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Multi Objective Optimization of Cutting Parameter in EDM Using Grey Taguchi Method

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Abstract: ***In present days non-conventional machining method plays an incredible role in producing industries. To attain the extremely correct, finished product with smart quality and to create the complex shapes, non-conventional machining like discharge machining (EDM) is employed to face up to the competition and to fulfill the stress within the trade. The parts of automotive industry, aerospace and surgical instruments can be finished by Electrical discharge machining. The target of this venture is to enhance the machining parameters in kick the die sinking EDM with a specific end goal to capable the best parameter to get the high MRR and low Surface Roughness (SR). In present the work piece is AISI 316 stainless steel material and Copper terminal with 9.9mm distance across are utilized to direct the trials by differing the control variables, for example, Discharge current (Ip), Pulse on time (Ton) and Duty cycle (%).Process reactions, for example, MRR and SR are resolved for each test run. With a base measure of experimentation Taguchi's L9 orthogonal exhibit (OA) is utilized to consider the reaction of control variables with fluctuating levels in commercial tool MINITAB 17. To get the improved results independently for process reactions, Taguchi single objective advancement is utilized. Grey Taguchi multi objective improvement method is utilized to focus the mix of ideal levels of control components.***

Keywords: EDM, MRR, SR,MINITAB 17,Grey Taguchi.

1. Introduction

EDM is among the earliest un conventional manufacturing process, having a beginning 50 years prior in a basic die sinking application. Any individual who has ever seen what happens when an electrical discharge strikes the ground will have a reasonable thought of the procedure of EDM. For a few decades, Electrical discharge machining (EDM) has been an essential assembling procedure for the instrument, mold, what's more, bite the dust commercial enterprises. It is currently progressively utilized inferable from its capacity to create geometrically complex shapes, too as its capacity to machine hard materials that are to a great degree hard to machine utilizing routine procedures. The anode is moved around the work piece until the hole is sufficiently little so that the awed voltage is sufficiently awesome to ionize the dielectric. Brief time releases are produced in a dielectric crevice, which isolates device and work piece. In spite of the fact that EDM is not influenced by material hardness and quality, it is much slower in examination with different preprocesses. To accelerate the procedure, a higher electrical Current release is needed, however simultaneously, the dimensional exactness and surface harshness of the item then turns out to be more terrible. The world market in the shape and bite the dust produce industry has get to be progressively focused. To meet necessities like short conveyance, excellent, and ease, the EDM framework must have the abilities of rapid, high exactness, and process strength. A Taguchi element test methodology is effective in building up a strong procedure plan with numerous quality attributes. Subsequently, the primary target of this study is an endeavor to apply the Taguchi dynamic strategy to enhance the EDM machining process for strength, high productivity, and high item dimensional

2. EDM Process Flow chart

The following fig shows the process parameters and process responses of EDM.

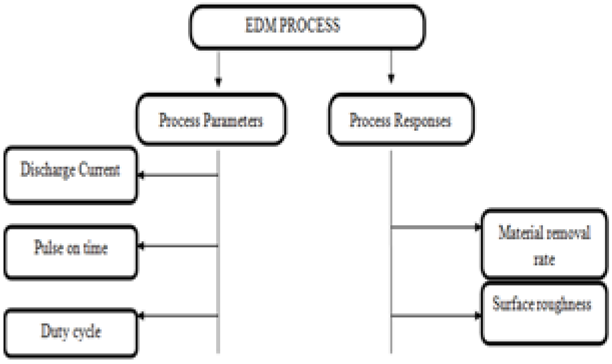

Figure 2.11: Process Parameters and process responses of EDM

3. Experimental Setup

The fig shows EDM machine experimental setup

Figure : EDM

Figure: Spark produced between tool and work piece during machining

4. Selection of Tool and Work piece Material

4.1 Work piece Material:

a. AISI 316 Stainless steel

The dimensions of the work piece were 316 SS size 150mm × 58mm × 12mm plate. Grade of SS 316 is a high chromium (16%to18%)steel alloy with high degree of corrosion resistance, hardness, strength and possesses magnetic property.

4.2 Tool Material

b. Copper electrode

While selecting tool material, it should not undergo much tool wear when it is impinged by positive ions. For machining of complex shapes, the tool should be easily workable.

5. Taguchi Technique

The taguchi technique was able to determine the levels and control variables.L9orthogonal array by using design of experiments.

S.NO	Design Factors	Symbol	Units	Levels		
				1	2	3
1	Discharge current(Ip)	D	Amp	6	8	10
2	Pulse on time(Ton)	E	Micro Sec(μsec)	100	150	200
3	Duty cycle(τ)	F	Percentage (%)	10	11	12

Table: Levels of process parameters

5.1 Material Removal Rate

It is the ratio of weight loss of the work piece plate before and after machining to machining time.

$$\text{MRR} = \frac{\text{weight loss}}{\text{machining time}} = \left(\frac{W_i - W_f}{t}\right) \text{gm/min}$$

Where W_i = initial weight before machining

W_f = final weight after machining

t = machining time

5.2 Surface Roughness

By using Mitutoyo Talysurf electronic device we can calculate surface roughness (Ra) values.

Figure: Mituyo Talysurf Equipment

Table: SS316 experimental results for MRR and SR

Run No.	Discharge current(D)	Pulse on time(E)	Duty cycle(F)	MRR	SR
1	6	100	10	0.1845	3.605
2	6	150	11	0.19142	3.875
3	6	200	12	0.3076	4.4
4	8	100	11	0.1985	5.3
5	8	150	12	0.4598	5.2
6	8	200	10	0.3745	5.25
7	10	100	12	0.5324	6.1
8	10	150	10	0.4185	6.53
9	10	200	11	0.6832	6.81

6. Grey Taguchi Method

The following fig shows steps of Grey Taguchi Method

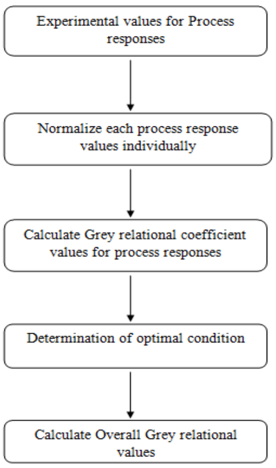

Figure: Procedure of Grey-Taguchi technique

6.1 Normalization of Experimental results

The normalization of experimental results of MRR and SR. Each value is normalized in the range of 0to 1.

$$X_i(M)=\frac{Y_i(M)-\min Y_i(M)}{\max Y_i(M)-\min Y(M)} \longrightarrow (1)$$

$$X_i(M)=\frac{\max Y_i(M)-Y_i(M)}{\max Y_i(M)-\min Y_i(M)} \longrightarrow (2)$$

Where,

$X_i(M)$ = value after normalizing data/Grey relational generation value.

Min $Y_i(M)$ = smallest value of $Y_i(M)$ for M^{th} response.

Max $Y_i(M)$ = largest value of $Y_i(M)$ for M^{th} response.

Table: Normalized data for MRR and SR

Run No.	Normalized Values	
	Material removal rate(MRR)	Surface Roughness(SR)
1	0	1
2	0.0138	0.9158
3	0.2468	0.7519
4	0.0280	0.4711
5	0.5520	0.5023
6	0.3809	0.4867
7	0.6976	0.2215
8	0.4692	0.2462
9	1	0

6.2 Grey Relation Coefficient

The calculation of grey relational coefficient values for MRR and SR.The following grey relation coefficient can be used to calculate MRR and SR.

$$\varepsilon_i(M)=\frac{\Delta_{min}+\varphi\,\Delta_{max}}{\Delta_{oi}(M)+\varphi\,\Delta_{max}} \longrightarrow (3)$$

Where Δ_{0i}=quality loss function= $\Delta_{0i}(M)$ = [X oi (M)- Xi (M)], Δ_{min} and Δ_{max} are the minimum and maximum values of the differences of Δ_{0i}. Values of Ψ lie between 0 to1. The considerable value of Ψ is0.5

Table: Grey relational coefficient for MRR and SR

Run No.	Grey Relational Coefficient values	
	MRR	SR
1	0.3333	1
2	0.3364	0.8558
3	0.3989	0.6683
4	0.3396	0.4859
5	0.5274	0.5011
6	0.4467	0.4934
7	0.6231	0.3910
8	0.4850	0.3539
9	1	0.3333

6.3 Grey relational grade and order

By averaging the gray relative coefficients akin to the performance characteristics, the gray relative grade is calculated. By exploitation the gray relative grade, the multi objective responses ar regenerate into single response.

$$\text{Grey relational garde } (\gamma_i)=\frac{1}{n}\sum_{M=1}^{n}\varepsilon_i(M) \longrightarrow (4)$$

Where n=number of responses, $\varepsilon_i(M)$ = Grey relational coefficient.

Table: Grey relational grade and order

Exp No.	Grade	Order
1	0.6667	2
2	0.5961	3
3	0.5336	4
4	0.4126	9
5	0.5142	5
6	0.4700	7
7	0.5070	6
8	0.4194	8
9	**0.6767**	**1**

6.4 Response table for SR

The average of each process parameters(Means and S/N ratio) for each response at each level. In response tables, ranks square measure allotted for method parameters supported the delta values. The delta value is that the distinction of highest and lowest average values of every method parameter. The rank indicates the importance of every issue on the response. The ranks and delta values shows that Pulse on time have high result on MRR and SR and is followed by Discharge current and duty cycle.

Table: Response table for grey relational grade(means)

Level	Discharge Current (D)	Pulse on time(E)	Duty cycle (F)
1	0.5988	0.5288	0.5187
2	0.4656	0.5099	0.5585
3	0.5310	0.5568	0.5183
Delta	0.1332	0.0469	0.0402
Rank	1	2	3

Table: Response table for grey relational grade(S/N ratios)

Level	Discharge Current (D)	Pulse on time(E)	Duty cycle (F)
1	-4.490	-5.704	-5.876
2	-6.675	-5.939	-5.235
3	-5.656	-5.178	-5.711
Delta	2.185	0.761	0.641
Rank	1	2	3

6.5 Analysis of multi objective optimization:

ANOVA table was obtained by execute the Analysis of variance (ANOVA) in Minitab17 tool. This analysis is distributed for a significance level of α=0.05, i.e. for a confidence level of 95%. Sources with a P-value but zero.05 were thought-about to own a statistically vital contribution to the performance measures. and therefore the higher F-ratio shows additional result and additional contribution of input parameter on grade. The magnitude relation between the mean sq. factors to the mean sq. errors is named F-ratio.

Table: ANOVA for Grey relational grade

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value	% Contribution
D	2	0.026616	0.013308	0.68	0.594	36.89
E	2	0.00336	0.001668	0.09	0.921	4.57
F	2	0.003198	0.001599	0.08	0.924	4.29
Error	2	0.038970	0.019485			54.03
Total	8	0.072120				

It is observed that Pulse on time has the higher percentage of contribution i.e. 36.89% on grade. And discharge current (4.57%), duty cycle (4.29%) has no significant effect on grade.

Figure: Main effect plot for Grey relational grade (Means)

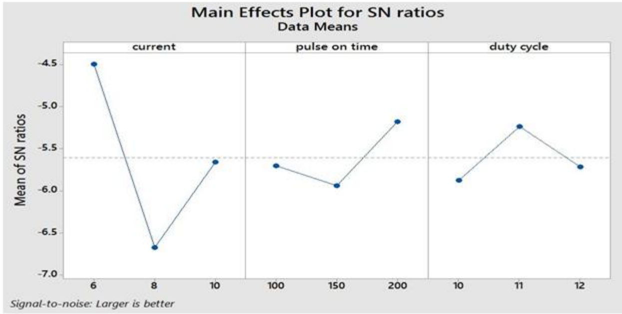

Figure: Main effect plot for Grey relational grade(S/N ratio)

As grade implies 'higher the better' kind response, it are often seen from the most impact plots five.3 that the third level of discharge current (D3), initial level of pulse on time (E1) and second level of duty cycle (F2) provides highest value of grade. The S/N quantitative relation plot (figure five.4) additionally suggests constant best condition i.e. D1E3F2 because the best optimal condition for getting most MRR and minimum SR in EDM method.

7. Conclusion

In the earlier chapters, the consequences of process parameters on process responses of the discharge machining (EDM) method are mentioned and additionally best setting of method parameters has been obtained for max MRR and minimum SR individually at the same time. The vital conclusions from this work square measure summarized as follows:

- The optimum set of method parameters ar known for achieving most MRR and minimum SR using Taguchi technique is as follows:
- The optimum setting of for achieving most MRR is D3 E3 F3 i.e. discharge current of ten Amp, pulse on time of two hundred µ sec and duty cycle of twelve the concerns.
- The optimum setting for achieving minimum SR is D1 E1 F1 i.e. discharge current of six Amp, pulse on time of a hundred µ sec and duty cycle of ten the concerns.
- Grey Taguchi optimization technique is utilized to getting most MRR and minimum SR at the same time. By conducting analysis of variance, it may be determined that Pulse on time is that the additional effecting parameter compared to discharge current and duty cycle.

References

[1] Vikas, kaushik Kumar, Apurba Kumar Roy, "Effect and optimization of various machine process parameters on the Surface roughness in EDM for an EN 41 material using Grey Taguchi". 3rd international conference on Material processing and characterization (ICMPCV2014), Procedia material science 6(2014) 383-390.
[2] Raghuraman S., Thiruppathi K., Panneerselvam T., Santos S, "Optimization of EDM parameters using Taguchi method and Grey Relational analysis for mild steel is 2026" International journal of Innovative research in science, engineering and technology vol. 2, issue 7, July 2013.
[3] Shashikanth, Apurba Kumar Roy, Kaushik Kumar, "Effect and optimization of various machine process parameters on the Surface Roughness in EDM for an

EN19 material using Response surface methodology" International conference on advanced in manufacturing and materials engineering, AMME 2014, Procedia material science 5(2014) 1702-1709.

[4] Jadi Laxman and Kotakonda Guru Raj. "Optimization of electric discharge machining process parameters using Taguchi technique" International journal of advanced mechanical engineering .ISSN 2250-3234 Volume 4, Number 7(2014), pp.729-739.

[5] Ayush Poddar and Dr.K.Biswash, "Experimental investigation of MRR, Surface roughness and overcut Of AISI 304 stainless steel in EDM" international journal of engineering science and technology, vol. 2(8), 2010, 3535-3550.

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