Optimization of Drilling Parameters using Genetic Algorithms

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Abstract— Surface roughness in drilling process is important aspect so there is needs to minimize surface roughness while drilling. This paper investigates the influence of drilling parameters such as spindle speed, feed rate and cutting tools on surface roughness while drilling titanium alloy. The experiments have been conducted by employing L27 orthogonal array by considering HSS, Coated HSS and carbide drills. After experimentation second order empirical modelling was done using regression method. Finally, optimization of drilling parameters for surface roughness was done through genetic algorithms. The genetic algorithms give minimum value of surface roughness was 0.0689 corresponding optimize drilling parameters were 576.069, 0.03, and carbide as spindle speed, feed rate and cutting tool respectively.

Key words: Drilling, surface roughness, genetic algorithms, Anova, Regression, Taguchi

I. INTRODUCTION

Drilling process is one of the most important due to both number of operations and machining time consumed. The importance of this process is even higher in aerospace, heat exchanger, die making and in aircraft manufacturing industries. Titanium and its alloy s are widely used in aircraft, automobiles, turbines blades and in space craft. Mostly uses of titanium and its alloy in aircraft as well as in space craft.

For example, titanium is used in the primary structure of the F-22 fighter and in Boeing 787. In the past few decades the usage of titanium and its alloys increasing rapidly. It was estimated that the worldwide demand for titanium would be over 136000 tons by 2020. This is due to superior properties of titanium and its alloys such as high strength to weight ratio, high compressive and tensile strength, low density, high fatigue resistance in air and sewage water and exceptional corrosion resistance.

II. LITERATURE REVIEW

From the review we analyze that no work has been reported during drilling of titanium alloy using different types of cutting tools hence the work conducted to analyze and optimize the process parameters during drilling of titanium alloy.

III. EXPERIMENTAL DETAIL AND RESULTS

The experiment was conducted on radial drilling machine (of HMT model RM 62) and surface roughness was measured using surface roughness tester, of Mitutoyo model SJ 400. The table 1 shows factors and their levels of interest used for experimentation and Table 2 shows experimental Results and S/N ratios.

Factors	Factor designation	Level 1	Level 2	Level 3
Spindle Speed (RPM)	A	250	450	650
Feed rate (mm/rev)	B	0.03	.06	.09
Tool material	C	HSS	TiN	Carbide

Table 1: Factors and their levels of interest

Sr. no	Spindle speed	Feed rate	Cutting tool	surface roughness	S/N Ratio
1	250	0.03	HSS	1.800	-5.10545
2	250	0.03	TiN	1.359	-2.66439
3	250	0.03	Carbide	0.896	0.95384
4	250	0.06	HSS	2.010	-6.06392
5	250	0.06	TiN	1.670	-4.45433
6	250	0.06	Carbide	1.010	-0.08643
7	250	0.09	HSS	2.267	-7.10903
8	250	0.09	TiN	1.896	-5.55677
9	250	0.09	Carbide	1.256	-1.97979
10	450	0.03	HSS	2.100	-6.44439
11	450	0.03	TiN	1.790	-5.05706
12	450	0.03	Carbide	1.140	-1.13810
13	450	0.06	HSS	2.130	-6.56759
14	450	0.06	TiN	1.999	-6.01626
15	450	0.06	Carbide	1.356	-2.64519
16	450	0.09	HSS	2.389	-7.56432
17	450	0.09	TiN	2.145	-6.62855
18	450	0.09	Carbide	1.580	-3.97314
19	650	0.03	HSS	2.410	-7.64034
20	650	0.03	TiN	2.210	-6.88785
21	650	0.03	Carbide	1.800	-5.10545
22	650	0.06	HSS	2.765	-8.83390
23	650	0.06	TiN	2.245	-7.02433

24	650	0.06	Carbide	1.780	-5.00840
25	650	0.09	HSS	2.890	-9.21796
26	650	0.09	TiN	2.130	-6.56759
27	650	0.09	Carbide	2.180	-6.76913

Table 2: Experimental results and S/N ratios

IV. RESULTS AND DISCUSSION

The main effect plot for surface roughness is shown in Figure 1.From this figure we conclude that surface roughness increase from increasing speed and feed rate but surface roughness decrease by using carbide tool.

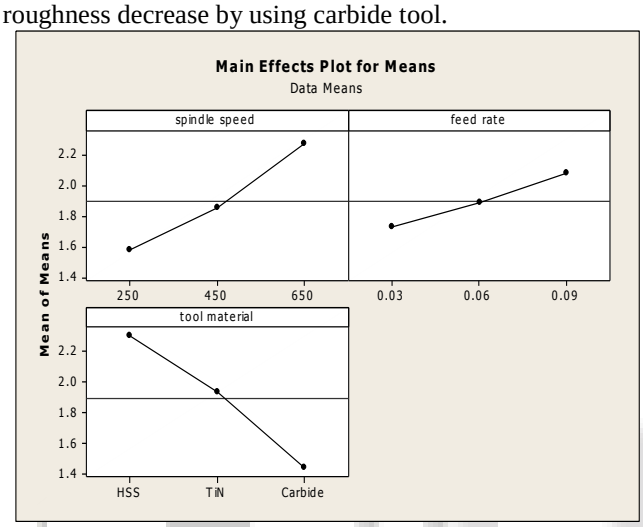

Fig. 1: Main effect plot for surface roughness

Figure 2. Shows residual plot for surface roughness. This figure also shows that data is normally distributed with constant variance and no existence of any pattern observed from the results.

V. REGRESSION ANALYSIS

Multiple nonlinear regression has been conducted to find out the relationship between the dependent variable and independent variables. The equation is given in in equation no 1

Surface roughness = 2.0384-0.00015A+7.9894B-0.2974C+0.0000A2 +19.0123B2 -0.0627C2 -0.0092AxB-0.0003AxC-0.1556BxC …… (1)

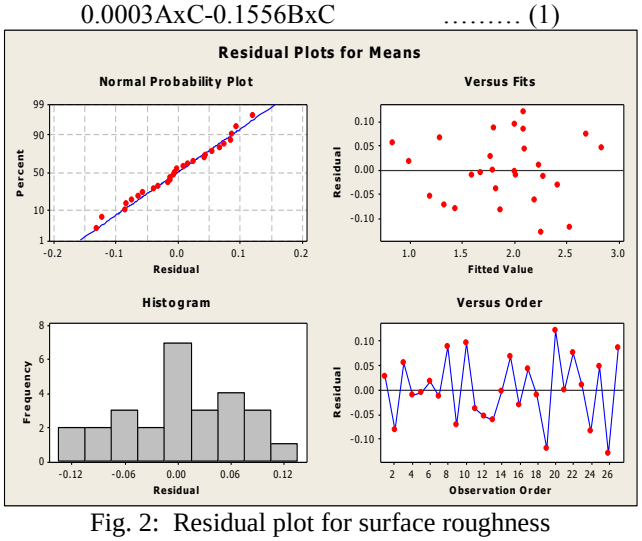

Fig. 2: Residual plot for surface roughness

VI. GENETIC ALGORITHM

This Is Used To Find Out The Optimal Process Parameters. This Is Based On Darwin Principal Of Survival Of Fit. Figure 3 Shows Flow Chart For Genic Algorithm And Figure 4 Shows Results Obtained From Genetic Algorithm. The Equation No 1 Used For Genetic Algorithm Optimization.

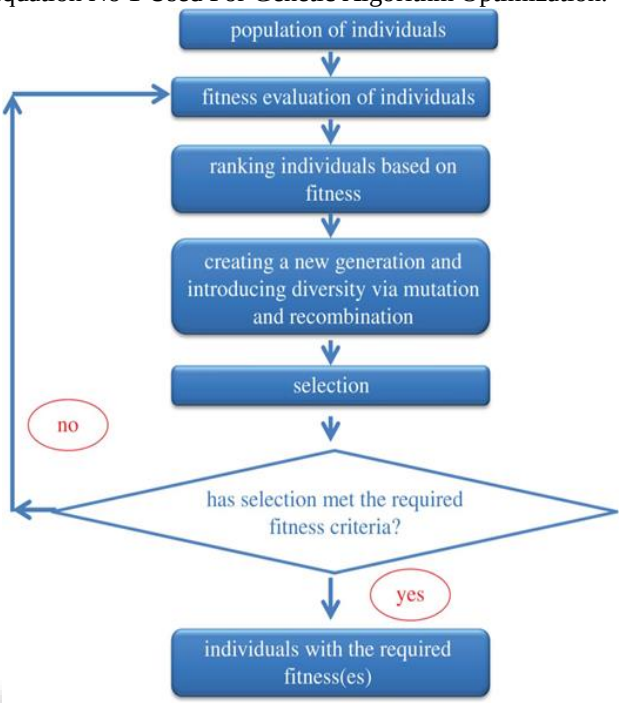

Fig. 3: Flow chart for genetic algorithms

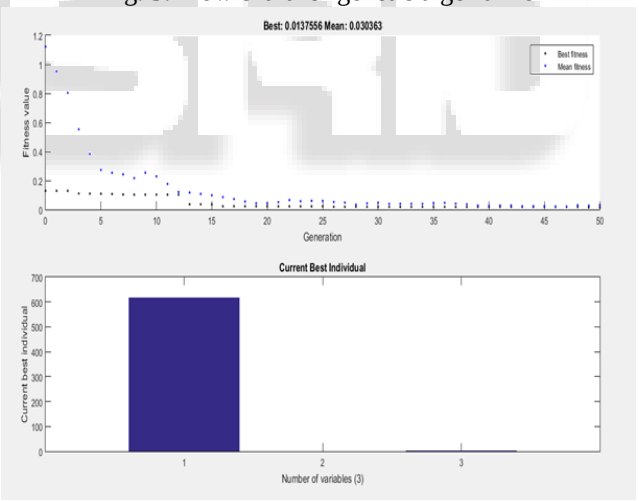

Fig. 4: Best results obtained from genetic algorithm

VII. CONCLUSION

From the above results following conclusion has been drawn.

1) From this analysis, it is revealed that For increasing the mean and reducing the variation around the target the controlling parameters are spindle speed, tool material and feed rate.
2) Surface roughness increase by increasing spindle speed and feed rate but surface roughness decrease by using carbide tools.
3) From the genetic algorithms results we conclude that the best parameter for surface roughness was speed 650rpm, feed 0.06mm/rev and carbide tools.
4) The best value for surface roughness was 0.01375 with mean value was 0.003036.

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