International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

CNC Turning Parameter Optimization for MRR of SS 430 Using Taguchi Methodology

Dr. A. M.Nikalje[1], Pawan Somavanshi[2]

[1]Astt. Prof. Mech Mechanical Engineering Department, Government Engineering College, Aurangabad.
[2]M. E. Production Mechanical Engineering Department, Government Engineering College, Aurangabad.

Abstract- *In this paper signal-to-noise ratio method is applied to find optimum process parameters for finishing operation of mild steel with the help of CNC milling machine and high speed steel tool used. The signal-to-noise ratio applied to find optimum process parameter for CNC finishing machining .A L9 orthogonal array and analysis of variance (ANOVA) are applied to study the performance characteristics of machining parameter (spindle speed, feed, depth, width) with consideration of material removal rate(MRR) .The material removal rate have been identified as quality attributes and assumed to be directly related to productivity improvement. Results obtained by taguchi method and signal-to-noise ratio match closely with (ANOVA) and the feed is most effective factor for MRR.. Multiple regression equation are formulated for estimating predicted value surface roughness and material removal rate Key Words: CNC, Taguchi, ANOVA, MRR, S/N Ratio, L-9 orthogonal array, Optimization.*

1. INTRODUCTION-

Taguchi's parameter design offers a procedural approach for utilization of various parameters with respect to performance quality and cost. The quality is most important factor to improve productivity of the any industries. The quality and cost are basic requirement to the customer and satisfy the customer demand. For this purpose quality of a product and productivity should be high and cost should be low. Design optimization for quality was carried out and single to noise ratio and analysis of variance (ANOVA) were employed using experiment result to confirm effectiveness of this approach. The signal to noise ratio in Taguchi methodology have been widely used in engineering design to find the optimal parameter for material removal rate operation based experimental results done on mild steel work piece and high speed steel tool. The personnel industry as well as in research and development is required maintain MRR. steel is extensive used us a main engineering material in various industry such as air craft and aerospace industry impact of finishing parameter The finishing tool diameter is constant in 5 mm. The taguchi optimization methodologies to optimize the finishing parameter in CNC milling machining use mild steel and tool is high speed steel .Authors analysed the data using ANOVA with the help of commercial software package minitab-16.A series of experiment based on the Taguchi L9 orthogonal array is utilized for experimental planning for CNC milling machining. Taguchi designs provide a powerful and efficient method for designing processes that operate consistently and optimally over a variety of conditions. In this paper the finishing of mild steel with parameters of finishing at three levels and four factor each. The main objective of taguchi methodology to find a specific range and interaction to achieve the lowest surface roughness value and highest material removal rate.

2. EXPERIMENTATION-

Fig 2.1-CNC Machine

The experiments have been conducted on the VMC of SIL expertise innovation excellence made in India which is available at ACE Micromatic Model no. SLC-16-LM Maximum Turning Diameter: 150 mm Maximum Turning Length: 100 mm Spindle Size: A2-5 Spindle Motor Power Fanuc Continuous: 5.5 kW fully integrated and with hardware, software and peripherals incorporated. It is a continuous mode machine having number of input parameters which could be varied i.e. cutting speed, Depth of cut, feed rate, tool shape, nose radius Each parameter has its effect on the output parameters such as Material Removal Rate (MRR), Kerf Width (KW) and Kerf Deviation

(KD),Surface roughness, cutting force, tool wear, feed force, trust force.

3. SELECTION OF LEVELS

The basic criteria for selection of levels of factors for CNC Machine of various mould steels is selected from technology guidelines of machine

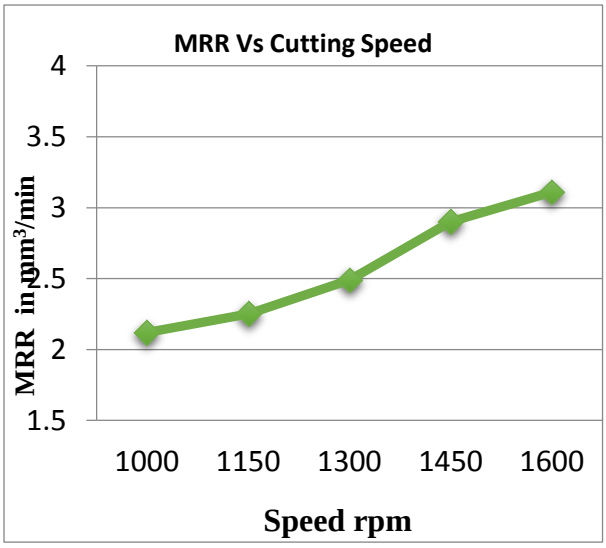
Cutting Speed: 1000, 1150, 1300, 1450, 1600 rpm

Feed Rate: 50, 75, 150, 200, 250 mm/min

Depth of Cut: 0.2, 0.4, 0.6, 0.8, 1.0 mm

3.1 O-VAT for Speed

When cutting speed is increases interaction between tool and material is decreases. That is Heat generation decreases which leads to minimum side burning.



Graph3.1 Speed Vs MRR

From the above table it is observed that, the rate of change of MRR is Higher in the region of cutting speed is 1150-1450 bar hence this level of factor is selected.

The experimental condition used for cutting the 5 mm thick SS 430 Stainless Steel is above given

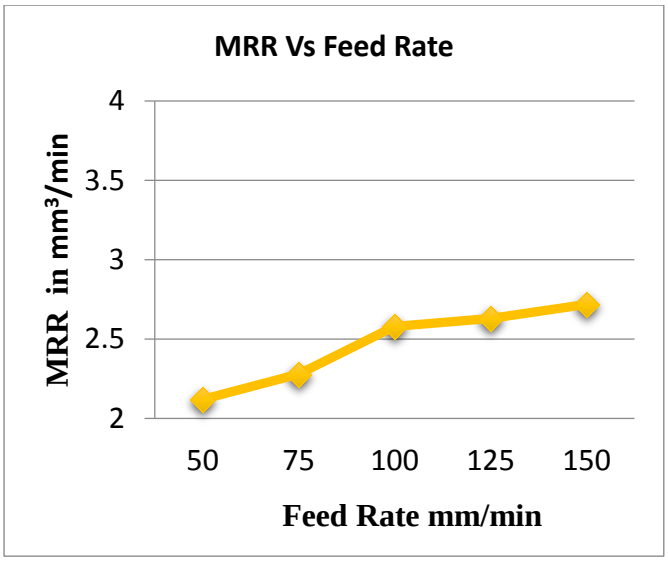
Summarizes the variation MRR as a function of CNC Turning Machine Cutting Speed 1000, 1150, 1300, 1450 and 1600 rpm.

From Table As the Cutting Speed is increases 1000 to 1600 rpm, the MRR is Increase from 2.25 to 2.90 mm^3/min

3.2 O-VAT for Feed Rate

The experimental condition used for cutting the 5 mm thick SS 430 Stainless Steel is above given

Summarizes the variation of MRR as a function of Feed Rate 50. 75, 100, 125 and 150 mm/min. Table As the Feed Rate is increases 50 to 100 mm/min, the MRR is increases from 2.12 to 2.58 mm^3/min



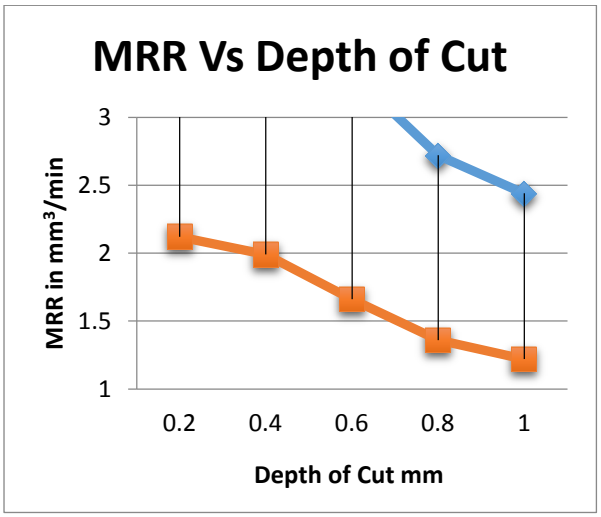
Graph 3.2-Feed Rate Vs SR

It is observed that, the rate of change of Surface roughness is higher in the region of Feed Rate is 50-100 mm/min hence this level of factor is selected.

3.3 O-VAT for Depth of Cut

The experimental condition used for cutting the 5 mm thick ss 430 Stainless Steel is above given

Table 4.3, summarizes the variation of surface roughness as a function of Depth of Cut 0.2, 0.4, 0.6, 0.8, 1.0 mm



Graph 3.2-DOC Vs SR

From the above table it is observed that, the rate of change of Surface roughness is higher in the region of Depth of Cut is 0.4-0.8 mm hence this level of factor is selected.

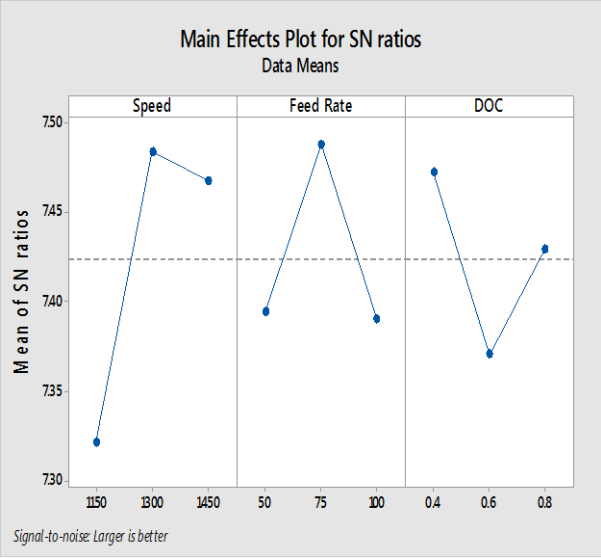
Levels of Input Parameters

Sr. No	Level 1	Level 2	Level 3
Speed	1150	1300	1400
Feed Rate	50	75	100
DOC	0.4	0.6	0.8

4. MODEL ANALYSIS FOR SR

SN Ratio SR-

4.1 Main Effects of SR



4.1 Graph Main effect plots for mean of SN ratio of SR

4.2 ANOVA Result

Source	DF	Adj SS	Adj MS	F-Value	P-Value	% Contribution
Cutting Speed	2	0.003528	0.001764	29.84	0.032	57.13
Feed Rate	2	0.001371	0.000685	11.60	0.079	22.20
Depth of Cut	2	0.001158	0.000579	9.79	0.093	19.10
Error	2	0.000118	0.000059			
Total	8	0.006175				

In ANOVA, the ratio between the variance of the cutting parameter and the error variance is called Fisher's ratio (F). It is used to determine whether the parameter has a significant effect on the quality characteristic by comparing the F test value of the parameter with the standard F table value at the P Significance level. If the F test value is greater than P test the cutting parameter is considered significant.

Exp	Inputs Factors			Output Responses	
Trial No.	Cutting Speed	Feed Rate	Depth of cut	SR (µm)	SNRA(dB)
1	1150	50	0.4	2.329	7.34339
2	1150	75	0.6	2.321	7.31350
3	1150	100	0.8	2.319	7.30601
4	1300	50	0.6	2.348	7.41396
5	1300	75	0.8	2.387	7.55705
6	1300	100	0.4	2.366	7.48029
7	1450	50	0.8	2.351	7.42505
8	1450	75	0.4	2.397	7.59336
9	1450	100	0.6	2.340	7.38432

Relevance of the models is tested by analysis of variance (ANOVA). It is a statistical tool for testing the null hypothesis for planned experiments, in which several different variables are studied simultaneously. ANOVA is used to quickly analyze the variances in the experiment using the Fisher test (F test). Anova table shows the result of the ANOVA analysis. The ANOVA analysis makes it possible to observe that the value of P is less than 0.5 in the three parametric sources. It is therefore clear that (1) the Cutting speed, (2) the Feed Rate, (3) the Depth of cut of the material have an influence on the 430 Stainless Steel. The last column of cumulative ANOVAs shows the

percentage of each factor in the total variance that indicates the degree of impact on the outcome.

The table shows that the Cutting Speed 57.13%), the Feed Rate (20.20%) and the Depth of cut (19.10%) have a major influence on the Surface roughness.

4.3 Optimum level of parameters

Sr. No.	Parameter	Optimum level
1	Cutting Speed (level 2)	1300
2	Feed Rate (level 2)	75
4	Depth of Cut (level 1)	0.4

4.4 Confirmation experiment result

Parameter	Model value	Experimental value	Error %
SR	2.29	2.22	3.15

5. CONCLUSIONS

This study covers the observations about the Surface Roughness over the 430 Stainless Steel material by the process of cnc for the different input parameters to thoroughly study over the effect of CNC process on the 430 Stainless Steel material. Throughout the experimentation I got some results as under.

The combination of cutting parameters i.e. cutting speed, Feed Rate and Depth of Cut were planned by L9 Orthogonal Array Taguchi method , based on the results obtained and derived analysis the following can be concluded.

- The optimal solution obtained for MRR based on the combination of CNC Machine parameters and their levels is (i.e. cutting speed 1300 rpm, Feed Rate 75 mm/min and 0.8 mm).
- ANOVA results indicate that cutting speed plays prominent role in determining the MRR. The contribution of Cutting speed, Feed Rate and DOC to the quality characteristics MRR is 22.13%, 20.20% and 19.10% respectively.
- Cutting speed and Feed Rate are the most significant parameters majorly affecting the surface roughness whereas the DOC is much smaller.
- The optimal cutting parameters are determined using Taguchi methods match with the experimental values by minimum errors i.e 3.15% for SMRR hrough the developed mathematical models, any experimental results of surface roughness with any combination of cutting parameters can be estimated.

6. REFERENCES

- Masounave, J., Youssef, A., Yves, B., Marc, T. (1997). An experimental design for surface roughness and built- up edge formation in lathe dry turning. International Journal of Quality Science, 2(3): 167-180. https://doi.org/10.1108/13598539710170803 [2] Ghani, J.A., Choudhury, I.A., Hassan, H.H. (2004). Application of Taguchi method in the optimization of end milling parameters. Journal of Materials Processing Technology, 145(1): 84-92. https://doi.org/10.1016/S0924-0136(03)00865-3 [3] Gopalsamy, B.M., Mondal, B., Ghosh, S. (2009). Taguchi method and ANOVA: An approach for process parameters optimization of hard machining while machining hardened steel. Journal of Scientific and Industrial Research, 68: 686-695. http://nopr.niscair.res.in/handle/123456789/5301 [4] Sarýkaya, M., Dilipak, H., Gezgin, A. (2015). Optimization of the process parameters for surface roughness and tool life in face milling using the Taguchi analysis. Materials Technology, 49(1): 139-147. [5] Surace, R., De Filippis, L.A.C., Ludovico, A.D., Boghetich, G. (2010). Application of Taguchi method for the multi-objective optimization of aluminium foam manufacturing parameters. International Journal of Material Forming, 3(1): 1-5. http://dx.doi.org/10.1007/s12289-009-0409-9 [6] Dahbi, S., Moussami, E.H., Ezzine, L. (2015). Optimization of turning parameters for surface Roughness for turning process of Steel AISI 1042 (58.55 HRC). Xème Conférence Internationale: Conception et Production Intégrées, Tanger, Morocco. [7] Yang, W.P., Tarng, Y.S. (1998). Design optimization of cutting parameters for turning operations based on the Taguchi method. Journal of Materials Processing Technology, 84(1-3): 122-9.
- http://dx.doi.org/10.1016/S0924-0136(98)00079-X [8] Pang, J.S., Ansari, M.N.M., Zaroog, O.S., Ali, M.H., Sapuan, S.M. (2014). Taguchi design optimization of machining parameters on the CNC end milling process of

halloysite nanotube with aluminium reinforced epoxy matrix (HNT/Al/Ep) hybrid composite. HBRC Journal 10(2): 138-144. http://dx.doi.org/10.1016/j.hbrcj.2013.09.007 [9] Nalbant, M., Gökkaya, H., Sur, G. (2007). Application of Taguchi method in the optimization of cutting parameters for surface roughness in turning. Materials & Design, 28(4): 1379-1385. http://dx.doi.org/10.1016/j.matdes.2006.01.008
[10] Hasçalık, A., Çaydaş, U. (2008). Optimization of turning parameters for surface roughness and tool life based on the Taguchi method. The International Journal of Advanced Manufacturing Technology, 38(9-10): 896-903. https://doi.org/10.1007/s00170-007-1147-0
[11] Benardos, P.G., Vosniakos, G.C. (2002). Prediction of surface roughness in CNC face milling