iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XII **Month of publication:** December 2017

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XII December 2017- Available at www.ijraset.com

Study to Achieve Minimum Surface Roughness on En-31 Steel Using One Variable at a Time Method on Wire Cut EDM

Harsh Kumar[1]
[1]*Department of Mechanical Engineering, College of Engineering & Management, Kapurthala, Punjab*

Abstract: ***Wire Electrical Discharge machining (WEDM) is nontraditional recent types of advance machining process which is used to machining of complex shapes. The process performance depends up on tool and work piece material also on manufacturing method. An appropriate selection of tool can reduce machining cost. The machining performance depends on the pulse on time, pulse off time, wire feed and wire tension parameters. This paper deals with investigation optimum surface roughness on EN-31 Steel material and copper wire (Zinc coated)as electrode having diameter 0.25 mm was used for conducting experiments. One variable at a time approach is implemented to regard as work surface roughness by deviation of parameters such as wire feed, wire tension, pulse on time and pulse off time.***

Keyword: Wire Electrical Discharge Machining (WEDM), Surface Finish (SF), Surface Roughness (SR), Pulse off Time (TOFF), Pulse on Time (TON).

I. INTRODUCTION

WEDM is one of non-traditional machine where electrical energy is utilized to produce spark between the electrode and the work piece. A dielectric fluid flows throughout the certain gap maintained between the wire and work piece. The material is wash out by flowing dielectric fluid from this gap [1]**.** The gap usually maintained between the wire and work piece and from 0.025 to 0.075 mm by a computer controlled system. The each electric spark produces approximately at around$15000^0$to 21000^0 Fahrenheit heat [2].Cutting shape is formed on the work piece by the programmed moving pathway of wire electrode. The WEDM is generally utilized for making dies and molds works. Working principle of WEDM cutting process is shown in figure 1.

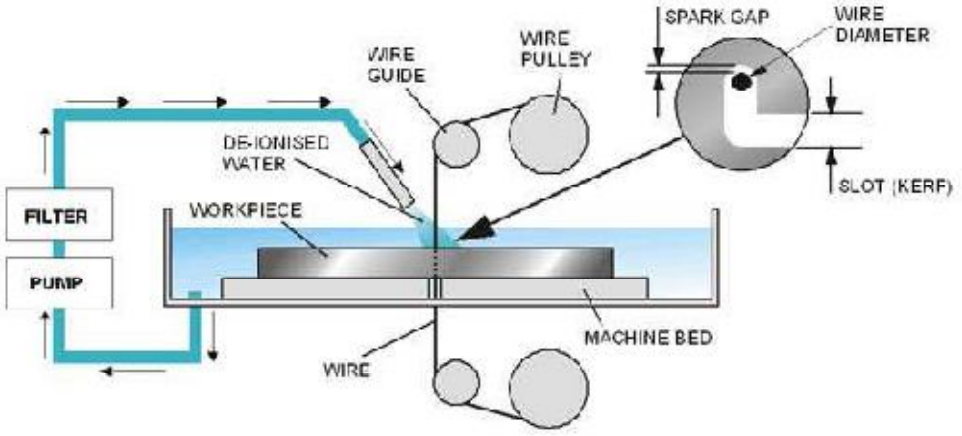

Fig.1.Working principle of WEDM cutting process [4]

II. EXPERIMENTAL METHODOLOGY

Experiments were performed ELECTRONICA ULTRACUT WEDM machine shown in figure 2 by variation of pulse on time, pulse off time, wire feed and wire tension. Flushing pressure (WP) was kept constant at some value during all experiments. Impacts of these parameters are considered on surface roughness by utilizing one factor variable at a time approach method. In this method one input parameter was changed at regular interval and other input parameters kept constant at mean predetermined value for Influence of machining parameters on surface roughness. The experiments were performed on EN-31 Steel as work piece die steel

having dimensions 125 mm × 125 mm × 25 mm. During the experiments work piece having dimensions 10 mm × 10 mm square was used to cut rectangular punch of 10 mm × 10 mm × 25 mm.

Fig.2. WEDM Machine

III. OBSERVATIONS

For first group of experiments pulse off time, wire tension, wire feed parameters were fixed at constant value. Pulse on time (TON) is changed from 100(µs) to 121 (µs) at regular interval of 3 units for obtain optimum value of surface roughness. The pulse on time effect on the surface roughness is described in Table1.During experiments fixed input experiments are:
TOFF =48 (µm); WF = 8 m/min; WT = 8 N.

Table I
Surface roughness and pulse on values

Sr. No.	Pulse on time (µs)	Surface roughness (µm)
1	100	1.23
2	103	1.35
3	106	1.61
4	109	1.91
5	112	2.10
6	115	2.32
7	118	2.34
8	121	2.37

For conduct second group of experiments pulse off time (TOFF) is changed from 63 (µs) to 38 (µs) with estimated decrement of 5 units. Additional parameters like pulse on time, wire feed, wire tension kept at some constant value. The work piece surface roughness affected by pulse off time is as described in Table2. Input fixed parameters experiments are:

TOFF= 114 units; WF = 8 m/min; WT = 8 N.0

Table II
Surface roughness and pulse off values

Sr. No.	Pulse off time (µs)	Surface roughness(µm)
1	63	2.27
2	58	2.32
3	53	2.36
4	48	2.41
5	43	2.45
6	38	2.47

During third group of experiments wire tension (WT) is decrease from 15 (N) to 3 (N) at the steps of 3. Parameters pulse on time, pulse off time wire feed, are kept at some fixed value. With respect to change in wire tension thevariant in surface roughness as represented in Table 3.During experiments input fixed parameters are:
TON = 115 (µs); TOFF = 48(µs); WF = 8 m/min.

Table III
Surface roughness and Wire tension

Sr. No.	Wire tension (N)	Surface roughness(µm)
1	15	1.66
2	12	1.79
3	9	1.93
4	6	2.15
5	3	2.33

In last group of experiment wire feed (WF) is increased in the steps of 3 units from2 m/min to 12 m/min. Other parameters like pulse on time, pulse off time and wire tension are fixed to some value. Due to due to the change in wire feed the effect on change in surface roughness is described in Table 4. During in forth set of experiments fixed input parameters are:

TON = 115 (µs); TOFF = 48 (µs); WT = 8 N

Table IV
SURFACE ROUGHNESS AND WIRE FEED

Sr. No.	Wire feed (m/min)	Surface roughness
1	15	1.23
2	12	1.35
3	9	1.61
4	6	1.91
5	3	2.10

IV. RESULT AND ANALYSIS

After performed the experiments theby one variable at a time methodthe various facts are came to front. The surface roughnessaffected by pulse on time (TON) is shown in Figure 3.

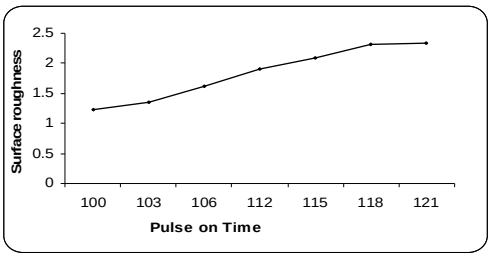

Fig.3Pulse on time vs. Surface roughness

The diagrams how that by increase pulse on time the value of surface roughness increases. So the pulse on time can be adjusted to get the desired surface roughness. In next set of experiments effect of pulse off time (TOFF) on the surface roughness is shown in the Figure 4.

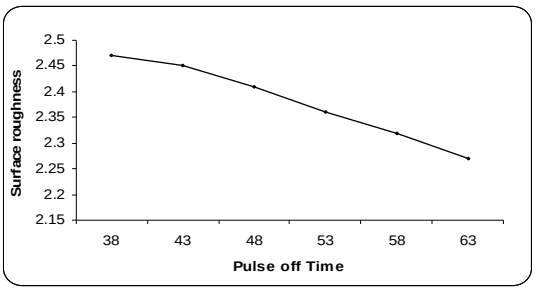

Fig.4 Pulse off time vs. Surface roughness

The above graph shows that the surface roughness diminishes with increment in the pulse off time. So to get the desired surface roughness the value of pulse off time can be selected with awareness. During third set of experiments the effect of wire tension (WT) on surface roughness is consider.

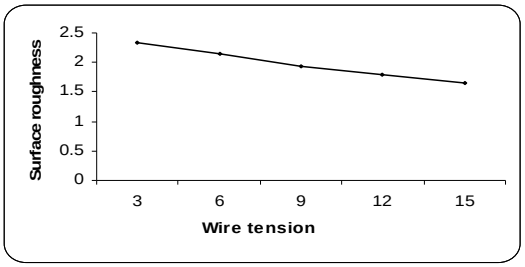

Fig.5 Wire tension vs. Surface roughness

The figure 5 reveals that the surface roughness decreases with respect to increase wire tension. So the value of wire tension can be selected in such a way that to get the surface roughness. During fourth group of experiments the effect of wire feed (WF) on the work piece surface roughness is shown in the Figure 6.

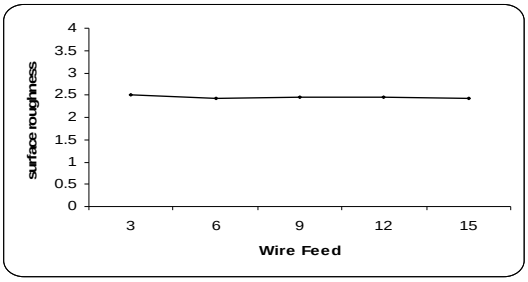

Fig.6 Wire Feed vs. Surface roughness

This graph shows that the surface roughness remains nearly constant with difference in the wire feed.

V. CONCLUSIONS

Experimental examination on wire electrical discharge machining of EN31steel has been done using copper wire of 0.25mm. The following conclusions are made

A. Surface roughness is not affected by wire feed (WF) parameters.
B. The surface roughness is direct affected by the pulse on time, as increase the pulse on time the value of surface roughness also increases.
C. With variation of the pulse off time and wire tension the value the of surface roughness decreases.
D. Wire feed is neutral input parameters. By increases pulse on time (TON), MRR increases also increase surface roughness value and while increase in pulse off time (TOFF) decreases with MRR also decrease surface roughness value

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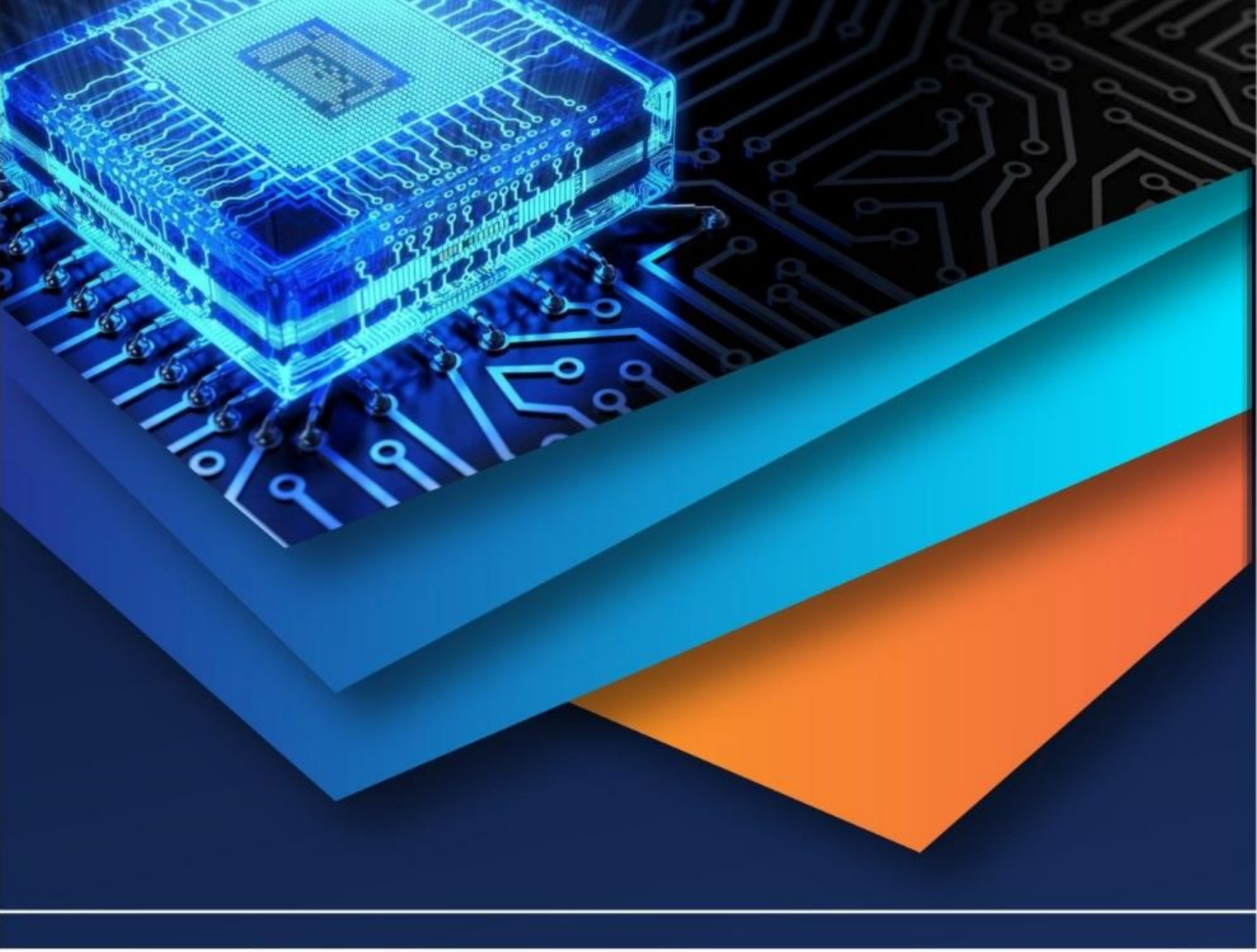

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