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OPTIMIZATION OF SURFACE ROUGHNESS, CIRCULARITY DEVIATION AND SELECTION OF DIFFERENT ALLUMINIUM ALLOYS DURING DRILLING FOR AUTOMOTIVE AND AEROSPACE INDUSTRY

Reddy Sreenivasulu
R.V.R&J.C College of Engineering (A), India
E-mail: rslu1431@gmail.com

Chalamalasetti SrinivasaRao
College of Engineering (A), Andhra University, India
E-mail: csr_auce@yahoo.co.in

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ABSTRACT

This paper presents the influence of cutting parameters like cutting speed, feed rate, drill diameter, point angle and clearance angle on the surface roughness and circularity deviation of Alluminium alloys during drilling on CNC vertical machining center. A plan of experiments based on Taguchi method has been used to acquire the data. An orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are employed to investigate machining characteristics of Alluminium alloys using HSS twist drill bits of variable tool geometry and maintain constant helix angle of 45 degrees. Confirmation tests have been carried out to predict the optimal setting of process parameters to validate the proposed approach and obtained the values 3.7451µm, 0.1076 mm for surface roughness and circularity deviation respectively. Finally, the output results of Taguchi method fed as input to the AHP and TOPSIS. The results generated in both AHP and TOPSIS suggests the suitable alternative of aluminum alloy, which results in better surface roughness and less error in circularity.

***Keywords**: Alluminium Alloys, Drilling, Taguchi method, S/N ratio, ANOVA, AHP, TOPSIS*

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1. INTRODUCTION

The surface quality is an important parameter to evaluate the productivity of machine tools as well as machined components. Hence, achieving the desired surface quality is of great importance for the functional behavior of the mechanical parts. A reasonably good surface finish is desired for improving the tribological properties, fatigue strength, corrosion resistance and aesthetic appeal of the product.

Excessively better surface finish may involve more cost of manufacturing. The surface roughness and roundness error are affected by several factors including cutting tool geometry, cutting speed, feed rate, the microstructure of the work piece and the rigidity of the machine tool. These parameters affecting the surface roughness and drilled hole qualities (roundness, cylindricality and hole diameter) can be optimized in various ways such as Taguchi method.

A number of Researchers have been focused on an appropriate prediction of surface roughness and roundness error. The Taguchi method has been widely used in engineering analysis and is a powerful tool to design a high quality system. Moreover, the Taguchi method employs a special design of orthogonal array to investigate the effects of the entire machining parameters through the small number of experiments.

Baychi et al. (1993) and Phadke (1989) discussed the application of Taguchi method in several industrial fields, and research works in their text books. By applying this Taguchi technique, the time required for experimental investigations can be significantly reduced, as it is effective in the investigation of the effects of multiple factors on performance as well as to study the influence of individual factors to determine which factor has more influence, which one less.

Chen and Hwang (1992) mentioned in their lecture notes applicability of fuzzy techniques in decision making systems.

Korkut et al. (2010) also applied Taguchi method to determine circularity deviation in bored hole experimentally. Yang and Chen (2001) used the Taguchi parameter design in order to identify optimum surface roughness performance on an aluminum material with cutting parameters of depth of cut, cutting speed, feed rate and tool diameter. It was found that tool diameter is not a significant cutting factor affecting the surface roughness.

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Davim and Reis (2003) presented an approach using the Taguchi method and ANOVA to establish a correlation between cutting speed and feed rate with the de lamination in a composite laminate. A statistical analysis of hole quality was performed by Furness, Wu and Ulsoy (1996). They found that feed rate and cutting speed have a relatively small effect on the measured hole quality features. With the expectation of hole location error, the hole quality was not predictably or significantly affected by the cutting conditions.

Tsao and Hocheng (2008) performed the prediction and evaluation of thrust force and surface roughness in drilling of composite material. The approach used Taguchi and the artificial neural network methods. The experimental results show that the feed rate and the drill diameter are the most significant factors affecting the thrust force, while the feed rate and spindle speed contribute the most to the surface roughness.

Yang and Chen (2001) performed a study of the Taguchi design application to optimize surface quality in a CNC face milling operation. Taguchi design was successful in optimizing milling parameters for surface roughness.

Nalbant, Gokkaya and Sur (2007) utilized the Taguchi technique to determine the optimal cutting parameters for surface roughness in turning of AISI 1030 steel with Ti N coated inserts.

Risbood et al. (2003) also applied Taguchi Method to predict the surface roughness and dimensional deviations experimentally.

Three cutting parameters such as insert radius, feed rate, and depth of cut, are optimized for minimum surface roughness. Kurt, Bagci and Kaynak (2009) employed the Taguchi method in the optimization of cutting parameters for surface finish and hole diameter accuracy in dry drilling processes. The validity of the Taguchi approach to process optimization was well established.

The objective of this study is to investigate the effects of the drilling parameters on surface roughness and circularity error, and is to determine the optimal drilling parameters using the Taguchi method later the results fed to multiple attributes in decision making techniques (AHP and TOPSIS) are applied to optimal selection of Aluminum alloys during drilling process.

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1.1. Multi-Attribute Decision Making Technique:

Decision making is the study of identifying and choosing alternatives based on the values and preferences of the decision maker. Making a decision implies that there are alternative choices to be considered, and in such a case, not only as many of these alternatives as possible are identified but also the best one is chosen to meet the decision maker’s goals, objectives, desires, and values.

Thus, every decision making process produces a final choice. The selection decisions are complex, as decision making is more challenging now a days. For obtaining the best decision in conjunction with the real-time requirements, a number of MADM approaches are available. MADM methods (OLSON, 2004; SAATY, 2000) are generally discrete, with a limited number of pre-specified alternatives.

These methods require both intra and inter-attribute comparisons, and involve explicit tradeoffs that are appropriate for the problem considered. Most commonly used MADM approaches (YOON et al., 1995) are weighted sum method (WSM), weighted product method (WPM), Analytic hierarchy process (AHP), Technique for order preference by similarity to ideal solution (TOPSIS), and Compromise ranking method (VIKOR), Graph theoretic approach (GTA).

The main objective of this paper is to explore the basic concepts of MADM methods. From the literature it is clear that Analytic hierarchy process (AHP), Technique for order preference by similarity to ideal solution (TOPSIS) approach as a decision making method is relatively new, and offers a generic, simple, easy, and convenient decision making method that involves less computation.

1.2. Back ground of Aluminum Alloys:

At present, alluminium is used in the aviation industry everywhere in the world. The casing of the first Soviet satellite was made of aluminum alloys. The body casing of American ‘Avant-garde’ and ‘Titan’ rockets used for launching the first American rockets into the orbit, and later on – spaceships, was also made of aluminum alloys.

They are used for manufacturing various components of spaceship equipment: brackets, fixtures, chassis, covers and casing for many tools and devices. Alluminium alloys have a certain advantage for creating space equipment units. High values of

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specific strength and the specific rigidity of the material enabled the tanks, inter-tank and casing of the rocket to be manufactured with high longitudinal stability.

The advantages of alluminium alloys also include their high performance under cryogen temperatures in contact with liquid oxygen, hydrogen, and helium. The so-called cryogen reinforcement happens in these alloys, i.e. the strength and flexibility increase parallel to the decreasing temperature. Engineers and manufacturers never cease to study the properties of alluminium, developing more and more new alloys for construction of aircraft and spaceships. 2xxx, 5xxx, 6xxx, and 7xxx series alloys are widely used in automotive and aviation industries.

2. Experimental Procedure:

2.1. Material

Alluminium 2014, 6069, 6061, and 7075 alloys used in the aircraft and automotive components, marine fittings, bicycle frames, camera lenses, brake components, electrical fittings and connectors, valves, couplings etc.

The composition of Alluminium alloy 2014 consists of Chromium: 0.1%, Copper: 3.9% - 5%, Iron: 0.5% ,Magnesium: 0.2% - 0.8%,Manganese: 0.4 - 1.2%, Silicon: 0.5% - 0.9Titanium: 0.15%, Titanium : 0.2% Zinc: 0.25% and remaining is alluminium.

The composition of Alluminium Alloy 6069 consists of Magnesium (Mg) 1.2 - 1.6%, Si 0.6 - 1.2%, Copper 0.55 - 1.0%, Vanedium 0.1 - 0.3 %, Cr 0.05 - 0.3%, Titanium- 0.1% , Iron - 0.4%, Manganese - 0.05%, Zinc - 0.05%, Strancium - 0.05%.

The composition of Alluminium alloy 6061consists of 0.63% Silicon, 0.096% Copper, 0.091% Zinc, o.466% Iron, 0.179% Manganese, 0.53% Magnesium, 0.028% Titanium, 0.028% Chromium, and remaining alluminium.

The composition of Alluminium alloy 7075 consists of Alluminium (Al) 87.2 to 91.4 %, Zinc (Zn)5.1 to 6.1 %,Magnesium (Mg)2.1 to 2.9 %, Copper (Cu)1.2 to 2.0 %, Iron (Fe)0 to 0.5 %, Silicon (Si)0 to 0.4 %, Manganese (Mn)0 to 0.30 %, Chromium (Cr)0.18 to 0.28 %, Zirconium (Zr)0 to 0.25 %, Titanium (Ti)0 to 0.2 %, Residuals 0 to 0.15 %. In this study 600x50x10mm rectangular bar was used.

2.2. Schematic machining:

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In this study, the experiments were carried out on a CNC vertical machining center (KENT and ND Co. Ltd, Taiwan make) shown in Figure.1 to perform different size of holes on Alluminium 2014, 6069, 6061, and 7075 alloy work pieces by alter the point and clearance angles on standard HSS twist drill bits and maintain constant helix angle of 45 degrees. Furthermore the cutting speed (m/min), the feed rate (mm/rev) and percentage of cutting fluid mixture ratio are regulated in this experiment.

Figure 1: Drilling of Aluminum alloys

Figure 2: Alteration of drill tool geometry using Tool and Cutter grinder

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Figure3: Coordinate Measuring Machine and surface analyser of Talysurf 50

2.3. Measuring Apparatus

After drilling on all Alluminium alloy work pieces, the surface roughness(R1) and circularity deviation(R2) of drilled holes measured by a surface analyzer of Talysurf 50 (Taylor Hobson Co Ltd) and coordinate measuring machine (CMM) respectively.

3. MOTIVATION OF THE PRESENT WORK

3.1. Methodology

The orthogonal array forms the basis for the experimental analysis in the Taguchi method. The selection of orthogonal array is concerned with the total degree of freedom of process parameters. Total degree of freedom (DOF) associated with five parameters is equal to 10 (5X2).

The degree of freedom for the orthogonal array should be greater than or at least equal to that of the process parameters. There by, a L27 orthogonal array having degree of freedom equal to (27-1) 26 has been considered, which is used to optimize the cutting parameters for surface roughness and circularity deviation using the S/N ratio and ANOVA for machining of Alluminium alloys of 2014,6069,6061,7075 and predicted results were nearer to the experimental results.

Although similar to design of experiment (DOE), the Taguchi design only conducts the balanced (orthogonal) experimental combinations, which makes the Taguchi design even more effective than a fractional factorial design. By Taguchi techniques, industries are able to greatly reduce product development cycle time for design and production, therefore reducing costs and increasing profit.

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Confirmation test have been carried out to compare the predicted values with the experimental values confirm its effectiveness in the analysis of surface roughness and circularity deviation. Later the results fed to multiple attributes in decision-making techniques (AHP and TOPSIS) are applied to optimal selection of Alluminium alloys during drilling process.

3.2. Experimentation as per Taguchi method

A plan of experiments based on Taguchi technique has been used to acquire the data. An orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are employed to investigate the drilling characteristics of Aluminum alloys using HSS twist drill bits. The complete procedure in Taguchi design method can be divided into three stages: system design, parameter design, and tolerance design.

Of the three design stages, the second stage – the parameter design – is the most important stage. Taguchi's orthogonal array (OA) provides a set of well-balanced experiments (with less number of experimental runs), and Taguchi's signal-to-noise ratios (S/N), which are logarithmic functions of desired output in the optimization process. Taguchi method uses a statistical measure of performance called signal-to-noise ratio.

The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (Signal) to the standard deviation (Noise). The ratio depends on the quality characteristics of the product/process to be optimized. The machining parameters and their levels are given in Table1. Plan of experiments based on Taguchi orthogonal array and observed responses shown in Table 2.

Table1: Machining parameters and their levels

LEVELS	**FACTORS**				
	Cutting Speed (rpm)	Feed Rate (mm/min)	Drill Diameter (mm)	Point Angle (Degrees)	Clearance Angle (Degrees)
	A	B	C	D	E
1	600	0.3	8	118	4
2	800	0.5	10	110	6
3	1000	0.6	12	100	8

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Table 2: Plan of experiments based on Taguchi orthogonal array and observed responses

Runs	A	B	C	D	E	Al 6061 Measured Responses		Al 2014 Measured Responses		Al 5035 Measured Responses		Al 7075 Measured Responses		S/N Ratio η
						R_1	R_2	R_1	R_2	R_1	R_2	R1	R2	
1	1	1	1	1	1	0.28	0.18	0.21	0.26	0.34	0.35	0.36	0.41	-1.6278
2	1	1	1	1	2	0.27	0.16	0.24	0.34	0.38	0.46	0.44	0.37	4.4320
3	1	1	1	1	3	0.30	0.18	0.29	0.44	0.31	0.52	0.33	0.46	-7.0672
4	1	2	2	2	1	0.29	0.20	0.35	0.38	0.43	0.44	0.35	0.44	3.7360
5	1	2	2	2	2	0.25	0.16	0.28	0.23	0.44	0.45	0.38	0.50	-4.5433
6	1	2	2	2	3	0.26	0.19	0.22	0.31	0.41	0.40	0.43	0.41	-5.4292
7	1	3	3	3	1	0.19	0.15	0.19	0.37	0.39	0.30	0.45	0.54	-6.1495
8	1	3	3	3	2	0.35	0.23	0.23	0.43	0.33	0.34	0.52	0.33	-4.8008
9	1	3	3	3	3	0.24	0.18	0.34	0.38	0.48	0.34	0.51	0.56	-1.2765
10	2	1	2	3	1	0.31	0.24	0.33	0.40	0.39	0.43	0.48	0.36	-4.4935
11	2	1	2	3	2	0.22	0.15	0.36	0.39	0.37	0.44	0.41	0.46	-1.0965
12	2	1	2	3	3	0.32	0.20	0.27	0.33	0.39	0.42	0.43	0.40	4.9026
13	2	2	3	1	1	0.23	0.15	0.30	0.34	0.42	0.46	0.49	0.49	-4.2749
14	2	2	3	1	2	0.20	0.15	0.38	0.28	0.41	0.51	0.52	0.51	-5.1270
15	2	2	3	1	3	0.18	0.16	0.35	0.38	0.48	0.43	0.56	0.36	2.0188
16	2	3	1	2	1	0.33	0.22	0.31	0.18	0.36	0.37	0.53	0.37	-5.0137
17	2	3	1	2	2	0.21	0.14	0.32	0.21	0.39	0.41	0.57	0.42	-1.8190
18	2	3	1	2	3	0.24	0.21	0.25	0.22	0.36	0.39	0.47	0.36	-6.8348
19	3	1	3	2	1	0.21	0.23	0.21	0.37	0.39	0.52	0.41	0.50	-3.2417
20	3	1	3	2	2	0.23	0.18	0.24	0.43	0.33	0.44	0.43	0.41	-3.3032
21	3	1	3	2	3	0.18	0.24	0.29	0.38	0.48	0.45	0.49	0.54	-4.6847
22	3	2	1	3	1	0.24	0.15	0.35	0.40	0.39	0.40	0.35	0.33	-3.8870
23	3	2	1	3	2	0.33	0.20	0.28	0.39	0.37	0.30	0.38	0.56	-3.6437
24	3	2	1	3	3	0.32	0.15	0.19	0.33	0.39	0.34	0.43	0.36	1.5171
25	3	3	2	1	1	0.36	0.16	0.23	0.34	0.42	0.34	0.45	0.41	-2.7075
26	3	3	2	1	2	0.27	0.18	0.34	0.26	0.39	0.43	0.52	0.37	-4.7936
27	3	3	2	1	3	0.24	0.20	0.33	0.34	0.42	0.44	0.51	0.46	-5.1176

3.3. Analysis of the S/N Ratio

In Taguchi method, the term ‘signal’ represents the desirable value (mean) for the output characteristic and the term ‘noise’ represents the undesirable value (Standard Deviation) for the output characteristic. S/N ratio used to measure the quality characteristic deviating from the desired value.

The S/N ratio η = -10 log (M.S.D), Where M.S.D is the mean square deviation for the output characteristic. Table 2 shows the experimental results for observed responses. The S/N ratio table for observed responses is shown in Table 3.

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Table3. Signal to Noise Ratios for Smaller is better

Level	Aluminum alloy 2014				
	cutting speed(rpm) A	feed rate (mm/min) B	drill diameter(mm) C	point angle(Deg) D	clearance angle(Deg) E
1	-3.01518	-2.42151	-2.25041	-2.72382	-2.48101
2	-2.40537	-1.76045	-3.12840	-4.05336	-3.71325
3	-3.31212	-3.07968	-3.42063	-3.61682	-3.67003
Delta	1.40265	3.04105	2.85124	2.91623	2.00203
Rank	5	1	3	2	4
Level	**Aluminum alloy 6069**				
	cutting speed(rpm) A	feed rate (mm/min) B	drill diameter(mm) C	point angle(Deg) D	clearance angle(Deg) E
1	-2.62382	-2.68011	-3.51302	-1.79783	-2.70312
2	-3.05136	-3.61305	-3.75534	-2.18147	-2.45034
3	-4.61288	-3.76003	-2.39812	-4.27928	-3.65602
Delta	2.51623	2.23053	1.25623	2.48145	1.15623
Rank	1	4	3	2	5
Level	**Aluminum alloy 6061**				
	cutting speed(rpm) A	feed rate (mm/min) B	drill diameter(mm) C	point angle(Deg) D	clearance angle(Deg) E
1	-3.15041	-2.52518	-2.44130	-3.11352	-2.66049
2	-2.12840	-2.41537	-2.74395	-3.42034	-2.17144
3	-3.46140	-3.31802	-3.07333	-2.09641	-3.42665
Delta	2.91126	0.90265	0.63203	1.55623	1.25522
Rank	1	4	5	2	3
Level	**Aluminum alloy 7075**				
	cutting speed(rpm) A	feed rate (mm/min) B	drill diameter(mm) C	point angle(Deg) D	clearance angle(Deg) E
1	-3.57514	-1.79783	-4.63041	-2.10312	-3.24031
2	-4.21302	-2.18147	-3.16164	-3.45934	-1.94792
3	-3.34812	-4.27928	-3.42205	-2.69612	-4.16343
Delta	2.60265	2.48145	2.75122	1.35623	1.73203
Rank	2	3	1	5	4

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Table4: Optimal combination of parameters to optimize surface roughness and circularity deviation by Taguchimethod

Material	Optimal combination of parameters	Surface Roughness(μm)	Circularity Deviation(mm)
Al 2014	A5B1C3D2E4	0.25	0.21
Al 6069	A1B4C3D2E5	0.34	0.24
Al 6061	A1B4C5D2E3	0.26	0.34
Al7075	A2B3C1D5E4	0.19	0.27

4. RESULTS AND DISCUSSIONS

The optimum parameter combination for surface roughness, circularity deviations are tabulated in table4 corresponding to the largest values of S/N ratio for all control parameters of different Aluminum alloys. From Table 4, it is observed that feed rate, point angle, drill diameter, cutting speed and clearance angle has the order of influence on surface roughness and circularity deviation during drilling of Alluminium alloys.

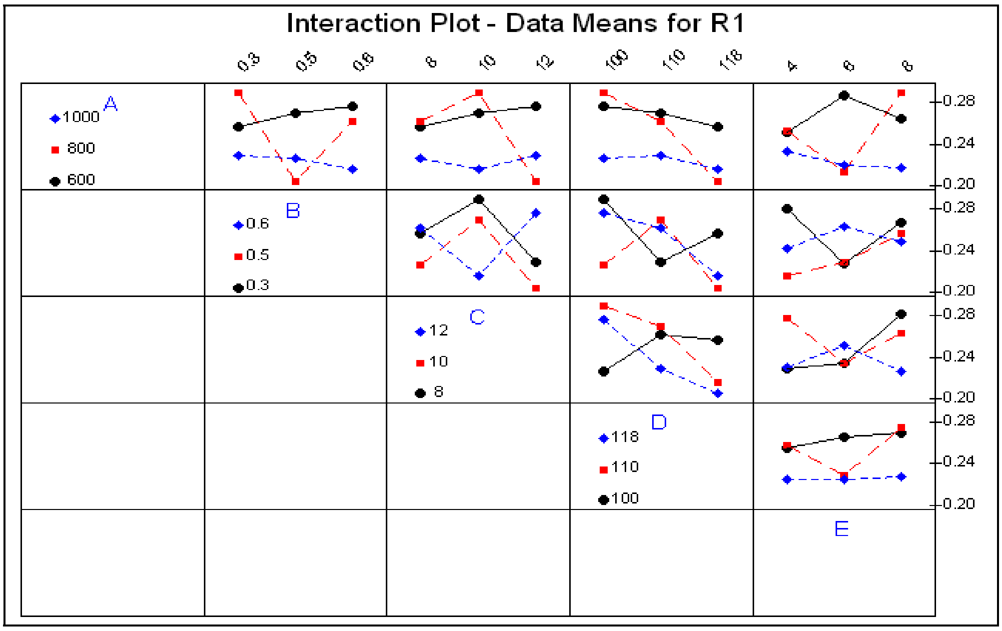

Figure 4: Interaction plot of surface roughness with effect of other parameters

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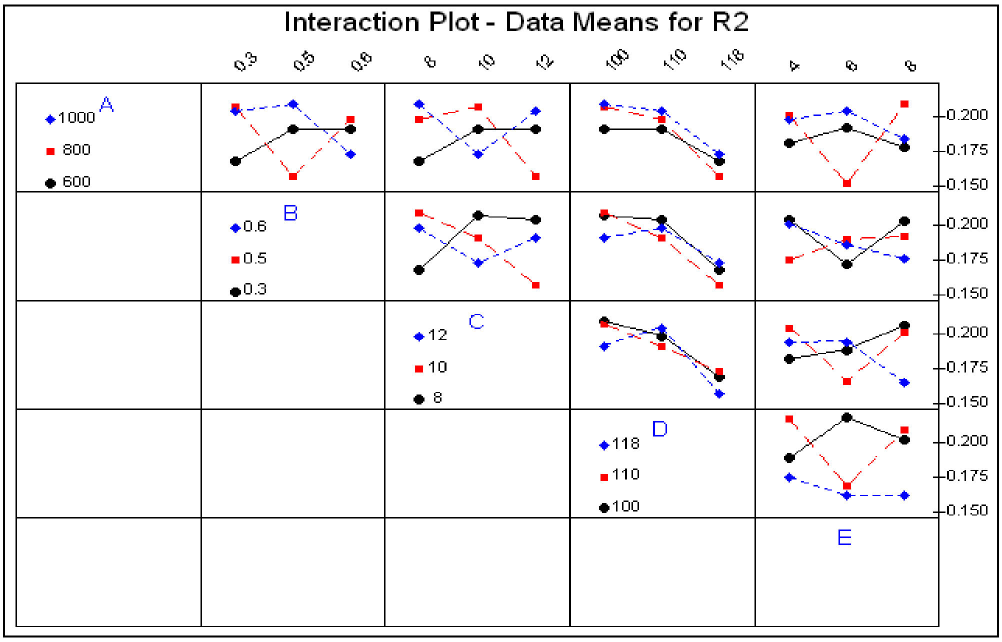

Figure 5: Interaction plot of circularity deviation with effect of other parameters

4.1. Results of ANOVA

The purpose of the analysis of variance (ANOVA) is to investigate which design parameters significantly affect the quality characteristic. Table 5 and 6 shows the results of ANOVA for both surface roughness and , circularity deviation , cutting speed, feed rate, point angle and clearance angle are the significant cutting parameters for affecting the both responses for Alluminium 2014 alloy. Same procedure applied for remaining Aluminum alloys.

Table 5: Results of ANOVA for surface roughness (Aluminum 2014 alloy)

Symbol	**Cutting Parameters**	**DO F**	**SS**	**MS**	**F**	
A	Cutting speed	2	2.96	1.48	3.797	significant
B	Feed rate	2	4.44	2.22	5.696	significant
C	Drill diameter	2	3.40	1.7	3.362	Insignificant
D	Point angle	2	3.76	1.88	4.824	significant
E	Clearance angle	2	3.43	1.715	4.4	significant
Error		16	6.2353	0.3897		
Total		26	23.3653			

Significant, F $_{table}$ at 95%confidence level is $F_{0.05,\,2,\,16} = 3.63$, F $_{exp} \geq$ F table

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Table 6: Results of ANOVA for circularity deviation (Aluminum 2014 alloy)

Symbol	Cutting Parameters	DOF	SS	MS	F	
A	Cutting speed	2	0.00584	0.00292	3.74	significant
B	Feed rate	2	0.00577	0.00885	3.64	significant
C	Drill diameter	2	0.00215	0.00107	1.37	Insignificant
D	Point angle	2	0.00579	0.00289	3.71	significant
E	Clearance angle	2	0.02307	0.01153	14.78	significant
Error		16	0.01248	0.00078		
Total		26	0.0511			

Significant, F table at 95%confidence level is F0.05, 2, 16 = 3.63, F exp ≥ F table

Table 7: Optimal values of individual machining characteristics

Machining characteristics	Optimal combination of parameters	Significant parameters(at 95% confidence level)	Predicted optimum value	Experimental value
Surface Roughness (R_3) µm	A3B3C3D2E3	A,B,D,E	3.7451	4.078
Circularity deviation(R_4) mm	A3B1C1D1E1	A,B,D,E	0.1076	0.1654

Confirmatory experiments were conducted for surface roughness and circularity deviation, corresponding their optimal setting of process parameters to validate the used approach, obtained the values of 3.7451µm, 0.1076mm for surface roughness and circularity deviation respectively. Predicted and experimental values of responses are depicted in Table 7. Same procedure applied for remaining Aluminum alloys.

4.2. Results of MADM

The results obtained in integrated grey based Taguchi method are given into the input for MADM apart from mechanical properties (resistance to corrosion, resistance to high temperature, fatigue strength, ultimate tensile strength, hardness) of Al 6061, 7075, 6069, 2014 alloys are also considered for air craft applications from previous literature, those weights are taken as per the importance of respective properties.

Then the Decision Matrix, C =

[0.1600 0.1100 3.0000 1.0000 3.0000 3.0000 2.0000

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0.3000 0.2600 2.0000 2.0000 1.0000 1.0000 1.0000

0.2600 0.2400 1.0000 3.0000 4.0000 4.0000 3.0000

0.1700 0.1400 4.0000 4.0000 2.0000 2.0000 4.0000]

Normalized Matrix (N) =

[1.0000 1.0000 0.7500 0.2500 0.7500 0.7500 0.5000

0.5333 0.4231 0.5000 0.5000 0.2500 0.2500 0.2500

0.6154 0.4583 0.2500 0.7500 1.0000 1.0000 0.7500

0.9412 0.7857 1.0000 1.0000 0.5000 0.5000 1.0000]

Normalized decision matrix, Ri =

[1.0000 4.0000 2.0000 6.0000 3.0000 4.0000 3.0000

0.2500 1.0000 1.0000 3.0000 6.0000 5.0000 8.0000

0.5000 1.0000 1.0000 2.0000 6.0000 4.0000 4.0000

0.1667 0.3333 0.5000 1.0000 1.0000 3.0000 3.0000

0.3333 0.1667 0.1667 1.0000 1.0000 2.0000 2.0000

0.2500 0.2000 0.2500 0.3333 0.5000 1.0000 1.0000

0.3333 0.1250 0.2500 0.3333 0.5000 1.0000 1.0000]

4.2.1. AHP Result:

Pair wise comparison

pwc(:,:,1) = 1.0000 1.8750 1.6250 1.0625

0.5333 1.0000 0.8667 0.5667

0.6154 1.1538 1.0000 0.6538

0.9412 1.7647 1.5294 1.0000

pwc (:,:,2) = 1.0000 2.3636 2.1818 1.2727

0.4231 1.0000 0.9231 0.5385

0.4583 1.0833 1.0000 0.5833

0.7857 1.8571 1.7143 1.0000

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pwc(:,:,3) =	1.0000	1.5000	3.0000	0.7500
	0.6667	1.0000	2.0000	0.5000
	0.3333	0.5000	1.0000	0.2500
	1.3333	2.0000	4.0000	1.0000
pwc(:,:,4) =	1.0000	0.5000	0.3333	0.2500
	2.0000	1.0000	0.6667	0.5000
	3.0000	1.5000	1.0000	0.7500
	4.0000	2.0000	1.3333	1.0000
pwc(:,:,5) =	1.0000	3.0000	0.7500	1.5000
	0.3333	1.0000	0.2500	0.5000
	1.3333	4.0000	1.0000	2.0000
	0.6667	2.0000	0.5000	1.0000
pwc(:,:,6) =	1.0000	3.0000	0.7500	1.5000
	0.3333	1.0000	0.2500	0.5000
	1.3333	4.0000	1.0000	2.0000
	0.6667	2.0000	0.5000	1.0000
pwc(:,:,7) =	1.0000	2.0000	0.6667	0.5000
	0.5000	1.0000	0.3333	0.2500
	1.5000	3.0000	1.0000	0.7500
	2.0000	4.0000	1.3333	1.0000
pwc(:,:,8) =	0.3236	0.1726	0.1992	0.3046
	0.3749	0.1586	0.1718	0.2946
	0.3000	0.2000	0.1000	0.4000
	0.1000	0.2000	0.3000	0.4000
	0.3000	0.1000	0.4000	0.2000
	0.3000	0.1000	0.4000	0.2000

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0.2000 0.1000 0.3000 0.4000

p1 = [0.3236 0.3749 0.3000 0.1000 0.3000 0.3000 0.2000

0.1726 0.1586 0.2000 0.2000 0.1000 0.1000 0.1000

0.1992 0.1718 0.1000 0.3000 0.4000 0.4000 0.3000

0.3046 0.2946 0.4000 0.4000 0.2000 0.2000 0.4000]

AHP matrix final = 0.3023

0.1662

0.2083

0.3231

AHP rank = 4 1 3 2

4.2.2. TOPSIS Method

su = 0.4605 0.3961 5.4772 5.4772 5.4772 5.4772 5.4772

r = 0.3474 0.2777 0.5477 0.1826 0.5477 0.5477 0.3651

0.6514 0.6564 0.3651 0.3651 0.1826 0.1826 0.1826

0.5646 0.6059 0.1826 0.5477 0.7303 0.7303 0.5477

0.3691 0.3534 0.7303 0.7303 0.3651 0.3651 0.7303

wm = 0.3159 0.2287 0.2090 0.0893 0.0680 0.0451 0.0439

vv = 0.1098 0.0635 0.1145 0.0163 0.0373 0.0247 0.0160

0.2058 0.1501 0.0763 0.0326 0.0124 0.0082 0.0080

0.1783 0.1386 0.0382 0.0489 0.0497 0.0329 0.0241

0.1166 0.0808 0.1527 0.0652 0.0248 0.0165 0.0321

vplus = 0.1098 0.0635 0.1527 0.0652 0.0497 0.0329 0.0321

vminus = 0.2058 0.1501 0.0382 0.0163 0.0124 0.0082 0.0080

siplus = 0.0658 0.1618 0.1542 0.0351

siminus = 0.1533 0.0415 0.0648 0.1705

Topsis matrix = 0.6997 0.2041 0.2960 0.8291

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TOPSIS rank = 4 1 3 2

5. CONCLUSIONS

In this paper, a study on the optimal selection of alluminium alloys especially for automotive and aerospace industry to optimize the surface roughness and circularity deviation of drilled holes is carried out. In this connection, MADM technique is proposed for decision making regarding selection of suitable material, which yields optimal values of surface roughness and circularity deviation of drilled holes. The output from Taguchi method fed as input to the MADM. Finally, the result generated in MADM suggests the suitable alternative of alluminium alloys in a rank wise (2014, 6061, 6069, 7075 in an order) in both AHP and TOPSIS methods.

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