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Research Article

Experimental investigation of Wire Electrical Discharge Machining (WEDM) Process Parameters on SS304 using Taguchi method

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Abstract

WEDM (Wire Electrical discharge machining) is a nonconventional machining processes used in complicated shapes with high accuracy which are not possible with other conventional methods .Stainless steel 304 is used in present experimental work. Experiments are completed using Taguchi's method with L9 orthogonal array .The aim of this work is to optimize the WEDM process parameters by considering input parameters are pulse on time , pulse off time ,peak current and wire feed and experiments are conducted with help of input parameters at three levels and response output parameters are MRR (Material removal Rate) and Surface Roughness (SR).Setting of parameters using by Taguchi's method.

Keywords: *WEDM, Taguchi's method, SS304, L9 Orthogonal array, MRR,SR.*

1. Introduction

The experiments are conducted on DK 7732 CONCORD WEDM wire electrical discharge machine which is available in Hyderabad .The goal of the work is to predict the MRR ,Surface roughness. The work is on WEDM machine on SS304 stainless steel material by different parameters. The WEDM consist of a machine tool, power supply unit and dielectric supply unit. WEDM is used for machining parts of hard materials with different shapes used in aerospace and automobile industries.

Taguchi's Design of experiments

Taguchi designed a standard approach to evaluate number of factors and with minimum of experiments. In this work SS304 is considered as work piece material .Molybdenum wire of 0.18 mm diameter is used as the tool electrode. De-ionized water is used as dielectric fluid. Thickness of the work piece 6 mm. The chemical composition of SS304

Table.1 Chemical composition (%)

C	Si	Mn	P	S	Cr	Ni
0.037	0.23	0.43	0.019	0.012	16.28	0.12

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Table 2 Mechanical Properties of SS304

S. No	Test Parameters	Value /Units
1	0.2% Proof Stress	359.193 Mpa
2	Tensile Strength	448.254 Mpa
3	Elongation (%)	30.160

Table.3 gives the levels of process parameters (viz., pulse on time, pulse off time , voltage and wire feed). The output parameters are MRR and SR. As per L9 Orthogonal array are presented in the table 4.

Table 3 Levels of process parameters

Input Parameters	Level 1	Level 2	Level 3	Units
Pon	35	40	45	µ sec
Poff	8	10	15	µ sec
Peak current	1	2	3	Amp
Wire feed	1	2	3	m/min

Table 4: L9 Orthogonal Array

S. No	Pon	Poff	Peak current	wire feed
1	35	8	1	1
2	35	10	3	2
3	35	15	2	3
4	40	8	3	3
5	40	10	2	1
6	40	15	1	2
7	45	8	2	2
8	45	10	1	3
9	45	15	3	1

2. Experimental work

WEDM machine DK 7732 CONCORD WEDM with molybdenum wire which is installed at Hyderabad as shown in fig .1.The machine consist of coordinate work table, wire frame and wire running system .Dielectric supply system and micro computer based control cabinet. In this molybdenum wire is wound which can rotate a speed of 1500 rpm .Guide pulleys are used to run the wire through guides at a speed of 11m/sec .Work piece is mounted on the worktable with help of clamps. Microcontroller delivers the pulse signals to the servo motors .Pulse power supply, controlling, programming are integrated in single unit.

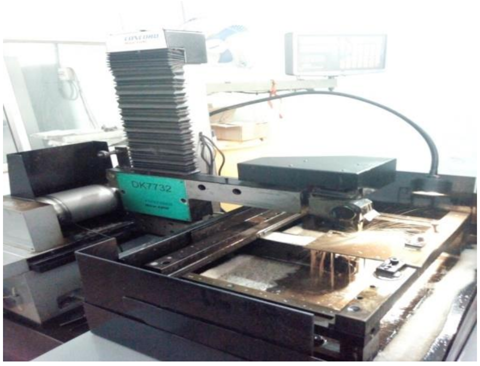
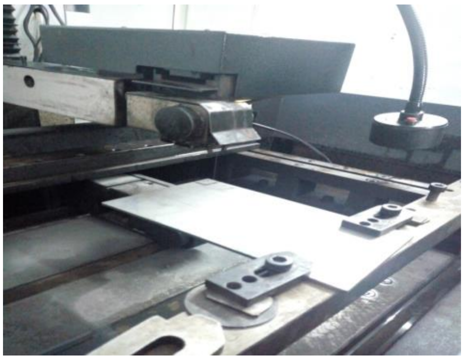
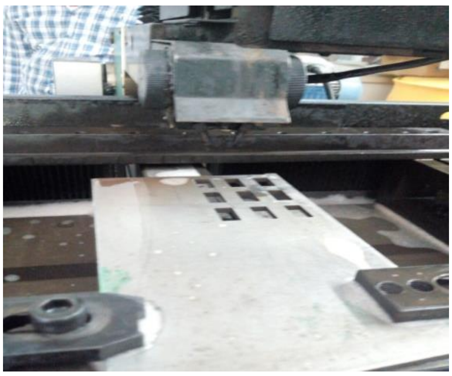


Fig.1 WEDM machine

(Model: DK 7732 CONCORD WIRE EDM)



(a)



(b)

Fig.2 (a) & (b) WEDM machine setup with tool and work piece (before and after machining)

3. Material and methods

Work piece material: SS304. Wire electrode: Molybdenum wire of diameter 0.18 mm is used in WEDM process to its good machining property .It has high tensile strength, good wire draw ability, high electrical conductivity and low calorification and heat release. Dielectric: Work piece are submerged in a dielectric fluid .WEDM is used de-ionized water due to low viscosity and rapid cooling rate

4. Calculation of MRR (Material Removal Rate)

MRR= [(2×Spark gap)+(Wire diameter)]× Job thickness × speed of the machine

Here

Spark gap=0.16mm,Wire diameter=0.18mm ,Job thickness=6mm

MRR= [(2×Spark gap)+(Wire diameter)]× Job thickness × speed of the machine

= [(2×0.16)+(0.18)]×6×speed = 3× speed

[speed= perimeter of specimen/ time taken]

Specimen 1:

MRR= 3×60/9.9 = 18.18 mm^3/min

Specimen 2:

MRR= 3×60/7.13= 25.23mm^3/min

Specimen 3:

MRR=3×60/18.66 =9.63 mm^3/min

Specimen 4 :

MRR = 3×60/6.63 = 27.12 mm^3/min

Specimen 5:

MRR = 3×60/12.03 =14.94 mm^3/min

Specimen 6:

MRR = 3×60/25.76 = 6.96 mm^3/min

Specimen 7:

MRR = 3×60/9.3 = 19.35 mm^3/min

Specimen 8:

MRR = 3×60/20.31 = 8.85 mm^3/min

Specimen 9:

MRR = 3×60/9.53 = 18.87 mm^3/min

Table 5 Response table for Means

Level	Pon	Poff	Peak Current	Wire feed
1	17.95	21.78	11.56	17.56
2	16.34	16.37	14.64	17.21
3	15.69	11.82	23.77	15.2
Delta	2.26	9.96	12.21	2.36
Rank	4	2	1	3

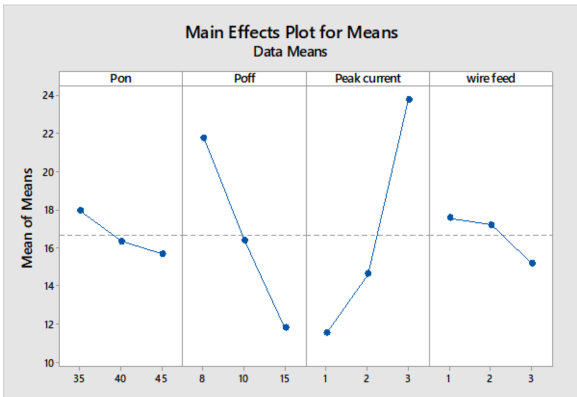


Fig 3 Main effect plot for Means

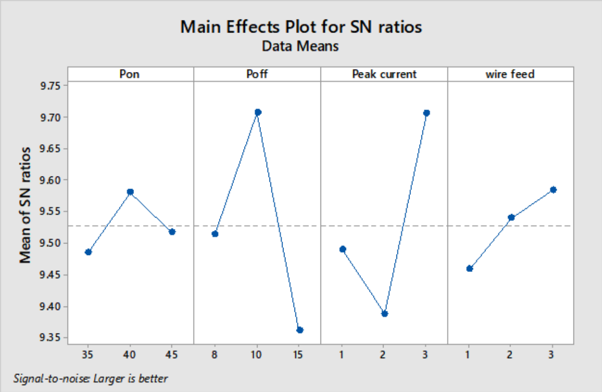


Fig.4 Main effect plot for SN ratios

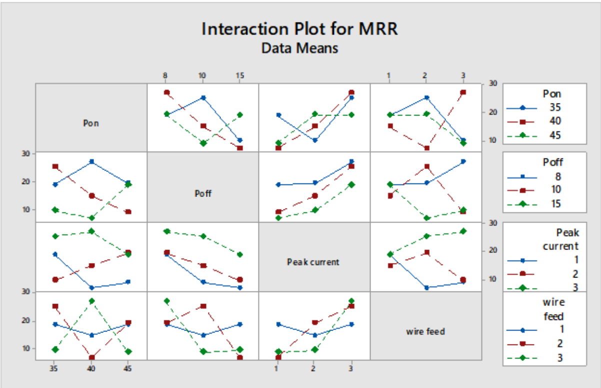


Fig 5 Interaction plot for MRR

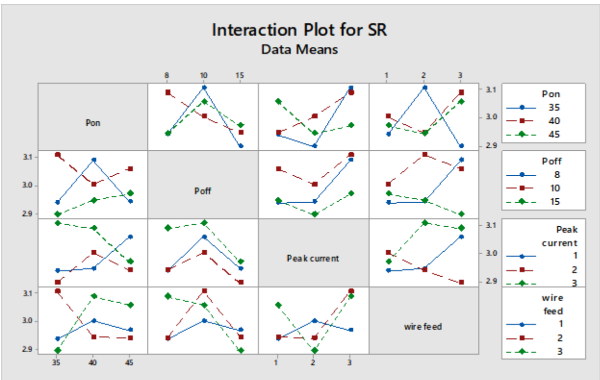


Fig 6 Interaction plot for SR

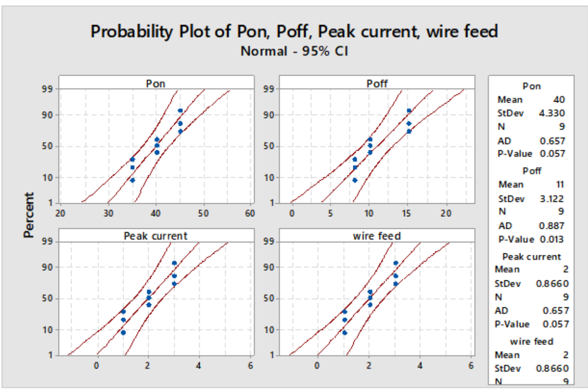


Fig 7 Probability plot of Pon, Poff, Peak current, wire feed

5. Result and discussion

Nine experiments (L9) were conducted using Taguchi orthogonal array design methodology. The result from the experiments are collected MRR. All the designs and analysis are done by using MINITAB 17 software. Larger the better is applied to calculate S/N ratio. Influence on MRR are calculated by using equation (1).

$$\text{LB: } \eta = -10 \log \left[\frac{1}{n} \sum_{i=1}^{n} yi^{-2} \right] \quad (1)$$

The analysis shows the percentage contribution of input process parameters of WEDM on material removal rate. The high level of current, pulse on time, pulse off time are produced poor material rate.

Conclusions

Experimentations be there accompanied according to Taguchi design method by using the machining set up and the solid Molybdenum wire electrode with side flushing. The control parameters are peak current (V), pulse duration (Ton) Pulse off time (Toff) and wire feed (f). Experimentations were varied to complete 9 altered trials and the weights of the work piece for calculation of MRR and with the help of profilometer surface roughness (Ra) have been measured.

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