EXPERIMENTAL ANALYSIS IN WIRE-CUT ELECTRICAL DISCHARGE MACHINING OF INCONEL 718

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ABSTRACT

Wire Electrical Discharge Machining (WEDM) is a metal-working procedure where material is expelled from a conductive work piece by methods for electrical disintegration. A few explores were done on early WEDM to alter its cutting abilities. In late decades, many endeavors were done with a specific end goal to fulfill different assembling necessities, particularly in the exactness form and pass on mold and die industry. Wire EDM effectiveness and efficiency have been enhanced through advance in various perspectives, for example, quality, exactness, and accuracy. This work concentrates on discovering the ideal parameters in Wire - EDM for machining of Inconel 718. The significant utilization of the Inconel 718 material is in the aeronautic trade, both in airframes and motor parts. Information process parameters mulled over are wire sustain rate, Pulse on time, Pulse off time and Wire speed though the yield parameters are Material expulsion rate (MRR) and Surface unpleasantness (SR). Zn-Coated Brass wire is utilized as a part of this analysis. For outline of trial Taguchi strategy of L18 orthogonal exhibit was utilized and the execution ponder was completed utilizing ANOVA and Response Surface Methodology.

Keywords: WEDM; Inconel 718; Response Surface Methodology; Anova; Zinc coated wire.

1. INTRODUCTION

BijayaBijetaNayak et al [1] (2015) researched wire electrical discharge machining of profound cryo-treated Inconel 718 for the impact of process parameters amid decrease cutting in process. The versatile nature and nonlinearity associated with this procedure, great practical association with sensible precision between execution qualities and process parameters was tended by artificial neural network (ANN) model. Ravindranadh Bobbili et al [2] (2015) examined a multi reaction improvement system of consolidating Taguchi and Gray social investigation for wire-EDM operations on ballistic review aluminum combination for protection applications. Variety of execution measures with process factors was displayed by utilizing reaction surface strategy.

Ravindranadh Bobbili et al [3] (2015) exhibited a near investigation of wire electrical release machining (WEDM) of protective layer materials, for example, aluminum combination 7017 and moved homogeneous defensive layer (RHA) steel utilizing Buckingham pi hypothesis to show the info factors and thermo-physical attributes of WEDM. The reliance of thermo-physical properties and machining factors on instrument of MRR and Ra has been portrayed by performing examining electron magnifying lens (SEM) ponder. The penchant of arrangement of pits increments with a higher present and bigger heartbeat on time. Neeraj Sharma et al [4] (2015) led investigates High quality low composite (HSLA) steel in Wire electric release machining (WEDM). The numerical model has been produced with the assistance of Response Surface Methodology (RSM) for concentrate the procedure parameters. Assist advancement was finished utilizing Genetic Algorithm (GA). P. Sivaprakasam, et al [5] (2014) explored the impact of information parameters on material removal rate (MRR), Kerf width (KW) and surface roughness (SR) utilizing response surface methodology with central composite design (CCD). The trials are done on titanium combination (Tie6Ale4V). Analysis of variance (ANOVA) was performed to discover the noteworthy impact of each factor. The model created can utilize a genetic algorithm (GA) to decide the ideal machining conditions.

G.Ugrasen, et al [6] (2014) considered and built up a model to advance WEDM machining parameters. In light of this examination, process parameters are advanced. ANOVA is performed to decide the relative greatness of each factor on the goal work. Estimation and correlation of reactions was finished utilizing simulated neural system. Brajesh Kumar Lodhi, et al [7] (2014) endeavored to streamline the machining conditions for surface harshness in view of Taguchi procedure. Tests were done under fluctuating heartbeat on-time, beat off-time, top current, and wire nourish and the examination of change (ANOVA) were utilized to the investigation the surface unpleasantness in the WEDM of AISI D3 Steel. It was watched that the release current was the most persuasive factor. Dinesh et al [8, 10, 12] made an attempt to understand the effect of machining parameters on the WEDM of HCHCr material suited for die preparation in industries. The analysis used RSM and the empirical relation was developed for predicting the results. Several authors [9, 11, 13-14] have used the Response Surface tool for understanding the effect of process parameters on the outputs. The combined effect of the independent variables can also be easily studied with this tool. Henceforth the same is being utilized in this research work as well.

2. EXPERIMENTAL SETUP

The exploratory work is completed in SODICK AG600L wire cut electrical discharge machine on Inconel 718 material. This exploration work has centered to discover the impact of machining parameters like wire speed, pulse on time and pulse off time on material removal rate (MRR) and Surface roughness (SR). The Zn-Coated Brass wire of 0.25 mm diameter is utilized for machining. Choice can be made on autonomous factors for accomplishing most extreme MRR and higher surface smoothness. The impacts of machining parameters on subordinate results are related by ANOVA. The dependent and independent factors association and their relations are seen from the Response Surfaces. The experimental data set was represented in Table 1.

Table 1 – Experimental details

S. NO	PULSE ON TIME	PULSE OFF TIME	WIRE SPEED	SURFACE ROUGHNESS	Material Removal Rate
	(μs)	(μs)	(mm/min)	(μm)	(g/min)
1	5	12	5.1	2.42	1.2736
2	8	14	4.8	2.28	1.2085
3	10	16	5.4	2.47	1.2388
4	5	16	5.4	1.65	1.2119
5	8	14	4.8	2.74	1.1261
6	10	12	5.4	2.91	1.2412
7	10	16	5.1	2.18	1.2233
8	8	12	4.8	2.95	1.1659
9	5	14	4.8	1.85	1.2751
10	8	16	5.1	1.89	1.2366
11	10	18	5.1	2.09	1.1687
12	12	25	5.4	2.67	1.2562
13	12	16	5.4	2.28	1.1172
14	10	25	5.1	2.68	1.2243
15	8	18	4.8	2.44	0.9879
16	8	25	5.4	1.98	1.2596
17	12	14	4.8	1.33	0.9851
18	10	16	5.1	1.53	1.0344

3. RESULTS & DISCUSSION

3.1. Analysis of Variance

The Analysis of Variance (ANOVA) is a statistical tool used for understanding the deviations present between the given data set. The effect of independent variables (machining parameters) on the dependent variable can be easily udnderstood from the ANOVA table. The table 3 shows the ANOVA results for Material Removal Rate whereas table 2 is for Surface Roughness.

Table 2 - ANOVA for Surface Roughness

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
Model	3.143282	9	0.349254	4.540951	0.0222
A-Pulse ON time	0.247449	1	0.247449	3.217297	0.1106
B-Pulse OFF time	0.002453	1	0.002453	0.031893	0.8627
C-Wire Speed	0.464193	1	0.464193	6.035382	0.0395
AB	0.573578	1	0.573578	7.457591	0.0258
AC	0.038858	1	0.038858	0.505223	0.4974
BC	0.34292	1	0.34292	4.458608	0.0677
A^2	1.04752	1	1.04752	13.61973	0.0061
B^2	0.432833	1	0.432833	5.627644	0.0451
C^2	0.434727	1	0.434727	5.65227	0.0447
Residual	0.615296	8	0.076912		
Lack of Fit	0.298246	6	0.049708	0.313563	0.8861
Pure Error	0.31705	2	0.158525		
Cor Total	3.758578	17			

Table 3 - ANOVA for Material Removal Rate

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
Model	0.063579	3	0.021193	3.461911	0.0455
A-Pulse ON time	0.035884	1	0.035884	5.861798	0.0296
B-Pulse OFF time	0.001709	1	0.001709	0.279137	0.6055
C-Wire Speed	0.032447	1	0.032447	5.300342	0.0372
Residual	0.085704	14	0.006122		
Lack of Fit	0.064468	12	0.005372	0.505951	0.8188
Pure Error	0.021236	2	0.010618		
Cor Total	0.149283	17			

3.2. Response Surface Methodology

Figure 1 demonstrates the impact of speed and Pulse ON time on Material Removal Rate. The MRR reduces with the increase in Pulse ON time and the highest is achieved at 5 µs. The increase in speed increases the MRR upto 5.10 mm/min and decrease from there on. The maxiumum MRR is obatined at minimum Pulse ON time and at mid-speed.

The plot 2 is drawn between speed, Pulse OFF time and material removal rate. The MRR decreases with the increase in Pulse OFF time and the maximum is achieved at 12 µs. The MRR increased with the increase in speed with the hghest marked at 5.40 mm/min. The largest MRR is recorded at minimual Pulse OFF time and at peak of speed.

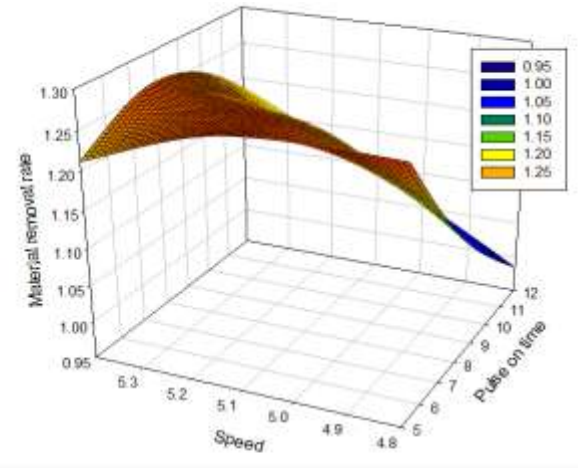

Figure 1- Effect of Pulse ON time and speed on material removal rate

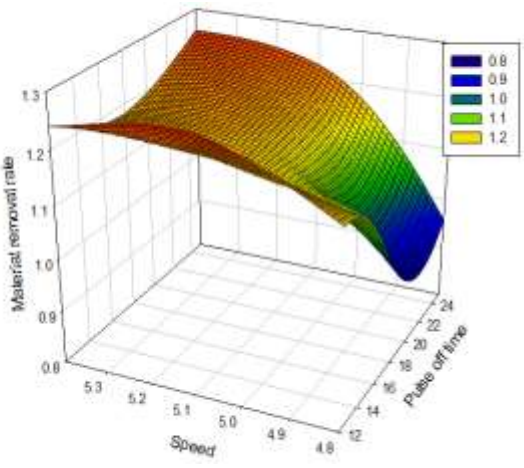

Figure 2 - Effect Speed and Pulse OFF time on material removal rate

The figure 3 depicts the relation between Pulse ON time, Pulse OFF time and Material removal rate. The MRR increases linearly with the increase in Pulse ON time and Pulse OFF time. The Maximum MRR is obtained at the highest Pulse ON time and Pulse OFF time of 20 µs and 12 µs.

The figure 4 explains the effect of Pulse ON time and Pulse OFF time on Surface roughness. The SR decreases with the increase in Pulse OFF time and the least is recorded at 20 µs. The Pulse ON time increases the SR upto 8.50 µs and decreases it then after. The minimal SR is achieved at maximum Pulse OFF time and mid range of Pulse ON time. The effect of speed and Pulse OFF time over Surface Roughness is shown in figure 5. The SR increases with increase in Pulse OFF time and the least SR is identified at 12 µs.The increase in speed decreases the Surface Roughness upto 5.10 mm/min and increases after that. The minimal Pulse OFF time and mid value of Speed produced the minimum SR.

The relationship between Pulse ON time, Speed and Surface Roughness is ploted in figure 6. The SR increases with increase in Pulse ON time till 8.50 µs and decreases with further increase in Pulse ON time. A decrease in SR was recorded with increase in speed till 5.10 mm/min and increases afterwards. The SR is minimum at the mid range of Pulse ON time and speed.

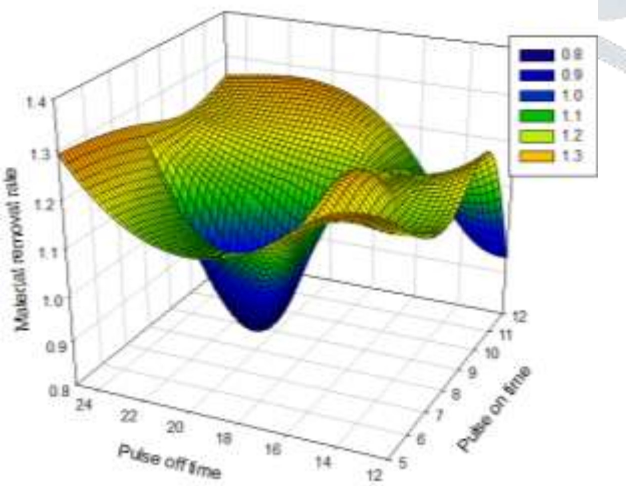

Figure 3 - Effect of& Pulse ON time and Pulse OFF time on material removal rate

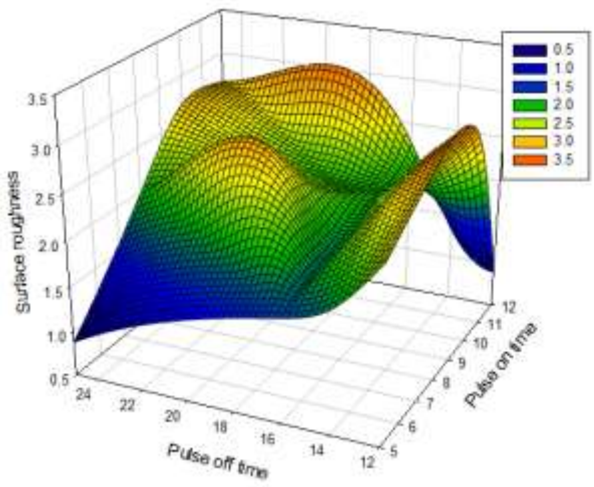

Figure 4 - Effect of Pulse ON time and Pulse OFF time on Surface Roughness

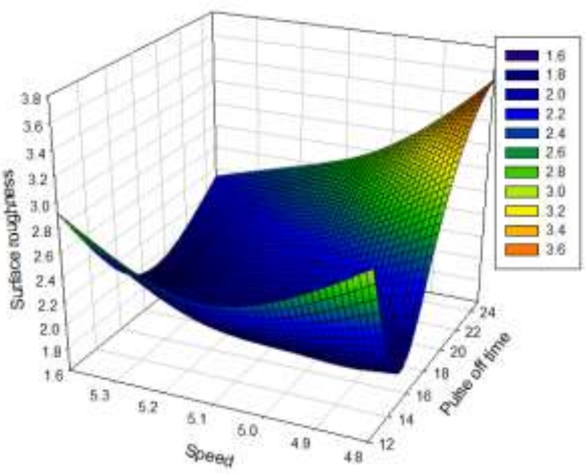

Figure 5 - Effect of Speed and Pulse OFF time on Surface Roughness

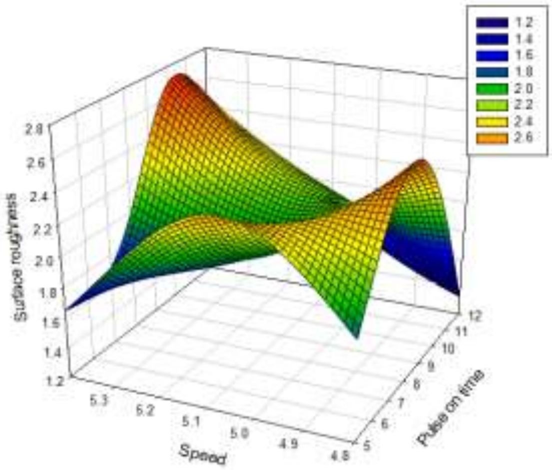

Figure 6 - Effect of Speed & Pulse ON time on Surface Roughness

4. CONCLUSION

The main objective of this work is to study the influence of process parameter on machinability of the Inconel 718 material. The following conclusions were done after conducting the conducting the experiments.

- When considering the Surface Roughness, the factors speed has higher influence than other factors.
- Similarly, the factor Pulse ON time has the next significant effect on SR.
- The MRR shows more effect in output for the alterations carried over Pulse ON time and Wire speed.

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