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INVESTIGATION OF MOST INFLUENCING PARAMETER FOR SURFACE ROUGHNESS AND MRR IN AISI D3 STEEL ALLOY BY USING TAGUCHI APPROACH

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Abstract

Wire electric discharge machining process performance mainly depends on the selection of suitable input variable and finding the most significant variable is critically important to achieve required material removal rate and good surface finish so that we enhance our potential profit in term of cost. As there are many processes parameter variables concerned with wire electrical discharge machining and it is quite tough to find out correct aggregate which affect the parameter. The fundamental target of this proposal is to recognize the primary impacts of procedure parameter like P on time, P off time and servo voltage on material removal rate (MRR), surface roughness inside the WEDM machining method on AISI D3.The investigation has been finished by utilizing Taguchi approach L_{27} (33). DOE formed with the assistance of ANOVA and Taguchi approach and most significant parameters were identified with the help of MINITAB 18 which point out Pulse Ton and SV is most considerable parameter to influence MMR and Ra.

Keywords: *P On time, P off Time, ANOVA, and Taguchi.*

1. INTRODUCTION:

Wire electric discharge machining use thermo electric medium to perform. In WEDM, an easy transferring cord travels along a fixed path and expel material from the workpiece. The material is expelled with the resource of a series of discrete discharge among the cord electrode and the paintings piece within the incidence of dielectric fluid, which creates a direction for each discharge due to the fact the fluid turns into ionized in the gap M. Manjaiah et.at [1].

The region wherein a discharge takes place is heated to enormously excessive temperature in order that the floor get melted and expelled. The expelled particles get flushed away by way of the flowing dielectric fluids. The wires for WEDM are commonly made of brass, copper, tungsten, and molybdenum. M. Durairaj et.al [2] Zinc-lined or brass-lined wires also are used comprehensively in this procedure. The wires used inside the method have to accumulate excessive tensile power and top electric conductivity. The mechanism of steel elimination specially includes the removal of material due to melting and vaporization resulting from the electric discharge generated thru a pulsating direct modern-day energy supply between the electrodes G. Venkateswarlu et.al [3].

The electrical sparks generated amongst two carefully spaced electrodes underneath the affect of dielectric liquid. Water is applied as dielectric in WEDM due to its depraved proper consistency and brief rate of cooling. These universal performance traits are allied with machining parameters in conjunction with P on time, P off time, and servo voltage and so on. The favoured machining parameters are sturdy-minded based totally on test. T. U. Siddiquet.al [4]. Consequently, more than a few techniques are in use to obtain high-quality viable machining parameters. After an intensive research of the present day literature, various gaps had been visible in WEDM method parameters.

The mainstream of the researches have examine the affect of the insufficient number of machining parameters on the execution overall performance parameters of WEDM technique. The impact of machining parameters on AISI D3 metallic (workpiece) has now not been absolutely investigated through the usage of WEDM with zinc lined brass cord as electrode. Procedure parameters of WEDM have now not been analysed with a few more variety of machining experimental parameters.

In view of the formerly stated gaps, the prevailing work manner to identifying quantities of machining parameters of WEDM of AISI D3 steel (workpiece) with portions of execution parameters and take a look at the outcomes through Taguchi approach and ANOVA. The D3 steels contain 1.5 to 2.35% of C and 12% of Cr, .60% of Si and .60% of Mn. The carbon substance will influence the hardness and Chromium could enhance the solidifying limit of warmth treatment, and particularly enhance the rough opposition. Due to these properties composite it is used in my application of Blanking, forming dies, Forming rolls, Press tools, Punches, Bushes etc.

A D Udare et. al [15] It is carefully observed from the literature survey that the past researchers had performed work for optimizing the one performance parameters on electrical discharge machining and selects suitable techniques to optimise the result. The principle goal is to analyse the process conducted inside the end to reduce machining work interval which leads to adequate surface roughness via optimizing system variables. Better Surface texture received after EDM machining consequences in reduction of completing efforts and lead time. Development of variables is done to have a look at the impact of pulse current, Pulse on time, spark gap voltage and spark discharge region for you to arrest floor roughness and subsequently get better floor.

The version of spark discharge place is precision machining issue in correlation with other technique parameters and at the end the process parameters are tested through Taguchi L_{27} method.

But Wire EDM is an advance version of non convention machining and whose surface roughness and material removal rate is more as compared to EDM and is consume comparatively less time to finish the operation. Hence the demand of wire edm is more as compare to electrical discharge machining.

2. EXPERIMENTAL WORK

With the help of electronic ultima f1 experiment was carried out and use zinc coated brass wire as electrode.

2.1 Workpiece material

AISI D3 steel alloy is used as workpiece material and its composition are as follows:

Table: 2.1 Chemical composition of AISI D3 steel

Composition	C	Mn	Si	P	S	Cr	N
Wt. %	2	0.29	0.31	0.011	0.009	1.14	0.25

3. TOOL MATERIAL

Zinc lined Brass wires was used because the electrode for experiments that have diameter of .25 mm. specifically Brass is an alloy which incorporates copper and zinc typically brass twine includes sixty three percentage copper and 37 percentage zinc.

4. METHODOLOGY

This work is examined with the help of Taguchi method and consequent are used to perform the Analysis of Variance. Orthogonal array L_{27} is used along with three levels. The experiments was performed on the Electronica Ultima F1 cord electric powered discharge machine via taking AISI D3 as the workpiece material and brass cord as the electrode. Total 27different experiment were performed and three process parameters were taken for experimentation to examine their effect on performance parameter like MRR and SR and result analyzed take all other parameter constant.

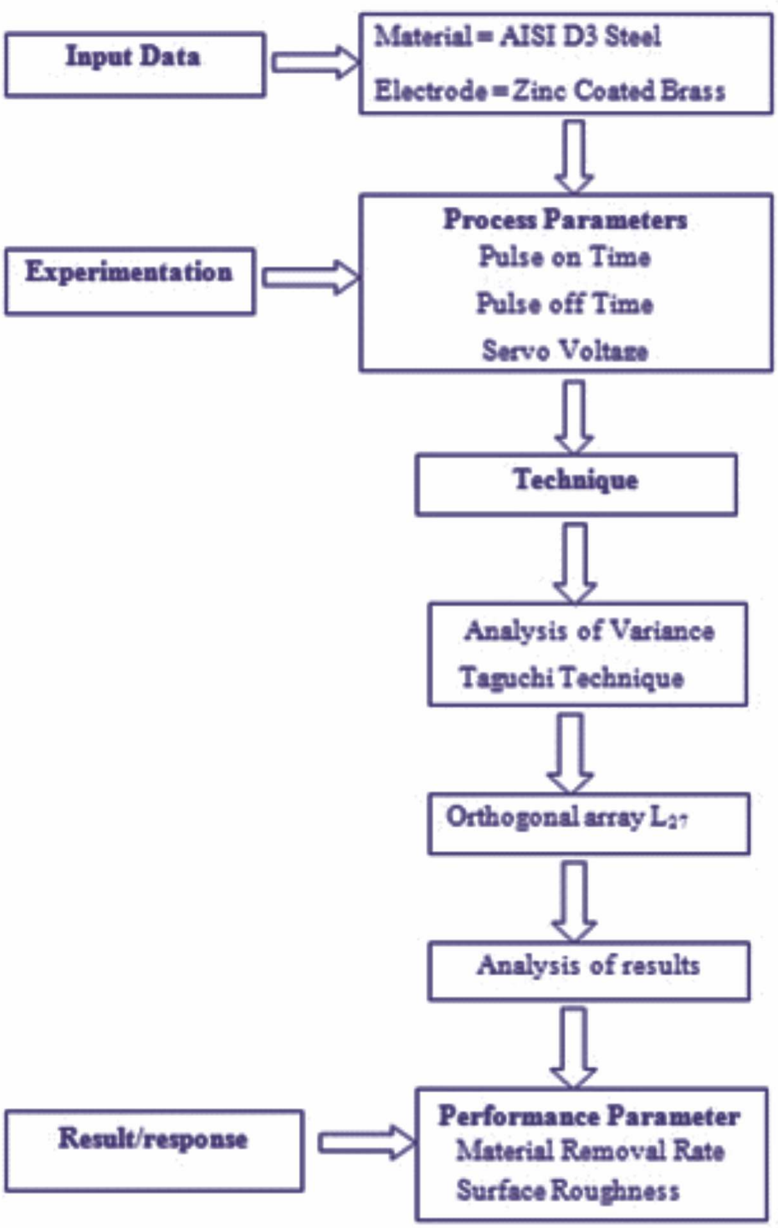

Fig: 4.1 Flow chart of Methodology used

4.1 Experimental Design

Firstly Taguchi matrixes are formed with the help of input variable and opted L_{27} orthogonal arrays to perform the experiment with three different levels. After execution of input parameter now next to it is to execute performance parameter in matrix table so that different analysis can be performed. ANOVA investigation is utilized to discover most critical parameter which impacts the outcome yield of material expulsion rate and surface roughness. Concurrently signal to noise ration graph analysis is also performed to find out the effect of input variable on performance parameter The S/N ratio predict loss of characteristics. The S/N ratio characteristics may be labeled into three class accordingly larger is better, smaller is better and higher is better. For material MMR higher is better preferred and for SR smaller is preferred. Mathematical for calculation formula is mentioned bellow.

For material Removal Rate, higher is better.

$(S/N)_{HB} = -10 \log_{10} (MSRD)$

Where,

(I) MSRD stands for mean of sum square of reciprocal of measured data.

(ii) HB stands for higher is better

For Surface Roughness Smaller is better

$(S/N)_{SB} = -10 \log_{10} (MSSD)$

Where,

(I) MSSD stands for mean of sum of measured data.

(ii) SB stands for smaller is better.

Table: 4.1Machining parameters and their levels

S.N.	Process Parameter	Unit	Level 1	Level 2	Level 3
1	Pulse On Time	µs	8	12	16
2	Pulse Off Time	µs	47	53	59
3	Servo Voltage	Volt	20	30	40

4.2 Measurement

The MRR and surface roughness are opted as performance parameter and wearing of tool is much nit important in wire electrical discharge machining. Once electrode is used after that it is a scrap and is not reusable. The initial weight of workpiece is measured in electronic balance weigh machine having accuracy of .0001gm and MRR is calculated by following method.

$$MRR = \frac{\text{final mass - initial mass}}{\text{Time* density}} \text{ in } (mm^3/min)$$

Where, MRR stands for material removal rate and surface roughness is measured with the help of surface profilometer SURFCORDER SE300 and noted down all twenty seven reading.

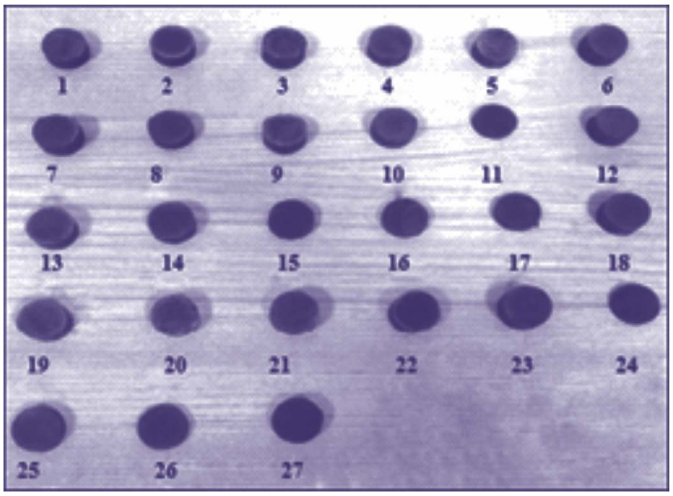

Figure: 4.1 workpiece of machined specimen

Table: 4.2 L-27 orthogonal arrays

Exp. No	T On	T Off	SV	Material Removal Rate		Surface Roughness	
				mm3/ min	S/N Ratio	µm	S/N Ratio
1	8	47	20	5.471	14.761	4.152	-12.366
2	8	47	30	5.485	14.784	4.263	-12.595
3	8	47	40	5.453	14.733	4.439	-12.945
4	8	53	20	5.977	15.530	4.537	-13.135
5	8	53	30	5.962	15.508	4.525	-13.113
6	8	53	40	5.974	15.525	4.593	-13.241
7	8	59	20	5.749	15.192	4.363	-12.797
8	8	59	30	5.715	15.140	4.338	-12.745
9	8	59	40	5.738	15.175	4.355	-12.780
10	12	47	20	5.845	15.336	4.436	-12.941
11	12	47	30	5.853	15.348	4.442	-12.952
12	12	47	40	5.838	15.325	4.431	-12.930
13	12	53	20	6.051	15.637	4.593	-13.241
14	12	53	30	6.004	15.569	4.557	-13.174
15	12	53	40	6.063	15.654	4.602	-13.259
16	12	59	20	6.418	16.148	4.871	-13.753
17	12	59	30	6.307	15.996	4.787	-13.601
18	12	59	40	6.411	16.139	4.866	-13.743
19	16	47	20	6.474	16.223	4.914	-13.828
20	16	47	30	6.461	16.206	4.904	-13.811
21	16	47	40	6.466	16.213	4.908	-13.818
22	16	53	20	6.508	16.269	5.004	-13.986
23	16	53	30	6.516	16.280	4.946	-13.884
24	16	53	40	6.498	16.256	4.932	-13.860
25	16	59	20	6.796	16.645	5.358	-14.580
26	16	59	30	6.774	16.617	5.141	-14.222
27	16	59	40	6.781	16.626	5.068	-14.096

5. RESULTS AND DISCUSSION

Effect of MRR

On increasing pulse on time, the discharge energy gets increase immediately for a span of time that's why the melting rate of workpiece material gets huge time. This offers a high material removal rate of workpiece material and hence by figure we can say by changing the pulse on time from 8 units to 16 units the material removal rate get increases drastically. Similarly, on increasing pulse off time, there is an extra time for water pressure to flush out melted debris from the surface of a workpiece which offers a slight upgrading in material deduction rate. This improvement can be seen in the figure as pulse off time value from 47 to 59 units, the material removal rate comparatively increased but not as much as a pulse on time. The graph of signal to noise ratio is bellow.

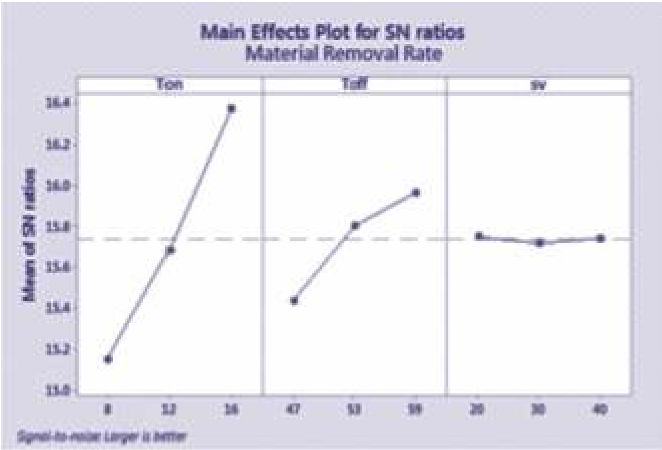

Fig: 5.1 Effect of MRR for AISI D3 steel

Effect of Surface Roughness

On increasing pulse on time from values 8 to 16 units, there is decreasing in quality of surface as shown.

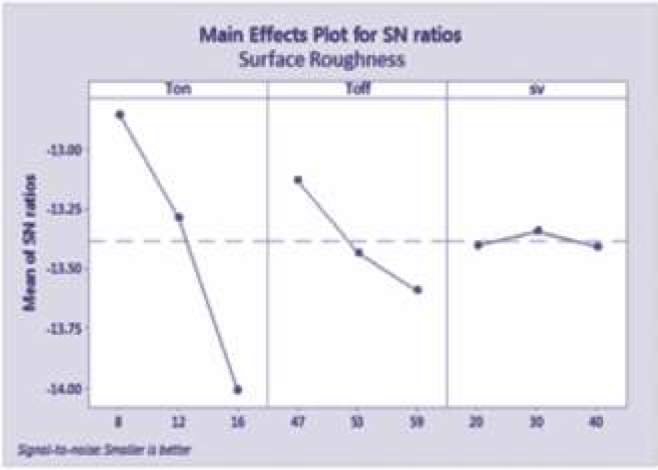

Fig: 5.2 Effects of Ra AISI D3 steel

On increasing pulse off time values from 47 to 59 units, the surface quality is comparatively decreasing, but not as much as a pulse on time. Whereas the servo voltage doesn't show any significant changes in surface quality while changing its value from 20 to 40 units.

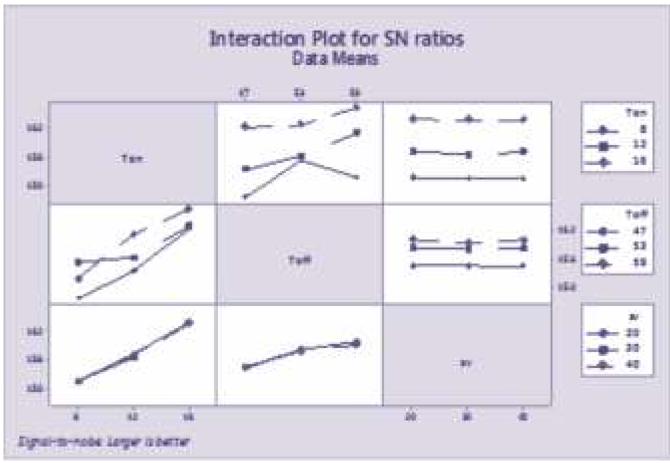

Fig: 5.3 Interaction graph between Ton, Toff and sv

6. CONCLUSION

The complete work focused to improve the performance parameter of the AISI D3 material. Which is presently used for making of die, lamination dies etc. in manufacturing process. The main aim of this is to increase the surface quality by reducing surface roughness and increase the material removal rate of the material and optimize the overall manufacturing cost of the product For accomplishing this purpose, all raw data are analyzed by using ANOVA which predict most significant parameter which decrease the performance parameter of the product and through Taguchi technique find most performance parameter of the operation by using Minitab 18. At that point three process parameter investigations were done. Subsequent to getting the last outcomes, a few ends were made and recorded in segment.

I. The investigation of wire electrical machining parameters to inspect the ideal mix to expand MRR and limit surface harshness (Ra) was done by utilizing Taguchi-based utility methodology during machining of D3 steel and established likewise as far in terms of signal to noise ratio.

II. The P On time and SV is the huge influencing parameters of MRR and Ra. This is a direct result because of expanded P On time and has higher terminal release vitality, causes additional dissolving and development of more profound pit on the machined confront surface.

7. FUTURE SCOPE

Additional studies can be done on the effect of different wire material and wire diameter on machining uniqueness of AISI D3 alloy steel. Additionally, the impact of Wire EDM system parameters at the residual stresses can be evaluated and optimize the set of process parameters to reduce the high residual.

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