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Process Limitations of A Wedm in Tool And Die Steel

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Abstract:- Wire Cut EDM process is extensively used where the conventional machining process are not useful. A metal wire with machining . The paper envisaged about the control parameters required for machining of tool steel. EN 31 is used vastly in engineering applications. The work roll of rolling mill and many tools like dies and punches are manufactured by EN 31 and En 31 modified. The main objective of the research paper to analyze the cutting and Metal removal rate of tool steel. The Metal removal rate can be controlled by machining parameters which can be controlled and set according to the hardness and cutting speed. The wire cut EDM process is required to produce dies, punches and various machine parts.

Keywords: Wirecut, EDM, Machining,MRR

I. INTRODUCTION

Wire Cut EDM In wire electrical discharge machining (WEDM) is also known as wire-cut EDM. A thin single metal wire, usually brass, is fed through the work piece which is submerged in the tank of dielectric fluid usually water deionized). Wire-cut EDM is typically used to cut plates of hard metals as EN 31, HCHCr, die steel etc. The thickness varies from 10 to 300 mm to make punches, tools, and dies.

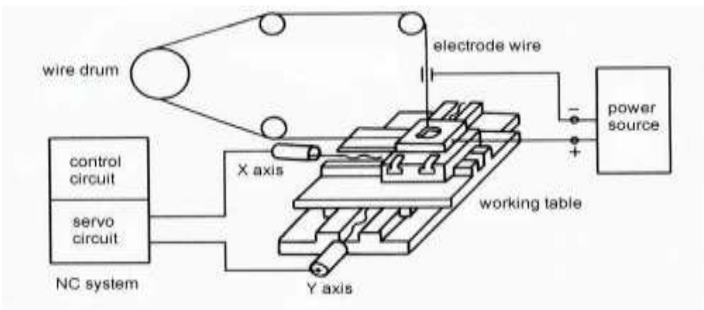

Fig 1: Wire Cut EDM (schematic diagram)

The machine tool comprises of a main worktable (called X-Y table) on which the work piece is clamped, an auxiliary table (called U-V table) and wire drive mechanism. The main table moves along X and Y axes, in step of 1 micrometer, by means of X and Y pulse motors, whereas the U-V table moves, in steps of 1 micrometer, by means of U and V pulse motors along U and V axes which are parallel to X and Y axes respectively.

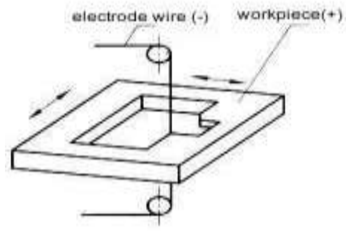

Fig 2 :Working Principle of Wirecut EDM

The water flushes the cut material debris away from the cutting zone. Flushing is an important factor in determining the maximum feed rate for a given material thickness.

A travelling wire which is continuously fed from wire feed spool and collected in bin, which moves through the work piece and it is supported under tension between a pair of wire guides which are located at the opposite sides of work piece. The lower wire guide is stationary whereas the upper guide which is supported by U-V table can be displaced transversely, along U and V axis,with respect to the lower wire guide. The upper wire guide can also be positioned vertically along Z axis by moving, vertical arm by means Z axis UP/DOWN switch.

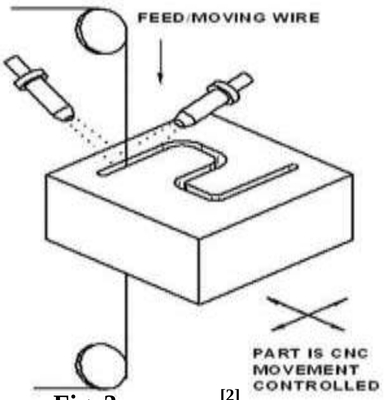

Fig 3 : source [2]

In order to produce taper machining, the wire electrode has to be tilted. This is achieved by displacing the upper wire guide (along U-V axis) with respect to the lower wire guide. The desired taper angle is achieved by simultaneous control of the movement of X-Y table and U-V table along their respective predetermined paths stored in the controller. The path information of X-Y table and U-V table is supplied to the controller in terms of linear and circular elements via NC program.

While the machining is continued the machining zone is continuously flushed with water passing through the nozzles on both sides of the work piece. Since water is used as dielectric medium, it is very important that water does not ionized. Therefore, to prevent the ionization of water an ion exchange resin is used in the dielectric distribution system to maintain the resistivity of the water constant

2. Literature Review

Kumar, Bhushan and Gupta [3] study reveals about various features of WEDM and improvement from the past to recent improvements in manufacturing processes. His paper also give details about a better understanding and basic overview of the fundamentals, features and practical uses of WEDM

Miller, Shih and Qu [4] study reveals about the development of new, advanced engineering materials and the need for precise and flexible prototypes and low-volume production have made the wire electrical discharge machining (EDM) an important manufacturing process to meet such demands. Their research investigates the effect of spark on-time duration and spark on-time ratio, two important EDM process parameters, on the material removal rate (MRR) and surface integrity of four types of advanced material: porous metal foams, metal bond diamond grinding wheels, sintered Nd-Fe-B magnets, and carbon-carbon bipolar plates. An experimental procedure was developed. During the wire EDM, five types of constraints on the MRR due to short circuit, wire breakage, machine slide speed limit, and spark on-time upper and lower limits are identified. An envelope of feasible EDM process parameters is generated for each work-material. Applications of such a process envelope to select process parameters for maximum MRR and for machining of micro features are discussed.

Marigoudar, Kanakuppi and Sadashivappa [5] have published their work on behavior of zinc-aluminium alloy reinforced with silicon carbide particles when machined with wire electric discharge machining process (WEDM). The difficulty faced by conventional machining is severe tool damage while machining metal matrix composites. Electrical discharge machining can be successfully employed for reduce the tool damage and to produce complicated contours with superior finish. In the present study ZA43 reinforced with SiCp is machined by wire EDM process. Machining is carried- out by varying applied current of (2, 4 and 6amp.), pulse on time (4, 8 and 16µs) and pulse off time (5, 7 and 9µs) while other parameters such as voltage, dielectric flushing pressure, wire tension etc. are maintained constant. It is observed that reduction in the material removal rate and increase in surface roughness for increasing reinforcement percentage in the composite. It is also observed that applied current and pulse on time increases the material removal rate where as pulse off time has less effect on it.

Kumar [6] clearly mentioned in his research paper about the various parameters of EDM. The various

parameters which are effecting MRR are as **On-time or pulse time:** It is the amount of energy applied during this on-time. **Off-time Or Pause time:** It is the duration of time between the sparks. This time allows the molten material to solidify and to be wash out of the arc gap. **Arc Gap:** It is the distance between the electrode and the work piece during the process of EDM. It may be called as the spark gap. **Duty Cycle:** It is the percentage of on-time relative to total cycle time. This parameter is calculated by dividing the on-time by the total cycle time (on-time plus off-time). The result is multiplied by100 for the percentage of efficiency or the so called duty cycle. **Intensity:** It points out the different levels of power that can be supplied by the generator of the EDM machine.
Voltage (V): It is a potential that can be measure by volt it is also effect to the material removal rate and allowed to per cycle.

Daneshmand, Kahrizi& Ghahi[7] Considering the importance of titanium alloys in aerospace, automobile and medical industries, the impact of electrical discharge machining (EDM) on smart NiTi60 alloy has been reviewed in this research. In view of the high competition that exists among various industries to lower the time, cost of production, and improve the quality, the parameters of material removal rate (MRR) and tool wear rate (TWR) are highly significant. In this research, the impact of process input parameters such as pulse on time, pulse off time, discharge current (A) and gap voltage (V) on output parameters such as tool wear rate, material removal rate and surface roughness (SR) has been investigated. For determining the better parametric settings, lot of work has been done in the engineering design. The WEDM processes are having several performance characteristics like Metal Removal Rate, Surface roughness, Kerf width; Dimensional error etc. The optimal parametric settings with respect to different performance characteristics are different. **SS. Mahapatra and Amar patnaik** [8] have described in their paper about Parametric Optimization of Wire Electrical Discharge Machining (WEDM) Process using Taguchi Method. In this study27 experiments are Performed based on the Orthogonal array of L27 considering Discharge current, Pulse duration, Pulse frequency, wire speed, Wire tension and dielectric flow rate as control factors and the responses measured are Surface finish (Ra) and MRR. with Zinc coated copper wire electrode and proposed some optimized parameter settings for desired yielding.

R.Ramakrishnan & L.Karunamoorthy[9] in their paper have applied the Taguchi's method, which is one of the methods of robust design of experiments to optimize multi responses of the wire cut electric discharge machining operations. Experimentation was carried out using L16 orthogonal array. Each experiment was conducted under different cutting conditions of pulse-on time, wire tension, delay time, wire feed, speed, and ignition current intensity to measure material removal rate, surface roughness, and wire wear ratio as the multi responses.

Jose Marafona and Catherine Wykes [10] have investigated a new method of optimizing MRR using EDM with copper- tungsten electrodes. This paper describes an investigation into the optimization of the process which uses the effect of carbon which has migrated from the dielectric to tungsten copper electrodes. This work has led to the development of a two stage EDM machining process where different EDM settings are used for the two stages of the process giving a significantly improved material removal rate for a given wear ratio.

II. SELECTION OF MATERIAL

The work piece selected to conduct the experiment is EN 31, the EN 31 is widely used for the mechanical tooling purposes. The chemical composition of EN31 is as follows:

Table 1: Composition of EN 31

S.No.	Element	Chemical Composition
1	Carbon C	0.9-1.10
2	Silicon Si	0.10-0.35
3	Manganese Mn	1.10 max
4	Phosphorus P	0.05 max
5	Sulfur S	0.05 max

6		Chromium Cr	1.00-1.501

III. EXPERIMENTAL SET UP

About Experimental setup: The experiments were performed on ELECTRONICA DL-25P unit four axis CNC Wire-cut electrical discharge machining (WEDM). The basic parts of the WEDM machine consists of a wire Electrode, a work table, and a servo control system**,** a power supply and dielectric supply system. The practical experiment conducted at CIPET (Central Institute of Plastic Engineering and Technology, Sitapura, Jaipur).

Fig4. Experimental setup

V. METHODOLOGY OF EXPERIMENT

Meta removal rate can be calculated by
MRR = Volume of metal removed/ Machining Time X 100

Table 2 : Specifications

Dielectric fluid	Unit	Deionised water
Tank Capacity	Liters	250
De-ion resin capacity	Kg	7.5
Filter Cartridge	Microns	10 microns paper filter
Ion exchange capacity	Liters/H	70

Table 3: Levels of various control factors

Control		I		II	II I		IV
Factors							
Pulse On		12		16	2 0		24
Pulse Off		6		7	8		9
Bed Speed		20		25	3 0		35
Current		2		3	4		5

Table 4: Experimental plan with assigned values

S.No.	Pulse On	Pulse Off	Bed Speed	Current
1	12	6	20	2
2	12	7	25	3
3	12	8	30	4
4	12	9	35	5
5	16	6	25	4
6	16	7	20	5
7	16	8	35	2
8	16	9	30	3
9	20	6	30	5
10	20	7	35	4
11	20	8	20	3
12	20	9	25	2
13	24	6	35	3
14	24	7	30	2
15	24	8	25	5
16	24	9	20	4

Table 5 : Fixed Parameters of the machine

Wire Used	Brass wire of dia 0.180 mm
Shape cut	10 mm square
Angle of cut	Vertical
Location of the work piece	At the centre of table
Stability	Servo Control
Number of passes	One

VI. RESULT AND ANALYSIS

The results obtained are analyzed using S/N Ratios, Response table and Response Graphs with the help of Minitab software Minitab is a computer program designed to perform basic and advanced statistical functions. It is a popular statistical. analysis package for scientific applications, in particular for design and analysis of experiments. In this experimental results are analyzed and Regression equation is developed to predict the metal removal rate.

Table 6 : Results of the machine

SNo.	Pulse On	Pulse Off	Bed Speed	Current	Machining Time	MRR
1	12	6	20	2	122.13	3.17
2	12	7	25	3	95.8	4.04
3	12	8	30	4	80.32	4.81
4	12	9	35	5	67.68	5.71
5	16	6	25	4	60.92	6.35
6	16	7	20	5	60.00	6.45

7	16	8	35	2	93.2	4.15
8	16	9	30	3	70.63	5.47
9	20	6	30	5	38.48	10.05
10	20	7	35	4	45.75	8.45
11	20	8	20	3	72.85	5.31
12	20	9	25	2	92.27	4.19
13	24	6	35	3	47.43	8.15
14	24	7	30	2	75.67	5.11
15	24	8	25	5	45.02	8.59
16	24	9	20	4	59.23	6.53

140					**Bed Speed**	
120						
100					**Machining**	
80					**Time**	
60						
40					**MRR**	
20						
0					**Current**	
1	**4**	**7**	**10**	**13**	**16**	

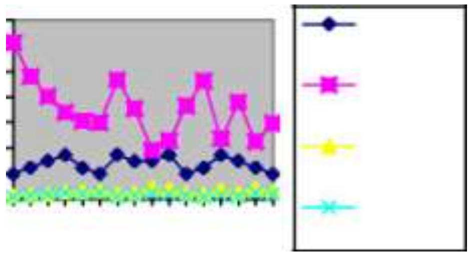

Fig6. Graph indicating machine results

VII. CONCLUSION

Based the results and discussion the following conclusions are drawn,

1. The better Parameter setting is Pulse on 24µs, pulse off 6 µs, Bed speed 35 µm/s and Current to obtain maximum metal removal rate.
2. The order strength of parameters are found from response table is current, pulse on, Bed speed and pulse off.
3. Analysis is used to predict the MRR with 6.77% error.

REFERENCE

[1]. http://www.kingedms.com/blog/index.php/2011/11/principle-of-wire-cut-edm/
[2]. http://sumitshrivastva.blogspot.in/2011/12/electrochemical-machining-ecm.html
[3]. Praveen Kumar, Bharat Bhushan & Dr. R.K. Gupta (2013), A literature review on optimization of input machining parameters of wire EDM, IJRMEC, Vol 3 Issue 9, ISSN 2250-057X.
[4]. Miller, Shih and Qu (2004), Investigation of the spark cycle on material removal rate in wire electrical discharge machining of advanced materials, International journal of machine tools and manufacture, pp 391 – 400.
[5]. Marogoudar, Kanakuppi and Sadashiappa (2013), Effect of machining parameters on MRR and surface roughness in machining of ZA43/SiCp Composite by WEDM, International journal of applied science and engineering, pp 317-330.
[6]. Kumar Sandeep (2013), Current research trends in electrical discharge machining: A review, Research journal of engineering sciences, Vol 2(2), 56-60, ISSN 2278-9472.
[7]. Daneshmand, Kahrizi & Ghahi (2012), Investigation of EDM Parameters on surface roughness and metal removal rate of NiTi60 shape memory alloys, Australian Journal of Basic and Applied Sciences 6(12): 218-225, ISSN 1991-8178.
[8]. Swarup S. Mahaptra, Amar Patnaik (2006), "Parametric
[9]. Optimization of wire electrical discharge machining process using taguchi method." Journal of Brazil Society of Mechanical
[10]. Science and Engineering Vol 28, pp 422-429.
[11]. R. Ramakrishnan and L. Karunamoorthy (2006),"Multi response optimization of WEDM operations using robust design."
[12]. International journal of advanced manufacturing technology, Vol 29, May, pp 105-112.
[13]. Jose Marafona, Catherine Wykes (1999),"A new method of optimization MRR using EDM with copper tungsten electrodes." International journal of Machine tools and manufacturing Vol 40, pp 153-164.
[14]. Parashar, V Rehman, Bhagoria J.L. and Puri Y.M. (2009) Investigation and optimization of surface roughness for wire cut Electro Discharge Machining of SS304L using Taguchi
[15]. Hsue W. J., Liao Y. S. and Luet. S.S. (1999) Fundamental geometry analysis of wire electrical discharge machining in corner cutting, International journal of machine tools and manufacture, pp 651-667.
[16]. Qu. J., Shih, Albert J. and Ronald O. (2002), Development of the cylindrical wire electrical discharge machining process, part 1:concept, International journal of manufacturing science Eng. 124, pp 702-707.
[17]. R. Konda, K.P Rajurkar, R. R. Bishu, A Guha, M. Parsovo (1984), International journal of Quality and Reliability Management, As a case study, experimental design technique used by the authors to study the performance of wire electrical discharge machining process for machining beryllium copper alloys is presented.
[18]. Mahaptra S and Patnaik (2007), Optimization of wire electrical discharge machining process parameters using Taguchi method, International journal of advanced manufacturing technology, pp 911-925
[19]. Kamla Jangra, Sandeep Grover, Aman Agarwal (2011), Simultaneous optimization of material removal rate and surface roughness for WEDM of WC-CO composite using grey relational analysis along with taguchi method. International journal of Industrial Engineering Computations pp 479-490.
[20]. Jaganathan P, Naveen Kumar, Dr. R. Sivasubramanian (2012), Machining parameters optimizations of WEDM using Taguchi method, International journal of scientific and Research publications, Issue 12.
[21]. S.B. Prajapati and N.S. Patel (2013), Effect of process parameters on performance measure of wire EDM for AISI A2 tool steel, International journal of Computational Research, Vol 03, Issue 4.
[22]. Obara H, Satou H and Hatano Masatoshi (2004), Fundamental study on corrosion of cemented carbide during wire EDM. Journal of Material Processing Technology 149, pp 370-375.
[23]. Kartz Z and Tibbles C (2005), Analysis of microscale EDM Process, International journal of advanced manufacturing technology 25, pp 923-928.
[24]. Kinoshita N, Fukui M and Gamo G (1982), Control of Wire EDM preventing electrode from breaking Ann CIRP 31, pp 497-511.
[25]. Speeding T and Wang Z (1997), Parametric Optimization and surface characterization of wire electrical discharge machining process, Precision Engineering 20. Pp 5-15.