International Journal of Mechanical Engineering and Technology (IJMET)
Volume 8, Issue 3, March 2017, pp. 159–167 Article ID: IJMET_08_03_018
Available online at http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=8&IType=3
ISSN Print: 0976-6340 and ISSN Online: 0976-6359

EXPERIMENTAL OPTIMIZATION OF DRILLING PROCESS PARAMETERS ON DIE STEEL (H13) USING CARBIDE COATED DRILL BY TAGUCHI DESIGN METHOD

J. Ganesh
PG Scholar, Department of Mechanical Engineering,
PRIST University, Thanjavur, TN, India

P. Renukadevi
Assistant Professor, Department of Mechanical Engineering,
PRIST University, Thanjavur, TN, India

P. Vijayakumar
Assistant Professor, Department of Mechanical Engineering,
PRIST University, Thanjavur, TN, India

ABSTRACT

Drilling is one of the most common fundamental machining processes. In which a 12mm twist drill with coated carbide is used.H13 Die steel play an important role in many application such as Shaft, Axle, Gears and fasteners due to their strength to weight ratio. The present work is to optimize the cutting condition (Cutting speed, feed in dry cutting to the depth of hole) parameters for minimum surface roughness, optimum power utilization and tool life are optimized. With different process parameters like spindle speed, and feed rate to find optimal machining conditions of minimum surface roughness(Ra), Out of roundness and Material removal power are designed and conducted based on design of Experiments using L16orthogonal array and

Optimized by Taguchi Design of experiments and analysis of variance are utilized to analyze a dominating parameter of surface roughness.

Key words: Drilling Parameters, Taguchi, DOE, S/N ratio, ANOVA, H13

Cite this Article: J. Ganesh, P. Renukadevi and P. Vijayakumar, Experimental Optimization of Drilling Process Parameters on Die Steel (H13) Using Carbide Coated Drill By Taguchi Design Method. *International Journal of Mechanical Engineering and Technology*, 8(3), 2017, pp. 159–167.
http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=8&IType=3

1. INTRODUCTION

Drilling is a machining operation in which a drill is fed in a rotating axis direction in axial direction to the tool with single or multiple cutting edges parallel to the axis of rotation to the feed direction of tool forming a helix. This is called the drill bit cutting edges are called flute. Mostly circular holes or oval holes are created by drilling. It is accomplished by a rotating tool the chip is formed in a twisted shape .H13 is a versatile chromium molybdenum hot work steel that is utilized in hot working die tooling application. H13 resist more thermal fatigue and cracking that happens as the result of cyclic heating and cooling process in hot work tool and die applications. It hasa wonderful combination of high toughness and resistance to thermal fatigue, cracking(also called heat cracking). H13 provides higher hardenablity and higher wear resistance than common alloy steels like H11, H12 materials.

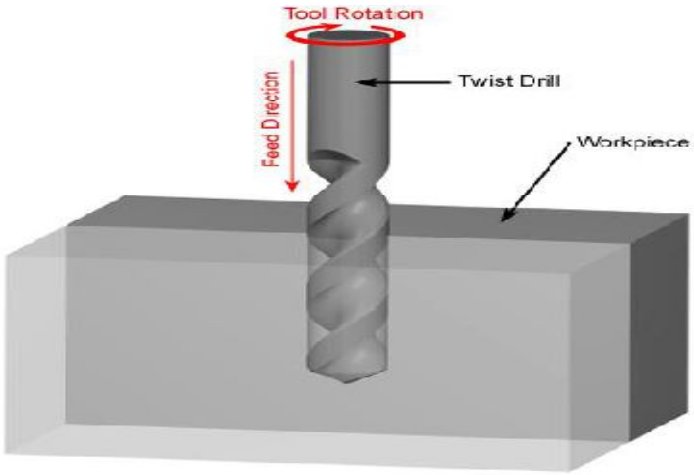

Figure 1 Machining of H13 die steel material

2. CHEMICAL AND MECHANICAL PROPERTIES OF H13 GRADE DIE STEEL

Table 1 Chemical Composition of H13 Grade Steel

C	Mn	P	S	Si	Cr	V	W	Mb	Fe
0.37%	0.71%	0.01%	0.013%	0.94%	4.88%	0.96%	0.17%	1.68%	99.63%

Table 2 Mechanical properties of H13 Grade steel

Young's Modulus	Poisson's Ratio	Density	Modulus of Elasticity	Bulk Modulus
210GPa	0.29	7.8 g/cm^3	220GPa	150GPa

2.1. Coated Carbide Drill Tool

Figure 2 Carbide coated drill bit on profile projector

Cemented carbide coatings are the most popular and most common high production tool material available today. The increase need to boost productivity. To machine more difficult material. To achieve superior tribological attainment and wear resistance. To increase tool life by as much as slow down the wear phenomenon of the cutting tools. This increase in tool life allows better productivity. Reduce the machining time and heat generation. It is manufactured by chemical vapour deposition (CVD) or physical vapour deposition.

2.2. The Drilling Process Parameters

Although there are many different types of drilling The drill bit chip formation is basic in which the drill is feed in the axial direction of the spindle no of drill flute. Taking spindle speed and feed as input parameter and surface roughness, Out of roundness, Power consumption and dimension as Output parameters.

Spindle speed (S): This is the rotation speed of the tool, and is measured by revolutions per minute (rpm). Typical values are from hundred rpm, up to five thousand rpm.

Feed rate (F): This is the speed at which the material is fed into the cutter. Typical values are from r Revolution per minute. Or feed per revolution 0.01 mm/rev

3. TAQUCHI DESIGN OF EXPERIMENT

Taking spindle speed and feed as input parameter and surface roughness and out of roundness as response parameter of drilling process of H13 steel plates. Here the factors are helix angle 118˚degree. And tool of double helical flute is used. Four levels of drilling process parameter are used as design of experiment in L16 orthogonal array.

4. PROBLEM STATEMENT

- H13 die steel material is difficult to drill.
- H13 has a high hardness value which produce out of round holes.
- In drilling H13 tool wear is more in H.S.S tool.
- Required finish is not got with ordinary drilling tools.
- Reduce machine time and improve metal removal rate.
- Power required for machining is minimized by coated drill.

5. OVER COME THE EXISTING PROBLEM

- H13 die steel material is drilled with coated carbide drill.
- H13 is drilled with coated carbide drill to achieve required surface finish,
- Reduce roundness error by optimum drill parameters.
- H13 is drilled with varying speed and feed to achieve optimum finish and roundness.
- Coated drill improves machining time.

6. METHODOLOGY

- State the problem.
- State the objective of experiment.
- Select the factors that may influence the quality characteristics.
- Identify the quality and noise factor.
- Select of Orthogonal array.
- Conduct the test by trail in Orthogonal array.
- Analyze and interpret the experimental result.

Figure 3 Machined work piece

7. SURFACE ROUGHNESS

Conducting the experiments of drilling operation onH13 die steel rectangular flat of(100x80x20mm) the surface roughness values and signal to noise ratio arrived from the.

Surface roughness equipment (Surf test sj-201p) the surface roughness of machined surface is measured at the two different locations in each specimen and the average is taken and tabulated in table 3

Table 3 Taguchi L_{16} OA with Surface Roughness values of H 13 Die Steel

Spindle Speed	Feed	Surface Finish	Snra1
300	0,060	7.32	-17.2902
300	0.030	5.86	-15.3580
300	0.020	6.86	-16.7265
300	0.016	6.54	-16.3116
600	0,060	3.58	-11.0777
600	0.030	3.47	-10.8066
600	0.020	3.39	-10.6040
600	0.016	3.18	-10.0485
900	0,060	6.24	-15.9037
900	0.030	5.94	-15.4757
900	0.020	4.93	-13.8569
900	0.016	4.52	-13.1028
1200	0,060	4.64	-13.3304
1200	0.030	4.48	-13.0256
1200	0.020	4.24	-12.5473
1200	0.016	4.02	-12.0845

Spindle speed feed depth response table is tabulated in Table 4.

Table 4 Response table of H13 Die steel drilled plate

Level	Spindle speed	Feed
1	-16.42	-14.40
2	-10’63	-13.67
3	-14.58	-13.43
4	-12.75	-12.89
DELTA	5.79	1.51
RANK	1	2

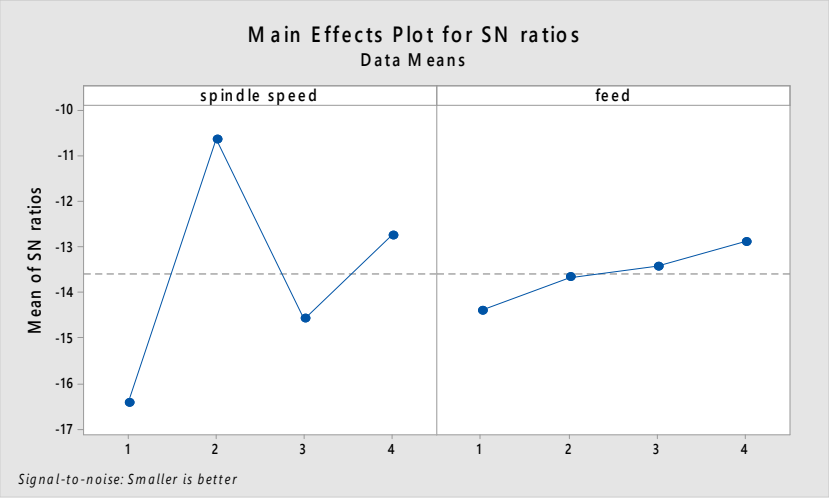

Figure 4 Signal to noise ratio for smaller is better is selected.

Table 5 Analysis of variance value of Surface roughness of H13 Die steel

Source	D F	ADJ SS	ADJ MS	F-VALUE	P-VALUE
Spindle speed	3	23.342	7.7806	38.49	0.000
Feed	3	1.610	0.5367	2.64	0.112
Error	9	1.819	0.2021		
Total	15	26.770			

Table 6 Response of variance value of Surface roughness of H13 Die steel

Signal	R-square	R-square(adj)	R-square(pred)
0.449599	93.20%	88.678%	78.52%

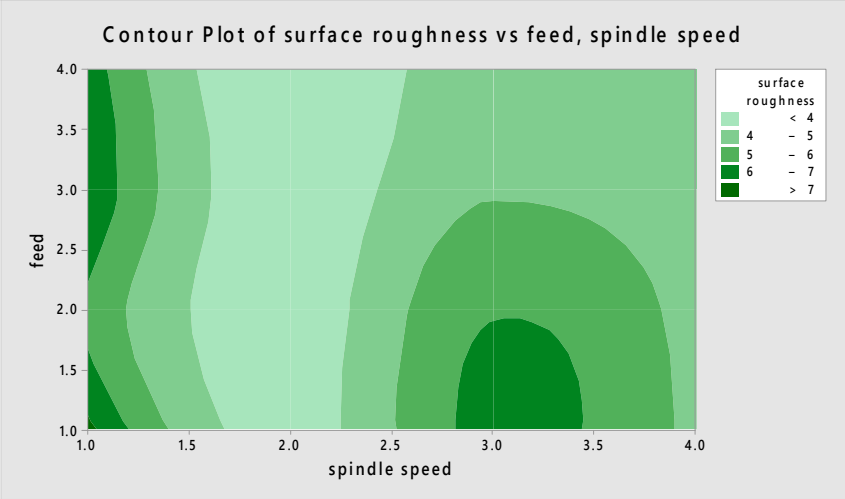

Figure 5 Contour plot for surface roughness:

7.1. Out of Roundness

Out of roundness is the property of drilled hole in which the hole is not in a perfect circle the hole has a wave on its circular periphery this is caused by the helical flut of the drill. This is measured in CMM.

Table 8 Drilling parameters of Out of roundness of H13 Die steel

Spindle speed	Feed	Out of roundness	S N ratio
300	0,060	0.060	24.4370
300	0.030	0.061	24.2934
300	0.020	0.053	25.5145
300	0.016	0.049	26.1961
600	0,060	0.041	27.7443
600	0.030	0.051	25.8486
600	0.020	0.057	24.8825
600	0.016	0.049	26.1961
900	0,060	0.029	30.7520
900	0.030	0.033	29.6297
900	0.020	0.034	29.3704
900	0.016	0.042	27.5350

1200	0,060	0.039	28.1787
1200	0.030	0.024	32.3958
1200	0.020	0.021	33.5556
1200	0.016	0.029	30.7520

Table 9 Response parameters of Out of roundness of H13 Die steel

Level	Spindle speed	Feed
1	30.87	30.42
2	29.97	28.04
3	29.32	29.09
4	34.51	37.11
Delta	5,19	9.07
Rank	2	1

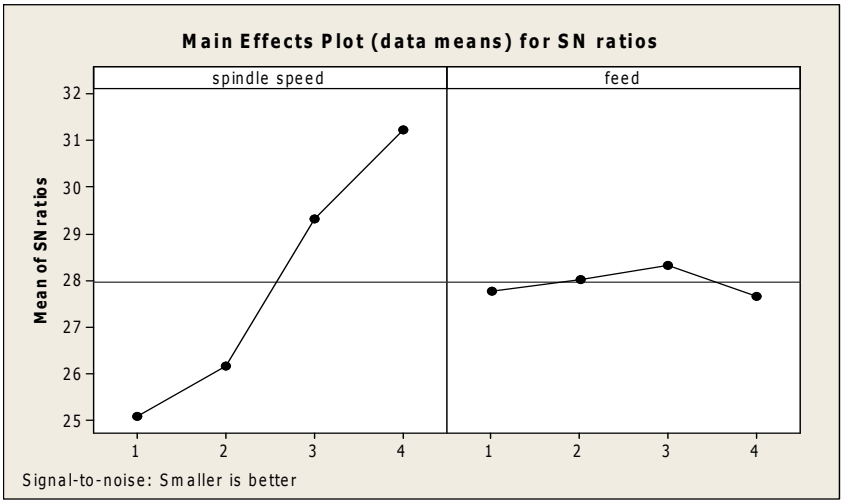

Figure 6 Signal to noise ratio: smaller the better:

Table 10 Analysis of variance for Out of roundness of H13 Die steel

SOURCE	DF	SEQSS	ADJ SS	ADJ MS	F	P
SPINDLE SPEED	3	0.0019625	0.0019625	0.0006542	11.72	0.002
FEED	3	0.0000030	0.0000030	0.0000010	0.02	0.996
ERROR	9	0.0005025	0.0005025	0.0000558		
TOTAL	15	0.0024680				

Table 11 Response of variance value of Out of roundness of H13 Die steel

Signal	R-square	R-square(adj)
0.0747217	79.64%	66.07%

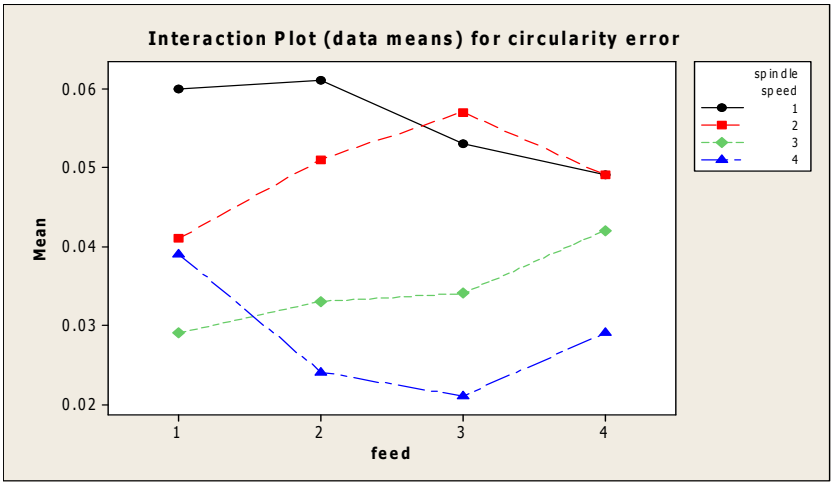

Figure 7 Interaction plot for circularity error:

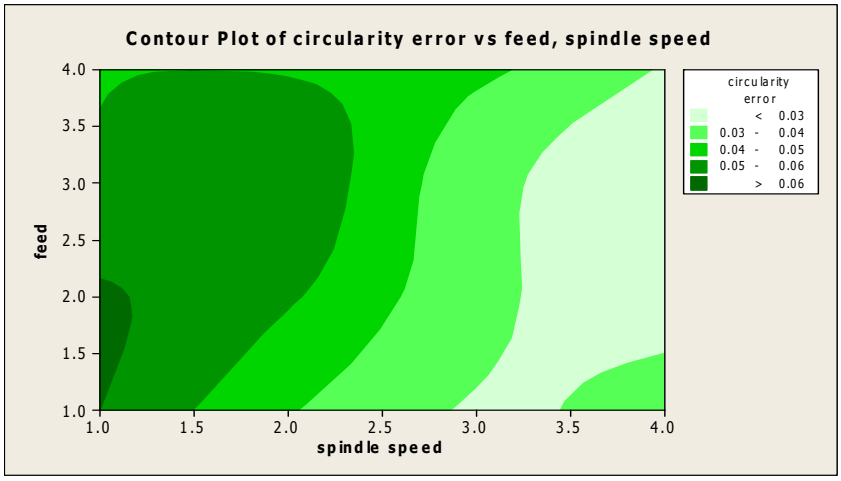

Figure 8 Contourn plot for circularity error

8. CONCLUSION

- Optimization of the process done in H13 dies steel material. To get a better surface finish with coated carbide drill tool a better finish is got in spindle speed of 600 rpm and feed of 0.03 rev/ mm with a surface roughness finish of 3.18 Ra value.
- The R square value is (93.20%) surface roughness is achieved in H13 die steel.
- A better circularity is achieved in the speed of 900rpm and feed of 0.06rev/min with a circularity error of 0.029 microns.
- The R square value of circularity error is got by 79.64%

REFERENCES

[1] W.S.Chen, K.F.Ehmann, Experimental investigation on the wear and performance of micro-drills, Proceedings ofthe1994InternationalMechanical Engineering Congress and Exposition, November6–11,1994,pp.145–157.

[2] K.K. Gupta, Prof. Tapan Jain, Manish Deshmukh ,(2013)

[3] ”Optimization of Process Parameters in High RPM Micro Drilling Machine”IJIET,Vol 2,pp-128-130.

[4] Vimal, Sam, Latha, B., and Senthilkumar,V.S., 2009. Modelling and analysis of Thrust force and Torque in drilling GFRP composites by multifaceted drill using fuzzy logic, International Journal of Recent Trends in Engineering, Vol. 1, No. 5, pp 66-70.

[5] Yu Teng Liang et al ,Investigation into Micro Machining Cutting Parameters of PMMA Polymer Material Using Taguchi's Method, 2009, Key Engineering Materials, 419-420, 341.

[6] P.F Zheng, L., Wang, C., Yang, L., Song, Y., Fu, .L, 2012,Characteristics of chip formation in the micro-drilling of multi material sheets, International Journal of Machine Tools & Manufacture, 52:40-49.

[7] THIREN G. POKAR ,PROF. V. D. PATEL,(2013) "Optimization and Modeling of Micro drilling Process Parameters" International Journal of Research in Modern Engineering and Emerging Technology. Vol. 1, Issue: 2, pp 26-30.

[8] Dong-Woo Kim , Myeong-Woo Cho , Tae-Il Seo and Eung-Sug Lee, Application of Design of Experiment Method for Thrust Force Minimization in Step-feed Micro Drilling, Sensors 2008, 8, 211-221.

[9] M. K. A Mohd Ariffin, M. I. Mohd Ali, S. M. Sapuan and N. Ismail, An optimise drilling process for an aircraft composite structure using design of experiments, Scientific Research and Essay Vol.4 (10), pp. 1109-1116, October 2009.

[10] Azlan Abdul Rahman, Azuddin Mamat and Abdullah Wagiman, Effect of Machining Parameters on Hole Quality of Micro Drilling for Brass, Modern Applied Science, vol 3, no. 5, May 2009

[11] TM.Kannan,S.Giridharan and P.vijaya kumar "Optimization of drilling parameters EN-8 Steel plates using Taguchi Technology "International of journal of research in Mechanical Engineering,Volume -2,Oct 2014.

[12] Vikas Mukhraiya, Raj Kumar Yadav and Pooja Tiwari, Optimization of Drilling Parameters Using Grey Based Taguchi Method. *International Journal of Advanced Research in Engineering and Technology*, 6 (12), 2015, pp. 16-24

[13] Piyush P. Gohil, Vijaykumar Chaudhary, Kundan Patel, Significance of Drilling Parameters on Delamination Factor in GFRP: An Image Analysis Approach. *International Journal of Mechanical Engineering and Technology*, 3 (2), 2012, pp. 200-209