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Original Research Article

OPTIMIZATION AND ANALYSIS OF LUBRICATING EFFECT ON MACHINING PARAMETER

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ABSTRACT

Lubrication in machining is important aspect to minimize surface roughness and material removal rate. Analysis of the surface roughness and MRR is done experimentally with specific input values of feed, speed, and Depth of cut has to design the experiment for optimize the best parameter. To optimize these machining parameters in which the most significant parameters affecting the surface roughness can be identified, Taguchi design is used with the orthogonal array L9 but for both cases are performed to make 18 experiment. With the help of ANOVA (Analysis of Variance), the most effective or the optimal parameters for the output is determined. Resolve the most significant factors and their level for optimum surface roughness by analysis of variance (ANOVA) methods are implemented for optimization to select best parameter apply TOPSIS method.

KEYWORD : Optimization, Composite materials, Responses, Lubrication.

INTRODUCTION

Milling is the process of cutting away material by feeding a work piece past a rotating multiple tooth cutter. The cutting action of the many teeth around the milling cutter provides a fast method of machining. The machined surface may be flat, angular, or curved. The surface may also be milled to any combination of shapes. Thus improvement in the quality of a product ensures its demand from the costumer thus helping the organization for achieving the higher revenue. Milling is a versatile and useful machining operation. End milling is the most imperative milling operation and it is widely used in most of the manufacturing trades due to its capability of producing complex geometric surfaces with reasonable accuracy and surface finish. However, with the inventions of CNC milling machine, the flexibility has been adopted along with versatility in end milling process. It is found that many research works have been done so far on continuous improvement of the performance of end milling process. The selection of efficient machining parameters is of great concern in manufacturing industries, where economy of machining operations plays a key role in the competitive market. Many researchers have dealt with the optimization of machining parameters. CNC machine tools have been implemented to realize full automation in milling since they provide greater improvements in productivity, quality of the machined parts with less operator input. The surface finish of the machined surface has been recognized as quality attribute whereas MRR has been treated as performance index directly related to productivity.

Sometimes high specific stiffness is more important than stiffness to increase the natural frequency of the vibration of the machine tool structure in high speed machining[1].The static stiffness of a machine tool can be increased by using either higher modulus material or more material in the structure of a machine tool. The basic function of machine tool is to produce a workpiece of the required geometric form with an acceptable surface finish at high rate of production in the most economical way [2]. Yasir et.al [3] investigates the effect of cutting parameters on the surface topography of stainless steel AISI 316L with tungsten carbide tool by using response surface methodology. Kathiresan et. al. [6] focused on investigation into Minimum Quantity Lubricant (MQL) and wet machining in milling processes of AISI 6060 Aluminum work material has been carried out with the main objective is to determine the effect of lubrication conditions on the surface roughness.

OBJECTIVE OF PRESENT WORK

Therefore, there should be research endeavour to apply to composite material of AISI 4140 alloy in milling machine for achieve reasonably low value of SR and MRR. Milling machines are capable of achieving reasonable accuracy and surface finish. Processing time is also very low as compared to some of the conventional machining process. The analysis of mean and variance technique is required to study the significance of each machining parameter on the surface roughness and MRR by ANOVA Analysis. DOE combination of factors, parts, processes and design factors that will satisfy functional and economical specifications by MINITAB. Taguchi Design of Experiment are design on the basis of orthogonal array for each condition of lubricant. Responses of those factors which have the largest encouragement on variation are adjusted to achieve the target quality level. According to Taguchi's parameter design machining are perform to obtain responses in term as of Surface Roughness and MRR.

METHODS AND MATERIALS

AISI 4140 alloy steel is introduce as high strength, high surface hardness and good fracture toughness carburized steel that also has high temperature resistance, corrosion resistance and hardenability. AISI 4140 alloy steel is a higher performance upgrade from 9310, X53 (AMS 6308), EN36A, EN36B, EN36C and 8620. It can achieve a surface hardness of 45-50 Rockwell (HRC) via vacuum carburization. AISI 4140 alloy steel is double vacuum melted for high purity, leading to much greater fatigue strength. Solid end mills are made from carbide coated high-speed steel or sintered carbide. They are usually made from high speed steel (HSS) or carbide, and have four flutes. The machine used in the work is a vertical-type machining with end milling cutter of four flute. The spindle has constant position preloaded bearings with oil-water lubrication, and the maximum rotational speed is 20,000 rpm. The work specimen of 100mm x 100mm x10mm is a AISI 4140 alloy steel square plate which is thoroughly cleaned. These work piece side edge are cut by milling machine of 10mm thickness in all sides then it will pass through roughness tester machine of all sides. The machining parameters and their levels are presented the Table 1.

Table 1 Machining parameter and their level

Control Parameter					
Parameter	Symbol	Level			Unit
		1	2	3	
Cooling Mixture	C	Coolant with 10% water Coolant with 20% water			
Speed	S	2000	2500	3000	RPM
Feed	F	150	200	250	mm/min
Depth of Cut	D	10	12	15	Mm

Roughness is a measure quantified by the vertical deviations of a real surface from its ideal form. If these deviations are large, the surface is rough; if they are small the surface is smooth. Roughness is typically considered to be the high frequency, short wavelength component of a measured surface. Material removal rate is the volume of material removed per unit time from the work piece surface. We can calculate material removal rate as the volume of material removed divided by the time taken to cut. The volume removed is the initial volume of the work piece minus the final volume. The cutting time is the time needed for the tool to move through the length of the work piece this parameter strongly influences the finishing grade of the work piece.

RESULT ANALYSIS

Vertical milling machines, in which the tool is moved through two horizontal axes and the cutting tool is moved vertically, are common. All input parameter are inserted by mean of programming through CNC milling machine for a milling operation. New cutting geometries as well as coatings are constantly being advanced to increase the cutting speed as well as improve surface finish and MRR for AISI 4140 alloy materials. The analysis of variance (ANOVA) has been used to check the adequacy of the second order model. The results for the three different secondary bed materials are presented of both responses. Surface finish in milling has been found to be influenced by a number of factors such as cutting speed, feed rate and depth of cut. The various simple surface roughness parameters used in the industries such as average roughness (Ra). It means that surface roughness increases with increasing feed rate and a large tool nose radius reduce surface roughness of the work piece. Results of surface roughness tests best parameter are presented in terms of graphs. If the speed is increase in the roughness value is decreasing up to maximum level after that they are start to increasing. The optimum parameter for surface roughness of the speed is 2500 rpm, feed rate 200, DOC is 12 mm with coolant added of 10% water for good surface finish. Depth of cut is slightly increasing so there is not significantly effect on surface roughness that are also described in the main effect plots graph of surface roughness as shown in fig 1.

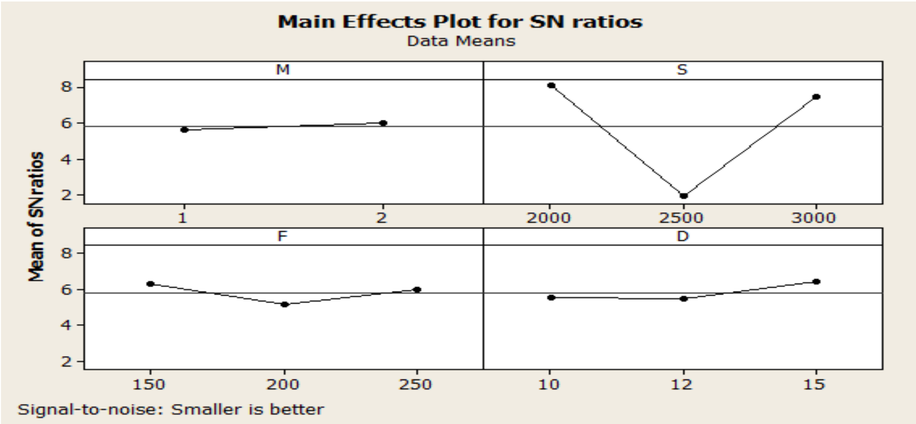

Fig. 1 Main effect plots for surface roughness

The results of analysis of variance (ANOVA) for surface roughness are shown in Table 2. In this table the speed is the significant factor because speed P Value is less than 0.05. The analysis of variance (ANOVA) is used to discuss the relative importance of all control factors on the machined MRR and also to determine which control factor has the most significant effect. Analysis of variance (ANOVA) is employed to find the optimal process parameter levels and to analyse the effect of these parameters on metal removal rate response rank is speed as shown in table 3.

Table 2 ANOVA for Ra

Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**
M	1	0.009339	0.009339	0.009339	0.41	0.535
S	2	0.603033	0.603033	0.301517	13.36	0.001
F	2	0.011700	0.011700	0.005850	0.26	0.777
D	2	0.002433	0.002433	0.001217	0.05	0.948
Residual Error	10	0.225744	0.225744	0.022574		
Total	17	0.852250				

Table 3 Analysis of Variance MRR

Source	DF	Seq SS	Adj SS	Adj MS	F	P
M	1	8889	8889	8889	1.40	0.264
S	2	37795	37795	18898	2.97	0.097
F	2	12722	12722	6361	1.00	0.402

D	2	54187	54187	27094	4.26	0.046
Residual Error	10	63538	63538	6354		
Total	17	177131				

The optimum parameter for MRR of the speed is 2500 rpm, feed rate 200, DOC is 15 mm with coolant added of 20% water for good surface finish. Depth of cut is slightly increasing so there is not significantly effect on surface roughness that are also described in the main effect plots graph of surface roughness as shown in fig 2.

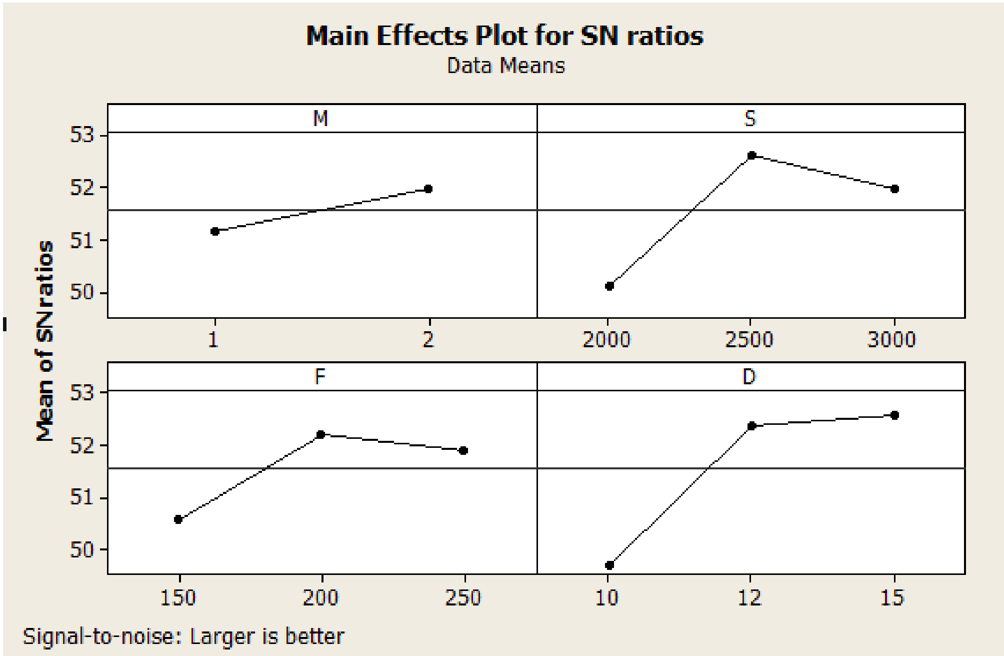

Fig 2 S/N graph of MRR

OPTIMIZATION

TOPSIS method is a very effective method to optimize the values and analyse the input parameters to give effective response. This method optimize based on DOE and its responses where four input parameters are taken and two response factors are optimizing. The Close Coefficient Index has been calculated for optimize the responses and it will convert multi-objective problem into single objective problem. Greater value of CCI is the optimum parameter for observed responses are shown in fig 3. This analysis is used to find optimum parameter for the response factor Surface roughness and MRR. In the given polt in figure 4, the optimum performance of the coolant mixture, speed feed and DOC can be seen at, 10% of water in coolant, 2500rpm, 200mm/min and 12mm respectively for CCI.

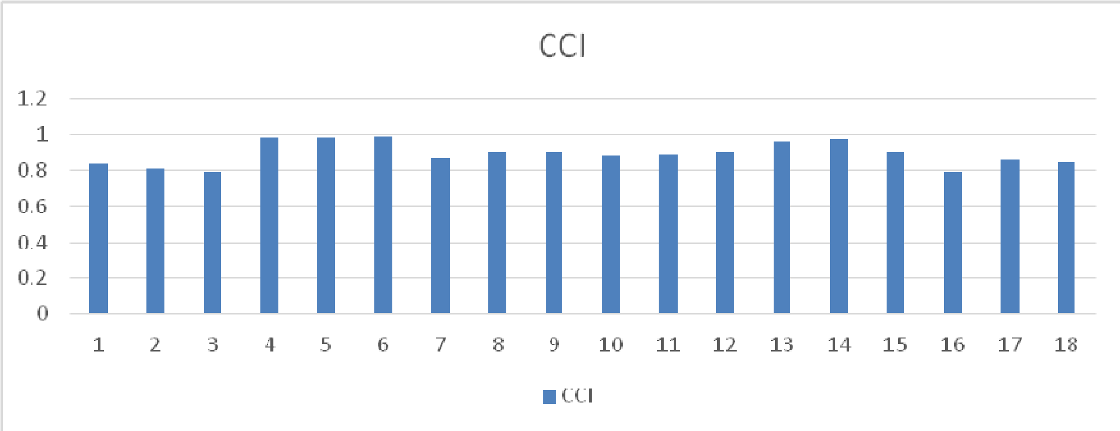

Fig 3 Optimize Quantity

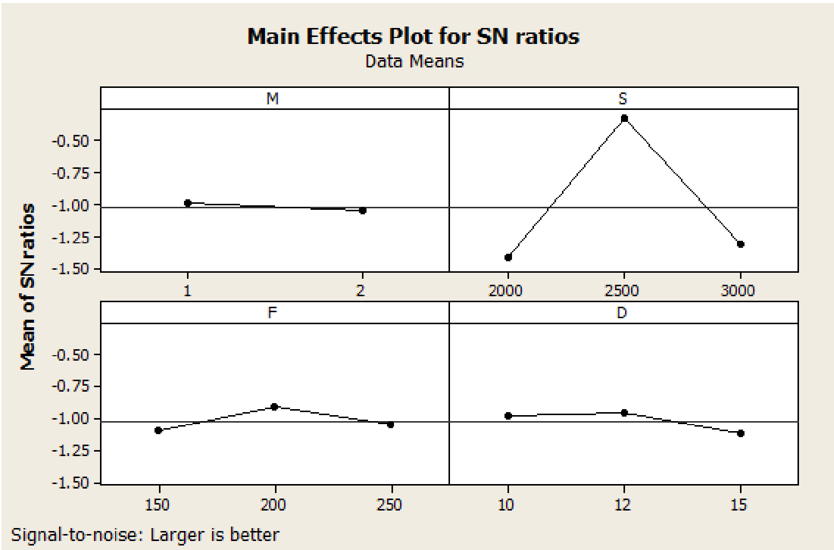

Fig 5. 6 Optimize factor by CCI

CONCLUSIONS

Design of experiment is found to be a successful technique to perform trend analysis of surface roughness and MRR in milling operation with respect to various combinations of design variables (feed rate, cutting speed, and coolant mixture). The speed is 2500 rpm is given the good surface finish of these experiments where the speed factor is predicted for surface roughness. MRR is more precise significant results during machining operations, the prediction parameter is DOC is for MRR. TOPSIS is utilized for getting best machining parameters. This work can be extended to obtain the significant factor for optimize parameter by ANOVA analysis.

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