

# Optimization of Process Parameter in Wirecut EDM Machine on Al-Si Carbide Material Using Response Surface Method

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**ABSTRACT:** In wirecut EDM various techniques are applied to improve the Material Removal Rate (MRR). However, the machining parameters are also effective while machining. In our project, an experiment is performed to analyze the effect of machining parameters like discharge current ( $I_p$ ), pulse on time ( $T_{on}$ ), pulse off time ( $T_{off}$ ), Servo voltage ( $v$ ) over the responses of MRR. For this copper electrode is used while the work piece chosen as Al-SiC which is utilized for manufacturing of various products in our daily life. We found that discharge current is most significant factor after that pulse on time over response of Material Removal Rate. For analysis and explanations Response Surface Methodology software is used.

**KEYWORDS:** Copper Electrodes, Material Removal Rate, Discharge current ( $I_p$ ), Pulse on time ( $T_{on}$ ), Pulse off time ( $T_{off}$ ), Servo Voltage ( $v$ ).

## I. INTRODUCTION

Wirecut Electrical Discharge Machining (EDM) is a thermo-electrical process in which material is eroded by a series of sparks generated between the work piece and electrode tool. Work piece and the electrode are immersed in a dielectric fluid. In EDM, dielectric fluid acts as a coolant and to maintain a constant gap between the work piece and electrode.

Modern technology has placed increasing demands on materials. This need for better Materials is particularly acute in the area of dynamic structure. Where not only high strength is required but also light weight. The efficiency of dynamic structures such as aircraft, high speed manufacturing machinery, power generating equipment could be affected by an improvement in the structural efficiency of the materials. The structural efficiency of materials is becoming even more important as hardware and capital equipment become larger and larger.

## II. LITERATURE REVIEW

**Mr.Somnath M. Kale, Mr.D.S.Khedekar et al. (2012)**

In this journal et all studied the authors optimized the process parameters in wire cut Electric discharge machine for machining Inconel 718 using brass tool material. The input parameters are voltage, discharge current, pulse on time while the output parameters are Material Removal Rate, Tool Wear Rate. Response surface Methodology and ANOVA techniques are used for data analysis while RSM's D-Optimal Method is used to solve the multi-response optimization. It is observed that current is most significant parameter for material removal rate and less significant for tool wear rate followed by pulse on time and voltage.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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## Ch. Maheswara Rao<sup>1</sup> and K.Venkatasubbaiah et al. (2013)

In this paper et al studied the author Optimize the effect of wirecut EDM Process Parameters on Surface Roughness for En41 Steel. They considered the input process parameters such as pulse on time, pulse off time and the output parameter is surface Roughness. Taguchi's Technique, Anova Table, Regression analysis method is used to find the optimal combination of process parameters affecting the Surface Roughness. They did this paper for the future scope. They conclude that the pulse off time, Pulse on time has the least significance among all the process parameters in effecting the surface roughness.

## D. K. Ojha<sup>1</sup>, S. Panda , D.Mishra et al. (2012)

In this peper et al studied the author analyze the effect and percentage contribution of various machining parameters on output parameters is studied using Taguchi's method and ANOVA analysis on AISI 304L Stainless steel. A hybrid Taguchi based grey relational analysis is proposed for multi objective optimization of performance variables like high material removal rate, low tool wear rate, better surface finish with lower dimensional tolerance. Further a regression analysis can be used for finding the model equations for various performance parameters. The input parameters considered in this study are dielectric flow rate, discharge current, Pulse on time ( $T_{on}$ ) and Pulse off time ( $T_{off}$ ). The tool material used is copper. Analysis of variance is used to study the significance of process variables on Material Removal Rate (MRR), Tool Wear Rate (TWR), Surface Roughness (Ra), Dimensional Tolerance (DT). The analysis using Taguchi method reveals that discharge current significantly affects Material Removal Rate, Dimensional Tolerance and Surface Roughness where Tool Wear Rate is mostly affected by flow rate of the dielectric used. A comparison of the hybrid approach and Taguchi analysis is presented in this study. The confirmation test supports the result of the proposed hybrid Grey-Taguchi analysis.

### III. PREPARATION OF SAMPLES

For carrying out this work, the aluminium and silicon carbide has been chosen for preparing composite structure. Epoxy resin has been selected as matrix materials. The mechanical properties of the selected aluminium and silicon carbide materials have been tabulated below in table 3.1.

Grade	Symbol	Tensile Strength [Mpa]	Atomic Weight [gms]	Melting point [°C]	Coefficient of linear expansion	Specific weight [If/cm <sup>3</sup> ]
6061	Al	310	26.09	660	0.000024	2.7

Table 3.1: Mechanical properties of aluminium material

Symbol	Tensile Strength [Gpa].	Atomic Weight [gms]	Melting point [°C]	Coefficient of linear expansion	Specific weight [If/cm <sup>3</sup> ]
Sic	0.137	24.034	2730	0.000023	7.3

Table 5.1.2 Mechanical properties of Silicon carbides

Composite material fabrication can be broadly classified into following categories:

- Hand lay up
- Vacuum bag moulding
- Compression moulding
- Pressure bag moulding

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Vol. 8, Issue 3, March 2019



Figure:3.2 split moulding

Composites are formed by placing AL-sic impregnated in resin on to female mould and applying pressure using a male mould to eliminate any excess resin from the ACM compression moulding is useful for fabrication such as boat hulls. In this project compression moulding process is used for fabrication of composite. The size of the composite sheet that is to be fabricated is 300\*150\*5 the materials used for fabrication are:

- Die- 300\*150\*5
- Epoxy LY556& hardener HY951
- Aluminium sheet
- Silkicon carbide

The die is used to fabricate the composite in the cross section of 300\*150\*5. Initially the grease is applied over the female die. After that OHB sheet is placed over it. The hardener grade 951 will be added to the epoxy resin. Which is used to increase the hardness of the epoxy resin.

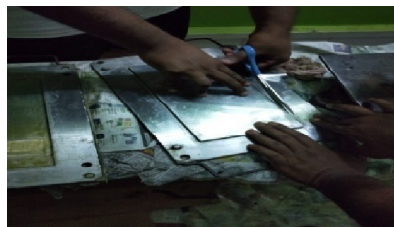


Figure: 3.3 preperation of die

The flax fiber and carbon fiber is cut in dimension of 300\*150mm the epoxy resin is mixed in the ratio of 10:1 and stirred slowly in order to avoid air bubbles. The various layers are used for making the specimen First the resin is equally poured on the die and carbon fiber will be placed above the die with correct dimension. Again the resin is equally distributed over the fiber. After that the specimen is allow them to dry for 24 hours in compression moulding. It gets the single layer of the composite specimen. The cycle is repeated to obtained the required layers of composites.

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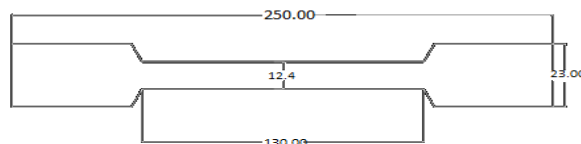
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And thus fabrication is completed by means of split moulding. The finished specimen is used to under go the strength analysis for analysing its mechanical behaviour such as Copper Electrodes, Material Removal Rate, Discharge current (Ip), Pulse on time (Ton), Pulse off time (Toff), Servo Voltage (v).

## V. EXPERIMENTAL ANALYSIS

Mechanical properties like ultimate its mechanical behaviour such as Copper Electrodes, Material Removal Rate, Discharge current (Ip), Pulse on time (Ton), Pulse off time (Toff), Servo Voltage (v). absorption test will be evaluated.

**Tensile test:** Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area.



all dimensions are in mm

Figure 5.1: Tensile ASTM A378

S.NO	Reinforcement percentage	Diameter of indentation (d)	BHN= $P/(\Pi d(D-\sqrt{(D-d)/2}))$
1	0	2.88	150
2	2.5	2.78	163
3	5	2.73	169
4	7.5	2.63	178
5	10	2.75	167

Table 5.1: Tensile strength result

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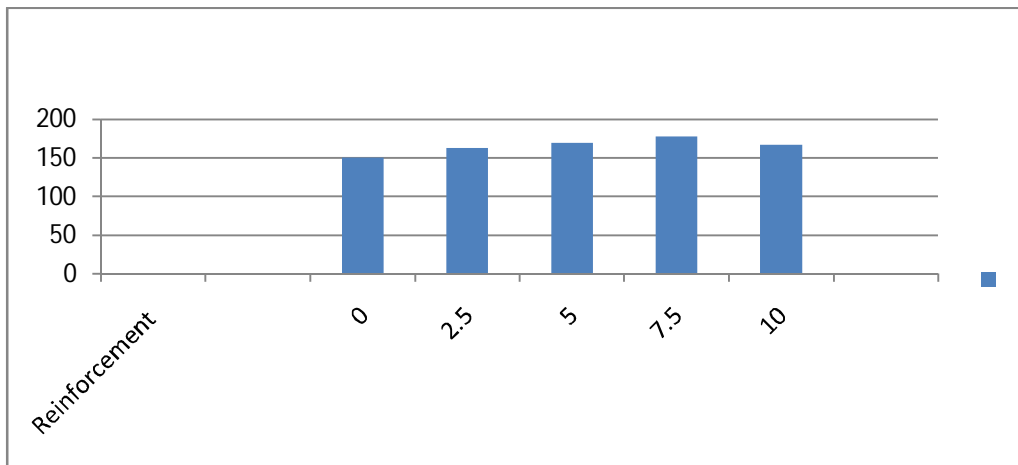
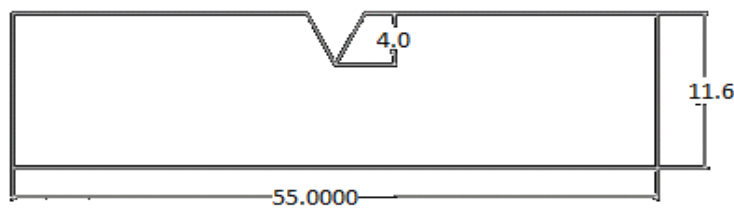


Figure 5.2: brinell hardness value for AL-SIC

The above chart shows the effect of reinforcements on UTS of the Fibers reinforced composites as can clearly see the increase in the ultimate tensile strength in single layer carbon fiber composite. A1,B1,C1 are the single flax and carbon layer samples which are tested under the different load. The graph is plotted between load vs elongation of specimen i.e .displacement.

**Impact test:**

The apparatus consists of a pendulum of known mass and length that is dropped from a known height to impact a notched specimen of material. The energy transferred to the material can be inferred by comparing the difference in the height of the hammer before and after the fracture.



all dimensions are in mm

Figure 5.3: Impact test ASTM standard

S.NO	% reinforcement	Energy absorbed by the specimen in J	Impact strength In N/M
1	0	19.2	240000
2	2.5	20	250000
3	5	26	325000
4	7.5	28	350000
5	10	25	312500

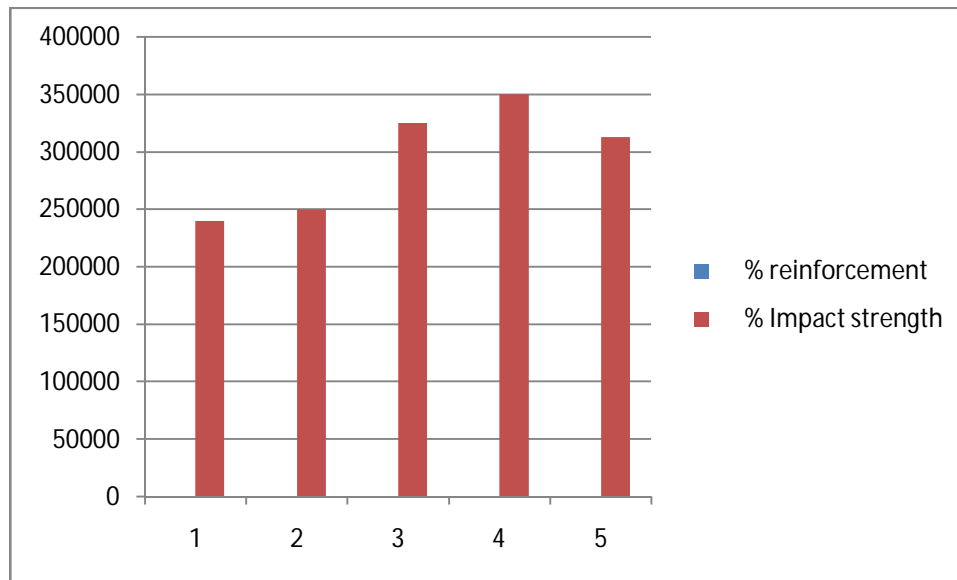
Table 5.2: Impact test result

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### Wirecut edm test:

Mechanism behind material removal of EDM process is based on the conversion of electrical energy to thermal energy that categorized it to electro thermal process. During machining both the surfaces may have present smooth and irregularities causes minimum and maximum gap in between tool and work piece. At a given instant at minimum point suitable voltage is developed produces electrostatic field for emission of electrons from the cathode there electrons accelerated towards the anode. After getting velocity of electrons collides with the dielectric molecules breaking them into negative and positive ions. Because of that spark is generated with high temperature causes melting and vaporization of material from the workpiece shape of tool on to the workpiece.

S.NO	Pulse Time(Ton), mins	On	Pulse OffTime(Toff), mins	Discharge current (Amp)	Servo Voltage (volt)	Machining Time (mins)	Wt. of the material before machining(grams)
1	29		1	8	50	150	32
2	32		3	12	53	120	32
3	36		5	16	56	90	32
4	38		6	18	59	60	32
5	40		8	21	65	45	32
6	42		10	24	80	30	32

Table 5.3:wirecut edml test result

The graph was drawn between the load and displacement. From the above graph the load increases the flexural strength decreases. The above graph is the single layered flax/carbon fiber sample which is tested.

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## VI. CONCLUSION

By comparing Tensile stress Results of Experimental Analysis and numerical analysis. From the test results of carbon fiber composites based on mechanical tests conducted a conclusion is reached from the study. All the result are compared to various proposition of flax and carbon fiber to increase the strength. From the study it's concluded that the composites used in aerospace and aeronautical applications abundant and highly reliable. Flax/carbon fiber composite material result of tensile strength [67MPa] is increase with increase of carbon fiber layer .

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