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MACHINING AND OPTIMIZATION OF PROCESS PARAMETERS FOR TITANIUM ALLOY IN WEDM USING ANN

Dr. A.Baraniraj[1], P. Gunasekaran[2]

Abstract- Wire-Cut Electrical Discharge Machining (WEDM) is an electric and thermal process to do that machining parts with various hardness, toughness and complicate shapes. Metal removal is a WEDM conductive material removal because of flash release between tool station and work piece, deep in a fluid electric medium and electrical current. The information procedure parameters considered are pulse on time, pulse off time, and wire feed rate with yield estimated and decided as MRR, SR and Micro structure analysis. The investigation has been executed by the under various cutting states of titanium grade-2 material into operating molybdenum wire. To simplify the WEDM machining process parameters neural system (ANN) apparatus was chosen in MATLAB is evaluate the best cutting input process parameter is optimized. This is significant because three level of input process parameters to L27 experimental data to get better machining parameter in WEDM. The ANN is a train network of a best validation, performance and regression value of 0.92.

Keywords:WEDM, MRR, SR, ANN, MATLAB, TITANIUM.

I. INTRODUCTION

A. WEDM PROCESS

WEDM is an extremely compelling procedure utilized for this sort of hard to-removing material. WEDM is a basically machining for electrical conductive material. Different technique parameters measured for the examination is pulse on time, pulse off time, and wire feed rate. Surface reliability, for example, SR estimated during the various sorts of cutting is considered in the present work. Tests require remained managed by changing pulse on time, pulse off time, and wire feed rate. Inspected output parameters on SR, and MRRas the EDM of high hardness instrument [1]. The Wire cut JK MACHINE ECO-40S shown in the figure-1. During process wire takes single side of an electrical charge and work piece transfers the opposite cross of the charge. Wire finds a good speed, the interest of electrical charges makes a controlled flash, softening and decomposing minute elements of material. The flash moreover dismisses a microscopic piece of the wire, so after the wire goes through the work piece one time, the machine disposes of the pre-owned wire and naturally progresses new wire. A determinedly traveling around wire anode made arranged molybdenum, copper, metal or tungsten of distance across 0.05 to 0.30 mm [2]. Used the obtained outcomes, a quadratic reversion model for surface unpleasantness lankiness (Ra) has been created. An effort consumes be there through to develop the development parameters for surface roughness (Ra). To approve, declaration tests have been done and anticipated outcomes have been seen as in great concurrence with exploratory discoveries. The outward morphology of machined surfaces has likewise been examined utilizing SEM. Different surface imperfections and their potential reasons have been talked about [7]. Micro structure scale structure assessment of the course of action of littler scope globules, melted waste and debris reduced scope holes on the machined surface, yet no decreased scale split was recognized since of the high toughness of the complex. EDAX

[1]*Assistant Professor, Department of Mechanical Engineering, Government College of Engineering, Salem-636011.*
[2]*PG Scholar, Government College of Engineering, Salem-636011*

takes be present finished to consider the metallurgical modifications of the WEDM cutting area. The work material sharing zone was traded up to comprehension of 50µm, 100µm and 200µm in the view of revised deep stacking through the WEDM procedure [8]. The WEDM input process parameters and output parameters are shown in the figure-2.

Fig-1, Wire cut JK MACHINE ECO-40S

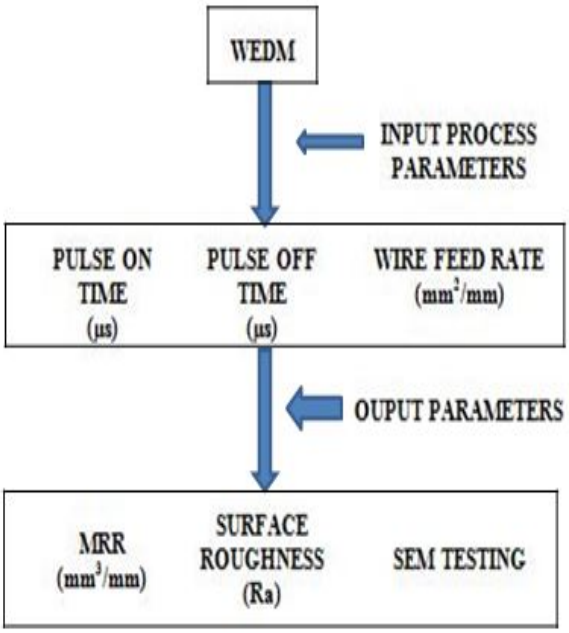


Fig-2, WEDM input process parameters and output parameters

B. ARTIFICIAL NEURAL NETWORK METHOD PROCESS

Present investigation plots the estimation of machining exhibitions in the wire EDM of Cu-1Cr-0.1Zr combination consuming GMDH and ANN. Cu-1Cr-0.1Zr composite was machined utilizing individual procedure parameters

dependent on Taguchi's L27 standard collection. Input parameters are Pulse on time, Pulse off time and wire feed rate. The reaction factors estimated for the examination are SR, and MRR [3]. The RSM and ANN demonstrating of WEDM process have been decided to the partner in the core of the procedure factors and reaction factors. It has been assessed that the two models give exact outcomes for the SR and MRR. The neural system displaying of WEDM as made up separate the remaining pressure arrangement in EDM of metal network composites. It takes recognized that Pulse off time expressively affects the remaining pressure development [10]. ANN is an interconnection with gathering layer of fake neurons to as expenditures a mathematical or computation model for data process. This procedure is taking a shot at three layers of associations; they are seemed in the figure-3.

There are two optimization techniques,

i. Forward propagation,
ii. Back propagation.

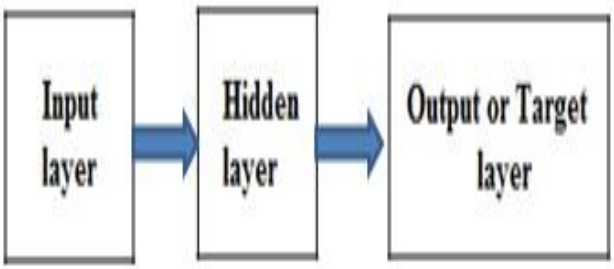


Fig-3, ANN network layers

II. MATERIAL SELECTION

The titanium is more strengthens of the material. This material is six evaluations of unalloyed titanium and four groupings of titanium blends accessible. Normally contains hints of tantalum, zirconium, manganese, iron, chromium, cobalt, aluminum, molybdenum, vanadium, niobium, nickel and copper materials are bit of titanium material. Titanium metal has a property of high elasticity, great malleability and protection from wear. Titanium is noticeable for its wear obstruction properties and furthermore was high quality properties are required. The example Titanium alloy size of 100×50×30 mm^3, rectangular a profile was has been seemed in the figure-4.

Titanium and its composites are poor warm conductors that results in the consider dissolving of warm temporarily as machiningtitanium and the greater part of warmth is notable on the motion face and cutting area [9].

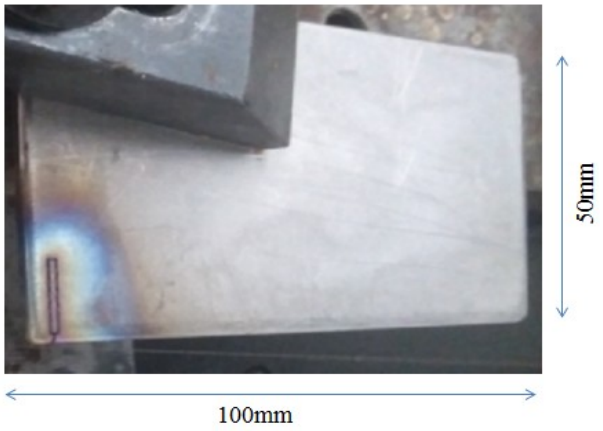


Fig-4, Titanium grade-2 plate

III. METHODOLOGY

A. WIRE-CUT EDM PROCESS

A WEDM standard is a high accuracy cutting an electrically observing material. EDM wire among top and down mechanical support structures one cathode, whereas the material was being cut structures of the anode. Wire EDM machining works by making power between the terminal and the work material is then removing from the EDM. This would coordinate all metals, including steel, aluminum, metal, titanium, and composites and super mixes of different kinds. EDM is a warm material clearing process in which material is removed by melting or breaking down little areas at the work piece. A fitting "gap" is critical to deliver begins between a wire and work material. First of all setting the position to fit the cutting setup and work material in EDM. Then experimentally evaluate the titanium material cut input parameters are and finally set the three levels of cutting parameters. In the parameters are shown in table-1, the cutting of L27 samples are into size of 10x5x3 mm^3 has been cut with molybdenum wire. The cutting work process and material seemed in the figure-5, and 6.

Levels	**Pulse On Time (P-on) µs**	**Pulse Off Time (P-off) µs**	**Wire Feed (VF) mm^2/min**
Level- 1	12	4	7
Level- 2	14	5	8
Level- 3	16	6	9

Table-1, Input process parameter three levels of data

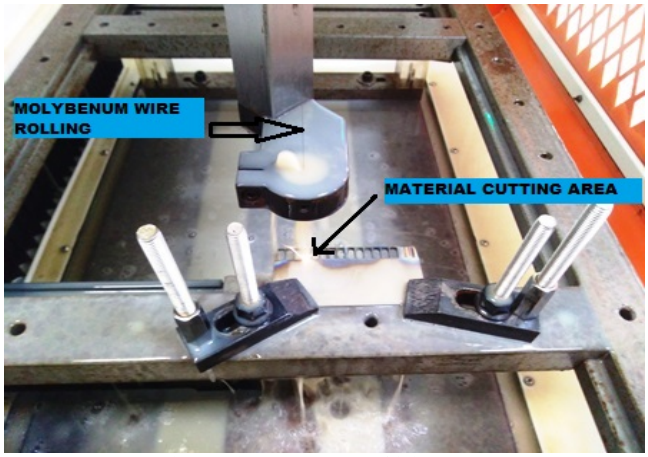


Fig-5, Wire cut EDM machining setup

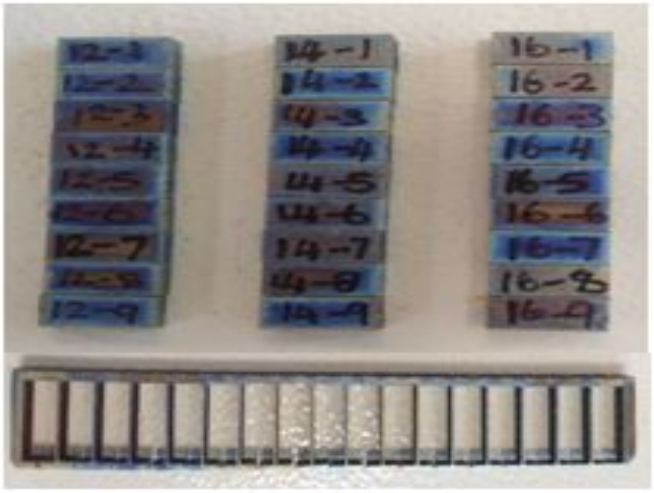


Fig-6, The 27 samples of cutting work piece

IV. RESULT & DISCUSSION

WEDM working process to 27 work materials experimentally is cutting. The cutting parameters and output values are optimization of the MATLAB in NNTOOL method. WEDM input parameters are Pulse on time, Pulse off time, and feed rate of machine working condition and output values are MRR, SR and SEM result. The MRR defends on increase the Pulse on time and wire feed rate also increases the MRR. To optimize get the best input parameters in WEDM. The MRR calculated value and SR value are shown in the table-2.The level three is a get much better MRR and SR the results are shown in the graph-1, 2.

A. SURFACE ROUGHNESS TESTER

Estimation when the START/STOP key is squeezed in measuring mode, the test starts to travel. At the point when the arrangement setup from the SR tester nip to the travel cutting area in-progress shown in the figure-7. The assessment length can be set either to a predefined standard length or to any subjective length inside the estimating range. The SR is basically three standard parameters of a Ra, Ry and Rz, are measure and to making the valuation. But best squeezing parameter is Ra over the measuring for SR tester display unit to getting value. The SR tester measuring reading shown in the figure-8, and Ra measuring readings are show the table-2.

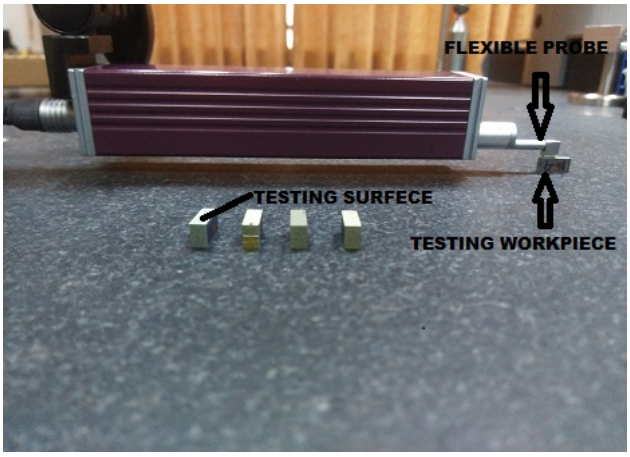
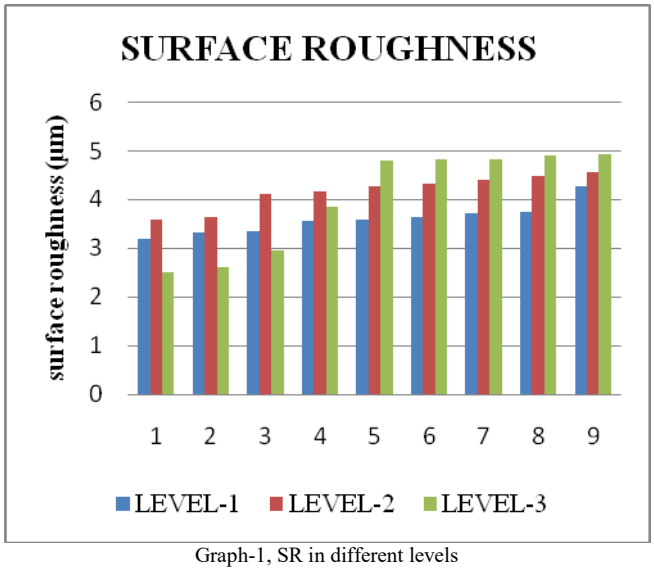


Fig-7, SR tester measuring process

Fig-8, SR tester measuring value (Ra)



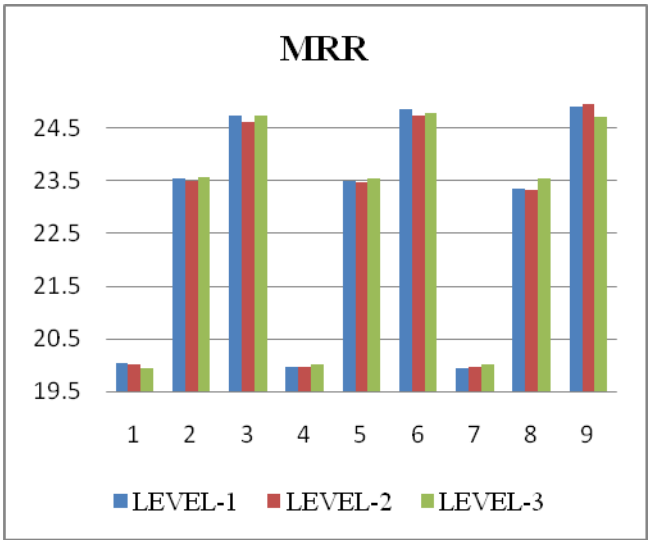
Graph-1, SR in different levels

B. MRR CALCULATION

The MRR equation is the dimension of material cutting rate and divided machining time. The dimension of material is length*Breath*Thickness (10*5*3) mm^3.Machining time is a reading that program START/STOP to cycle time (min) for display the WEDM monitor every levels of cutting. The MRR is depends on Pulse on time, Pulse off time, and wire feed rateprocess parameters. The MRR equation show in figure-9 and calculated values are shown in the table-2.

$$MRR = \frac{Volume\ of\ material\ removed}{Time\ taken\ in\ min}$$

Fig-9, The MRR equation



Graph-2, MRR in different levels

C. SEM TEST

Machined surface were taken into different technique parameter types on machined of titanium by separating surface finish and characteristics. . Basically is test the three levels of parameters are given table-1, whereas 3 levels of specimen 50 µm, 100µm, and 200 µm created to zooming for SEM test figure-10, 11, 12. Figure shows an assessment between the outside of titanium compound machined under the relative conditions and planning parameter respect. The full refinements of globules of debris, crakes, and blow holes analyze three characteristic pits and clearly watched. Finally level three is a best cutting parameter gets good results. The experimental work is Pulse on time, Pulse off time and wire feed rate parameters consider on micro crakes, blow holes and debris of titanium materials. Whereas Pulse on time increases than cracks is high level shows the SEM figures.

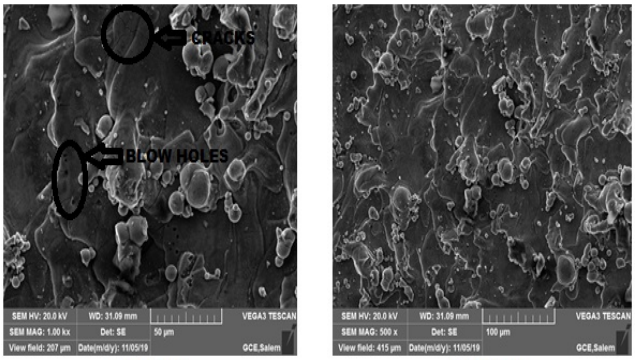


Fig-10 First level cutting parameter SEM test

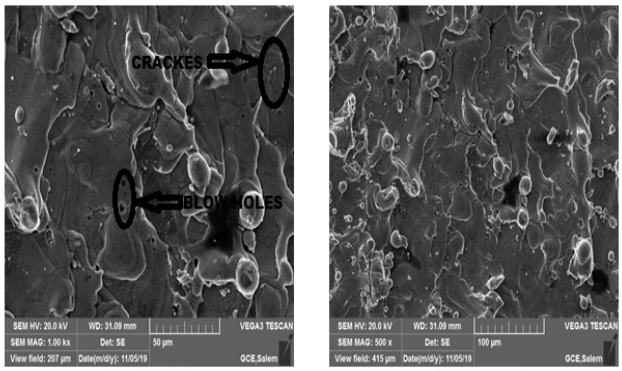


Fig-11 Second level cutting parameter SEM test

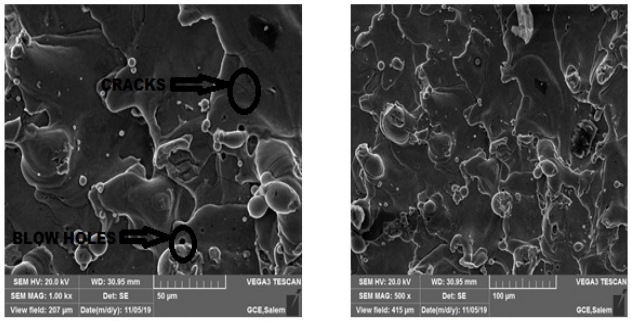


Fig-12 Level three cutting parameter SEM test

D. OPTIMIZATION TECHNIQUE (MATLAB- NNTOOL)

The optimization technique was used in ANN methods of solution refer to the MATLAB 2018 version. Here optimize technique using process parameter is Pulse on time, Pulse off time, wire feed rate. The MRR take for numerical calculation. SR is a taking on SR tester. The NNTOOL method of train to the linear neural network method of import input parameters and target values to get better results of best validation, performance and regression value technique flow process chart show the figure-13. The regression target is overall 0.92 above this is best regression for ANN show the figure-14.

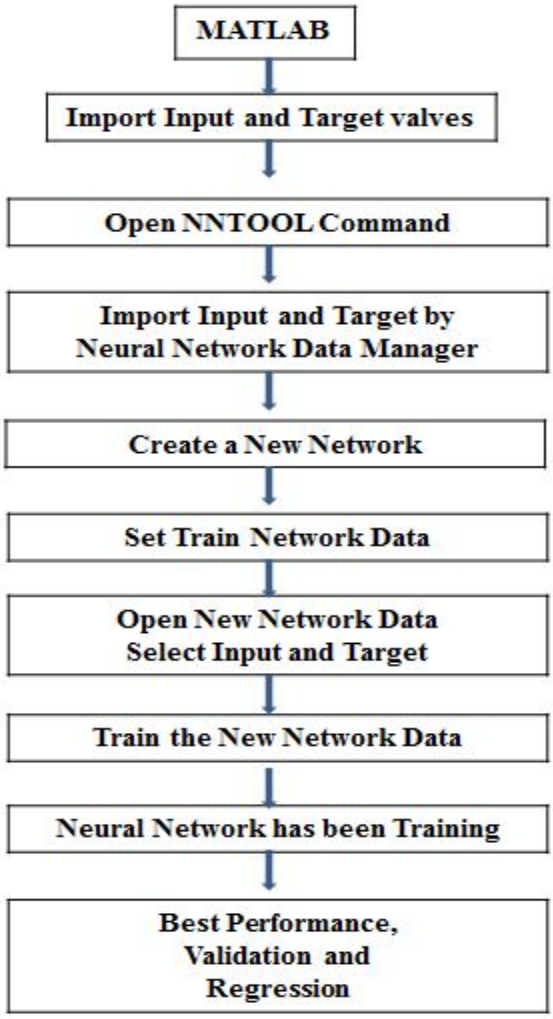


Fig-13 NNTOOL flow process chart

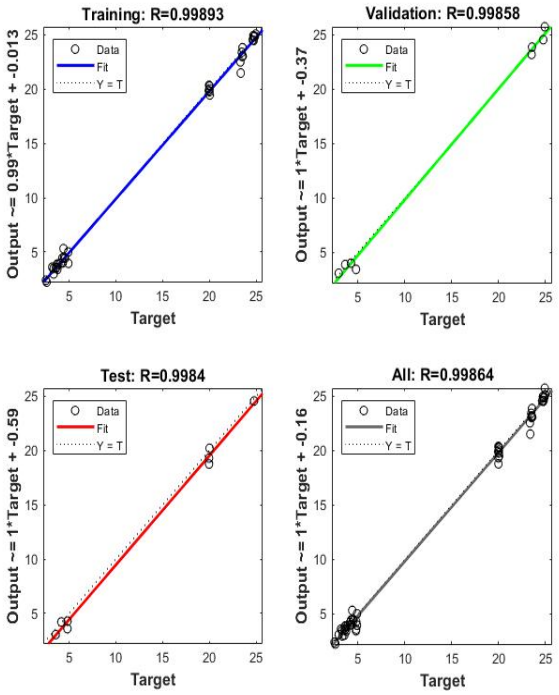


Fig-14 NNTOOL Regression valve

Table-2, Output parameters SR and MRR

S.NO	P-ON (µs)	P-OFF (µs)	VF (mm^2/min)	SR (µm)	MRR (mm^3/min)
1	12	4	7	3.1826	20.053476
2	12	4	8	3.327	23.547881
3	12	4	9	3.3366	24.752475
4	12	5	7	3.559	19.973369
5	12	5	8	3.592	23.510972
6	12	5	9	3.6401	24.875622
7	12	6	7	3.7221	19.946809
8	12	6	8	3.7441	23.364486
9	12	6	9	4.2609	24.916944
10	14	4	7	3.5743	20.026702
11	14	4	8	3.6433	23.510972
12	14	4	9	4.1013	24.630542
13	14	5	7	4.1585	19.973369
14	14	5	8	4.2612	23.474178
15	14	5	9	4.3081	24.752475
16	14	6	7	4.3827	19.973369
17	14	6	8	4.4621	23.328149
18	14	6	9	4.5489	24.958403
19	16	4	7	2.5023	20.026702
20	16	4	8	2.5933	23.584906
21	16	4	9	2.9525	24.752475
22	16	5	7	3.8478	20.026702
23	16	5	8	4.7923	23.547881
24	16	5	9	4.8092	24.793388
25	16	6	7	4.8224	20.026702
26	16	6	8	4.8926	23.547881
27	16	6	9	4.8926	24.711697

V. CONCLUSION

The optimization technique of the WEDM input process parameter is considered on pulse on time, pulse off time, and wire feed rate of machine working condition for improved MRR and SR. The optimization with NNTOOL using the 27 experimental data sets resulted in the get better input process parameter values obtained as pulse on time (16μs), pulse off time (4μs), and wire feed rate (8mm^2/min). The MRR improved considerably on the increase of pulse on time and wire feed rate. As the pulse on time increases SR also increases whereas pulse off time decreases resulting in improved SR.

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