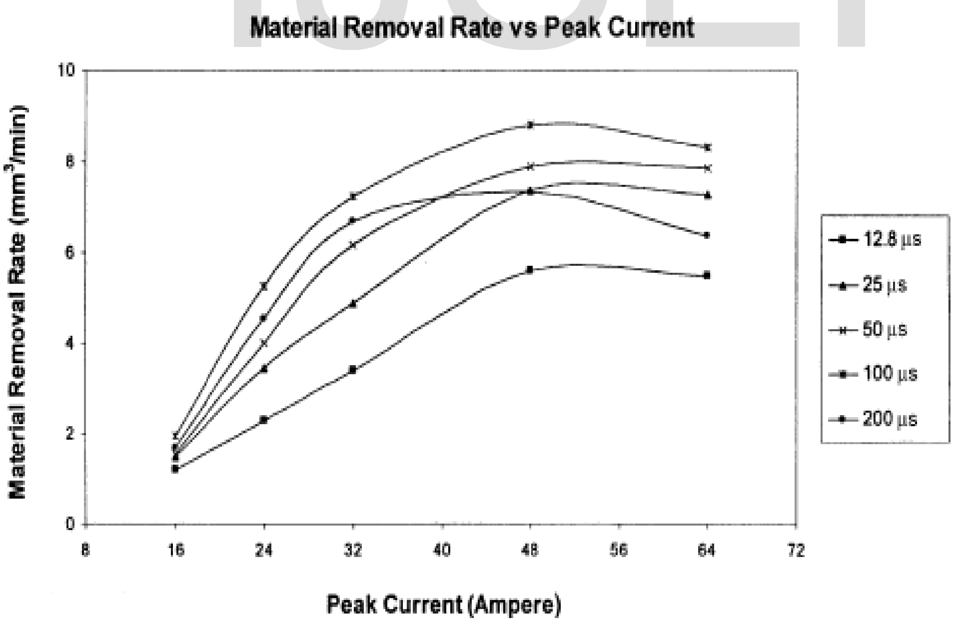

Fig 1a Effect of peak current on material removal rate on tungsten carbide

Fine finish is possible only at low amperage, but creates greater electrode wear. Thus, the finer the required surface, the lower is the machining rate and the greater is the electrode wear. Material removal rate increases as the energy input increases. The total energy depends on the number of sparks each second and the amount of energy in each spark. The amount of material removal is normally proportional to the energy used.

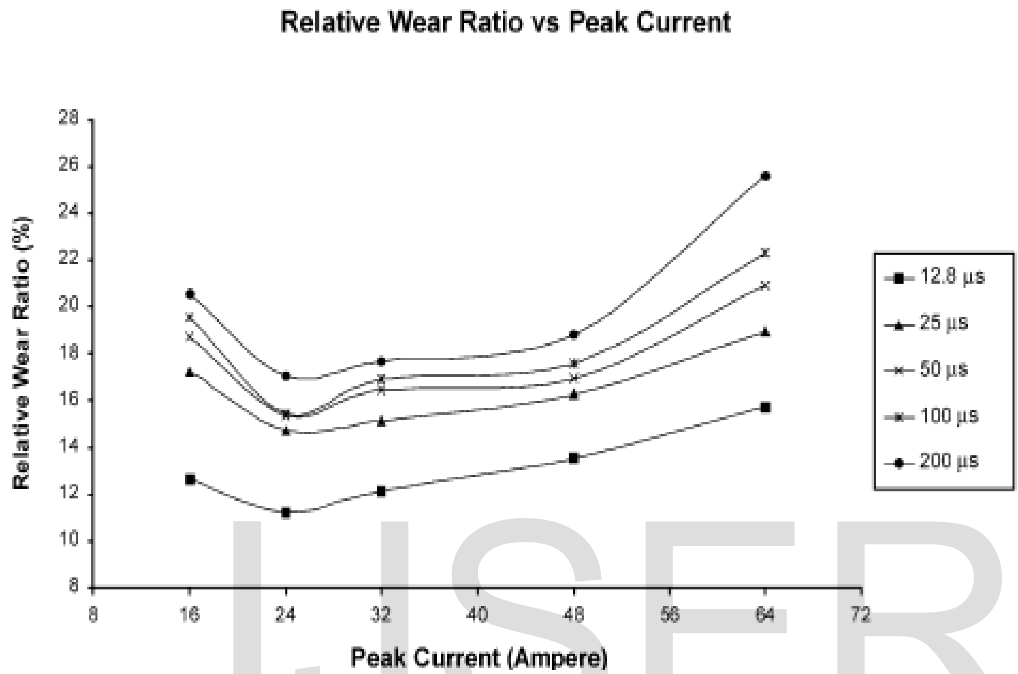

Fig 1b Effect of peak current on relative wear ratio on tungsten carbide

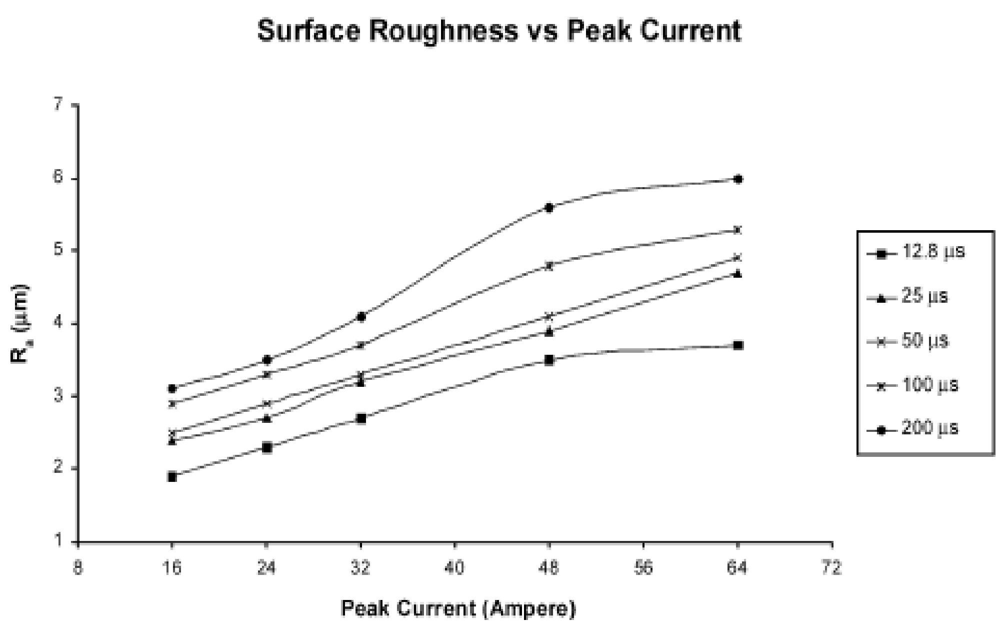

Fig 1c Effect of peak current on workpiece surface roughness on tungsten carbide

The correlation between machining characteristics and peak current in machining of AISI H13 tool steel using copper electrode are shown in Figs. 2a to 2b. According to these figures, an increase in the peak current causes an increase in the MRR and Ra, but a decrease in the TWR. By the increase in peak current, the discharge energy of the plasma channel and the period of transferring of this energy into the electrodes increase. This phenomenon leads to a formation of a bigger molten material crater on the workpiece which results in a higher surface roughness. However, the dimension of plasma channel and the effect of thermal conductivity of electrodes in dispersing the thermal from the spark collision position increase by the increase in pulse on time. Consequently, by dispersing more heat from the spark stricken position and increasing the amount of heat transferred from the plasma channel to the electrodes, the plasma channel efficiency in removing molten material from the molten crater at the end of each pulse decreases, while the dimensions of the molten crater on the electrodes increases. This effect is more pronounced for copper electrode, since its thermal conductivity is much higher than that of the workpiece. As a result, tool wear ratio decreases by increase in pulse on-time. The increase in pulse on-time leads to an increase in the material removal rate, surface roughness, as well the white layer thickness and depth of heat affected zone.

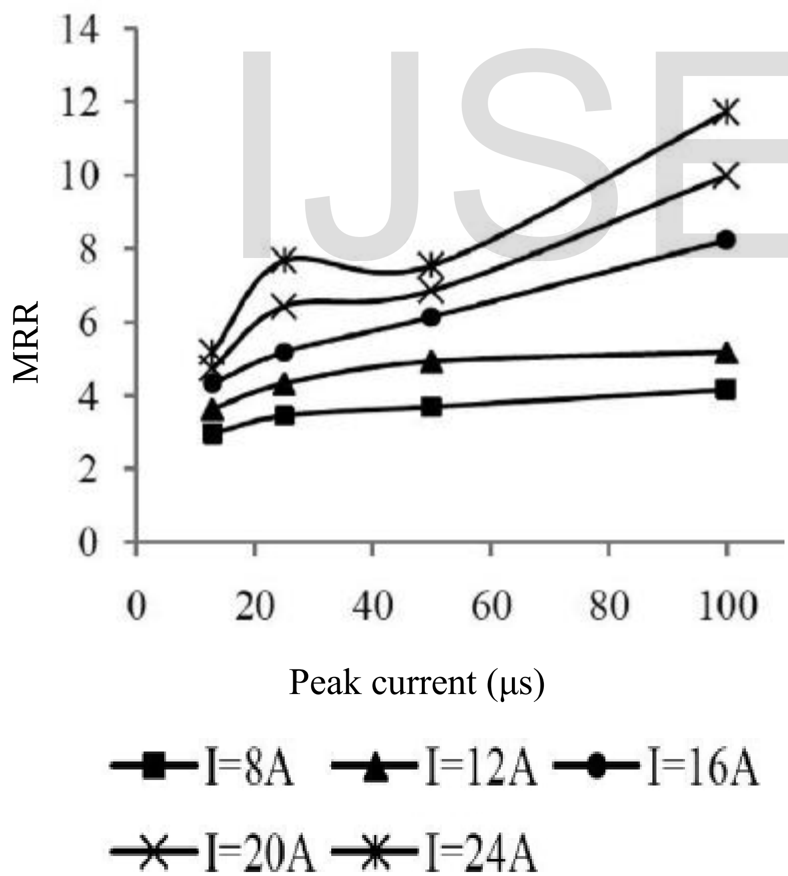

Fig 2a. Effect of peak current on Material removal rate on AISI H13

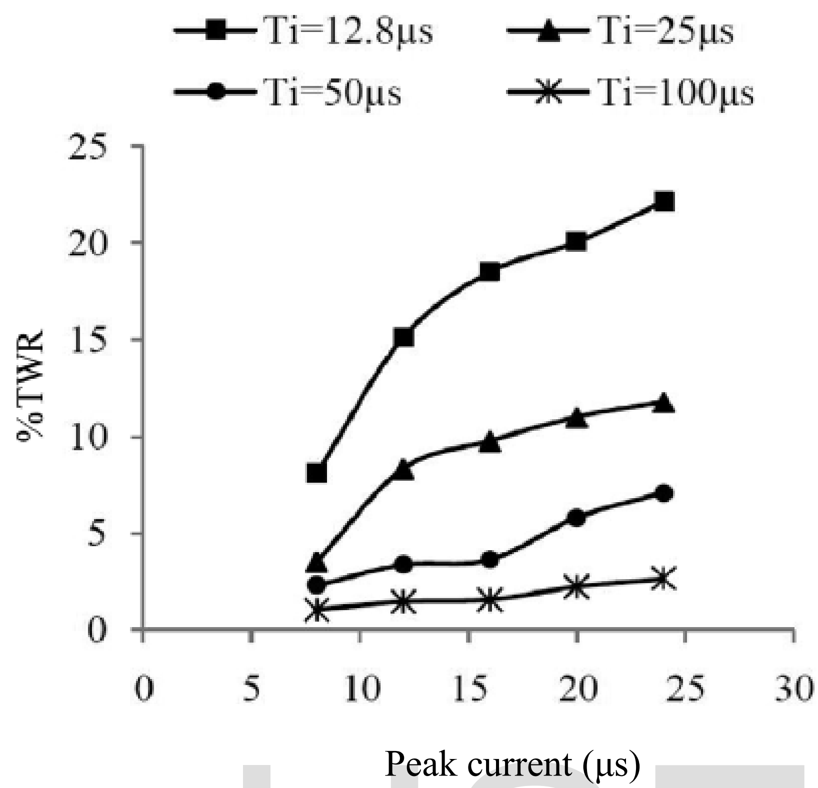

Fig 2b. Effect of peak current on relative wear ratio on AISI H13

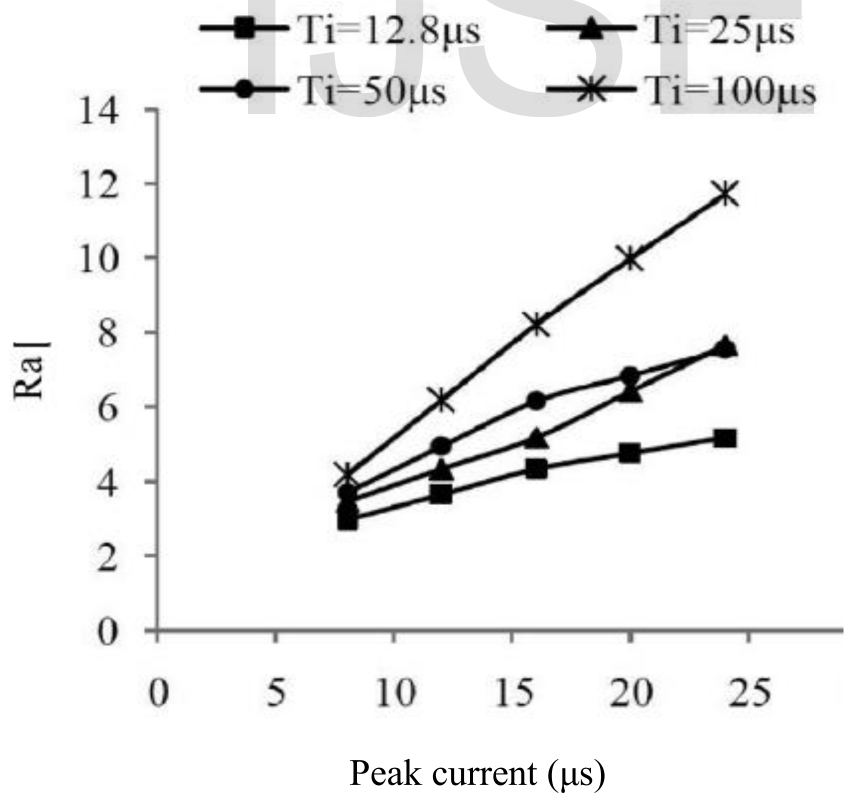

Fig 2c. Effect of peak current on surface roughness on AISI H13

As, we compare the effect of peak current on electrical discharge machined between tungsten carbide and AISI H13, the result is that the MRR of AISI H13 is more than the MRR of tungsten carbide.Similarly by showing the graph of Relative wear ratio ,the RWR of tungsten carbide is less than the AISI H13 and the surface roughness R_a of tungsten carbide is less than the AISI H13.So by comparision of all these the tungsten carbide is better worpiece than AISI H13.

CONCLUSIONS

An extensive experiment study has been conducted to investigate the effect of the machining characteristics in edm of tungsten carbide and AISI H13. For the tungsten carbide, effect of the peak current, it is observed that for all values of pulse duration, the material removal rate increases with the increase of the peak current in the range of low current settings, and becomes constant when machining at higher values of peak current. the relative wear ratio first decreases slightly with the peak current and then increases with further increase of the peak current. there is an optimum peak current, at which the relative wear ratio is minimum for all settings of pulse duration. The surface roughness of the workpiece increases steadily with increasing peak current.

For the AISI H13 effect of the peak current, it is observed thal for all values of pulse duration, the material removal rate increases with the increase of the peak current and increases continsually. The relative wear ratio increases with increase of the peak current.The surface roughness of the workpiece increases steadily with increasing peak current. By these study the overall performance of tungsten carbide is more useful or better than the AISI H13workpiece.

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