OPTIMIZING THE PROCESS PARAMETERS OF EDM USING TAGUCHI METHOD AND ANOVA ON INCONEL 718

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ABSTRACT

Wire Electro - Discharge Machining (EDM) is a metal-working process whereby material is removed from a conductive work piece by electrical erosion. This project work focuses on finding out the optimum parameters in Wire - EDM for machining of Inconnel 718. The major application of the Inconnel material is in the aerospace industry, both in airframes and engine components. Biocompatibility of Inconnel is excellent, especially when direct contact with tissue or bone is required.

Input process parameters that are taken into consideration are wire feed rate, Pulse on time, Pulse off time, Peak current, and Servo voltage. Output parameters are Material removal rate (MRR), Kerf width and Surface roughness (SR) are measured. Also different wire materials like Half Hard Brass wire, Zn-Coated Brass wires are used in this experiment.

For design of experiment Taguchi methodology of L_{18} orthogonal array is used. From the experiment, it can be conclude that Zn-Coated Brass wire is desirable for maximum MRR and minimum SR with good surface integrity, but Half Hard Brass wire is desirable for minimum Kerf width. An excellent combination of better flush ability, high mechanical strength and good electrical conductivity are the advantages of Zn-Coated Brass wires in contrast to Half Hard Brass wire.

Key words : wire feed rate, Pulse on time, Pulse off time, Peak current, and Servo voltage. Material removal rate (MRR), Kerf width and Surface roughness (SR).

1.INTRODUCTION

1. Electrical Discharge Machining (EDM)

Electrical Discharge Machine (EDM) is now become the most important accepted technologies in manufacturing industries since many complex 3D shapes can be machined using a simple shaped tool electrode. Electrical discharge machine (EDM) is an important „non-traditional manufacturing method", developed in the late 1940s and has been accepted worldwide as a standard processing manufacture of forming tools to produce plastics moldings, die castings, forging dies and etc.
Major development of EDM was observed when computer numerical control systems were applied for the machine tool industry. Thus, the EDM process became automatic and unattended machining method. At the present time, Electrical discharge machine (EDM) is a widespread technique used in industry for high precision machining of all types of conductive materials such as: metals, metallic alloys, graphite, or even some ceramic materials, of whatever hardness.

1.2 Wire Electrical Discharge Machining (WEDM)

The world"s first WEDM was produced by the SWISS FIRM „AGIE" in 1969. The first WEDM machine worked simply without any complication and wire choices were limited to copper and brass only. Several researches were done on early WEDM to modify its cutting speed and overall capabilities. In recent decades, many attempts were done on Wire EDM technology in order to satisfy various manufacturing requirements, especially in the precision mold and die industry. Wire EDM efficiency and productivity have been improved through progress in different aspects of WEDM such as quality, accuracy, and precision .

1 .3 Principle of Wire - EDM

The Spark Theory on a wire EDM is basically the same as that of the vertical EDM process. In wire EDM, the conductive materials are machined with a series of electrical discharges (sparks) that are produced between an accurately positioned moving wire (the electrode) and the work piece. High frequency pulses of alternating or direct current is

discharged from the wire to the work piece with a very small spark gap through an insulated dielectric fluid (water).
Many sparks can be observed at one time. This is because actual discharges can occur more than one hundred thousand times per second, with discharge sparks lasting in the range of 1/1,000,000 of a second or less. The volume of metal removed during this short period of spark discharge depends on the desired cutting speed and the surface finish required. The wire electrode is usually a spool of brass, copper or brass and zinc wire from 0.001 to 0.014" thick.

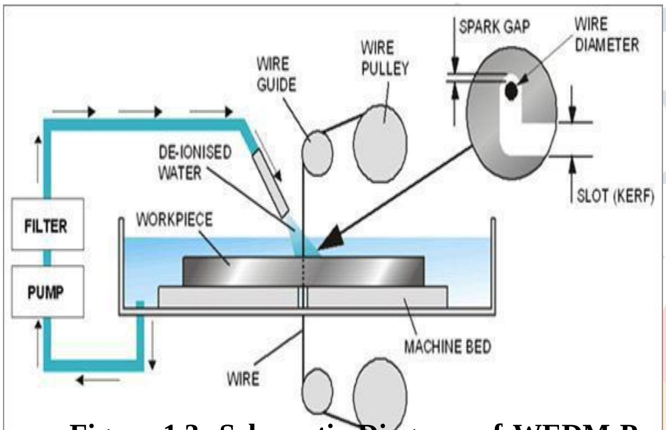

Figure 1.3: Schematic Diagram of WEDM Process [6]

The heat of each electrical spark, estimated at around 15,000° to 21,000° Fahrenheit, erodes away a tiny bit of material that is vaporized and melted from the work piece and some of the wire material is also eroded away. These particles (chips) are flushed away from the cut with a stream of de-ionized water through the top and bottom flushing nozzles. The water also prevents heat build-up in the work piece. Without this cooling, thermal expansion of the part would affect size and positional accuracy. Wire EDM removes material with electricity by means of spark erosion. Therefore, material that must be EDM must be electrically conductive.

1.4 Advantages of Wire EDM Process

- Mechanical stress is eliminated during machining since there is not any contact between Wire and work piece.
- This process is able to produce complicated work pieces in different shapes and size.
- WEDM process can be applied for repairing damaged parts.
- A good surface finish can be obtained.
- Very fine holes can be easily drilled.
- Any electrical conducting materials can be machined by WEDM process apart from its hardness, toughness and brittleness.

1.5 Disadvantages of Wire EDM Process

- High cost is required for wire and machining.
- There is a problem regarding the formation of recast layer on machined part surface.
- WEDM process shows very slow cutting rate.
- WEDM process is not applicable for machining very large work piece.
- Potential fire hazard associated with use of combustible oil based dielectrics.
- Power consumption is high.

2. LITERATURE REVIEW

Literature review provides the scope for the present study. This chapter will play a part to get the information about wire cut electrical discharge machine and will give idea to operate the test and form the early stage of the projects; various literature studies have been done. This chapter includes almost the whole operation including the test, history, machining properties and results. In this chapter we have included research papers related to WEDM with effect on Material Removal Rate (MRR), kerf width, Surface Roughness (SR), work piece material, work piece thickness and electrode material.

1. Atul kumar and Dr D.K. Singh [1] have study variation of cutting performance with pulse on time, pulse off time, open voltage, feed rate override, wire feed, servo voltage, wire tension and flushing pressure were experiment investigated in wire electric discharge machining processes. Brass wire with 0.25 mm diameter and SKD 61 alloys steel with 10 mm thickness were used as tool and work materials. The output considered has been MRR and surface roughness. Experimentation has been competed by using Taguchi's L18 ($2^1 \times 3^7$) orthogonal array under different conditions of parameters. Finally it concluded that the MRR increases with the increase in pulse on time and decrease with increase in pulse off time and open voltage. The effect of feed rate overdrive, wire feed, servo voltage, wire tension and flushing pressure on MRR is not very significant. For the surface roughness it decrease with increase of pulse off time open voltage and wire feed and increases with increase in feed rate override and servo voltage. The effect of other parameter is not significant.

2. Pujari Srinivasa Rao, Koona Ramji, Beela Satyanarayana [2] studied Wire-cut electric discharge machining of Aluminum-24345. Experimentation has been done by using Taguchi's L18 (21x37) orthogonal array under different conditions of parameters. The response of surface roughness is considered for improving the machining efficiency. Optimal combinations of parameters were obtained by this method. The confirmation experiment shows, the significant improvement in surface finish (1.03µm) was obtained with this method. The study shows that with the minimum number of experiments the stated problem can be solved when compared to full factorial design. All the experiments were conducted on Ultra Cut 843/ ULTRA CUT f2 CNC Wire-cut EDM machine.

3. Kuriachen Basil, Dr. Josephkunju Paul, Dr. Jeoju M.Issac [3] investigates the effect of voltage, dielectric pressure, pulse on-time and pulse off-time on spark gap of Ti6AL4V alloy. It has been found that pulse on time and pulse off time have the more impact on the spark gap. The minimum spark gap was obtained as 0.040407mm. The WEDM experiments were conducted in Electronic Ultracut S1 machine using 0.25 mm brass wire as the tool electrode. Pulse on time, pulse off time, voltage and dielectric pressure are the four WEDM parameters that were selected for investigations. In this experimental study two level full factorial experiment is adopted because this gives all possible combinations of machine parameters. It can be noticed from that corresponding to minimum value of pulse off time the spark gap decreases with increase in dielectric pressure, whereas the spark gap increases with increase in dielectric pressure corresponding to maximum value of pulse off time.

4.Saurav Datta, Siba Sankar Mahapatra [4] experimented with six process parameters are discharge current, pulse duration, pulse frequency, wire speed, wire tension and dielectric flow rate; to be varied in three different levels.

mm Predicted data given by the models as per Taguchi's L18 (3*6) Orthogonal Array (OA) design have been used in search of an optimal parametric combination to achieve desired yield of the process, maximum MRR, good surface finish and dimensional accuracy of the product. Grey relational analysis has been adopted to convert this multi-objective criterion into an equivalent single objective function. It has been found that that the spark gap increases with increase in pulse on time, whereas spark gap decreases with increase in pulse off time. The pulse on time, pulse off time, the interaction of dielectric pressure and pulse off time, and interaction of pulse on time and pulse off time are significant parameters which affect the spark gap of WEDM.

5. Nihat, Can, Gul [5] investigated on the effect and optimization of machining parameters on kerf and material removal rate (MRR) in WEDM operations. Experimental studies were conducted using different pulse duration, open circuit voltage, wire speed, and dielectric flushing pressure. Importance levels of parameters were analysed using analysis of variance (ANOVA). The optimum machining parameter combination was obtained by using the analysis of signal-to-nois (S/N) ratio. The variation of kerf and MRR with machining parameters is mathematically modelled by using regression analysis method. Objective of minimum kerf together with maximum MRR was performed. The experimental studies were performed on a Sodick A320D/EX21 WEDM machine tool. CuZn37 Master Brass wire with 0.25mm diameter was used in the experiments. As work piece material, AISI 4140 steel with 200mm × 40mm × 10mm size was used. The results show that open circuit voltage was three times more important than pulse duration for controlling kerf, while for MRR, open circuit voltage was about six times more important than pulse duration.

6. Mustafa Ilhan et al. [6] aims to select the most suitable parameter combination for the wire electrical discharge machining process in order to get the desired surface roughness value for the machined work pieces. A series of experiments have been performed on 1040 steel material of thicknesses 30, 60 and 80 mm, and on 2379 and 2738 steel materials of thicknesses 30 and 60 mm. The test specimens have been cut by using different cutting and offset parameter combinations of the "Sodick Mark XI A500 EDW" wire electrical discharge machine. The related tables and charts have been prepared for 1040, 2379, 2738 steel materials. The tables and charts can be practically used for WEDM parameter selection for the desired work piece surface roughness. And finding out that increasing work piece thickness more stable & better SR characteristics.

7. G.Rajyalakshmi, Dr.P.Venkata Ramaiah [7] presented experiments with eight process parameters: pulse on time, pulse off time, corner servo voltage, wire feed, wire tension, dielectric flow rate, spark gap voltage and servo feed to be varied in three different levels. Data related to the process response is SR which corresponds to randomly chosen different combinations of factor setting. The electrode material used was a 0.25 mm diameter brass wire. A small gap of 0.025 mm to 0.05 mm is maintained in between the wire and work-piece. Inconel825 is used as work piece material. Pulse on time and wire feed rate have been most significant effect on SR.

8. Chiang et al [8]. have been investigated on "Optimization of the WEDM process of particle-reinforced material with multiple performance characteristics using grey relational analysis" employed grey relational analysis to optimize the input parameters are pulse on time, pulse off time, arc on time, arc off time, servo voltage, wire feed and water flow are optimized parameters for Al_2O_3 particle reinforced material with two response parameters are material removal rate and surface roughness. It have concluded the response table and response graph for each level of the machining parameters are obtained from the grey relational grade, and select the optimal levels of machining parameters.

3.DESIGN OF EXPERIMENT

WEDM Process Parameters

The process parameters that can affect the quality of machining or cutting or drilling in Wire EDM process are shown through Ishikawa cause – effect diagram as shown in Figure 3.1.

The major parameters are as follows:-

- Electrical parameters: Peak current, pulse on time, pulse off time, supply voltage and polarity.
- Non – electrical parameters: wire speed; work feed rate, machining time, gain and rate of flushing.
- Electrode based parameters: Material and size of wire.

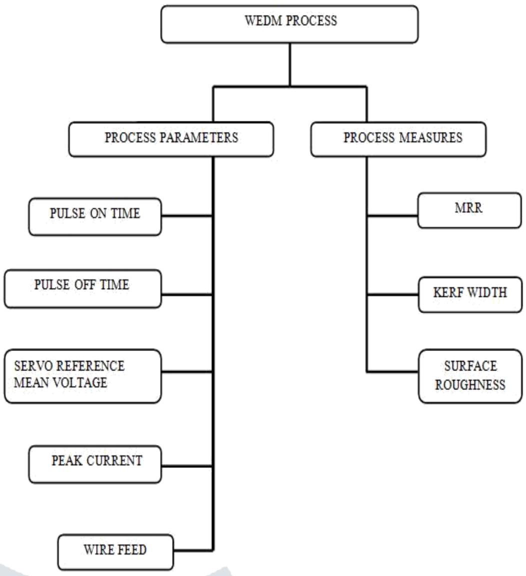

Figure 3.1: Process Parameters and Performance Measures of WEDM

3.1 Wire Cut Electro Discharge Machine [WEDM]

This experimental work performed at **Shubham wire cut,** Odhav, Ahmedabad. The experiment work is carried out in sprintcut wire cut electro discharge machine (ELEKTRONICA SPRINTCUT 734) of Inconnel 718 material by varying machining parameters.

The sprintcut wire cut electric discharge machine is consist of a machine tool, a power supply unit and dielectric supply unit. A schematic diagram of the sprintcut wire cut EDM is shown in Figure 4.1.

Figure 3.1: Sprintcut Wire Cut EDM.

Table No 3.1: Final Measurement Data (Half Hard Brass wire (0.25mm))

3.2 Results of Zn-Coated Brass wire (0.25mm)

No.	WF (m/min)	Ton (μs)	Toff (μs)	Ip (Amp)	SV (Volt)	MRR (mm^2/min)	KERF (mm)	SR (μm)
1	6	110	50	120	15	22.12	0.3178	2.2702
2	6	110	55	140	20	17.70	0.3296	2.2372
3	6	110	60	160	25	16.22	0.3584	2.1223
4	6	115	50	120	20	27.80	0.3714	2.7865
5	6	115	55	140	25	25.80	0.3602	2.6851
6	6	115	60	160	15	27.08	0.3489	2.5604
7	6	120	50	140	15	38.04	0.3642	2.9653
8	6	120	55	160	20	33.08	0.3789	2.8116
9	6	120	60	120	25	26.33	0.3447	2.2608
10	8	110	50	160	25	23.08	0.3322	2.2992
11	8	110	55	120	15	19.80	0.2842	2.1893
12	8	110	60	140	20	18.10	0.2983	1.8632
13	8	115	50	140	25	31.50	0.3463	2.5792
14	8	115	55	160	15	32.12	0.3207	2.7323
15	8	115	60	120	20	21.80	0.3144	2.3725
16	8	120	50	160	20	37.58	0.3519	2.9865
17	8	120	55	120	25	32.75	0.3315	2.6012
18	8	120	60	140	15	36.44	0.3088	2.498

Sr. No.	WF (m/min)	Ton (μs)	Toff (μs)	Ip (Amp)	SV (Volt)	MRR (mm^2/min)	KERF (mm)	SR (μm)
1	6	110	50	120	15	15.20	0.2908	2.5569
2	6	110	55	140	20	14.90	0.2989	2.5011
3	6	110	60	160	25	8.92	0.3102	2.4235
4	6	115	50	120	20	23.76	0.3086	2.8834
5	6	115	55	140	25	19.80	0.3179	3.1024
6	6	115	60	160	15	21.14	0.2788	3.2561
7	6	120	50	140	15	28.91	0.3385	3.7236
8	6	120	55	160	20	29.80	0.3028	3.3842
9	6	120	60	120	25	20.08	0.2739	2.8923
10	8	110	50	160	25	18.80	0.2633	2.3908
11	8	110	55	120	15	16.90	0.1934	2.4198
12	8	110	60	140	20	14.20	0.2031	2.1600
13	8	115	50	140	25	25.20	0.2897	2.9785
14	8	115	55	160	15	26.84	0.2332	3.4236
15	8	115	60	120	20	18.00	0.1989	2.6039
16	8	120	50	160	20	31.60	0.3310	3.5139
17	8	120	55	120	25	29.10	0.2697	3.0667
18	8	120	60	140	15	27.60	0.2381	3.1522

4.Analysis of Variance (ANOVA)

ANOVA is a standard statistical technique to interpret the experimental results. The percentage contribution of various process parameters to the selected performance characteristic can be estimated by ANOVA. Thus information about how significant the effect of each controlled parameter is on the quality characteristic of interest can be obtained. ANOVAs for raw data has been performed to identify the significant parameters and to quantify their effect on the performance characteristic. The ANOVA based on the raw data identifies the factors which affect the average response rather than reducing variation.

ANOVA helps in formally testing the significance of all main factors and their interactions by comparing the mean square against an estimate of the experimental errors at specific confidence levels. Study of ANOVA table for a given analysis helps to determine which of the factors need control and which do not. Once the optimum condition is determined, it is usually good practice to run a confirmation experiment. The analysis of the partial experiment must include an analysis of confidence that can be placed in the results. So analysis of variance is used to provide a measure of confidence.

First the formula finding for the Pure Sum of Square (SS') is given below:

SS'= Seq SS – DF * (Adj MS Error)

And the Percentage Contribution formula is given below:

Percentage contribution = (SS'/ Total Seq. SS) * 100% Percentage contribution of input

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribution
WF (m/min)	1	36.78	36.780	36.78	19.54	0.002	**4.93**
Ton (μs)	2	514.25	514.25	257.1	136.6	0.000	**72.12**
Toff (μs)	2	106.25	106.25	53.12	28.23	0.000	**14.48**
Ip (Amp)	2	16.506	16.506	8.253	4.39	0.052	**1.80**
Sv (Volt)	2	18.993	18.99	9.497	5.05	0.038	**2.15**
Error	8	15.056	15.05	1.882			**4.52**
Total	17	707.84					**100**

parameters to outputs MRR, Kerf width, and Surface Roughness

4.1 ANOVA for MRR (Half Hard Brass Wire (0.25mm))

In this research work, ANOVA Table for MRR Half Hard Brass wire (0.25mm) is shown in Table 5.15

- Calculation of SS' and Percentage Contribution of MRR for Half Hard Brass wire.

1) Pure Sum of Square (SS') -

- For WF SS':
  - 36.780 – (1*1.882)
  - 36.780 – 1.882
  - 34.898
- For Ton SS':
  - 514.252 – (2*1.882)
  - 514.252 – 3.764
  - 510.488
- For Toff SS':
  - 106.255 – (2*1.882)
  - 106.255 – 3.764
  - 102.491
- For Ip SS':
  - 16.506 – (2*1.882)
  - 16.506 – 3.764
  - 12.742
- For SV SS':
  - 18.993 – (2*1.882)
  - 18.993 – 3.764
  - 15.229

Percentage Contribution -

- **For WF Percentage Contribution:**

2) WEDM on Inconnel 718 for Material removal rate for Half Hard Brass Wire. The percentage contribution of Wire feed rate is 4.93%, Pulse on time is 72.12%, Pulse off time is 14.48%, Peak current is 1.80%, Servo voltage is 2.15%, and error is 4.52%. This error is due to machine vibration.

3)

4) Percentage Contribution -

- **For WF Percentage Contribution:**
  =34.898/707.842* 100%
  =4.93 %
- **For Ton Percentage Contribution:**
  =510.488/707.842* 100%
  =72.12 %
- **For Toff Percentage Contribution:**
  =102.491/707.842* 100%
  =14.48 %
- **For Ip Percentage Contribution:**
  =12.742/707.842* 100%
  =1.80 %
- **For SV Percentage Contribution:**
  =15.229/707.842* 100%
  =2.15 %

Above analysis shows the percentage contribution of individual process input parameters of WEDM on Inconnel 718 for Material removal rate for Half Hard Brass Wire. The percentage contribution of Wire feed rate is 4.93%, Pulse on time is 72.12%, Pulse off time is 14.48%, Peak current is 1.80%, Servo voltage is 2.15%, and error is 4.52%. This error is due to machine vibration.

ANOVA for Kerf Width (Half Hard Brass wire (0.25mm))

4.2ANOVA Table for Kerf Width for Half Hard Brass wire (0.25mm)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	Percentage Contribution
WF (m/min)	1	0.0138889	0.0138889	0.0138889	35.74	0.000	39.60
Ton (µs)	2	0.0032444	0.0032444	0.0016222	4.17	0.057	7.23
Toff (µs)	2	0.0087155	0.0087155	0.0043578	11.21	0.005	23.29
Ip (Amp)	2	0.0032068	0.0032068	0.0016034	4.13	0.059	7.13
Sv (Volt)	2	0.0019261	0.0019261	0.0009631	2.48	0.145	3.37
Error	8	0.0031089	0.0031089	0.0003886			19.38
Total	17	0.03409					100

Percentage Contribution -

For WF Percentage Contribution:
=0.013500/0.0340906* 100%
=39.60 %

For Ton Percentage Contribution:
=0.002467/0.0340906* 100%
=7.23 %

For Toff Percentage Contribution:

=0.007938/0.0340906* 100%
=23.29 %

For Ip Percentage Contribution:
=0.0024296/0.0340906* 100%
=7.13 %

For SV Percentage Contribution:
=0.0011489/0.0340906* 100%
=3.37 %

Above analysis shows the percentage contribution of individual process input parameters of WEDM on Inconnel 718 for Kerf Width for Half Hard Brass Wire. The percentage contribution of Wire feed rate is 39.60%, Pulse on time is 7.23%, Pulse off time is 23.29%, Peak current is 7.13%, Servo voltage is 3.37%, and error is 19.38%. This error is due to machine vibration.

ANOVA for Surface Roughness (Half Hard Brass wire (0.25mm))

In this research work, ANOVA Table for Surface Roughness for Half Hard Brass wire (0.25mm) is shown in Table

Table ANOVA for Surface Roughness (Half Hard Brass wire (0.25mm))

Source	DF	Seq SS	Adj SS	Adj MS	F	P	Percentage Contribution
WF (m/min)	1	0.0571	0.0571	0.057	6.50	0.034	1.40
Ton (µs)	2	2.4722	2.4722	1.236	140.69	0.000	71.04
Toff (µs)	2	0.2467	0.2467	0.123	14.04	0.002	6.63
Ip (Amp	2	0.3280	0.3280	0.164	18.67	0.001	8.98
Sv (Volt)	2	0.2811	0.2811	0.140	16.00	0.002	7.63
Error	8	0.0702`2	0.0702	0.008			4.32
Total	17	3.45549					100

- **Percentage Contribution -**
  - For WF Percentage Contribution:
    - 0.04834/3.45549* 100%
    - 1.40 %
  - For Ton Percentage Contribution:
    - 2.45465/3.45549* 100%
    - 71.04 %
  - For Toff Percentage Contribution:
    - 0.22912/3.45549* 100%
    - 6.63 %
  - For Ip Percentage Contribution:
    - 0.31044/3.45549* 100%
    - 8.98 %
  - For SV Percentage Contribution:
    - 0.26353/3.45549* 100%
    - 7.63 %

Above analysis shows the percentage contribution of individual process input parameters of WEDM on Inconnel 718 for Surface Roughness for Half Hard Brass Wire. The percentage contribution of Wire feed rate is 1.40%, Pulse on time is 71.04%, Pulse off time is 6.63%, Peak current is 8.98%, Servo voltage is 7.63%, and error is 4.32%. This error is due to machine vibration.

5.RESULTS

ANOVA analysis result for the Half Hard Brass wire on Material Removal Rate, percentage contribution of wire feed 4.93%, pulse on time is 72.12%, pulse off time 14.48%, peak current is 1.80%, and servo voltage is 2.15%. The optimal level combination factor for MRR in Half Hard Brass wire is 30m/min for Wire feed, 120 µs for Pulse on time, 50 µs for Pulse off time, 2Amp for Peak Current and 20 V for Servo Voltage.

ANOVA analysis result for the Zn-Coated Brass wire on Material Removal Rate, percentage contribution of wire feed 2.25%, pulse on time is 75.41%, pulse off time 11.33%, peak current is 3.93%, and servo voltage is 4.88%. For the various parameters show that pulse on time is the greatest effect on MRR and is followed by pulse off time, servo voltage, peak current, and wire feed rate in that order. The optimal level combination factor for MRR in Zn-Coated Brass wire is 30 m/min for Wire feed, 120 µs for Pulse on time, 50 µs for Pulse off time, 2 Amp for Peak Current and 20 V for Servo Voltage.

ANOVA analysis result for the Half Hard Brass wire on kerf width (Kw), the percentage contribution of wire feed 39.60%, pulse on time is 7.23%, pulse off time 23.29%, peak current is 7.13%, and servo voltage is 3.37%. For the wire feed is the greatest effect on kerf width and is followed by pulse off time, pulse on time, peak current, and servo voltage in that order. The optimal level combination factor for kerf width in Half Hard wire is 8m/min for Wire feed, 110 µs for Pulse on time, 60 µs for Pulse off time, 120 Amp for Peak current and 15 V for Servo Voltage.

ANOVA analysis result for the Zn-Coated Brass wire on kerf width (Kw), the percentage contribution of wire feed 38.91%, pulse on time is 21.09%, pulse off time 8.35%, peak current is 11.08%, and servo voltage is 12.22%. For the wire feed is the greatest effect on kerf width and is followed by pulse on time, servo voltage, peak current, and pulse off time in that order. The optimal level combination factor for kerf width in Zn-Coated Brass wire is 8m/min for Wire feed, 110 µs for Pulse on time, 60 µs for Pulse off time, 120 Amp for Peak current and 15 V for Servo Voltage.

6.CONCLUSION

In the presented work, experiments are carried out on Inconnel 718 work-piece and used two wires like Half Hard Brass wire (0.25mm) and Zn-Coated Brass wire. The experiments are carried out for Material Removal Rate (MRR), Kerf width (Kw) and Surface Roughness with variables as wire feed, pulse on time, pulse off time, peak current and servo voltage. There are 18 experimental readings taken for both Half Hard Brass wire and Zn-Coated Brass wire for all variables to conduct the parametric study.

Finally it can be concluded that:

Experimental results show that the increasing the pulse on time and peak current increasing the material removal rate (MRR), kerf width, and surface roughness. This is because the discharge energy increases with pulse on time and the number of discharges within a given period becomes more.

From the experiment results pulse on time is the greatest effect on MRR and surface roughness compare to other parameters in both the wires. Kerf width is largely affect by wire feed rate in both the wires.

At higher pulse off time, less number of discharges in a given time during machining, and results in small MRR, and Kerf width. Due to less no. of discharge, small craters on the surface. Hence, surface roughness is getting minimum. Increasing servo voltage decreases the discharge energy across the electrodes which results in reduce MRR.

7.REFERENCES

1.Atul Kumar and Dr. D. K. Singh, 2012. “Performance Analysis of Wire Electric Discharge Machining (W-EDM).” International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 4, June – 2012, ISSN: 2278-0181.

2.Pujari Srinivasa Rao, Koona Ramji, Beela Satyanarayana. “Effect of WEDM Conditions on Surface Roughness: A Parametric Optimization Using Taguchi Method.” IJAEST, Volume No. 6, Issue No. 1, pp. 041 – 048.

3.Kuriachen Basil, Dr. Josephkunju Paul, Dr. Jeoju M.Issac, 2013. “Spark Gap Optimization of WEDM Process on Ti6Al4V.” ISSN: 2319-5967, ISO 9001:2008 Certified. International Journal of Engineering Science and Innovative Technology (IJESIT). Volume 2, Issue 1, January 2013.

4.Saurav Datta, Siba Sankar Mahapatra. “Modeling Simulation And Parametric Optimization Of Wire EDM Process Using Response Surface Methodology Coupled With Grey-Taguchi Technique.” International Journal of Engineering, Science and Technology. Vol. 2, No. 5, 2010, pp. 162-183.

5.Mustafa I˙lhan Go¨kler, Alp Mithat Ozano¨zgu, 2000. “Experimental Investigation of Effects Of Cutting Parameters On Surface Roughness In The WEDM Process.” International Journal of Machine Tools & Manufacture 40 (2000) 1831–1848.

6.G.Rajyalakshmi, Dr.P.Venkata Ramaiah. “Simulation, Modelling and Optimization of Process parameters of Wire EDM using Taguchi – Grey Relational Analysis”, IJAIR, ISSN: 2278-7844.