OPTIMIZATION OF PROCESS PARAMETER FOR MULTISPINDLE DRILLING MACHINE BY USING TAGUCHI METHOD

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ABSTRACT

This paper Investigates effects of Process parameter on various drill diameter by input parameters speed, feed and checking effects on response parameter torque, Thrust and Surface finish. The Response parameters are checked on calibrated Dynamometer (Torque, thrust). By using Taguchi Method Investigation is done. The Methodology for above experimentation is presented in this paper along with result and experimental setup.

Keywords: Taguchi method, Dynamometer Thrust, Torque, Surface finish.

I. INTRODUCTION

Drilling creates cylindrical hole in solid material, mention above multispindle systems [1].The Multispindle drilling Head are in different orientation [2]. The Special Purpose Machine (SPM)is machine that is useful to specific component. Number of machining processes can do on single machine which is made for only that component[3]. Productivity depends upon many factors, one of the major factors being manufacturing efficiency with which the operation activities are carried out. Productivity can be improved by reducing the total machining time, combining the operations [4]. The purpose of this paper is to study the effect of process parameters such as spindle speed and feed, on thrust force and torque generated during drilling of Aluminum Alloy material of grade AlSi9MnMg using high speed steel (HSS) drill bit. Feed of drilling depends on torque and thrust [5]. Higher value of feed damage works whereas lower one affects cycle time. Drill diameter is the main contributing factor.

II. MATERIAL AND COMPONENT

Component under investigation and design of Multispindle drilling head is having the following material specifications[4],

Table I: Material Composition of The ALSI9mnmg

Si%	Fe%	Cu%	Mn%	Mg%	Zn%	Pb%	Ni%	P%	Ti%	S%	Sr%	Al%
9.0	0.7	0.05	0.4	0.2	0.15	0.05	0.15	0.05	0.05	0.02	0.015	remaining

Fig.1: Sample Components Developed For Torque Measurement

III. METHODOLOGY

Experimentation is carried out using VMC (VICTOR make) which enables high precision machining specimen was rigidly held by the fixture which is attached to the dynamometer mounted on the machine table. The thrust force generated during cutting was measured with the help of INTELLECTUAL make dynamometer (Specification:-Drill Diameter Ø 12mm, Torque 20 kgf-m, Thrust200kgf). The data collected was transferred to a computer. After studying literature it can be concluded that, controllable factors are spindle speed and feed for drilling operation[2]. The selection of cutting parameters and their levels (table II) have been made based on literature review, as it is widely used under common machining conditions. After studying factor, Taguchi method is used for parameter optimization and L_9 orthogonal array is used (table III).

During Experimentation following steps were followed

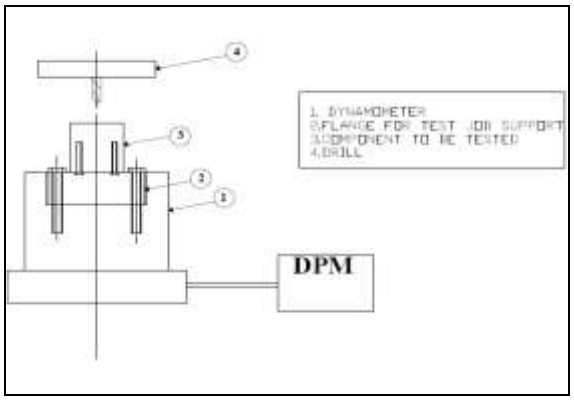

Fig.1: Dynamometer Setup **Fig .2 Surface tester**

1. Sutable fixture was design for connecting dynamometer for testing purpose.
2. A clamp was designed to fit on table.
3. Two holes of M6 are provided on dynamometer to fit testing component
4. The set for experimentation is shown in fig.1
5. A flange 2 is designed for mounting the component 3 to be tested on the dynamometer1 As shown in fig.1
6. The drill from SPM created necessary torque and thrust was measured with help of dynamometer1
7. The results were obtained as seen on the DPM (Digital Panel meter).
8. Surface finish was measure on Tally surf tester as shown in fig2.

IV. EXPERIMENTATION

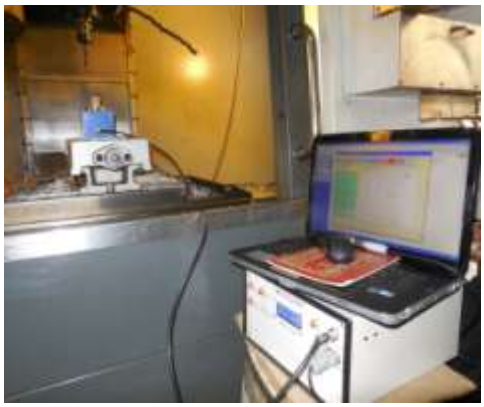

Fig.3: Experimentation Setup

Experimentation is carried out using Dynamometer .The setup is shown in fig.3, which show that electromechanical dynamometer with software interfacing[5]

4.1 Taguchi Method

Taguchi defines the quality of a product in terms of the loss imparted by the product to the society from the time products are shipped to the customer. Some of these losses occur due to the deviation of the products' functional characteristics from its desired value and these are called losses due to functional variation. Uncontrollable factors, which cause the functional characteristics of a product to deviate from their target values, are known as noise factors. Taguchi recommends analysing the means and S/N ratio using conceptual approach which involves graphing the effects and identifying the factors visually that appear to be significant without using ANOVA, which makes the analysis simple. The characteristics of the S/N ratio are given by the following equations.

Larger the better Characteristic: $\frac{S}{N} = -\log\frac{1}{n}\sum\frac{1}{y2}$

Nominal is the better characteristic: $\frac{S}{N} = 10\log\frac{\bar{y}}{s^2 y}$

Smaller is the better Characteristic: $\frac{S}{N} = -\log\frac{1}{n}\sum\frac{1}{y2}$

Taguchi-based optimization technique has produced a unique and powerful optimization discipline that differs from traditional practices[1]. This approach can economically satisfy the needs of problem solving and design optimization with minimum number of experiments. The proposed method is employed to determine the optimal values of cutting speed (Vc), feed (Fr), for a given drill diameter (d) to optimize cycle time, hole size and surface finish. For present work, a characteristic of the S/N ratio smaller is better taken is considered.

4.2 Factors and levels

Table II: Factors and levels

Code	Factor	Levels		
		1	2	3
A	Spindle speed rpm(N)	934	1324	2504
B	Feed (f_r) (mm/rev)	0.05	0.075	0.1

In this experimentation there are two factors and each having three levels, so L_9 array are selected.

For L_9 orthogonal array the levels of input parameters are in tabulated form as follows as taking three response parameter torque thrust surface finish there is three L_9 response array

Table III: L9 Orthogonal array

Trial No.	A	B
1	1	1
2	1	2
3	1	3
4	2	1
5	2	2
6	2	3
7	3	1
8	3	2
9	3	3

The measured response in tabular form as follows:

Table IV: Tabulation of Measured Response For Drill Diagram Ø 5.5

Trial No.	Torque -kgf-mm	Thrust-kgf	Surface finish-Ra
1	0.2	23	6.22
2	0.15	36	6.29
3	0.16	32	6.46
4	0.2	44	6.3
5	0.17	24	6.14
6	0.15	25	5.58
7	0.13	26	5.59
8	0.12	25	6.31
9	0.11	23	5.46

Table V: Tabulation of Measured Response For Diameter Ø 8.5

Trial No.	Torque-kgf-mm	Thrust-kgf	Surface finish-Ra
1	0.3	62	6.37
2	0.22	42	6.21
3	0.18	63	5.7
4	0.17	65	5.69
5	0.16	60	5.51
6	0.12	41	5.43
7	0.22	64	6.37
8	0.36	67	5.46
9	0.19	49	5.52

Table Vi: Tabulation of Measured Response For Diameter Ø 12

Trial No.	Torque-Kgf-mm	Thrust-kgf	Surface finish-Ra
1	0.42	39	5.92

2	0.27	36	6.72
3	0.23	31	5.44
4	0.28	47	6.38
5	0.31	37	6.53
6	0.27	35	5.6
7	0.31	32	6.73
8	0.35	35	5.66
9	0.38	37	5.94

V. RESULT AND DISCUSSION

By using Minitab software the results are as follows

For drill 5.5

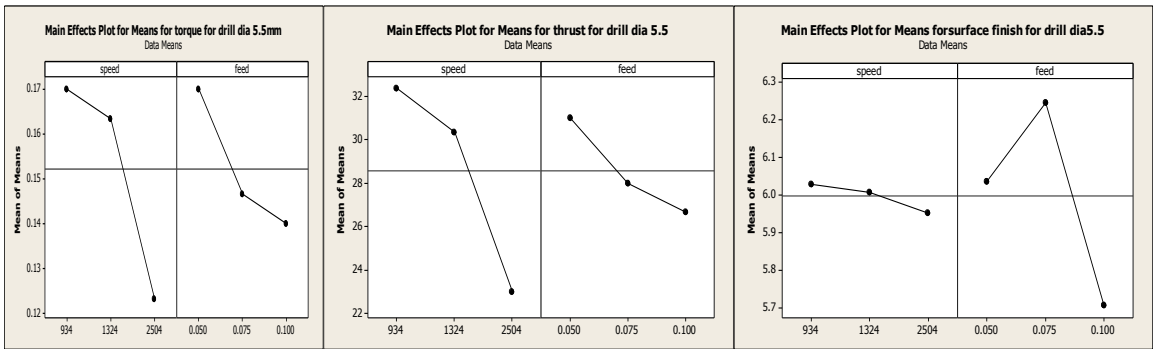

Fig.4: Main Effect Plot For Means For Torque, Thrust and Surface Finish For Drillø5.5mm

5.1 Main Effect Plot For Drill Dia 5.5 The Effect Of Torque, Thrust And Surface Finish On Speed and Feed[3]

Characteristics for signal to noise ratio for feed time is smaller is better, for hole size is also smaller is better because in the component drawing the positional accuracy for the holes is given at maximum material condition and the material is maximum when hole size is small. From fig. 4, signal to noise ratio for cycle time is less for spindle speed (N=2504rpm) and feed (Fr=0.1mm/rev).

For drill 8.5

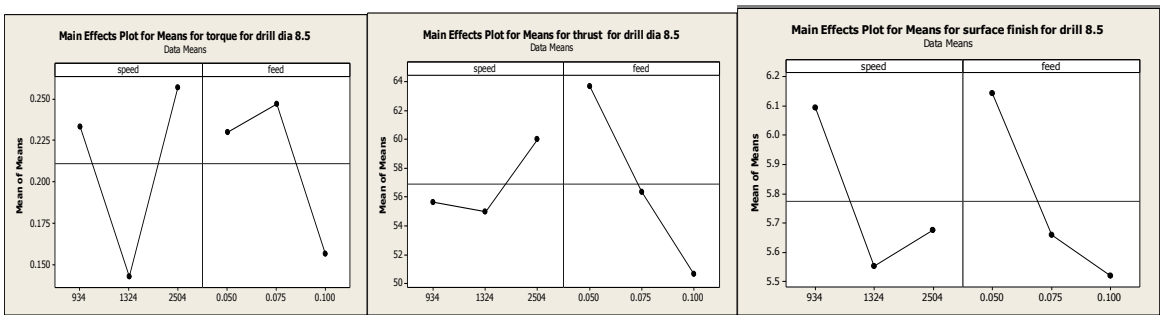

Fig.5: Main Effect Plot For Means For Torque, Thrust and Surface Finish For Drillø8.5mm

5.2 Main Effect Plot For Drill Dia 8.5 The Effect of Torque, Thrust and Surface Finish On Speed And Feed

Characteristics for signal to noise ratio for feed time is smaller is better, for hole size is also smaller is better because in the component drawing the positional accuracy for the holes is given at maximum material condition and the material is maximum when hole size is small. From fig. no. 5signal to noise ratio for hole size is less for spindle speed (N=1324 rpm) and feed (Fr=0.1mm/rev). From above it is clear that the optimize parameters are spindle speed (N) 1324 rpm and feed (F_r) is 0.1mm/rev.

The data sequences have smaller is better characteristics. From above graphs it is clear that the optimize parameters is feed (F_r) is 0.1mm/rev.

For drill 12

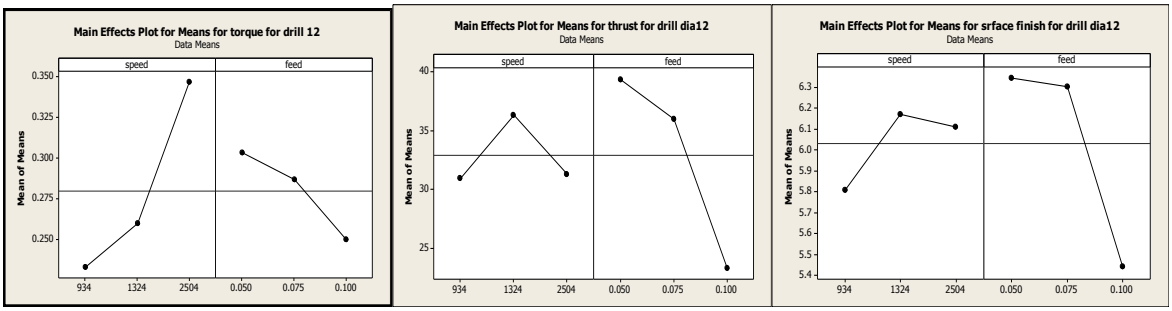

Fig.6: Main Effect Plot For Means For Torque, Thrust and Surface Finish For Drillø12mm

5.3 Main Effect Plot For Drill Dia 12 The Effect of Torque, Thrust and Surface Finish On Speed and Feed

Characteristics for signal to noise ratio for feed time is smaller is better, for hole size is also smaller is better because in the component drawing the positional accuracy for the holes is given at maximum material condition and the material is maximum when hole size is small. From fig. 6 signal to noise ratio for hole size is less for spindle speed (N=934 rpm) and feed (Fr=0.1mm/rev). From above it is clear that the optimize parameters are spindle speed (N) 934 rpm and feed (F_r) is 0.1mm/rev.

The data sequences have smaller is better characteristics. From above graphs it is clear that the optimize parameters is feed (F_r) is 0.1mm/rev.

VI. CONCLUSIONS

From experimental investigation it was observed that,

1. Drill diameter of 5.5 with Feed is 0.1 mm/rev and speed 2504rpm offered optimum torque0.111kgf-m (111 N-mm), thrust 23.3kgf (233N)and surface finish Ra 5.46.
2. Drill diameter of 8.5 with Feed is 0.1 mm/rev and speed 1324rpm offered optimum torque0.120kgf-m (120 N-mm), thrust 41kgf (410N)and surface finish Ra 5.43.
3. Drill diameter of 12 with Feed is 0.1 mm/rev and speed 934rpm offered optimum torque0.23kgf-m (230 N-mm), thrust 31kgf (310N)and surface finish Ra 5.44.

Hence, while working on AlSi9 alloy by using HSS drills, higher spindle speed are recommended for process parameter range under consideration. Cutting torque is significantly influenced by drill diameter. Higher the drill diameter, larger will be the thrust force .As thrust force increases, whereas, cutting torque decreases.

REFERENCES

[1]. V.N. Gaitonde, S.R. Karnik, B.T. Achyutha, B. Siddeswarappa–"Taguchi optimization in drilling of AISI 316L stainless steel to minimize burr size using multi-performance objective based on membership function". Journal of Materials Processing Technology. 202 (2008), PP374–379.

[2]. Masakazu Soshi, Haruki Ishiguro, Kazuo Yamazaki –"A study on the development of a multi-purpose spindle system for quality productive machining". CIRP Annals- Manufacturing Technology 58 (2009),PP 327–330.

[3]. T. Lakshmi Narayanan, S. Madhavan, AnkurSinha– "Investigation of Thrust, Torque and Dclamination on drilling of Glass fabric/Polypropylene matrix composite". 2010 International Conference on Mechanical & Electrical Technology (ICMET 2010),PP99-103

[4]. L.N. Lo´pezdeLacalle, A.Ferna´ndez, D.Olvera, A.Lamikiz, D.Olvera,C. Rodrı´guez, A. Elias-"Monitoring deep twist drilling for a rapid manufacturing of light high-strength parts".Elesvier Science Direct Mechanical Systems and Signal Processing 25 (2011)2745-2752.

[5]. Murthy B.R.N., Lewlyn L.R. Rodrigues and AnjaiahDevineni- "Process Parameters Optimization in GFRP Drilling through Integration of Taguchi and Response Surface Methodology".Research Journal of Recent Sciences Vol. 1(6), June (2012) 7-15