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EXPERIMENTAL INVESTIGATION AND OPTIMIZATION OF CONVENTIONAL DRILLING PROCESS PARAMETERS ON ALUMINIUM ALLOY 7075 MATERIAL TROUGH FUZZY - TAGUCHI METHOD

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Abstract: This paper focuses on the optimization of drilling process parameters using the Fuzzy-Taguchi technique to obtain minimum surface roughness (Ra) and maximum Material Removal Rate (MRR). A number of drilling experiments were conducted using the L9 Orthogonal Array on a conventional machining center. The experiments were conducted on Aluminium Alloy 7075 material blocks using three types of drill bits under wet cutting conditions. A Design of Experiment was employed to determine the most significant control the factors affecting the Surface Roughness and Material Removal Rate. The Cutting Tool, Cutting Speed and Coolant were selected as the control factors. After the nine experimental trails, the most significant factor on the surface roughness and the material removal rate was found

Key words: Optimization, MRR, Ra, Fuzzy – Taguchi Technique

1. Introduction

Aishah Najiah Dahnel, Mohamad noor Ikhwan Naiman carried out a study on drilling of 7075 Aluminum Alloys. Cutting speed and feed rate was considered as input parameters and the output parameters are surface roughness and tool wear. It is observed that at high cutting speed and feed rate they got the better results and the coolants are used to reduce the tool wear[1]. Muhammad Aamir, ShanShan Tu, Majid Tolouei-Rad, Khaled Giasil and Ana Vafadar employed Fuzzy logics and Taguchi method is employed to obtain better surface roughness and hole size on Al5083. The drilling used is one shot drilling and multi hole drilling with poly drill head. The Regression analysis and Analysis of Variance (ANOVA) were applied. And fuzzy logic technique was employed for the prediction of surface roughness and hole size[2].

Natasha A.Raof, Nor Khai Russhima MK and Suhaily Mokhtar investigated the effect of cutting parameters on tool wear in drilling Aluminium 7075. The cutting speed taken in range of 4000-8000 RPM and the feed rates are 0.01 to 0.10 mm/rev. After drilling holes it is observed that lower cutting speed (4000 RPM) results low tool wear (0.024 mm) and higher cutting speed(8000 RPM) results in maximum tool wear (0.12 mm). then it is recommended to use low cutting speeds on drilling AA 7075 material[3]. Shahed, mahamud and Md.Ariful islam carried out a study on optimum drilling parameters for Al alloy combination for the minimum adverse effect on the drilled hole. The process considering the effect of drilling parameters such as spindle speed, feed rate, cutting environment and cutting edge angle on the material removal rate (MRR) and surface roughness based on L-9 orthogonal array (OA), S/N ratio, Annova and

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regression analysis were accustomed by using taguchi based grey relational analysis and full factorial analysis. By analysed they have found that the effect of surface roughness of cutting edge angle(118 deg), feed rate (0.1 mm/rev), Speed (670 rpm)[4]. Norfarah Huda abd Halim, Aishah Najiah Dahnel has carried out the effect of cutting parameters and cutting condition when drilling in terms of tool wear, surface roughness and hole circularity (cutting parameters are feed rate, cutting speed and cutting condition). This approaches the results high speed steel tool with diameter of 6mm with point angle 118 deg and feed rate of 0.15 mm/rev. The tool wear, surface roughness and hole diameter are mostly influenced by the cutting speed and cutting condition. Lower cutting speed of 22 m/min and the usage of cutting fluid with given improved results for the tool wear and surface roughness. It concludes that use of lower cutting speed and cutting fluid is preffered to produce a better hole during drilling process[5]. C.Venkatesha, N.M.Arunb , R.Venkatesan employed Taguchi coupled Fuzzy Logic to optimize the machining time during micro drilling of B4C/Al composite with help of micro electrochemical machine. The Taguchi method of experimental design was used to obtain the optimum process parameters. Additionally, the experimental data were optimized through unconventional optimization tool of fuzzy logic[6]. C. Manickam , N. Parthipan analyzed the values of the different input parameters like Cutting speed, Feed rate, and Type of drill bit using Taguchi method to ensure that the MRR, Surface Roughness, are best for the performance of the given workpiece and tools. ANOVA was used to study the degree of consequence of the different parameters for the different set of calculation[7].

2. Material and Methodology

Aluminium 7075 is a type of aluminium alloy that is generally used in various applications because of its high strength-to-weight ratio and resistance to fatigue. The number "7075" refers to the specific alloy within the 7000 series of aluminium alloys. Aluminium 7075 is composed mainly of aluminium, with small amounts of zinc, copper, magnesium, and chromium. It is known for its high strength, which makes it suitable for use in applications that require a material with high structural integrity. The alloy is also known for its excellent fatigue resistance, which means that it can withstand repeated stress and strain cycles without failing.

Table 2.1 Mechanical Properties

Property	Value
Tensile strength	572 MPa
Yield strength	503 MPa
Modulus of elasticity	71 GPa
Shear strength	331 MPa
Fatigue strength	159 MPa
Poisson's ratio	0.33

Table 2.2 Chemical Composition

S.No	Elements	Chemical Composition(%)
1	Zinc(Zn)	5.6
2	Magnesium(Mg)	2.5
3	Copper(Cu)	1.5
4	Manganese(Mn)	0.04
5	Iron(Fe)	0.3
6	Silicon(Si)	0.08
7	Aluminium(Al)	Remaining

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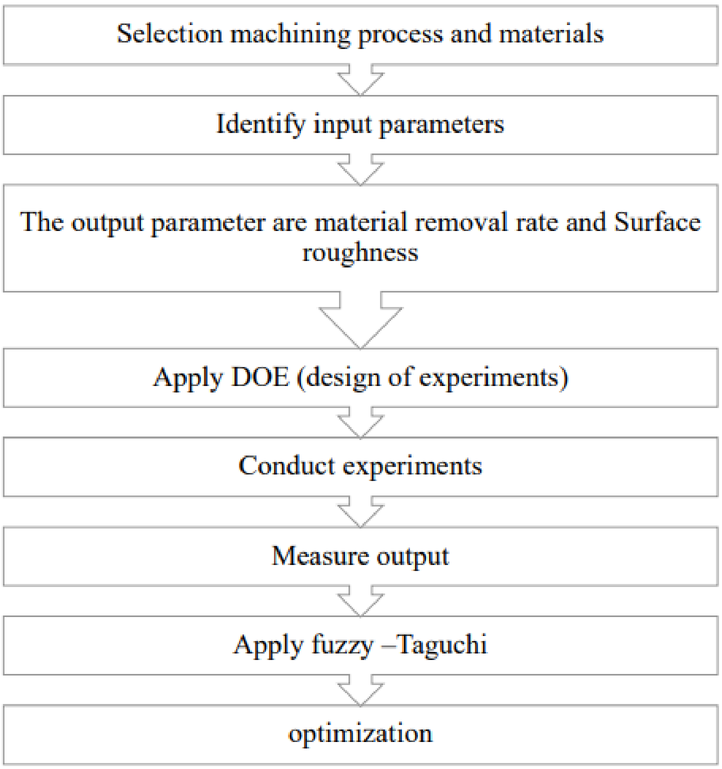
2.1 OBJECTIVE:

1. To obtain a better surface finish
2 To improve Material Removal Rate (MRR)
3 To increase productivity

2.3 Methodology:



2.4 Experimental Setup:

Table 2.1 Experimental Setup

Cutting Speed	Coolant type	Type of Drill bit
1000	water	HSS + TiN
1000	Diesel + Paraffin oil	HSS
1000	Oil	Carbide Tipped
1400	water	HSS
1400	Diesel + Paraffin oil	Carbide Tipped
1400	Oil	HSS + TiN
1800	water	Carbide Tipped
1800	Diesel + Paraffin oil	HSS + TiN
1800	Oil	HSS

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2.5 Optimization:

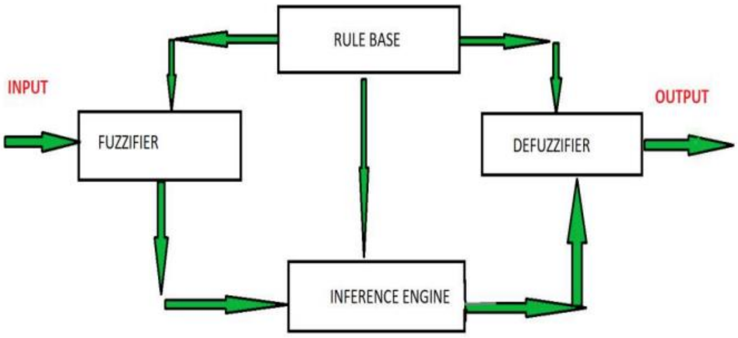

Figure 2.2.1 Fuzzy Logic Architecture

2.6 Normalization:

To make data easier to compare and analyse, normalisation values are used to bring data within a specific range, usually between 0 and 1. When a variable is normalised, its values are scaled to fall between a range of 0 and 1, depending on the variable's minimum and maximum values. When "Higher is better" is a characteristic of the original sequence, then the original sequence is

$$\text{Normalized value} = \frac{Xi - Min(Xi)}{Max(Xi) - Min(Xi)}$$

When "Lower is better" is a characteristic of the original sequence, then the original sequence is

$$\text{Normalized value} = \frac{Max(Xi) - Xi}{Max(Xi) - Min(Xi)}$$

3 Results and Discussion:

Table 3.1 Response Table with S/N ratio values

S.No	Cutting Speed	Type of Coolant	Type of Drill bit	MRR	Ra	SNRA1	SNRA2
1	1000	Water	HSS + TiN	1653.45	3.981	64.36782	-11.9998
2	1000	Diesel + paraffin oil	HSS	1518.58	3.64	63.62875	-11.222
3	1000	Oil	Carbide Tipped	1648.93	3.864	64.34404	-11.7407
4	1400	Water	HSS	1782.44	4.141	65.0203	-12.3421
5	1400	Diesel + paraffin oil	Carbide Tipped	1533.24	2.878	63.7122	-9.18182
6	1400	Oil	HSS + TiN	1675	4.288	64.4803	-12.6451
7	1800	Water	Carbide Tipped	1824.5	4.478	65.22288	-13.0217
8	1800	Diesel + paraffin oil	HSS + TiN	1890.84	4.576	65.5331	-13.2097
9	1800	Oil	HSS	1978.93	4.797	65.92861	-13.6194

From Taguchi we get the S/N values then the normalization values are calculated for these S/N values. The normalized values of MRR and Ra are taken as input for Fuzzy logic and MPCI is the output obtained from the Fuzzy Logics.. For MPCI values larger is better and minimum is worst.

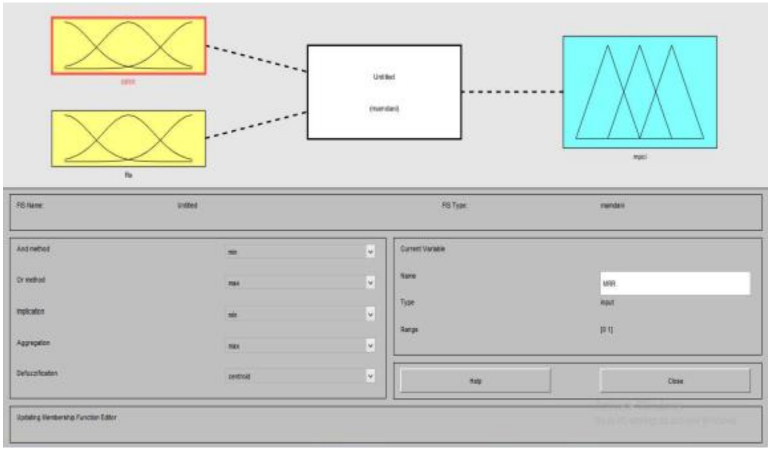

Figure 3.1 Fuzzy logic Designer

For initial fuzzy logic design, the triangular membership functions for MRR, Ra and MPCI which 3 levels as high, medium and low which indicates the triangular MFs was selected

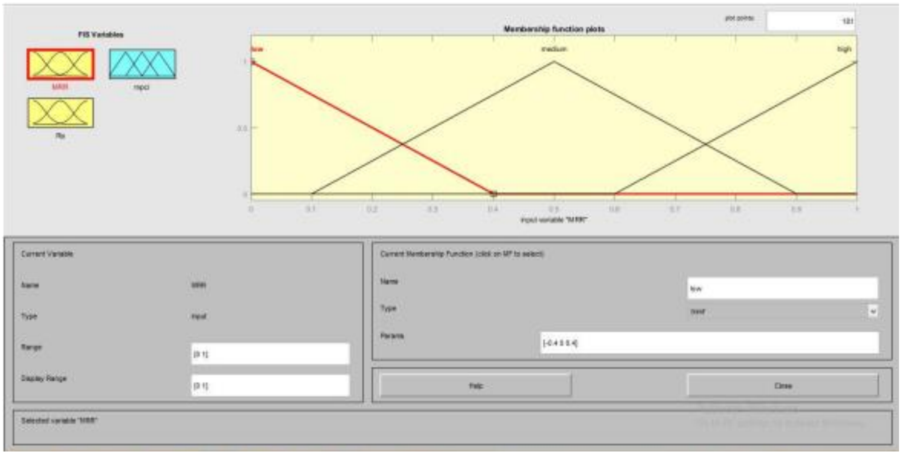

Figure 3.2 Membership Functions for MRR

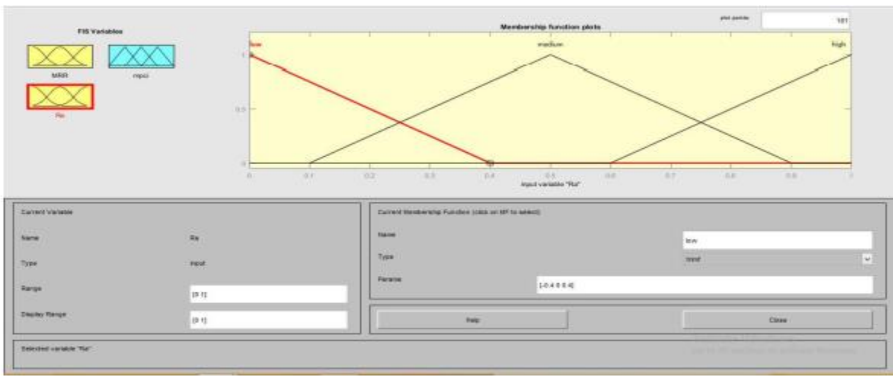

Figure 3.3 Membership Functions for Ra

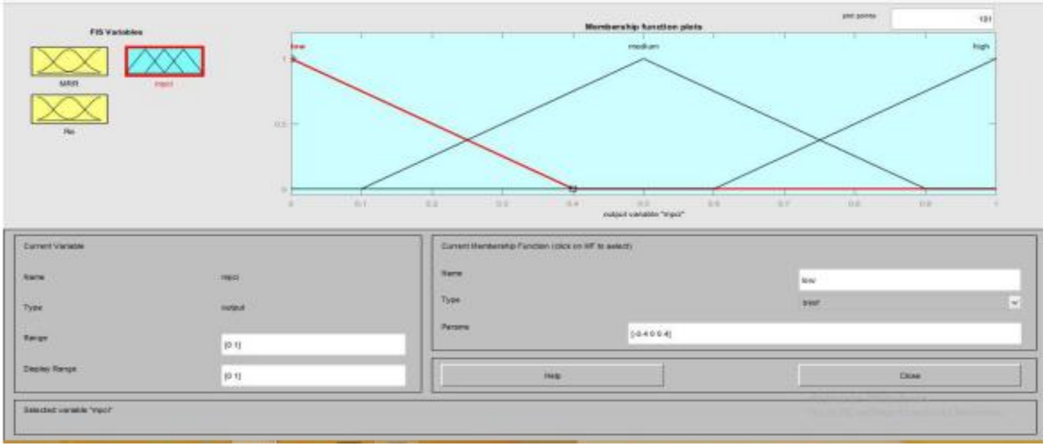

Figure 3.4 Membership Functions for MPCI

After selecting and applying the member ship functions rules are written in the rule editor of the fuzzy logic for MPCI

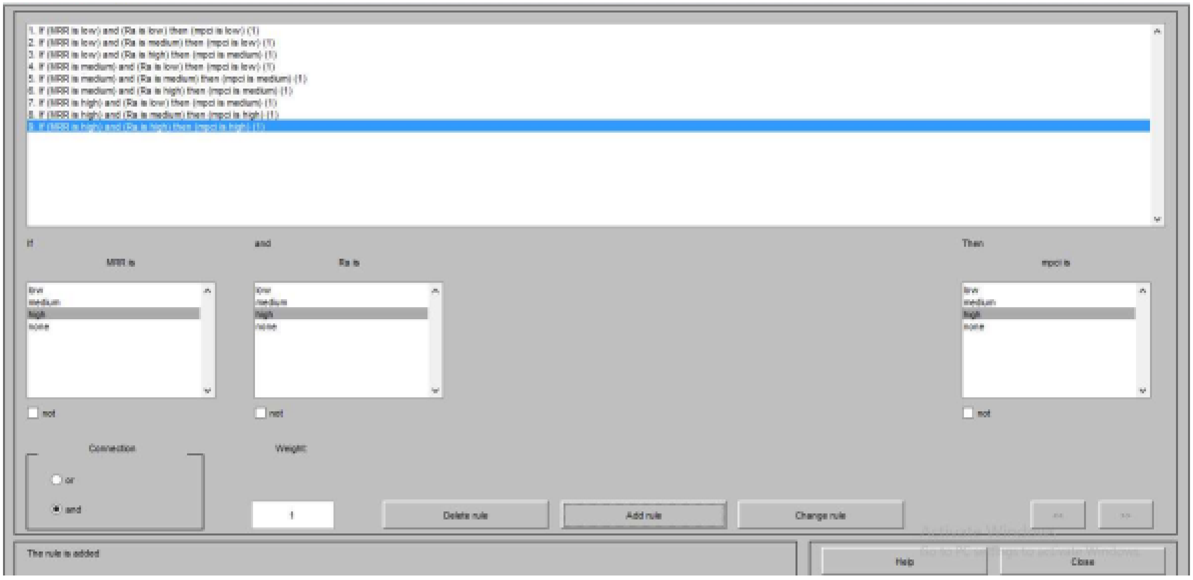

Figure 3.5 Rule Editor

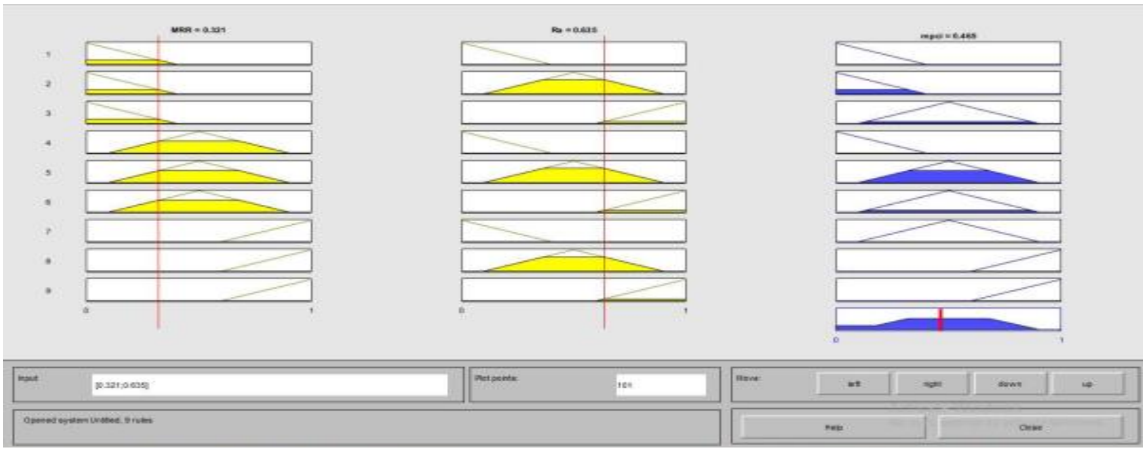

Figure 3.6 Rule Viewer

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The normalized values of MRR and Ra are given as input in the space provided in the rule viewer from this the MPCI values are extracted

Table 3.2 Normalized values of MRR, Ra and MPCI

S.No	MRR	Ra	MPCI
1	0.321	0.635	0.464
2	0.000	0.459	0.132
3	0.310	0.576	0.458
4	0.604	0.712	0.502
5	0.036	0.000	0.131
6	0.370	0.780	0.486
7	0.693	0.865	0.544
8	0.828	0.907	0.688
9	1.000	1.000	0.870

These MPCI values are again taken as input for Taguchi method. From this the S/N ratio for MPCI values are calculated and finallay the optimized values are obtained from Taguchi method

Table 3.3 S/N ratio values of MPCI

S.NO	MPCI	S/N-MPCI
1	0.464	-6.66964
2	0.132	-17.5885
3	0.458	-6.78269
4	0.502	-5.98593
5	0.131	-17.6546
6	0.486	-6.26727
7	0.544	-5.28802
8	0.688	-3.24823
9	0.87	-1.20961

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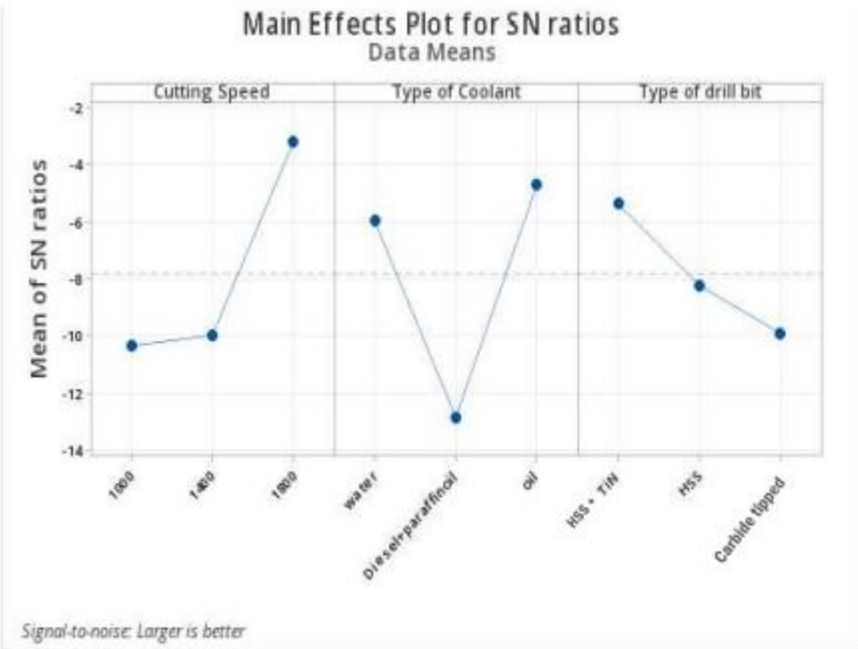

Figure 3. 7 MPCI Plot for Means and S/N ratios

4 Conclusions

The response from the Taguchi method are defined to predict the output parameters which are Surface Roughness (Ra) and MRR. The input parameters like cutting speed, type of drill bit and coolant type which influence the output parameters are identified.

Taguchi design provides the optimal conditions for process (input) parameters

- The Ra values should be low, from this work, it is find that, the best suited sequence for this is Cutting Speed-1400rpm, drill bit type – Carbide Tipped and Coolant-diesel + paraffin oil
- The MRR value should be high, from this work, it is find that, the best suited sequence for this is Cutting Speed-1800rpm, drill bit type – HSS and Coolant: Oil

  Fuzzy logic is applied to find the better sequence in which the Ra value is low and MRR value is high
- For low Ra and high MRR, we identified the results are: Cutting Speed-1800rpm, drill bit type – HSS + TiN and Coolant – oil

References

1. Aishah Najiah Dahnel, Mohamad Noor Ikhwan Naiman, Muhammad Azim Mirza Mohd Farid, Ahmad Faris Abdul Rahman, Nur Munirah Meera Mydin, Drilling of 7075 Aluminium Alloys – 2022
2. Muhammad Aamir, ShanShan Tu, Majid Tolouei-Rad, Khaled Giasil and Ana Vafadar, Optimization and Modelling of Process Parameters in Multi-hole Simultaneous Drilling Using Taguchi Method and Fuzzy Logic Approach – 2020

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11 Iss 10, 2022

3. Nur Munirah Binti Meera Mydin, Aishah Najiah Binti Dahnel, Natasha A.Raof, Nor Khairusshima MK, Suhaily Mokhtar, The Effect of Cutting Parameters on Tool Wear in Drilling Aluminium 7075 – 2020
4. C. Manickam, N.Parthipan, Optimization of drilling parameters in AISI SS317L stainless steel material using Taguchi methodology – 2019
5. C.Venkatesh, N.M.Arun, R.Venkatesan, Optimization of micro drilling parameters of B4C DRMM Al 6063 composite in μECM using Taguchi coupled Fuzzy Logic – 2014
6. U.Vishnuja, G.B.Bhaskar, Study on AISI1045 Material for Various Applications: An over View – 2018
7. Norbert geier, Tibor szalay, Optimization of process parameters for the orbital and conventional drilling of uni-directional carbon fibre-reinforced polymers (UD-CFRP) – 2017
8. Z. Sultana, Safian Sharifb, Denni Kurniawan, Effect of Machining Parameters on Tool Wear and Hole Quality of AISI 316L Stainless Steel in Conventional Drilling – 2015
9. K. Anand Babu, G. Vijaya Kumar and P. Venkataramaiah, Prediction of Surface Roughness in Drilling of Al 7075/10% - SiCp Composite under MQL Condition using Fuzzy Logic – 2015
10. Shahed Mahmud, Md.Ariful Islam, Md.Shohel Rana, and Md.Mosharraf Hossain, Optimization of Drilling Parameters Using Taguchi-Based Grey Relational Analysis and Full Factorial Analysis
11. Erol Kilickap & Mesut Huseyinoglu & Ahmet Yardimeden, Optimization of drilling parameters on surface roughness in drilling of AISI 1045 using response surface methodology and genetic algorithm
12. Eyup Bagci & Babur Ozcelik, Analysis of temperature changes on the twist drill under different drilling conditions based on Taguchi method during dry drilling of Al 7075- T651