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Probing the Effect of Parameters of Wire-EDM on Cutting Speed and Surface Integrity for D2 Steel

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***Abstract* - The indent of alloy steel of high toughness, hardness and strength is proliferating in present era of materials .These materials are used for typical Purpose. As difficulty is encountered in machining of these materials by traditional methods of machining. Wire cut EDM is used to machine them. It has been become an important machining process because it avails an effective way out for generating components made of materials like titanium, zirconium and complex shapes , which are rather difficult to attain by other machining methods. Due to large number of process parameters and responses, a lot of researches have tried to optimize this process. A remarkable amelioration in process efficiency may be obtained by optimization of parameters which recognize the region of censorious process control factors which leads to required response ensuring a lower cost of production.**

Keywords – Electrical Discharge Machining, Material removal Rate, Surface Roughness, One Factor At a Time.

I. INTRODUCTION

In the past decades, EDM technology has gradually evolved and become an important manufacturing process. EDM is a thermoelectric process that erodes work piece material by a series of discrete electrical sparks between the work piece and electrode flushed by or immersed in a dielectric fluid. Unlike traditional cutting and grinding processes which rely on a much harder tool or abrasive material to remove the softer work-material, the EDM process utilizes electrical sparks or thermal energy to erode the unwanted work-material and generate the desired shape.

Electrical discharge machining (EDM) is a nontraditional, thermoelectric process which erodes material from the work piece by a series of discrete sparks between a work and tool electrode immersed in a liquid dielectric medium. These electrical discharges melt and vaporize minute amounts of the work material, which are then ejected and flushed away by the dielectric. The sparks occurring at high frequency continuously & effectively remove the work piece material by melting & evaporation. The dielectric acts as a demonizing medium between 2 electrodes and its flow evacuates the re-solidified material debris from the gap assuring optimal conditions for spark generation. In micro wire EDM metal is cut with a special metal wire electrode that is programmed to travel along a pre-programmed path.

A wire EDM generates spark discharges between a small wire electrode (usually less than 0.5 mm diameter) and a work piece with deionized water as the dielectric medium and erodes the work piece to produce complex two- and three dimensional shapes according to a numerically controlled (NC) path.

II. LITERATURE REVIEW

J.Qu, A.J. Shih, R.O., et.al (2002), examined the EDM process parameters in a cylindrical EDM process. This survey found the lack of research in EDM of newly developed engineering materials and the boundaries that limits the MRR in wire EDM. This research investigates the effect of spark on-time duration and spark on-time ratio, two important EDM process parameters, on the surface finish characteristics and integrity of four types of advanced engineering material: porous metal foams, metal bond diamond grinding wheels, sintered Nd-Fe-B magnets, and carbon– carbon bipolar plates.

J.P. Kruth, Ph. Bleys et.al (2003),find out the residual stress profiles for rough and finish W-EDM of tool steel. The experiments show that the maximum tensile stress and the penetration depth of tensile stress are reduced with increasing number of finishing steps. In some cases, for rough W-EDM, a relaxation of residual stress in time is observed, reducing the maximum tensile stress. A small ratio of thickness to stress penetration results in deformation by machining thin beams by rough W-EDM.

Aminollah Mohammadi, Alireza Fadaei Tehrani, et.al (2008),evaluating the effects of machining parameters on material removal rate and expressing the mathematical relationship between machining parameters and material removal rate.Also presenting the optimal machining conditions by using ANOVA.

III. PROBLEM STATEMENT

Metal cutting is one of the important and widely used manufacturing processes in engineering industries. The study of metal cutting focuses on the features of tools, input work materials and machine parameter settings which influence the process efficiency and out- put quality characteristics (or response). A significant improvement in process efficiency process may be obtained by parameter optimization that identifies and determines the regions of critical process control factors leading to desired out-puts or responses with acceptable variations ensuring a lower cost of manufacturing.

In present work, effects of wedm process parameters are investigated on different machining characteristics i.e. mrr and sr during machining of d2 die steel.

1. PREPARATION OF SPECIMENS

The D-2 die steel plate of 125mm x 100mm x 25mm size is mounted on the ELECTRONICA SPRINTCUT WEDM machine tool (Figure 4.1) and specimens of 5mmx5mmx24mm size are cut. The close up view of plate blank used for cutting the specimens is shown mounted on the WEDM machine

2. EXPERIMENTAL PROCEDURE

A series of experiments were conducted to study the effect of various machining parameters on WEDM process. Studies have been undertaken to investigate the effects of selected parameters viz., discharge current, pulse on time, pulse off time, wire feed, wire tension on cutting speed & surface roughness. Single variable at a time approach concept is used to find out the effect of these input parameters on material removal rate and surface roughness. Experiments were carried out on D-2 die steel material as a work-piece electrode & brass copper as a tool electrode. Distilled water has been used as a dielectric fluid throughout the tests.

The experiments were carried out in CNC sprint cut wire EDM of Electronica Machine tool ltd. The pulse generator capacity of the machine is 40A. The pulse generator supplies the electrical energy to the spark gap in the form of pulses. The Elektra wire cut electrical discharge machine comprises of machine tool, a power supply unit (ELPULS) & a dielectric unit & a chiller unit. The machine tool unit comprises of a main work table (called x –y table) on which the work-piece is clamped an auxiliary table called (u-v table) & wire derive, mechanism. The main table moving along X & Y axesin the steps of 1 micrometer by means of D.C servomotor. The U & V axes which parallel to X& Y axes respectively are driven by the same motor which drives the table. The travelling wire which is continuously fed from wire feed spool which moves through the work-piece & is supported under tension b/w a pair of wire guides which are located at the opposite sides of work-piece. The lower wire guide is stationary whereas the upper wire guide which is supported by the U-V table can be displaced transversely, the U & V axes, with respect to lower wire guide. The upper wire guide can also be positioned vertically along Z axes by moving the quill. A series of electrical pulses generated by the pulse generator unit are applied b/w the work-piece & the travelling wire electrode, to cause the erosion of the work-piece material. As the removal or machining proceeds, the work table carrying the work-piece is displaced transversely by the X-Y controller & the drive along a predetermined path programmed in the controller. The path specifications can be supplied to the controller via a program which is stored on floppy disk or directly the controller (MDI made).

IV.WORKDONE

In this section, the influence of machining variables namely peak current(Ip), pulse-on time, pulse-off time, servo voltage(SV) and dielectric flow rate on cutting speed(or material removal rate) and surface roughness(SR) are discussed. Copper coated brass wire was used to produce 3.5×3.5×25mm cuts in the D2 die steel plate. Experiments were carried out at constant value of wire tension 10N, dielectric flow rate (distilled water) of 10 liters per minute and servo feed (SF) of 2080V. Cutting speed was measured in mm/min which was displayed on computer screen of the machine control unit and surface roughness was measured from in micro-mm from surface roughness tester.

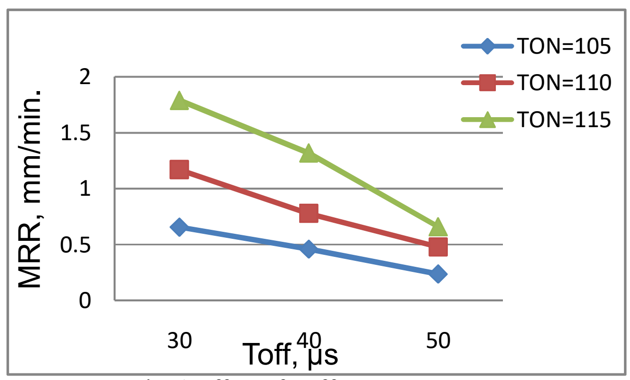

Fig. 1 Effect of Toff on MRR.

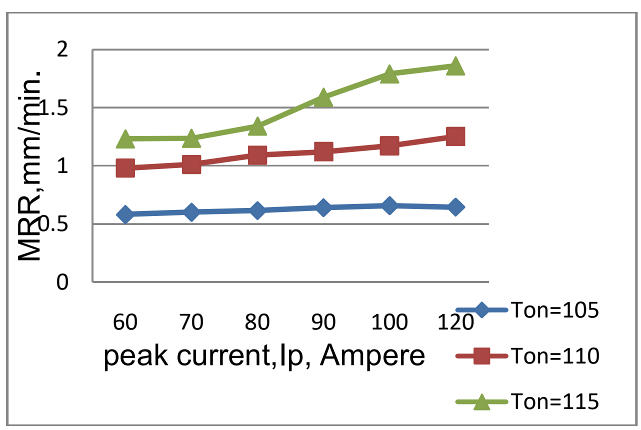

Fig. 2 Effect of peak current on MRR.

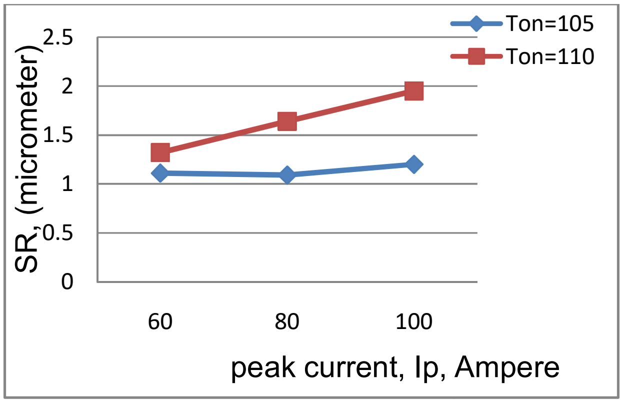

Fig. 3 Effect of peak current on SR.

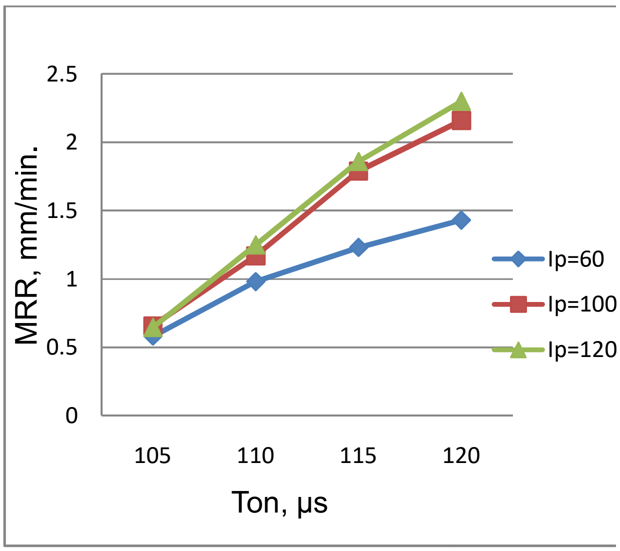

Fig. 4Effect of Ton on MRR.

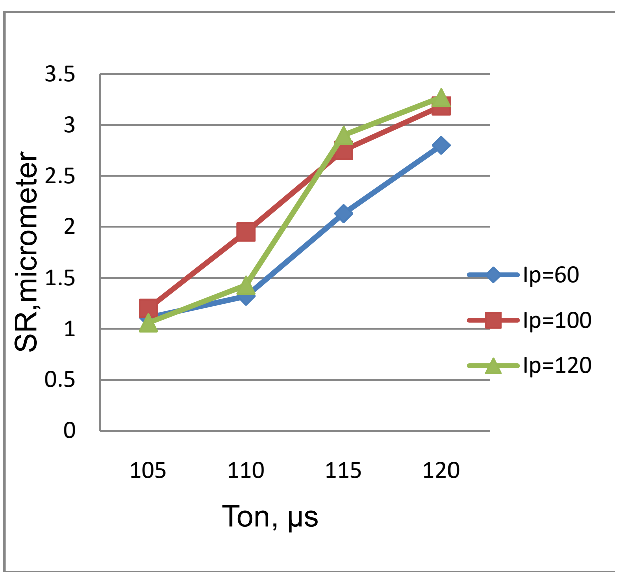

Fig. 5 Effect of Ton on SR.

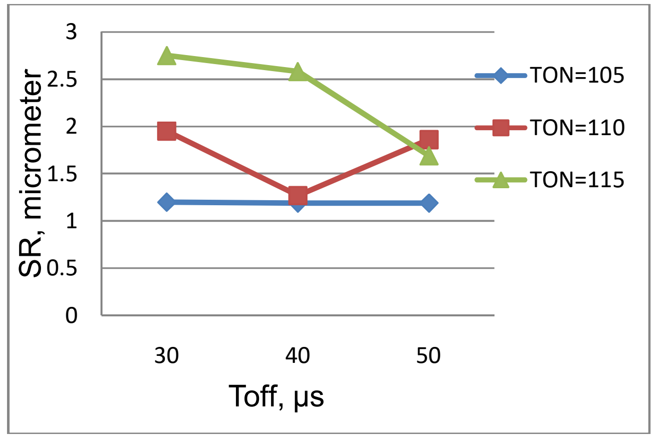

Fig. 6 Effect of Toff on SR.

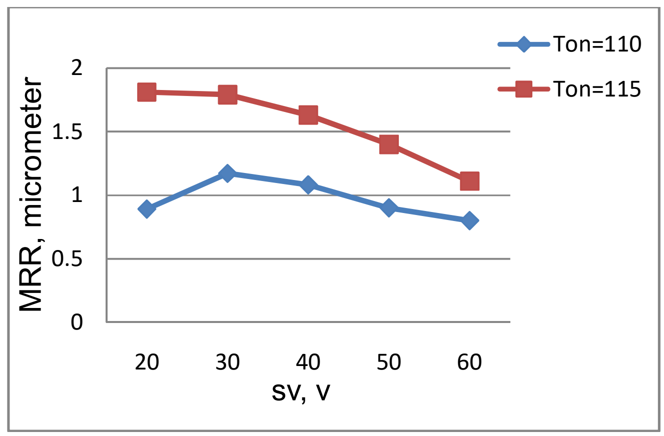

Fig. 7 Effect of SV on MRR.

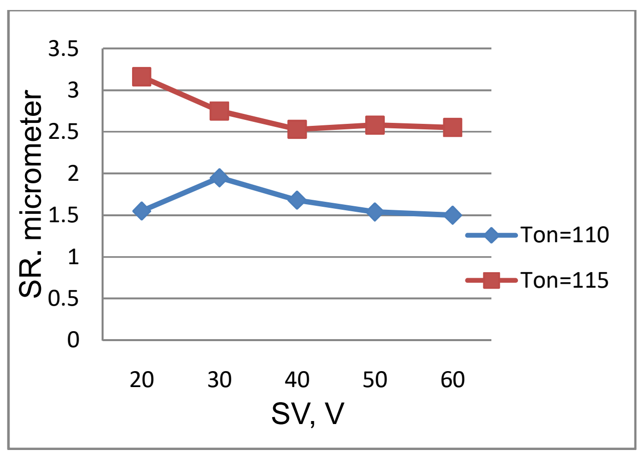

Fig. 8 Effect of SV on SR

IV. RESULT AND CONCLISION

Based on the present set of experimentation, the following conclusions are drawn:

1. Cutting speed or material removal rate and surface roughness both increase in peak current and pulse-on time and vice-versa.

2. Cutting speed or material removal rate and surface roughness both decrease with increase in pulse-off time and servo voltage. Thus fine surface get as we increase the value of both these variables.

V. FUTURESCOPE

1. The effect of process parameters such as flushing pressure, conductivity of dielectric, wire diameter, work-piece height etc. may also be investigated.
2. The effect of machining parameters on recast layer thickness and overcut should be investigated.
3. Efforts should be made to investigate the effects of WEDM process parameters on performance measures in a cryogenic cutting environment.

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