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ANALYSIS OF SIGNIFICANT FACTOR OF MILLING MACHINE OPERATION PARAMETERS

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The quality of the machined greatly influenced during machining operation are represented by various researcher. Various methods are applied to reduce and observe the surface roughness of the milling specimen. This work investigates for milling parameter optimization and to targets work performance system for the control of surface quality and MRR. The experiment is performed on Vertical Milling Machine using cutting Alloy material with end mill tools. Experiment wise investigation of the C64 plates is fixed as work-piece specimen and milling operation is carried out. The experiment performs on different sets of C64 plates as per design of experiment by MINITAB. Optimizing these machining parameters in which the most significant parameters affecting the surface roughness can be identified with the help of ANOVA (Analysis of Variance) and the most effective or the optimal parameters for the output are determined.

1. INTRODUCTION

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. 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 productivity of any machine tool and any machined component is determined by the quality of the surface produced by that machine. Hence for the good functional behaviour of any mechanical components achieving good surface quality is of great importance. The effective optimizations of these parameters affect dramatically the cost and production time of machined components as well as the quality of final products. In order to get quantified surface roughness, assortment of controlling parameters is necessary. Milling machines are mostly general purpose and used for piece or small lot production. But like other machine tools, some milling machines are also incorporated with certain type and degree of automation or mechanisation to enhance production rate and consistency of product quality. When the machine tool is operated without any vibration or chatter, the damping of the machine tool plays no important role in machining.

Rahman et al. [6] have made attempts to review and summarize the key developments in the area of non-conventional materials for machine tool structures over the last decades. Based on the results of previous studies they have stated that Alloy materials may be the choice to replace conventional materials. Lee et al. [7] have improved the damping capacity of the column of a precision mirror surface grinding machine tool by manufacturing a hybrid column by adhesively bonding glass fibre reinforced epoxy Alloy plates to a cast iron column. Suh et al. [8] have used Alloys for the massive slides for CNC milling machine in machining moulds and dies because presence of these massive slides do not allow rapid acceleration and deceleration during the frequent starts/stops encountered in machining moulds and dies. Okuba et al. [9] have improved the dynamic rigidity of machine tool structures by studying the mode shape animation based on the results of modal analysis. This technique was successfully applied to a machining cell, an arm of automatic assembling machine and a conventional cylindrical grinder. Schultz and Niclau[10] used epoxy resin as a bonding material between structural components of a milling machine to increase joint damping. It was reported that the bonded overarm of milling machine performed much better than those of welded and the cast iron.The responses of milling machining parameters are observed which has to be maintained to improve the quality of work piece. Improving the responses can help us to reduce the production cost by reducing the defects of products and also reducing the use of other finishing machining to achieve the maximum benefit applied under optimum condition.

2. METHODS AND MATERIALS

The Milling machine used in the work is a vertical-type machine with end milling cutter of four flutes. The spindle has constant position preloaded bearings with oil-water lubrication, and the maximum rotational speed is 20,000 rpm. The cutting process of a square workpiece of C64 material 120 x 120 x 10 mm is selected as a case study. However, to control the cutting temperature and to reducing friction between the tool and workpiece for better surface roughness and MRR the lubricant system is used in the machining process with variation of lubricant and mixture. Alloy material C64 each of 10 mm thickness and depth of cut is fixed parameter with variable parameters of milling is accomplished with different feed (F), speed (S), coolant mixture (M). 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	
Feed	F	150	200	250	mm/min
Speed	S	1800	2000	2200	RPM
Coolant Mixture	M	15	20	25	% of Water
Depth of Cut	10				Mm

A process designed with this goal will produce more consistent output. MINITAB can help us to select a Taguchi design L9 orthogonal array that does not confound interactions of interest with each other or with main effects are shown in table 2.

Table 2 Design of Experiment

S. No.	F	S	M
1	150	1800	15
2	150	2000	20
3	150	2200	25
4	200	1800	20
5	200	2000	25
6	200	2200	15
7	250	1800	25
8	250	2000	15
9	250	2200	20

ANALYSIS OF VARIANCE (ANOVA)

ANOVA is a fundamental step in the DOE, which is a dominant statistical tool aimed at statistically quantifying interactions between independent variables through their methodical modifications to determine their impact on the predicted variables.

The ANOVA pre requires the following assumptions:

- The treatment data must be normally distributed,
- The variance must be the same for all treatments,
- All samples are randomly selected

Each of the sources of variation is measured using its 'sum of squares'. The sum total of all the 'sums of squares' equals the total sum of squares for all the variation. The purpose is to find out how much of the variation can be explained by each factor. Thus it is possible to say that X% of the variation is due to factor A, Y% to factor B, Z% to common cause variation and so on.

3. EXPERIMENT PERFORMANCE

In a milling operation, the workpiece is fixed around the cutting tool and is moved side by side and cut 10 mm of each side wall of workpiece, the tool is moved across the stationary material and coolant flow during the machining performance. All input parameter are inserted by mean of programming through CNC milling machine for a milling operation. New cutting geometries are constantly being advanced to increase the cutting speed as well as improve surface finish and MRR for C64 materials. The influences of the cutting parameters likes Feed (F),speed (S) and coolant mixture (M) on the response variables selected have been assessed for three different secondary bed materials by conducting experiments as outlined in section of experimentation. The results are put into the "Minitab" software for further analysis following the steps outlined in same section. The second-order model was derived in obtaining the empirical relationship between the one response parameters surface roughness parameters (Ra)for four sides and their average as per the Design of Experiment and recorded MRR is stored in table 3.

Table 3 Material Removal Rate Response

S. No.	F	S	M	Ra	MRR
1	150	1800	15	1.2075	229
2	150	2000	20	1.365	334
3	150	2200	25	1.11	428
4	200	1800	20	0.6525	133
5	200	2000	25	0.9125	172
6	200	2200	15	1.3225	316
7	250	1800	25	0.9325	204
8	250	2000	15	0.9625	248
9	250	2200	20	0.855	362

4. ANOVA ANALYSIS

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. Results of surface roughness tests best parameter are presented in terms of graphs. The main effect of surface roughness is shown in fig 1which gives optimum parameters.

Table 4 Analysis of Variance for Ra Before eliminations

Source	DF	Seq SS	Adj SS	Adj MS	Fc	P
F	2	12.291	12.291	6.146	1.22	0.451
S	2	4.431	4.431	2.216	0.44	0.695
M	2	6.511	6.511	3.256	0.64	0.608
Residual Error	2	10.100	10.100	5.050		
Total	8	33.333				

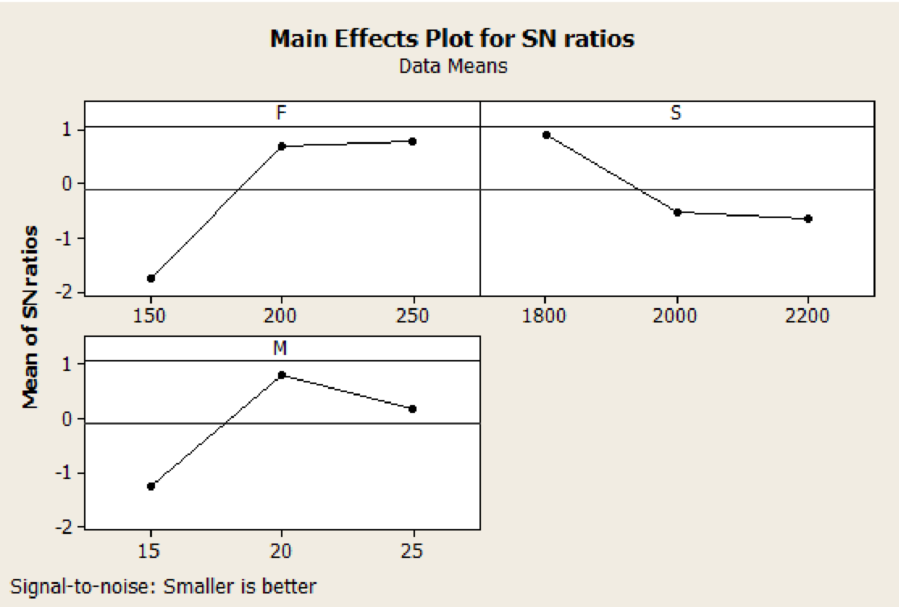

Fig. 1 Main effect plots for surface roughness

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 analyze the effect of these parameters on metal removal rate response rank is speed and also the ANOVA shows in fig 2.

Table 5 Analysis of Variance MRR

Source	DF	Seq SS	Adj SS	Adj MS	Fc	P
F	2	29.1954	29.1954	14.5977	10.00	0.091
S	2	54.2695	54.2695	27.1348	18.60	0.051
M	2	0.4063	0.4063	0.2031	0.14	0.878
Residual Error	2	2.9183	2.9183	1.4591		
Total	8	86.7895				

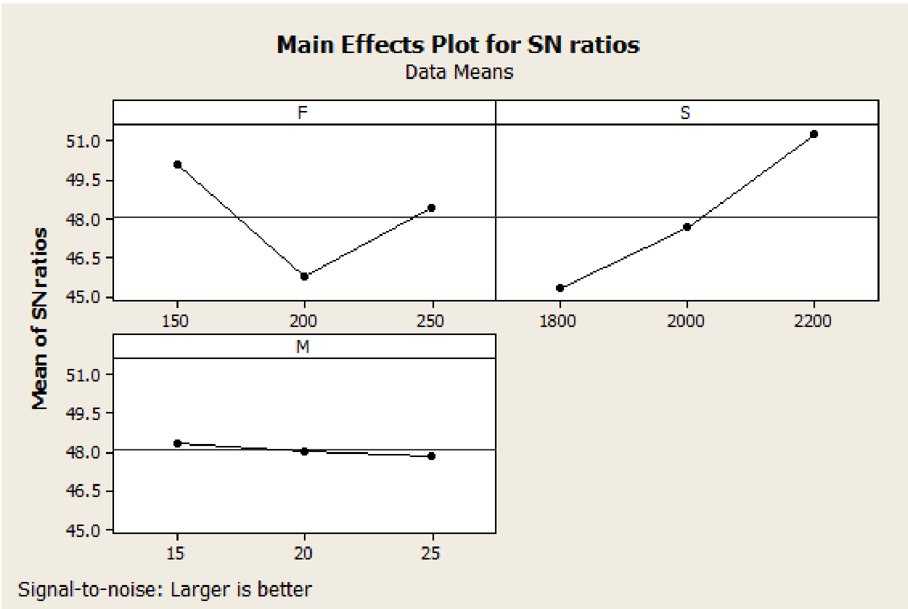

Fig 2 S/N graph of MRR

5. DISCUSSION

Control factors are those design and process parameters that can be controlled. Noise factors cannot be controlled duration of production or product use, but can be controlled during experimentation. The p-value is the probability of obtaining a test statistic that is at least as extreme as the actual calculated value, if the null hypothesis is true. The coolant mixture is identified as the most significant factor controlling the surface roughness and MRR because of its larger deviation from the mean as compared to others.

6. CONCLUSIONS

The relative importance of the machining parameters with respect to the surface roughness and MRR is investigated by analysis of experimental results, the following conclusions can be drawn;-

1. Design of experiment is found to be a successful technique to perform trend analysis of surface roughness and MRR in milling operation.
2. The higher value of feed is given the good surface finish of these experiments where the speed factor is predicted for MRR.
3. The optimum value of the speed in 2200 rpm for good surface finish.
4. Ra is more precise significant results during machining operations but for both responses the prediction parameter is coolant mixture with 20% of water per litre is optimized.

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