A Surface Integrity Find on Sailma350HI and Titanium in Wire Electrical Discharge Machining Using Main Cut to Trim Cut Strategy

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Abstract **WEDM process is a very unpredictable time differing process. The process output is affected by no of input variables. In this manner an appropriate choice of info factors for the wire electrical release machining (WEDM) prepare depends vigorously on the operator's innovation and experience on account of their various and differing range. By the study of the Trim cut strategy in wire EDM machining lead to us well developed manufacturing process. By control of the surface integrity it impact on the end product. Mostly the surface integrity control required in the die manufacturing where precision is important because of it directly impact on the end products. In this study we observe the surface parameter after WEDM machining on titanium and SAILMA 350HI. The study demonstrates that the WEDM process parameters like pulse on time, pulse off time, wire feed rate, servo voltage, peak current can be adjusted so as to achieve better performance on surface finish.**

Keywords — Wire EDM, Surface roughness, Trim Cut, Main Cut.

I. INTRODUCTION

Non-conventional machining processes are called advanced manufacturing processes since they are established in modern industries. These machining processes are fulfilled by various energies such as mechanical, thermal, electrical or chemical or combinations of these energies to remove extra material.

In Traditional machining processes such as drilling, shaping, turning, and milling are not utilize to machine extremely hard and brittle materials. Many difficulties arise in traditional machining processes. The machining processes elaborated in the previous lines are added material Removal by mechanical means: abrasion chip formation, or microchipping. [1]

Electrical discharge machining (EDM) is a non-conventional machining concept which has been widely used to produce dies, moulds and metal-working industries. This technique has been developed in the late 1940s and has been one of the fast growing methods in developed area during 1980s and 1990s. This machining method is commonly used for very hard metals that would be impossible to machine with conventional machine. It has been widely used, especially for cutting complicated contours or delicate cavities that also would be tough to produce with conventional machining methods. However, one critical limitation is that EDM is only works with electrically conductive materials. The world's first Wire electrical Discharge 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. Plethora researches were done on early WEDM to modify its cutting speed and overall capabilities.

Now a day, plenty work were done on Wire EDM technology in order to satisfy various manufacturing requirements, specifically in the precision die and mold factory. Wire EDM productivity and efficiency have been improved through progress in different aspects of WEDM such as accuracy, quality, precision operation. [2] A variation of EDM is wire EDM (Fig. 1), or electrical-discharge wire cutting. In this process, which is similar to contour cutting with a band saw a slowly moving wire travels along a prescribed path, cutting the work piece. This process is used to cut plates as thick as 300 mm and to make punches, tools, and dies from hard metals. It also can cut intricate components for the electronics industry.

Fig. 1 shows a thick plate being cut by this process. The method of material removal in wire electrical discharge machining is as like to the conventional electrical discharge machining process concerning the erosion effect on work piece by the spark. In wire electrical discharge machining, material is remove from the work piece by a cycle of spark occur between work piece and wire which is separate by Dielectric liquid, which is continuously fed to the machining zone. [1]

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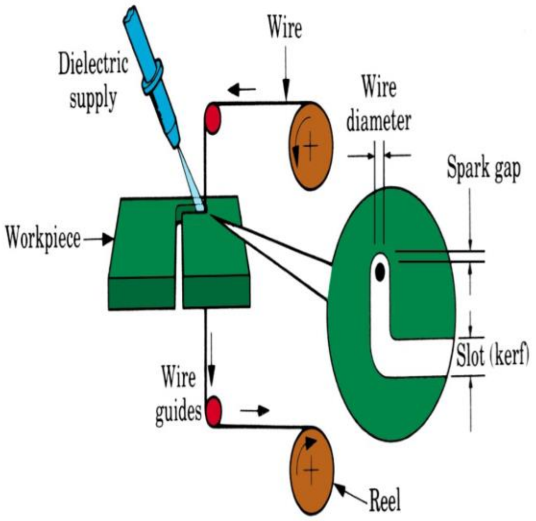

Figure 1: Wire EDM Process [1]

II. SURFACE INTEGRITY

Surface integrity is a generalize term which means the surface condition of a workpiece after being modified by a manufacturing process. The term was coined by Michael Field and John F. Kahles in 1964. [3] It can be controlled in the respect of the parameter Surface Roughness, Surface Roughness is the properties of the material which shows the smoothness of the metal, and how precision cutting is carried out in the material. Therefore one term trim cut strategy is carried to increase the surface roughness of the material. We can go for one, two or more trim cut as per requirement. But increasing the trim cut doesn't affect much more the surface roughness while obtaining the surface roughness in first trim cut.

III. LITERATURE REVIEW

M.T. Antar et al [4] shows the effect on parameter by using of two different wires coated and uncoated. They stated that in wire EDM process they have use coated and uncoated wire for machining of the Udiment 720 nickel based alloy and Ti-6Al-2Sn-4Zr-6Mo titanium alloy. They concluded that by using of coated wire **(**ZnCu50 and Zn rich brass) productivity (70% in titanium alloy and 40% in Udiment 720) increase by using of the coated wire in comparison of uncoated brass wires with the same parameter. They also concluded that by using of coated wire in recast layer they get better result in both condition like rough (main cut) and trim cut operation.

Kamal Kumar Jangra et al [5] carried out an experimental studies of rough and trim cutting operation in wire electrical discharge machining (WEDM) on four hard to machine materials namely WC-Co composite, HCHCr steel alloy, Nimonic-90 and Monel-400. They investigate that in rough cutting operation, machining speed and surface roughness increases with increasing discharge energy across the electrodes. They performed trim cutting operation at similar discharge parameters but with different wire offset were performed for four work materials. They find out that using single trim cutting operation with appropriate wire offset, surface characteristics can be improved irrespective of the rough cutting operation. They also notice that multi trim cut is not much effective in terms of the surface characteristics like surface roughness.

IV. METHODOLOGY

The experiment work requires the proper step, first find appropriate material for machining. Process and response parameter selection also a vital role for better surface finish. From the Analysis of variance find the experiment table, Using the experiment table experiment work carried on.

V. EXPERIMENT

The experiment work designed with initial goal of the research work is to find best the surface roughness. The work is carried out in sprint cut wire cut electro discharge machine of SAILMA and Titanium material by varying machining parameters. The machine used for experiments is Electronica sprint cut Wire cut EDM, Model- ELPULS-40 A DLX, incorporated with molybdenum wire technology. The input and fixed parameters used in the present study are also listed in Table 1.and Table2 respectively. These were chosen through review of literature, experience, and some preliminary investigations. Different settings of Servo Voltage (volt), Wire Feed Rate (m/min) ,Pulse On Time (µs), Pulse Off Time (µs), used in experiments.

Table 1: Input variable with level value

Sr. No.	M/C process parameter	Level 1	Level 2	Level 3
1.	Wire Feed Rate (m/min)	6	8	-
2.	Pulse On Time (µs)	110	115	120
3.	Pulse Off Time (µs)	50	55	60
4.	Peak current(Amp)	120	140	160
5.	Servo Voltage (volt)	15	20	25

Table 2: Fixed Parameters

Sr. No.	Fixed Parameters		
1.	Work Material	TITANIUM	SAILMA 350HI
2.	Wire Tension(Kg)	0.8	0.8
3.	Flushing Pressure(Kgf/Cm2)	1	1
4.	Servo Feed Setting	130	250
5.	Dielectric Fluid	Deionized water	Deionized water

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Table 3: Result Table for Surface Roughness for Sailma 350Hi

Sr. No	Wf (m/min)	Ton (µs)	Toff (µs)	Ip (amp)	Sv (volt)	SR(MC) (µm)	SR(TC) (µm)
1	6	110	55	140	20	2.2012	1.6235
2	6	115	55	140	25	3.1012	2.5080
3	6	115	60	160	15	3.1618	2.5392
4	6	120	55	160	20	3.3212	2.6925
5	6	120	60	120	25	2.5325	1.7853
6	8	110	55	120	15	2.2052	1.5753
7	8	115	55	160	15	3.3152	2.6293
8	8	115	60	120	20	2.3912	1.6923
9	8	120	55	120	25	2.8512	2.1214

Table 3:

Sr. No	Wf (m/min)	Ton (µs)	Toff (µs)	Ip (amp)	Sv (volt)	SR (µm)
1	6	110	50	120	15	2.2552
2	6	110	55	140	20	2.2012
3	6	110	60	160	25	2.1359
4	6	115	50	120	20	2.4912
5	6	115	55	140	25	3.1012
6	6	115	60	160	15	3.1618
7	6	120	50	140	15	3.5921
8	6	120	55	160	20	3.3212
9	6	120	60	120	25	2.5325
10	8	110	50	160	25	2.1819
11	8	110	55	120	15	2.2052
12	8	110	60	140	20	2.1918
13	8	115	50	140	25	2.8562
14	8	115	55	160	15	3.3152
15	8	115	60	120	20	2.3912
16	8	120	50	160	20	3.3752
17	8	120	55	120	25	2.8512
18	8	120	60	140	15	3.009

Table 4: Result Table for Surface Roughness for Titanium

Sr. No	Wf (m/min)	Ton (µs)	Toff (µs)	Ip (amp)	Sv (volt)	SR (µm)
1	6	110	50	120	15	2.4581
2	6	110	55	140	20	2.4032
3	6	110	60	160	25	2.3359
4	6	115	50	120	20	2.7712
5	6	115	55	140	25	3.1134
6	6	115	60	160	15	3.2898
7	6	120	50	140	15	3.7934
8	6	120	55	160	20	3.3395
9	6	120	60	120	25	2.8332
10	8	110	50	160	25	2.3703
11	8	110	55	120	15	2.4089
12	8	110	60	140	20	2.1300
13	8	115	50	140	25	2.9458
14	8	115	55	160	15	3.3758
15	8	115	60	120	20	2.5243
16	8	120	50	160	20	3.4832
17	8	120	55	120	25	2.989
18	8	120	60	140	15	3.1034

Sr. No	Wf (m/min)	Ton (µs)	Toff (µs)	Ip (amp)	Sv (volt)	SR(MC) (µm)	SR(TC) (µm)
1	6	110	55	140	20	2.4032	1.7523
2	6	115	55	140	25	3.1134	2.4023
3	6	115	60	160	15	3.2898	2.4135
4	6	120	55	160	20	3.3395	2.6534
5	6	120	60	120	25	2.8332	1.9925
6	8	110	55	120	15	2.4089	1.7269
7	8	115	55	160	15	3.3758	2.4372
8	8	115	60	120	20	2.5243	1.8567
9	8	120	55	120	25	2.989	2.1912

VI. RESULT AND DISCUSSION

A. Surface Roughness

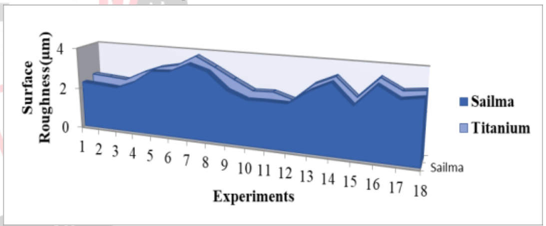

Figure 2. Surface Roughness for Both Materials (MC)

Figure. 2 shows the Surface Roughness for both materials. The surface roughness value for Pure Titanium is higher than Sailma material. The small surface roughness is desirable. The difference between both surface roughness is small, so both material has a equal surface roughness, here Titinium has more melting temperature, so getting poor surface compare to SAILMA.

A. Surface Roughness for Sailma-

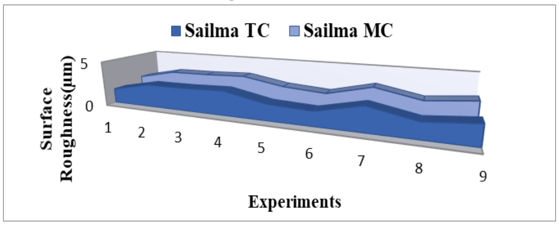

Figure. 3: Surface Roughness for Sailma

B. Surface Roughness for Titanium

In figure 3 comparison of the surface roughness of main cut and trim cut of Sailma material by wire EDM is shown.

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Figure shows that we get better surface roughness in trim cut operation. We get about 30to 50% finish surface after first trim cut which is shown in figure 2.

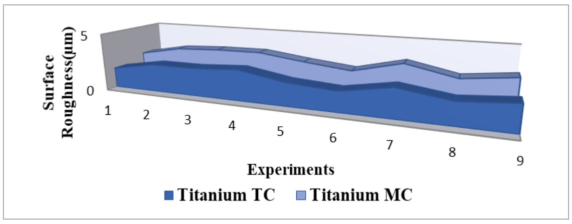

Figure. 4: Surface Roughness for Titanium

In figure 4 comparison of the surface roughness of main cut and trim cut of Titanium by wire EDM is shown. Figure shows that we get better surface roughness in trim cut operation. We get about 30to 50% finish surface after first trim cut which is shown in figure 3. Reason behind getting better surface is repeated cut remove all derbies and other particle.

VII. Conclusion

In this work a pursuit was made to consider the effects of Surface roughness (µs), with trim cut strategy is carried out in WEDM. Above analysis shows that with same parameter in main cut can be utilized for trim cut and it gives better surface roughness. From main cut to trim cut there is 30 to 50% increasing surface roughness for both materials. Repeated Cut on workpiece better surface quality, remove extra material and give super finish surface. In this work surface roughness value Pure Titanium is higher than SAILMA material. Titanium is higher surface rough than SAILMA material. Surface integrity during the main cut or rough cut get normal finish, after Trim cut better surface in SALIMA material compare to Titanium material.

VIII. Future Scope

Researcher should work by changing material for experiment purpose as well as by changing parameters. The effects of machining parameters on residual stresses should be investigated and temperature analysis on workpiece material is also effect surface roughness and kerf width.

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