

# **Comparison of Brass and Zinc Coated Wire Electrode Using Wire Cut EDM Concerning MRR of Machining SS304**

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**ABSTRACT:** The wire electrical discharge machining (WEDM) is one of the latest non-traditional machining process parameters, based on thermoelectric energy between the work piece and wire. WEDM is capable of machining of geometrically complex shapes and very difficult-to-machine such as composites, ceramics, heat resistant steels, carbides etc. These hard material components are widely used in aerospace industries, die and mold making industries. This investigation discusses the effects of machining parameters like pulse on time, pulse off time and voltage on the material removal rate of wire electric discharge machining. By comparing the wire the performance of WEDM is find out on the basis of Material Removal Rate (MRR). And also process parameters of the machining voltage, pulse on time, pulse off time, wire feed, wire tension. The process performance is measured in terms of Material Removal Rate (MRR). In this WEDM experiment using 0.25 mm diameter brass wire and zinc coated wire has been MRR, Surface finish and reducing cost of manufacturing. The setting of process parameters is determined by Taguchi's design of experiments. Signal to Noise(S/N) and analysis of variance (ANOVA) were used to analyze the effect of selected process parameters on MRR and identify the optimum cutting parameters setting.

**KEYWORDS:** Taguchi's Method, S/N ratio, ANOVA technique, Material Removal Rate, Surface Roughness

## **I. INTRODUCTION**

Wire electric discharge machining (WEDM) technology is being employed for machining parts of hard material with complex shapes in aerospace and automobile industries. Some few Examples of complex shapes are gears, turbine blades, narrow slots. Most often, Steel are processed with help- of wire electric-discharge machining. The electrodes are used for WEDM machining performances well .Wire is fed through the work piece, submerged in a tank of dielectric fluid typically deionized water. Wire-cut EDM is typically used to cut plates as thick as 300mm and to make punches, tools, dies from hard material that are difficult to machine with other methods.

The travelling wire is continuously fed from wire feed spool and collected on take up spool which moves though the work piece andis supported under tension between a pair of wire guides located at the opposite sides of work piece.

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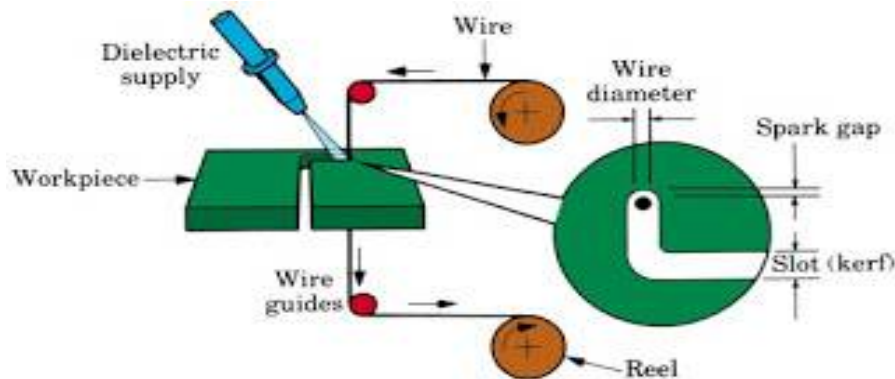


Fig. 1 Setup of Wire-cut EDM

The lower wire guide is stationary whereas the upper wire guide, supported by the U-V table, can be displaced transversely along U and V-axis with respect to lower wire guide. If spark is generated in between electrode and work piece immersed in a liquid dielectric medium. The wire is held by pin guide at the upper and lower part of the work piece. This wire-cut process uses water as its dielectric fluid, controlling its resistivity and other electric properties with filter and de-ionized units. The water flushes the cut debris away from the cutting zone. Flushing is an important factor in determining maximum feed rate for a given material thickness.

## II. LITERATURE REVIEW

Bharathi et.al. (2016) WEDM process performance parameters such as material removal rate, kerf and surface roughness of SS304 following the Taguchi's design of experiments. ANOVA is performed to trace the statistical significance of input parameter (viz. voltage, pulse-on-time, pulse-off-time and wire feed) on the output response parameters. A multi-objective optimization method is adopted here to trace the optimum WEDM process parameters for achieving sufficiently high material removal rate, and low surface finish as well as the kerf width.

Geetha et.al. (2013) The selection of machining parameters in any machining process significantly affects production rate, product quality and production cost of a finished component. WEDM process involves a large number of variables that affect its performance. However, based on the literature survey and the pilot experiments, five process variables, viz., pulse-on time, pulse-off time, wire tension, and water pressure are taken into consideration for the research.

Boopathi et.al. (2016) In the wire-cut electrical discharge machining (WEDM) process, the liquid dielectric fluid is replaced by the minimum quantity of liquid with the gas mixture, called near-dry WEDM. Near-dry WEDM exhibits the advantage of low environmental impact, good surface quality and machining stability at the minimum discharge energy input. The Taguchi approach has been applied to investigate the effect of pulse width, pulse interval, inlet liquid-gas pressure and discharge-current on the MRR and surface finish. The low pulse width and pulse interval are identified as key factors for improving the surface finish.

Takaleet.al.(2015) , the effects of various process parameters of WEDM like pulse on time ( $T_{on}$ ), peak current ( $I_p$ ) have been investigated reveal their impact on material removal rate (MRR), Micro hardness and Surface roughness (Ra) of Stainless Steel (SS-304) using one variable at a time approach.

Sumit Kumar et.al.(2016) ,The stainless steel 304 is considered in the present work. The experimentation has been completed using Taguchi's L9 orthogonal array with different input process parameters. The goal of given research work is to optimize the parameter of WEDM process by considering the input parameter of pulse on time, pulse of time, wire feed, wire tension. The setting of process parameters is determined by Taguchi's design of experiments.

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Signal to Noise(S/N) and analysis of variance (ANOVA) were used to analyze the effect of selected process parameters on MRR and Ra.

Dhruvh.Gajjaret.al. (2016) ,The important machining parameters of EDM which affecting on the performance parameters are discharge current, pulse on time, pulse off time, arc gap, flushing pressure, servo voltage and wire tension. Taguchi design of experiments is used to conduct experiments by varying the parameters servo voltage, pulse on time and pulse off time. The process performance is measured in terms of Material Removal Rate (MRR), KERF Width and Surface Roughness (SR). In this research WEDM experiment using 0.25 mm diameter molybdenum wire & EN-31 tool Steel work piece has been done for optimizing MRR, KERF width, Surface finish and reducing cost of manufacturing.

### III. MATERIAL SELECTION

#### 3.1 Work Piece Material

The wire electric discharge machining is used to machine hard materials like steel, carbides and composites. Stainless steel (SS304) is used as a work piece material in this experiment. SS304 is non-magnetic in the annealed condition, however, may turn out to be slightly magnetic as a result of cold working or welding.

**Table 1** Chemical Composition of SS304

Element	Cr	Ni	Mn	Si	C	P	S
% weight	18.1	8.02	1.211	0.3677	0.0458	0.01349	0.00898

#### 3.2 Tool

Different electrodes are used for WEDM machining performance. One is brass and another zinc coated wire both wires having 0.25 diameters.Brass wire the most common EDM wire in use today. Chemical composition of brass wire is 63% of copper and 37% of brass.Wires with high elongation can taper-cut to 45° but with much reduced threading reliability. The availability of wire is 0.20mm to 0.35mm.we are selected in 0.25mm dia of wire used in this experiment.

This zinc-coated wire consists of brass wire electroplated with high purity zinc. The high plating accuracy realizes faster machining speed and also provides a better surface finish on the work piece.The finishing process, improved surface roughness and a better machined profile are obtained.



Fig:2 brass wire



Fig:3 zinc coated

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## IV. TAGUCHI'S DESIGN OF EXPERIMENT

Taguchi as introduced the signal-to-noise(S/N) ratio transformation that amount of variation in the output response. But, many of the above researchers have applied the transformation on a signal value. The experimental layout for the machining parameters is based on their approach L8 orthogonal array. This array consists of four control parameters viz. pulse on time, pulse off time, wire feed, wire tension and their two levels.

$$SN_i = -10 \log 1/N_i \sum 1/y^2$$

**Table 2** Process Parameters and their Levels

Parameters		Pulse on Time	Pulse off Time	Wire Feed	Wire Tension
Brass	Level1	4	20	4	5
	Level2	7	17	6	10
Zinc coated	Level1	4	20	4	5
	Level2	7	17	6	10

. In Taguchi method, mostly observed values are calculated based on larger the better, smaller the better, nominal the better. And also in this method S/N ratio is the measure of quality characteristics. S/N ratio is determined for material removal rate larger the better criterion by using equation.

**Table 3** Experimental Results

Run	Pulse on Time (µs)	Pulse off Time (µs)	Wire Feed (mm/min)	Wire Tension (gms)	MRR (mm <sup>3</sup> /min)		S/N Ratio	
					Brass Wire	Zinc coated Wire	Brass Wire	Zinc coated Wire
1	4	20	4	5	49.99	67.74	33.9777	36.2943
2	4	20	6	10	48.65	65.27	33.7417	36.8109
3	4	17	4	10	46.94	69.27	33.4309	38.6190
4	4	17	6	5	58.20	85.30	35.2985	39.3453
5	7	20	4	10	61.83	92.74	35.8240	39.6264
6	7	20	6	5	51.90	95.79	34.3033	39.5389
7	7	17	4	5	49.23	94.83	33.8446	39.8316
8	7	17	6	10	54.76	98.08	34.7693	36.2943

## V. SELECTION OF THE BEST PARAMETER

An experimental result of present work observed and analysis using S/N ratio and mean value of corresponding MRR values. The response table and response graphs with help of Minitab 17 Software. Minitab is computer software to designed perform basic and advanced statically functions. MRR versus pulse on time, pulse off time, wire feed, wire tension, is carried out and average of each level. To find the S/N ratio using MRR from table 4 is evident that the parameter having highest delta value gets high rank. Pulse off time get rank 1 followed by pulse on time, wire feed, wire tension.

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**Table 4** Response Table for S/N Ratio using Brass wire

Level	A	B	C	D
1	34.11	34.46	34.27	34.36
2	34.69	34.34	34.53	34.44
Delta	0.57	0.13	0.26	0.09
Rank	1	3	2	4

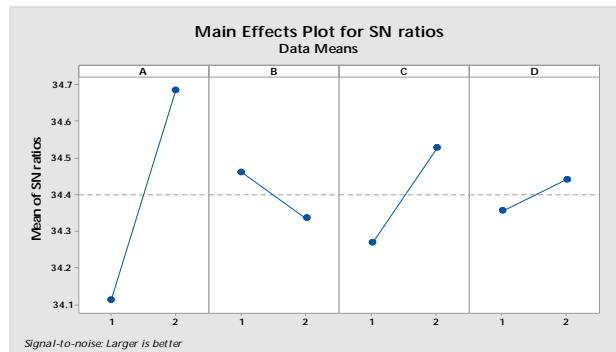


Fig: 4 Graph for S/N ratio using brass wire

During this process to find the S/N ratio using MRR in zinc coated wire table 5 the effort of various parameters like pulse on, pulse off, wire feed, wire tension, This graph clearly shows level 2 of pulse on time increase pulse on time gets rank 1 followed by pulse off time, wire feed, wire tension. This rank relative important of each factor.

**Table 5** Response Table for S/N Ratio using zinc coated wire

Level	A	B	C	D
1	37.09	37.97	38.08	38.60
2	39.59	38.70	38.59	38.07
Delta	2.50	0.73	0.51	0.53
Rank	1	2	4	3

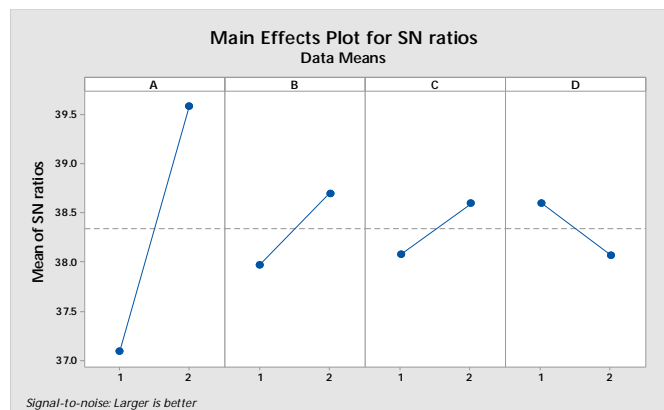


Fig:5 Graph for S/N ratio using zinc coated wire

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**Table 6** Response table for mean of MRR of Brass wire

Level	A	B	C	D
1	50.94	53.09	52.00	52.33
2	54.43	52.28	53.38	53.05
Delta	3.48	0.81	1.38	0.72
Rank	1	3	2	4

This table observed the mean value of corresponding MRR value. If the delta value high is gets the 1 rank of the table, it shows that best of this four parameters. This graph clearly shows that best of this 2 level, also improving the material removal rate from the best parameter of this table.

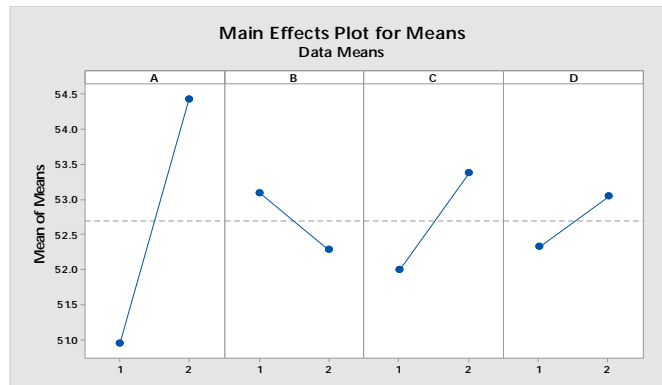


Fig:6 Graph for mean value of brass wire

**Table 7** Response table for mean of MRR of zinc coated wire

Level	A	B	C	D
1	71.89	80.39	81.14	85.91
2	95.36	86.87	86.11	81.34
Delta	23.47	6.48	4.97	4.58
Rank	1	2	3	4

This table and graph also show the same process of using zinc coated wire performances of MRR. pulse on time gets rank 1 followed by pulse off time, wire feed, wire tension. This rank relative important of each factor.

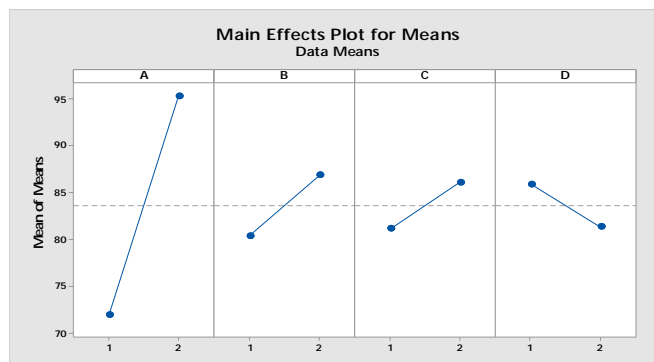


Fig:7 Graph of mean value of zinc coated wire

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## VI. CONCLUSION

In this research zinc coated wire, it gives more material removal rate (MRR) as compare to the brass wire and also analyzing S/N and mean value for optimal conditions for material removal rate. It is observed that the MRR increases with the increase of pulse on time, also increasing of wire feed rate decrease the pulse off time. This discharge energy increase pulse on time and wire feed to a faster cutting rate. As the pulse off time decreases, the number of discharge within a given period. With increase of pulse on time and wire feed rate gets widened resulting in to a lower cutting rate.

## REFERENCES

1. Dhruvh.gajjar., Prof. Jayesh v. Desai (2015), Optimization of MRR, Surface Roughness and KERF Width in wire EDM Using Molybdenum Wire. International journal for research in education, PP.2347-5412,
2. M. Geetha., BezawadaSreenivasulu (2013), Modeling & Analysis of performance characteristics of Wire EDM of SS304, International Journal of Innovative Technology and Exploring Engineering, PP.2278-3075,
3. BoggarapuNageswara Rao., (2016), Optimum WEDM Process Parameters of SS304 Using Taguchi Method, International Journal of Industrial and Manufacturing Systems Engineering, PP.69-72,
4. Arul Dassjames., (2016), Experimental Study of Eco-friendly Wire-Cut Electrical Discharge Machining Processes, International Journal of Innovative Research in Science, Engineering and Technology. PP.2347-6710,
5. A.M.Takale., T.D.Pawar (2015), Experimental Investigation on Machning Characteristics in Wire Electrical Dischrage Machine (WEDM) of Stainless Steel304 (SS304).International Journal of Engineering Technology, Management and Applied Sciences, PP.2349-4476,
6. Sameer kumarMishra.,Sujeet Singh, (2016), Optimization of Process Parameters in WEDM ProcessInternational Journal of Advance Research and Innovation, PP.2347-3258,
7. Sumit Malik, Dr.Vineet Kumar, (2016), Optimization for Performance Measure of Process Parameters of WEDM for SS 304, International Journal Of R&D In Engineering Science And Management. PP.2393-865X,
8. Sumit Kumar., S.K.Garg, (2016), Experimental Investigation of Effect of Process Parameters on Material Removal Rate during WEDM, International Journal of Current Engineering and Technology, PP.2347-5161,
9. Sivaraman B., Eswaremoorthy C., Shanmugham E.P. (2015), Optimal Control Parameters of Machining in CNC Wire Cut EDM. International Journal of Applied Science and Engineering Research, PP. 102-121,
10. Hemalatha K., Venkatachalapathy V.S.K., Alagumurthy N. (2014), Surface Integrity analysis in Wire-Cut Electric Discharge Machining of Al 6063/Al2O3 Metal Matrix Composite through Response Surface Methodology. International Journal of Scientific & Engineering Research, PP. 104-110,
11. Cyriac S., Prof. Sharos H. (2015), Optimization of wire-cut EDM Parameters of EN 24 Steel Using Taguchi's Method. International Journal of Engineering Research and Technology, PP. 633-636.