International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 08 | Aug - 2021 ISSN: 2582-3930

"Optimization of VMC Machine Process Parameters using Taguchi Parameter Design Approach "

Dr. Yogesh U. sathe[1] , Pawan Somavanshi[2]
[1]*Asst. Prof. Mechanical engineering department,*
Government engineering college, Aurangabad.

[2]*M.E.Production mechanical engineering department,*
Government engineering college, Aurangabad.

Abstract- *The Present work deals with the effects of various milling parameters such as spindle speed, feed rate, and depth of cut on the surface roughness of finished components. The experiments were conducted on UNS S30430 Stainless Steel plate material on vertical milling machine The factors considered for experimentation and analysis were cutting speed, feed rate and depth of cut. Signal-to-noise (S/N) ratio and analysis of variance (ANOVA) were employed to analyze the effect of these milling parameters. The analysis results revealed that the spindle speed was the dominant factor affecting surface roughness. Confirmation test results showed that the Taguchi method was very successful in the optimization of machining parameters for minimum surface roughness.*

Key Words: VMC,Taguchi, ANOVA, SR, S/N Ratio, L-9 orthogonal array, Optimization.

1.INTRODUCTION- The machining industries are facing a great challenge to achieve high quality, good surface finish and high material removal rate with a view to economize in machining. End Milling is widely used in a variety of manufacturing industries including the aerospace and automotive sectors, where quality is an important factor in the production of slots, pockets, precision molds, and dies because good-quality milled surface significantly improves fatigue strength, corrosion resistance, and creep life. The setting of machining parameters relies strongly on the experience of operators and machining parameter tables provided by machine tool builders. It is difficult to utilize the optimal functions of a machine owing to there being too many adjustable machining parameters. Surface roughness is an important measure of the technological quality of a product and a factor that greatly influences manufacturing cost. The mechanism behind the formation of surface roughness is very dynamic, complicated and process dependent so its calculation through theoretical analysis is difficult. Therefore, machine operators usually use "trial and error" approaches to set-up milling machine cutting conditions in order to achieve the desired surface roughness which is not effective and efficient and the achievement of a desirable value is a repetitive and empirical process that can be very time consuming. The dynamic nature and widespread usage of milling operations in practice have raised a need for seeking a systematic approach that can help to set-up milling operations in a timely manner and also to help achieve the desired surface roughness quality. The goal of the modern industries is to manufacture low cost, high quality product in short time. In milling to achieve high cutting performance, selection of optimum parameter selection is determined by the operator's experience knowledge or the design data book. But the availability of valid experimental data is very limited for machining with advanced cutting tool. The mach inability of hardened steel was evaluated by measurement of tool wear, cutting force and surface finish of work piece. Design methods such as factorial design, response surface methodology (RSM) and Taguchi methods are now widely used in place of one factor at a time experimental approach. Taguchi method is one of the Design of Experiment (DOE) methods that are frequently being used for optimization due to saving of cost, time and material. The Taguchi's dynamic experiments are simple, systematic and efficient method to determine optimum or near optimum settings of machining parameters. It optimizes the performance characteristic through the setting design parameter and reduces the sensitivity of the system performance due to variation of source.

Milling: is a metal cutting operation in which the excess material from the work piece is removed by rotating multipoint cutting tool called milling cutter. A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The milling cutter rotates at high speed and it removes metal at a very fast rate with the help of multiple cutting edges. One or more number of cutters can be mounted simultaneously on the milling machine. This is the reason that a milling machine finds wide application in production work. Used for machining flat surfaces, contoured surfaces, external and internal threads.

As the work piece moves against the cutting edges of milling cutter, metal is removed in form chips Machined surface is formed in one or more passes' of the work. The work to be machined is held in a vice, a rotary' table, a three jaw chuck, an index head, in a special fixture or bolted to machine table. In many applications, due to its higher production rate' and accuracy, milling machine has even replaced shapers and slotters.

2.EXPERIMENTATION-

Fig 2.1-VMC Machine

The experiments have been conducted on the VMC Machine model SIL10X5FL0020 of SIL expertise innovation excellence made in India which is available at Lane no. 7, Sub Plot No. 19 , Ramtekadi industrial area, Hadapsar, Pune in Machine Tool Lab. It is a 7500W, spindle speed 8000rpm and maximum load 6000kg cosmo VMC fully integrated and with hardware, software and peripherals incorporated. It is a continuous mode VMC 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 Cosmo Vertical Milling Centre Machine of various mould steels is selected from technology guidelines of machine

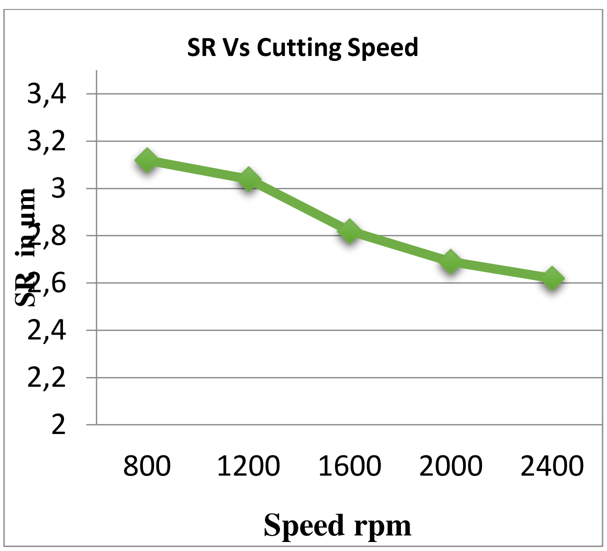
Cutting Speed: 800, 1200, 1600, 2000, 1400 rpm

Feed Rate: 100, 150, 200, 250, 300 mm/min

Depth of Cut: 0.3, 0.6, 0.9, 1.2, 1.5 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 SR

From the above table it is observed that, the rate of change of Surface roughness is lower in the region of cutting speed is 1200-2000 bar hence this level of factor is selected.

The experimental condition used for cutting the 5 mm thick UNS S30430 Stainless Steel is above given

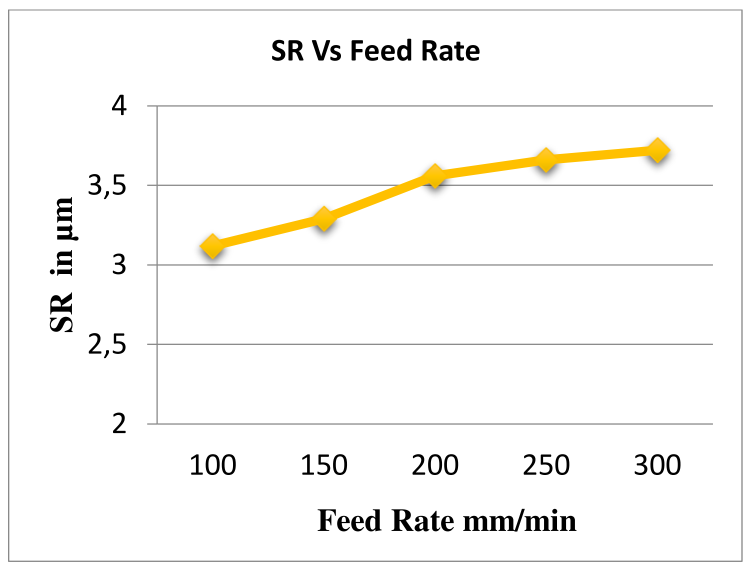
Summarizes the variation of surface roughness as a function of Cosmo Vertical Milling Centre Machine Cutting Speed 800, 1200, 1600, 2000 and 2400 rpm.

From Table As the Cutting Speed is increases 800 to 2400 rpm, the Surface Roughness is decreases from 3.66 to 2.88 µm.

3.2 O-VAT for Feed Rate

The experimental condition used for cutting the 5 mm thick UNS S30430 Stainless Steel is above given

Summarizes the variation of surface roughness as a function of Feed Rate 100,150, 200, 250 and 300 mm/min. Table As the Feed Rate is increases 100 to 300 mm/min, the Surface Roughness is increases from 3.12 to 3.72 µm



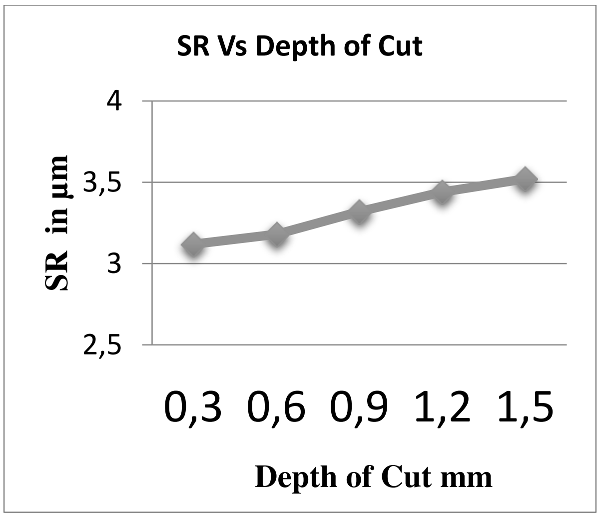
Graph 3.2-Feed Rate Vs SR

It is observed that, the rate of change of Surface roughness is higher in the region of Feed Rate is 100-200 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 UNS S30430 Stainless Steel is above given

Table 4.3, summarizes the variation of surface roughness as a function of Depth of Cut 0.3, 0.6, 0.9, 1.2, 1.5 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 0.6-1.2 mm hence this level of factor is selected.

Levels of Input Parameters

Sr. No	Level 1	Level 2	Level 3
Cutting Speed(rpm)	1200	1600	2000
Feed Rate (mm/min)	100	150	200
Depth of Cut (mm)	0.6	0.9	1.2

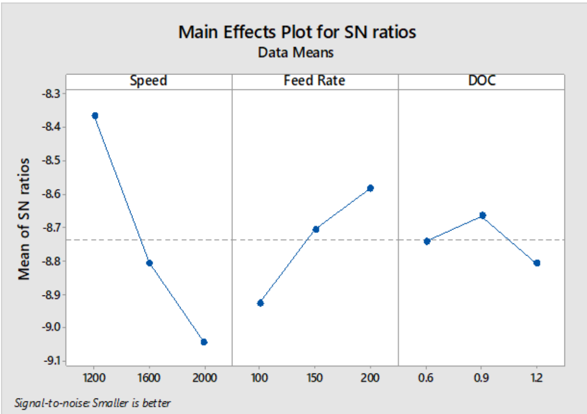
4. MODEL ANALYSIS FOR SR

Exp	Inputs Factors			Output Responses	
Trial No.	**Cutting Speed**	**Feed Rate**	**Depth of cut**	**SR (µm)**	**SNRA(dB)**
1	1200	100	0.6	2.68	-8.56270
2	1200	150	0.9	2.58	-8.23239
3	1200	200	1.2	2.60	-8.29947
4	1600	100	0.9	2.80	-8.94316
5	1600	150	1.2	2.77	-8.84960
6	1600	200	0.6	2.70	-8.62728
7	2000	100	1.2	2.91	-9.27786
8	2000	150	0.6	2.83	-9.03573
9	2000	200	0.9	2.76	-8.81818

SN Ratio SR

Shows the L_9 orthogonal array with repeat measurement of responses for runs one to nine. Repeats of response measurement technique is used overcome the drawback of saturated design in MINITAB software. It also shows that the SN ratio for run one and ten are same as it is calculated for the repeats measurement.

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	0.000426	0.000213	49.23	0.020	23.49
Feed Rate	2	0.000845	0.000423	97.71	0.010	46.60
Depth of Cut	2	0.000534	0.000267	61.74	0.016	29.45
Error	2	0.000009	0.000004			
Total	8	0.001813				

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.

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 UNS S30430 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 23.49%), the Feed Rate (46.60%) and the Depth of cut (29.45%) have a major influence on the Surface roughness.

4.3 Optimum level of parameters

Sr. No.	Parameter	Optimum level
1	Cutting Speed (level 1)	1200
2	Feed Rate (level 3)	200
4	Depth of Cut (level 2)	0.9

5.CONCLUSIONS

This study covers the observations about the Surface Roughness over the UNS S30430 Stainless Steel material by the process of Vertical Milling Machine for the different input parameters to thoroughly study over the effect of Vertical Milling Machine process on the UNS S30430 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 SR based on the combination of Vertical Milling Machine parameters and their levels is (i.e. cutting speed 1200 rpm, Feed Rate 200 mm/min and 0.9 mm).
- ANOVA results indicate that cutting speed plays prominent role in determining the surface roughness. The contribution of Cutting speed, Feed Rate and DOC to the quality characteristics surface roughness Ra is 23.49.46%, 46.60% and 29.45% 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 4.29% for SR
- Through the developed mathematical models, any experimental results of surface roughness with any combination of cutting parameters can be estimated.

6. REFERENCES

- M. Kaladhar, K. Venkata Subbaiah, Ch. Srinivasa Rao ,(2012), "Determination of Optimum Process Parameters during turning ofAISI 304 Austenitic Stainless Steels using Taguchi method andANOVA", International Journal of Lean Thinking Volume 3, Issue 1
- Ranganath M S, Vipin, (2013), "Optimization of Process Parametersin Turning Operation Using Taguchi Method and Anova: A Review",International Journal of Advance Research and Innovation Volume 1(2013) 31-45
- T. Sreenivasa Murthy, R.K.Suresh, G. Krishnaiah, V. Diwakar Reddy,(2013), "Optimization of process parameters in dry turning operationof EN41B alloy steels with Cermet tool based on the Taguchimethod", International Journal of Engineering Research andApplications (IJERA) ISSN: 2248-9622 Vol. 3, Issue , pp.1144-1148
- Vikas B. Magdum, Vinayak R. Naik, (2013), "Evaluation andOptimization of Machining Parameter for turning of EN 8 steel",International Journal of Engineering Trends and Technology (IJETT)Volume4, Issue5
- Taquiuddin Quazi, Pratik gajanan more, (2014), "Optimization ofTurning Parameters Such as Speed Rate, Feed Rate, Depth of Cut forSurface Roughness by Taguchi Method", Asian Journal ofEngineering and Technology Innovation 02 (02) 2014 (05-24)
- Anand S.Shivade, Shivraj Bhagat, Suraj Jagdale, Amit Nikam,Pramod londhe, (2014), "Optimization of Machining Parameters for Turning using Taguchi Approach", International Journal of Recent Technology and Engineering

(IJRTE)ISSN:2277-3878,Volume-3, Issue

- Aminollah Mohammadi, Alireza Fadaei Tehrani, Ehsan Emanian, Davoud Karimi, statistical analysis of wireelectrical discharge turning on material removal rate, Journalof Materials Processing Technology 205, 283- 289,2008.
- K. Kanlayasiri, S. Boonmung ,An investigation on effects ofwire-EDM machining parameters on surface roughness ofnewly developed DC53 die steel, journal mateProcess.technol.187,26-29, 2007.
- Arokiadas R., K. Palaniradja and N. Alagumoorthi.Prediction and optimization of end milling processparameters of cast aluminium based MMC. Trans.Nonferrous Met. Soc China. 22, 1568-1574, 2012.
- Baharudin B.T.H.T, M.R. Ibrahim, N. Ismail, Z. Leman,M.K.A. Ariffin and D.L. Majid. Experimental Investigation of HSS Face Milling to AL6061 using Taguchi Method Procedia Engineering, 50, 933 – 941, 2012.
- Lin Tsann-Rong Experimental design and performanceanalysis of TiN-coated carbide tool in face milling stainlesssteel. Journal of Materials Processing Technology, 127, 1-72 002.
- Ting-Cheng Chang, Feng-Che Tsai, Jiuan-Hung Ke, Datamining and Taguchi method combination applied to theselection of discharge factors and the best interactive factorcombination under multiple quality properties, Int J AdvManuf Technol 31: 164–174, 2006.
- S. S. Mahapatra, Amar Patnaik, Optimization of wireelectrical discharge machining (WEDM) process parametersusing Taguchi method, Int J Adv Manuf Technol 34:911–925, 2007.
- Aminollah Mohammadi, Alireza Fadaei Tehrani, EhsanEmanian, Davoud Karimi, A new approach to surface roughness and roundness improvement in wire electrical discharge turning based on statistical analyses, Int J Adv Manuf Technol 39:64–73, 2008. Douglas C. Montgomery, Design and Analysis of Experiments, john wiley and sons 2001. [10] Vishal Parashar, A.Rehman, J.L.Bhagoria, Y.M.Puri Investigation and optimization of surface roughness for wire cut electro discharge machining of SS 304L using Taguchi dynamic experiments, International Journal of Engineering studies,