Parametric Optimization of Wire Cut Electro-Discharge Machining Process for Surface Finish and Kerf Width for H-31 Tools Steel

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Abstract **- Wire electrical discharge machining (WEDM) is one of the important non- traditional machining processes. This is used for machining of difficult to machine materials and intricate profiles. Wire electrical discharge machining (WEDM) is extensively used in machining of conductive materials when precision is of prime importance. Wire electrical discharge machining (WEDM) allowed success in the production of newer materials, especially for the aerospace and medical industries. This process employed for the parts demanding higher accuracy levels with varying hardness or complex shapes. The main objectives of this study investigate and evaluate the effect of different input process parameters (pulse on time, pulse off time, servo voltage) on kerf width and surface roughness as response parameters have been considered for Each Experiment. Experimentation was planned as per Taguchi's L9 Orthogonal array during machining of H – 31 tool steel work material. Brass wire electrode with 0.25mm Diameter was used as tool in the Experiments. By analyzing the Grey relational grade we find the optimum parameters. Confirmation test has been conducted to validate the optimized parameter.**

IndexTerms **-Wire electrical discharge machining, KERF Width, surface roughness, Taguchi method.**

I. INTRODUCTION

Non-traditional machining processes are most commonly used for machining of high strength material in industries & increase in the availability and use of difficult-to- machine materials. Electrical Discharge Machining (EDM) is one such process which is widely used to machine electrically conductive materials. EDM is a thermo-electric process in which material removal takes place through the process of controlled spark generation. EDM has achieved a status of being nearly indispensable in the industry because of its ability to machine any electrically conductive material irrespective of its mechanical strength[1]

Basically, there are two different types of EDM: 1) Die-sinking EDM & 2) Wire-cut EDM. In the Sinker EDM Machining process, two metal parts submerged in an insulating liquid are connected to a source of current which is switched on and off automatically depending on the parameters set on the controller. While wire EDM Machining (also known as Spark EDM) is an electro thermal production process in which a thin single-strand metal wire (usually brass) in conjunction with de-ionized water (used to conduct electricity) allows the wire to cut through metal by the use of heat from electrical sparks.[2,3]

A series of electrical pulses generated by pulse generator unit is applied between the work- piece and travelling wire electrode spark discharge, the dielectric fluid gets ionized and there is flow of current across the wire electrode - work piece gap. Negatively charged particles (electrons) break from the cathode surface and move towards the anode surface under the influence of electric field forces. During this movement in inter -electrode gap, the electrons collide with the neutral molecules of dielectric, which is injected from a nozzle in the machining area. As a result, intensity of ionization becomes so high that a very narrow channel of continuous conductivity is established. Their kinetic energy of charge particles is converted into heat energy, resulting in heating of anode due to the bombardment of electrons and heating of cathode due to the bombardment of ions. Energy contained in tiny spark discharge removes a fraction of work material. Large number of such time spaced tiny discharges between the work piece and wire electrode cause the electro-erosion of work piece material.

II. KEY TERMS IN DOE

1. Factors

These are variables that have direct influence on the performance of the product or process under investigation. Factors are of two types:

(a) Discrete - Assumes known values or status for the level. Example: Container, Vendor, Type of materials, etc.
(b) Continuous - Can assume any workable value for the factor Levels. Example: Temperature, Pressure, etc.

2. Levels

This is the values or descriptions that define the condition of the factor held while performing the experiments

III. INPUT PARAMETERS

- Factor A: Pulse On Time(µs)
- Factor B: Pulse Off Time(µs)
- Factor C: Servo Voltage(volt)

IV. FACTORS WITH LEVELS VALUE

Table No: 1. Input Variables with Levels value

Sr. No.	Machining process parameter	Level 1	Level 2	Level 3
1	Pulse On Time (µs)	5	10	15
2	Pulse Off Time (µs)	30	35	40
3	Servo Voltage (volt)	20	25	30

Table No: 2. Fixed Variables

Sr. No.	Fixed Parameters	Set Value
1	Wire material	Brass (0.25mm)
2	Peak current (IP)	230
3	Pulse peak voltage	2
4	Servo feed setting	250

As per table, L9 orthogonal array of "Taguchi method" has been selected for the experiments design in MINITAB 17.

V. EXPERIMENT SETUP

The experimental setup and the experiment is designed and carried out at the Precision Die Cut wire cut which is placed at Odhav, Ahmedabad .the primary goal of the dissertation work is to predict the surface roughness and kerf width the work is carried out in sprint cut wire cut electro discharge machine of HCHCR material by varying machining parameters. Figure: 1 and Figure: 2 shows WEDM machines work table and Control Cabinet respectively.

Fig 1Work Table

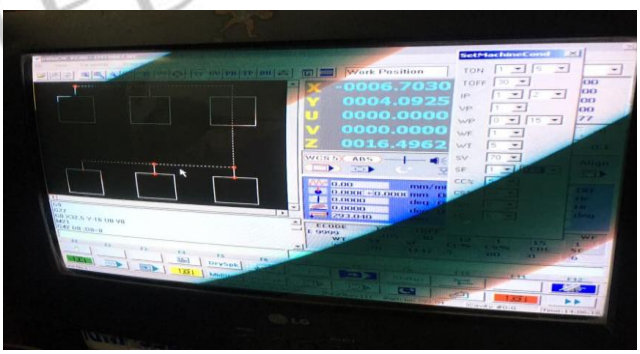

Fig 2Control Cabinet

Surface roughness values of finished work pieces were measured by Mahr GmbH Pocket Surf Ps 1 Surface Roughness Tester by a proper procedure. The Mahr GmbH Pocket Surf Ps 1 Surface Roughness Tester is an instrument that works by gently dragging a mechanical stylus across a Surface. Surface Roughness Tester acquires data by moving the sample beneath the diamond tipped stylus. Vertical movements of the stylus are sensed by an LVDT, digitalized, and stored in the instruments memory. Its output is a digital display of measured Surface roughness value Ra and other features. Surface Roughness Standard ISO was used for measurement. The temperature of environment was 32 ± 1◦C. In this present study we have taken Ra for measuring Surface Roughness.

For present experiments kerf width has been measured using Nikon profile projector model 6C available in HGCE which is placed at Vahelal, Ahmedabad. Kerf width is denoted by KW.

VI. MATERIAL SELECTION

The material selected for this dissertation work is H-31 TOOL STEEL. Chemical composition of this material is shown in Table No: 5.2. H-31 has the wide applications in stamping dies, metal cutting tools or any other industries because of its high strength and heavy weight. In general the edge temperature under expected use is an important determine of both composition and required heat treatment.

H-31 Tool steel has high melting point of about 2625°c. So tool wear is less compare to copper wire and brass wire.

Table No: 3. COMPOSITION OF MATERIAL

CHEMICAL	REQUIRED VALUES	OBTAINED VALUES
Carbon	0.90-1.20	1.020
Silicon	0.10-0.35	0.220
Manganese	0.30-0.75	0.440
Phosphorus	0.050 max	0.050
Sulphur	0.050 max	0.050
Chromium	1.00-1.60	1.150
Nickel	0.100 max	0.100
Moly	1.00-1.20	0.023

Fig 3 Tested Specimen

VII. RESULTS AND DISCUSSION

Table No: 4 Final Measurement Data

SR. No.	Ton (µs)	Toff (µs)	SV (volts)	KW (mm)	SR (µm)
1	5	30	20	0.324	1.085
2	5	35	25	0.302	1.257
3	5	40	30	0.291	1.243
4	10	30	25	0.293	1.436
5	10	35	30	0.294	1.554
6	10	40	20	0.304	1.856
7	15	30	30	0.305	1.812
8	15	35	20	0.303	1.917
9	15	40	25	0.302	1.654

After performing the experiment for all 9 runs and measuring the output parameters like material removal rate, surface roughness and kerf width for wire cut EDM of H-31 is discussed.

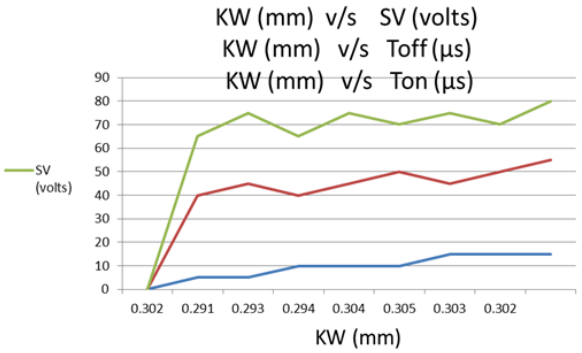

Fig. 4 Graph of input parameters v/s kerf width

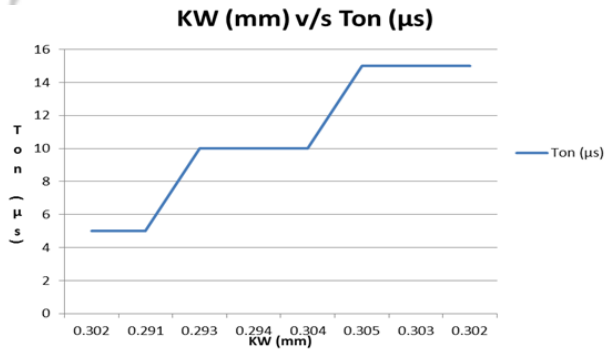

Fig. 5 Graph of Ton v/s kerf width

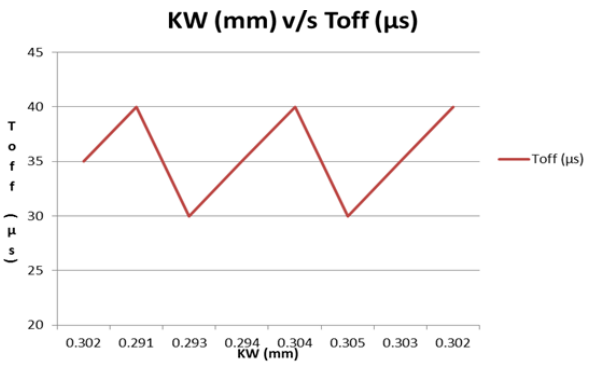

Fig. 6 Graph of Toff v/s kerf width

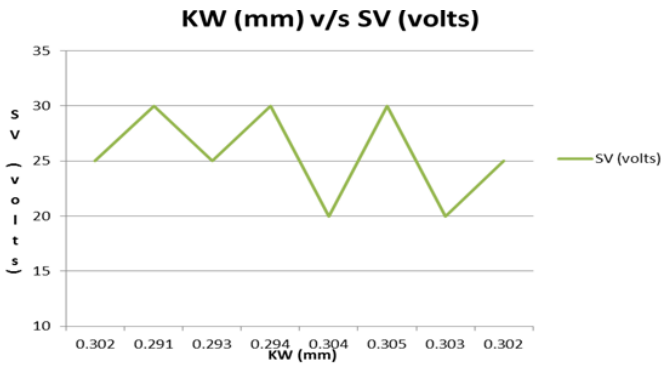

Fig. 7 Graph of SV v/s kerf width

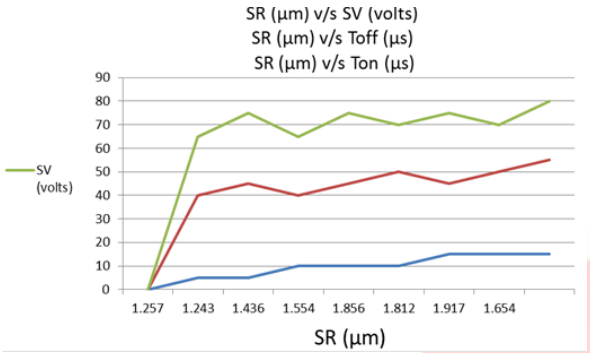

Fig. 8 Graph of input parameters v/s surface roughness

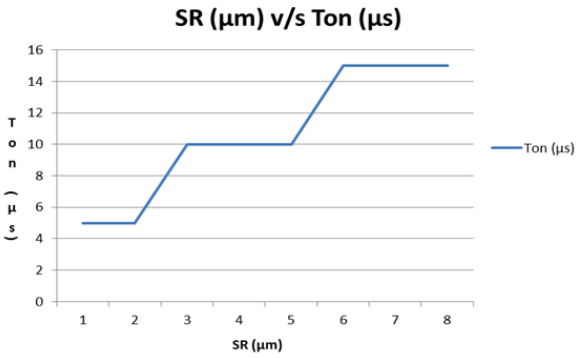

Fig. 9 Graph of Ton v/s surface roughness

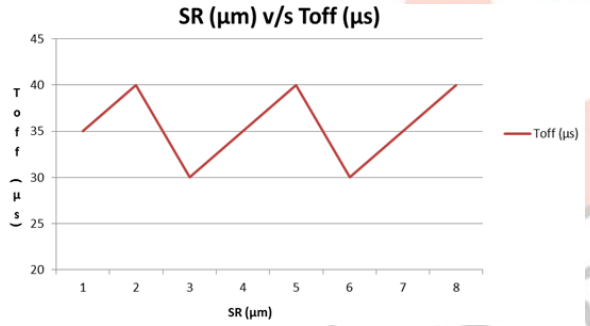

Fig. 10 Graph of Toff v/s surface roughness

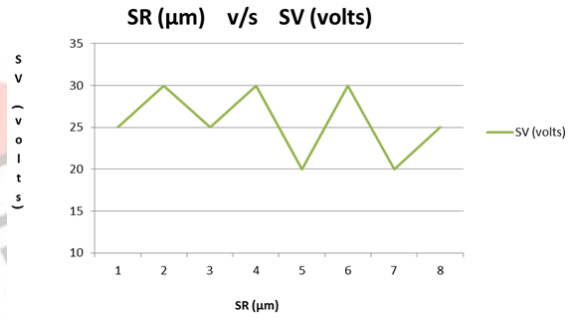

Fig. 11 Graph of SV v/s surface roughness

Above this fig. 9, Surface roughness increases surface finish decreases with increase in peak current and pulse on timebut decrease with pulse off time.

VIII. CONCLUSION

In this study, effect of process parameters such as peak current, pulse on time and pulse off time on response parameters namely material removal rate, surface roughness and kerf width has been studied WEDM. The main conclusions of this study is given as follows

- Surface roughness increases surface finish decreases with increase in peak current and pulse on time but decrease with pulse off time.
- Kerf width increases with increases in peak current and pulse on time but decrease with pulse off time.
- Surface finish is higher in EDM as compared to WEDM.

IX. REFERENCES

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