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OPTIMISATION OF CUTTING PARAMETERS BY USING ANNOVA METHOD

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Abstract : The primary purpose of contemporary production industries is to growth productiveness and reduce manufacturing rate without affecting high-quality of the product. Modern-day producers, searching out to live competitive within the marketplace, rely on their production engineers and manufacturing personnel to brief and effectively installation production methods for new merchandise. Optimization of the parameter to provide exceptional solution to decrease device put on, surface roughness, reducing forces supplied using optimization method. The selection of most useful cutting parameters is a totally vital problem for every machining procedure which will enhance the nice of machining merchandise and decrease the machining charges. This challenge investigates the machining of SS316 to find most efficient parameters for CNC turning technique. Stainless-steel is a notably used cloth in regular programs Taguchi's L9 Orthogonal array is used to formulate the experimental layout, to analyses the effect of every parameter at the machining developments and to are looking ahead to the highest quality choice for each turning parameters which includes pace, Feed and depth of lessen. It's miles placed that the ones parameters have a big affect on machining traits which includes Material elimination charge (MRR) and floor roughness (SR). The evaluation of Variance (ANOVA) is used to have a examine the overall overall performance characteristics in turning operation. The ANOVA were hired to check the general basic performance tendencies in turning operation. The ANOVA were hired to check the overall overall performance developments in turning operation. Evaluation of Variance (ANOVA) have been used to investigate the effect of reducing parameters on floor roughness and MRR. The contribution by using every reducing parameter to surface roughness and MRR changed into additionally determined. ANOVA performs an essential function for generating better roughness. Sooner or later The relationship between slicing parameters became superior by way of way of the use of MINITAB-18 software. The prediction values are in comparison with the experimental values.

***IndexTerms* – ANOVA, CNC Turning, MRR, SR, Minitab.**

I. INTRODUCTION

Traditional machines are manually managed by hand wheels or levers. The machines take more time to make one component and needs one man one machine for supervision. This makes the manufactured product luxurious as well as satisfactory of the product vary according to man know-how on that gadget, which isn't always possible in this competitive surroundings. The improvement of manufacturing technology to improve machining and acquire excessive productivity has emerged as a very crucial purpose in cutting-edge industry.

The assignment of present day machining industries is specifically targeted on the fulfillment of high first-class, in terms of work piece dimensional accuracy, floor end, high manufacturing charge, less wear on the cutting gear, economy of machining in terms of fee saving and growth the overall performance of the product with reduced environmental effect. Satisfactory and productivity are two important however contradictory standards in any machining operations.

Surface roughness and MRR play an vital position in lots of regions and is a factor of splendid significance in the assessment of machining parameters. The manner parameters like cutting speed , feed charge, Intensity of reduce, coolant situation and tool geometry influences the fabric elimination fee in turning. To acquire the objective of this studies, through deciding on finest manner parameters for a turning aluminum paintings piece on MAC power CNC turning gadget to get highest quality MRR, which ultimately increase mass production..

The choice of Computerized Numerical Control (CNC) manufacturing process is primarily based on optimization of cost, increased in productivity and improvement of quality of the product by precision manufacturing. CNC machine is capable of attaining the desired turning operation by high accuracy and very low processing time. There are many mathematical fashions defined through some researchers had been formulated primarily based on statistical regression for proper choice of reducing parameters and establish the connection between the reducing parameters and slicing performance. In this challenge, Taguchi method Has been done out as some other approach to find out the greatest reducing parameters greater appropriately.

This research has determined on 3 reducing parameters namely, lowering pace, feed fee and depth of reduce to optimize the MRR at some point of turning procedures, which similarly can be look into through the cost of the artificial product, productivity or some extraordinary criterion. Currently, several researchers have worked at the minimize of cutting parameters for most advantageous MRR and surface roughness. Some researchers paintings on setting up optimal slicing speeds in CNC machining have mentioned the method parameters need to be minimize for the duration of CNC machining is an critical and high-priced technique for small and medium type production industries. The slicing parameters based on the cutting characteristics of SS316 steel using Taguchi method and ANOVA analysis for determination of optimal cutting parameters.

The procedure parameters for SR on aluminum fabric in pocket machining and determined that floor roughness correlates negatively with slicing speed and undoubtedly with feed and intensity of cut. A few researchers have studied the have an effect on of process parameters on on performance of various factors of machining like: device lifestyles, tool wear, interaction of reducing forces, floor roughness, material removal charge, system tool chatter and vibration and many others. Some researchers have investigated the machining of nickel based totally C-263 alloy at excessive velocity the usage of titanium nitride included carbide inserts. They have located that the importance of feed charge is more than depth of reduce in terms of device performance and its life in the course of machining operation

Taguchi methodology is used to optimize slicing parameters in CNC turning for floor roughness. The experimental evaluation to decide the variant of machining parameters on MRR, gap width and floor roughness has been analyzed and supplied in graphical form with of Liao. The machining performance in terms of MRR and SR by using experimental evaluation on ceramics the usage of cord electrical discharge machining has been evaluated. There are two targets of this project to investigate technique parameters for a turning aluminum work piece on MAC energy CNC turning gadget. The first is to change methodical technique of using Taguchi parameter design in turning system. The second one is to illustrate using Taguchi parameter As a way to discover the best MRR with a selected aggregate of reducing parameters in a turning operation. The statistical evaluation strategies were used to assess the affects of lowering parameters on MRR. The right choice of approach parameters is important for purchasing immoderate reducing overall performance.. The statistical evaluation techniques been used to evaluate the to assess the impacts of lowering parameters on MRR. The right selection of technique parameters is critical for getting excessive reducing performance.

The statistical analysis strategies had been used to assess the influences of slicing parameters on MRR. The right choice of procedure parameters is critical for purchasing high lowering performance. The slicing parameters are meditated on MRR, which is used to decide and to assess the productivity of a turning product.

II. PROBLEM DEFINATION

Traditional machining gives exclusive styles of operations. In turning operation, it's miles hard to achieve preferred floor roughness with undefined performance parameters.

The objective of this work is as follows,

1. To discover most appropriate machining parameters for turning operation with the resource of Anova method.
2. To examine impact of parameters on the SR and MRR.The scope of the study was limited up to conventional turning process. The material used for take a look at purposes low carbon steel SS316. The look at makes a specialty of to the optimize performance parameter for traditional turning operation with material SS316.

III. RESEARCH METHODOLOGY

Advent method is the systematic, theoretical evaluation of the techniques implemented to a discipline of have a examine. It incorporates the theoretical analysis of the body of strategies and concepts related to a branch of expertise. Commonly, it encompasses standards which include paradigm, theoretical model, levels and quantitative or qualitative techniques. A way does now not got down to provide answers - it is therefore, now not the same as a way. As an alternative, a method gives the theoretical underpinning for know-how which method, set of strategies.

Among the available methods, Layout is one of the most effective DOE methods for analyzing of experiments It's miles extensively diagnosed in many fields specifically inside the improvement of recent products and tactics in high-quality manipulate.

The salient features of the method are as follows: a. A simple, efficient and systematic technique to optimize product/technique to enhance the overall performance or lessen the fee. The prevailing paintings deals with the turning of tough material as SS316 on CNC system.

Type 316 is an austenitic chromium-nickel stainless and warmth- resisting metallic with advanced corrosion resistance in evaluation to different chromium-nickel steels while visible to many styles of chemical in conjunction with sea water, brine answers, and so forth.It is an important engineering material employed in manufacturing of components in automotive industries. The experiment deals with machining of low carbon steel SS316 was carried out with High Speed Steel tool in conventional lathe.

3.1 BACKGROUND OF DESIGN OF EXPERIMENTS

Layout of experiments was developed within the early Nineteen Twenties with the aid of Sir Ronald Fisher on the Roth Amsted. Agriculture place research Station in London, England. His preliminary experiments were concerned with determining the effect of diverse fertilizers on specific plots of land. The very last condition of the crop turned into not simplest depending on the fertilizer but also at the variety of other elements (which includes underlying soil condition, moisture content of the soil, and many others.) of every of the respective plots. Fishers used DOE which can differentiate the effect of fertilizer and the effect of different factors. (such as underlying soil condition, moisture content of the soil, etc.) of each of the respective plots.

Fishers used DOE which could differentiate the effect of fertilizer and the effect of other factors. Since that time the DOE has been widely accepted in agricultural as well as Engineering Science.

3.1.1 TYPES OF METHODS USED IN DESIGN OF EXPERIMENT

a. Taguchi method

The Taguchi experimental design method is a well-known, unique and powerful technique for product or process quality improvement. It is widely used for analysis of experiment and product or process optimization.

b. Full Factorial design

Full Factorial design full Factorial layout In records, a full factorial test is an test whose layout includes or greater factors, each with discrete feasible values or "tiers", and whose experimental gadgets tackle all feasible mixtures of these ranges during all such factors.

c. Response surface method

Response floor method (RSM) is a collection of mathematical and statistical techniques for empirical model constructing. Through cautious design of experiments, the aim is to optimize a response (output variable) which is stimulated by means of the use of several independent variables (input variables).

d. Fractional factorial method

Fractional factorial designs are derived from full factorial matrices by substituting higher order interactions with new factors.

3.2 SELECTION OF TAGUCHI DESIGN OF EXPERIMENT

The method is popularly known as the factorial design of experiments. A complete factorial layout will become aware of all possible combinations for a given set of factors. Since maximum business experiments normally contain a huge quantity of things, a complete factorial layout results in a massive quantity of experiments. To reduce the range of experiments to a sensible level, simplest a small set from all of the possibilities . The method of choosing a confined wide variety of experiments which produces the maximum records is known as a partial fraction test. Even though this approach is widely known, there are no trendy pointers for its utility or the evaluation of the consequences obtained by means of appearing the experiments. Taguchi constructed a special set of standard layout hints for factorial experiments that cover many programs.

3.2.1 TAGUCHI METHOD

Taguchi approach is a effective tool for the layout of excessive pleasant structures. It gives easy, efficient and systematic approach to optimize design for performance, first-rate and fee. Taguchi method is efficient approach for designing process that operates always and optimally over a diffusion of conditions. Taguchi approach to layout of experiments clean to adopt and practice for users with limited expertise of statics, consequently won wide recognition in the engineering and clinical network. The desired reducing parameters decided by guide. Reducing parameters are pondered on floor roughness, surface texture and dimensional deviation on grew to become product. Taguchi method is especially suitable for industrial use but can also be used for scientific research.conditions. Taguchi approach to design of experiments easy to adopt and apply for users with limited knowledge of statics, hence gained wide popularity in the engineering and scientific community. The desired cutting parameters determined by handbook. Cutting parameters are reflected on surface roughness, surface texture and dimensional deviation on turned product. Taguchi method is especially suitable for industrial use but can also be used for scientific research.

3.2.2 TAGUCHI ORTHOGONAL ARRAY

TAGUCHI ORTHOGONAL ARRAY layout is a kind of fashionable fractional factorial layout. It's far a tremendously fractional orthogonal layout this is primarily based on a design matrix proposed by using Dr. Genichi Taguchi and allows you to bear in mind a specific subset of combos of more than one elements at a couple of degrees. Taguchi Orthogonal arrays are balanced to ensure that all degrees of all elements are taken into consideration similarly. Because of this, the elements may be evaluated independently of every different despite the fractionality of the layout. L9 (3x3) Orthogonal array is chosen for experimentation.Taguchi Orthogonal arrays are balanced to make sure that every one levels of all elements are taken into consideration similarly.

3.2.3 Analysis of the signal to noise (S/N) ratio

In the Taguchi approach, the term signal represents the The desired value (imply) lowering parameters are contemplated on ground roughness, floor texture and dimensional deviation on grew to emerge as product. Therefore, S/N ratio is the ratio of mean to the standard deviation. Taguchi makes use of the S/N ratio to degree the satisfactory characteristics deriving from desired value. The S/N ratio is defined as given equation.

"The smaller the better"

It is when the occurrences of some undesirable product characteristics is to maximized.

It is given by,

$$S/N \text{ ratio } (\eta) = -10 \log[(1/n) \sum^{n}_{i=1} y_i^2] \quad [1].$$

IV EXPERIMENTAL SETUP

Density (kg/m^3)	Elastic Modulus (GPa)	Mean Co-efficient of ThermalExpansion (µm/m/C)			Thermal Conductivity (W/m.K)		Specific Heat 0-100 C (J/kg.K)
		0-100C	0-315C	0-538 C	At 100 C	At 500 C	
8000	193	15.9	16.2	17.5	16.3	21.5	500

FIG 4.1 SET-UP ON CNC TURNING MACHINE

4.1 Set Up of Material with Machine

4.1.1 Selection of Stainless steel AISI 316 Material

Type 316 Is an austenitic chromium-nickel stainless and heat-resisting metallic with advanced corrosion resistance as compared to different chromium-nickel steels whilst uncovered to many varieties of chemical such as sea water, brine.

Table 4.1 Shows Chemical properties of SS-AISI316 Material

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	Fe
316	Min	-	-	-	0	-	16.50	2.00	10.0	-
	Max	0.08	2	0.75	0.045	0.03	18.50	2.50	14.0	0.10

Table 4.2 Shows Mechanical properties of SS-AISI316 Material

Fig 4.3 After operation of turning on AISI 316 Stainless Steel

4.2 Analysis of Parameter

- **Cutting speed: -** The slicing velocity is the charge of cutting on the main motion. Speed Usually Refers back to the spindle and the paintings piece. While it's far said in revolutions in line with minute (rpm) it tells their rotating speed.

  It is expressed in meter per minute (m/min),

  $$V = (DN)/1000$$

  Where v is cutting speed, D is the diameter of w/p in mm or m, N Spindle speed in RPM

- **Feed Rate: -** It It's far the Fee at which the tool advances alongside its cutting direction.. The feed of the device also influences to the processing pace and the roughness of surface. Whilst the feed is high, the processing pace becomes quick.

  $$F = f\,N \text{ mm/rev}$$

  Where F feed per minute, N spindle speed in rpm

- **Depth of cut:** - It's far the thickness of the layer being removed (in a single bypass) from the paintings piece or the space from the uncut surface of the work to the cut ground, expressed in mm. It's miles the thickness of the layer being removed (in a unmarried bypass) from the work piece or the space from the uncut surface of the work to the cut surface, expressed in mm.

  $$\text{Depth of cut} = (D-d)/2$$

  Where, D = initial diameter. d= final diameter.

4.3 Selection of process parameter

In this researcher suggests that major part of quality output of Lathe machine processed part primarily depends on input factors. Based on these exhaustive literature reviews, selected three important input factors such as Cutting speed, Feed Rate and Depth of Cut are considered to study on two output parameter Material remove rate and Surface Roughness. The selected control parameters and their values at different level.

- **Material remove rate**: - MRR is the volume of material removed per minute.

- **Surface Roughess: -** It is 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 consists of surface irregularities which result from the various machining process. Surface roughness is an important measure of product quality since it greatly influences the performance of mechanical parts as well as production cost. Floor roughness is an vital degree of product exceptional because it substantially impacts the overall performance of mechanical elements in addition to production price.

For obtain optimal cutting condition we choose followings

Input Parameters: -

1. Cutting Speed ,(rpm)
2. Feed Rate, (mm/rev)
3. Depth of cut ,(mm)

Output Parameters:-

1. Material Remove Rate (gm/min)
2. Surface roughness Ra (µm)

Table 4.3 Machining Parameter and Levels

Factors and their Levels for SS 316 in CNC Lathe

Control Factors	Level 1	Level 2	Level 3
Cutting speed (rpm)	35	55	81
Feed rate (mm/rev)	0.20	0.40	0.60
Depth of cut (mm)	0.3	0.6	0.9

From the above table according to design of experiments with Taguchi design total numbers of experiments to be performed are 9.Table shows developed 3x3 matrixes and L9 orthogonal array selected an experimental design by Taguchi method. In this research work Selected L9 orthogonal array design is accurate reading for our experimental work data. Work.

Table 4.5 shows experimental design made by Taguchi design

Experiment No.	Cutting speed (rpm)	Feed rate (mm/rev)	Depth of cut (mm)
1	35	0.2	0.3
2	35	0.4	0.6
3	35	0.6	0.9
4	55	0.2	0.6
5	55	0.4	0.9
6	55	0.6	0.3
7	81	0.2	0.9
8	81	0.4	0.3
9	81	0.6	0.6

V RESULT AND DISCUSSION

In design of experiment the results are analyzed due to one or more of the following threeObjectives

1. To establish the best or the optimum condition for a product or a process.
2. To estimate the contribution of individual factors.
3. To estimate the response under the optimum condition.

The purpose of the statistical analysis of variance (ANOVA) is to investigate which design parameter significantly affects the tensile strength. So ANOVA helps us to compare variability's within experimental data. In this dissertation ANOVA table is made with help of MINITAB 18 Software. The average loss is proportional to the mean squared error of Y aboutits target T. The initial techniques of the analysis of variance were developed by the statistician and geneticist R. A. Fisher in the 1920s and 1930s, and are sometimes known as Fisher's ANOVA or Fisher's analysis of variance, due to the use of Fisher's F distribution as part of the test of statistical significance.

5.1 Analysis of Variance (ANOVA)

The authentic thoughts evaluation of variance changed into advanced by using the English Statistician Sir Ronald A. Fisher at some point of the primary part of this century. While the aim of ANOVA is the detect differences among several populations means, the technique requires the analysis of different forms of variance associated with the random samples under study- hence the name analysis of variance. The authentic thoughts evaluation of variance changed into advanced by using the English Statistician Sir Ronald .Tons of the early work in this location dealt with agricultural experiments wherein plants had been. ANOVA is used to decide the affect of any given manner parameters from a sequence of experimental consequences by way of layout of experiments and it could be used to interpret experimental records. Given that there can be massive wide variety of system variables which control the procedure, a few mathematical model are require to represent the system. However these models are to be broaden the use of best the enormous parameters are to be develop using only the significant parameters which influences the process, rather than including all the parameters.

5.1.1 Analysis of variance (ANOVA) Terms & Notations

n = Number of trials

r = Number of repetition

C.F. = Correction factor

P = Percentage contribution

E=Error

T = Total of resultsF = Variance ratio

f = Degree of freedom

f_E = Degree of freedom of error

f_T = Total degree of freedom

S = Sum of squares

V = Mean squares (Variance)

Σy_i = Sum of all output values

- **Total number of trials**

General wide variety of trials the entire range of trial is the sum of numbers of trials at every stage.

- **Degree of freedom**

Degree of freedom it's miles a measure of amount of records that may be uniquely determined from a given set of statistics. DOF for information regarding a thing equals one much less than the variety of ranges. Suggests the range of impartial factors within the sum of squares the levels of freedom for each thing of the version are

DF (Factor) = r-1

DF (Error) = $n_t - r$

Total = $n_t - 1$

Where n_T = the total number of observations and r = the number of factor levels.

- **Mean square (MS)**

The calculations for the mean square for the factor and error are:

MS (Factor) = SS (Factor)/ DF (Factor)

MS (Error) = SS (Error)/ DF (Error)

- **Variance ratio (F)**

Variance ratio is the ratio of variance because of the impact of a component and variance due to the error time period. This ratio is used to measure the significance of the factor under investigation with respectto the variance of all the factors included in the error term. The F value obtained in the analysis is compared with a value from standard F – tables for a given level of significance. The sum of squares in the self assurance degree. A test to determine whether or not the element way are equal or no longer, the factor does not contribute to The sum of squares inside the self belief stage. A take a look at to determine whether the aspect means are same or not. The formula is F = MS (Factor)/ MS (Error)

The degrees of freedom for the numerator are r-1 and for the denominator are n_T- r. Larger values of F support rejecting the null hypothesis that the means are equal.

5.2 Results of MRR

Table 5.1 Experimental results for MRR

Cutting speed (rpm)	Feed rate (mm/rev)	Depth of cut (mm)	MRR (gm/min)
35	0.2	0.3	0.578
35	0.4	0.6	0.847
35	0.6	0.9	1.02
55	0.2	0.6	0.785
55	0.4	0.9	0.645
55	0.6	0.3	0.123
81	0.2	0.9	0.789
81	0.4	0.3	1.78
81	0.6	0.6	0.789

Table 5.2 ANOVA Analysis for SS316 for MRR

Source	DF	Adj SS	Adj MS	F	P
Cutting Speed	2	0.7177	0.3589	1.06	0.486
Feed Rate	2	0.5782	0.2891	0.85	0.539
Depth of Cut	2	3.4962	1.7481	5.16	0.162
Error	2	0.6773	0.3386		
Total	8	5.4694			
S=0.5819 R-Sq=87.62% R-Sq(adj)=50.47%					

General Linear Model: MRR versus Cutting Speed, Feed, Depth of Cut

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
Cutting Speed	Fixed	3	35, 55, 81
Feed	Fixed	3	0.2, 0.4, 0.6
Depth of Cut	Fixed	3	0.3, 0.6, 0.9

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Cutting Speed	2	0.7177	0.3589	1.06	0.486
Feed	2	0.5782	0.2891	0.85	0.539
Depth of Cut	2	3.4962	1.7481	5.16	0.162
Error	2	0.6773	0.3386		
Total	8	5.4694			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.581924	87.62%	50.47%	0.00%

Fig 5.1 ANOVA Analysis for SS316 for MRR

5.3 Results of Surface Roughness

Table 5.3 Experimental results for Surface Roughness

Cutting speed (rpm)	Feed rate (mm/rev)	Depth of cut (mm)	SR (µm)
35	0.2	0.3	0.253
35	0.4	0.6	1.207
35	0.6	0.9	0.54
55	0.2	0.6	1.15
55	0.4	0.9	1.12
55	0.6	0.3	0.48
81	0.2	0.9	1.059
81	0.4	0.3	1.027
81	0.6	0.6	0.785

Table 5.4 Anova Analysis for SS316 for Surface Roughness

Source	DF	Adj SS	Adj MS	F	P
Cutting Speed	2	0.14842	0.07421	2.03	0.330
Feed Rate	2	0.40297	0.20148	5.50	0.154
Depth of Cut	2	0.33428	0.16714	4.56	0.180
Error	2	0.07323	0.03661		
Total	8	0.95807			

Fig 5.2 Anova Analysis for SS316 for Surface Roughness

5.4 Response table on MRR & Surface Roughness

The experimental data for MRR & SR is made by full observation of CNC lathe machining process

General Linear Model: SR versus Cutting Speed, Feed, Depth of Cut

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
Cutting Speed	Fixed	3	35, 55, 81
Feed	Fixed	3	0.2, 0.4, 0.6
Depth of Cut	Fixed	3	0.3, 0.6, 0.9

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Cutting Speed	2	0.14842	0.07421	2.03	0.330
Feed	2	0.40297	0.20148	5.50	0.154
Depth of Cut	2	0.33428	0.16714	4.56	0.180
Error	2	0.07323	0.03661		
Total	8	0.95890			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.191350	92.36%	69.45%	0.00%

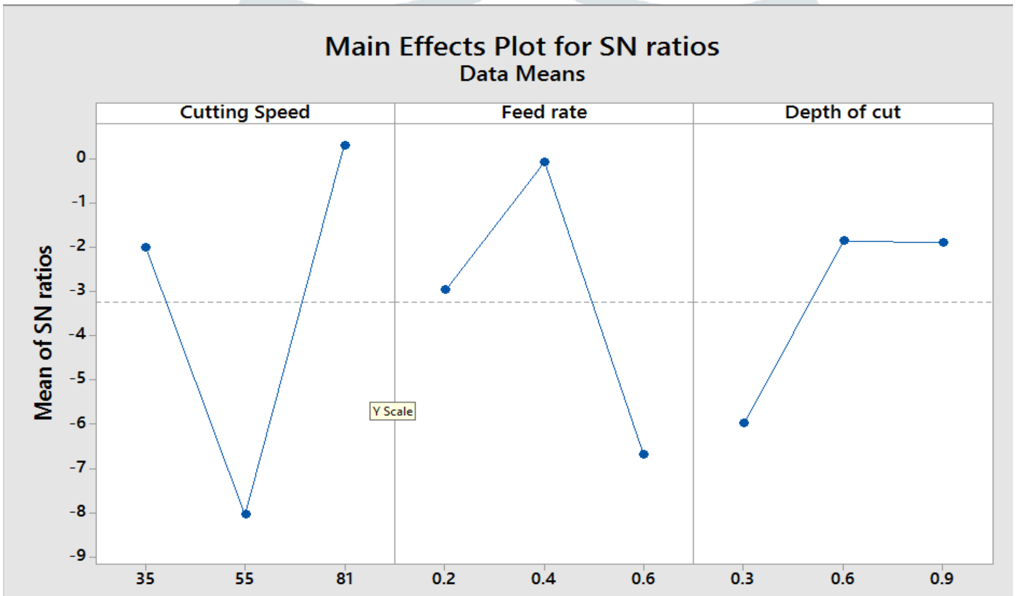
Table No 5.5 Experimental data for MRR & SR

Sr. No.	Cutting speed (rpm)	Feed rate (mm/rev)	Depth of cut (mm)	Material Removal rate (gm/min)	Surface Roughness (Ra), µm	S/N Ratio for MRR	S/N Ratio for SR
1	35	0.2	0.3	0.578	0.253	-4.7614	11.9376
2	35	0.4	0.6	0.847	1.207	-1.4423	-1.6341
3	35	0.6	0.9	1.02	0.54	0.172	5.3521
4	55	0.2	0.6	0.785	1.15	-2.1026	-1.214

5	55	0.4	0.9	0.645	1.12	-3.8088	-0.9844
6	55	0.6	0.3	0.123	0.48	-18.202	6.3752
8	81	0.4	0.3	1.78	1.027	5.0084	-0.2314
9	81	0.6	0.6	0.789	0.785	-2.0585	2.1026

5.5 Effects on MRR

Fig 5.3 Effect of Turning Parameters on MRR for S/N Ratio



From the fig 5.3 it is conclude that optimum condition for MRR is decrease at 55 rpm cutting speed, and then after MRR is increase at 81 rpm, the MRR is also increase at 0.4mm feed rate and then after decrease at 0.6mm feed rate, the MRR is increase at 0.6mm depth of cut and then after constant up to 0.9mm depth of cut.

5.6 Effects on Surface Roughness

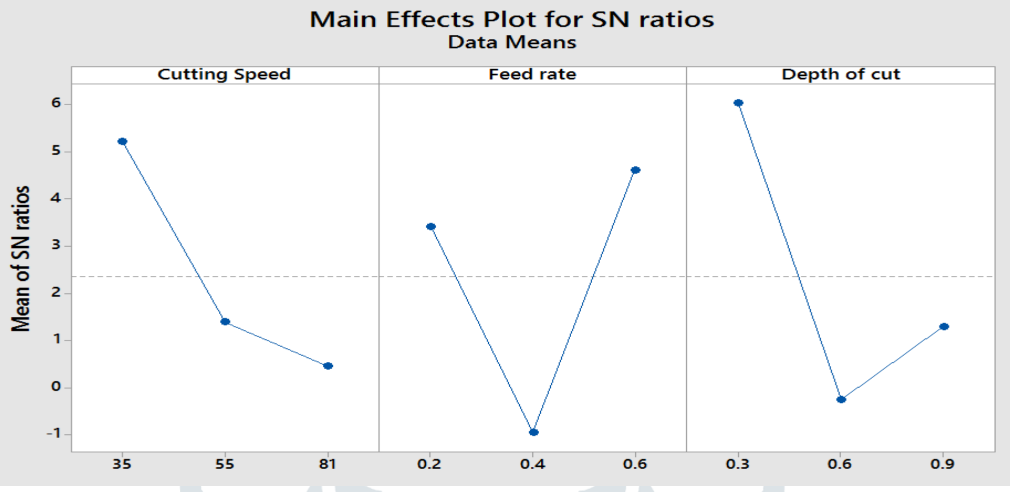


Fig 5.4 Effect of Turning Parameters on Surface Roughness for S/N Ratio

From the fig 5.4 it is conclude that optimum condition for SR is decrease at 55 rpm cutting speed, and then after SR is decrease at 81 rpm, the MRR is also decrease at 0.4mm feed rate and then after increase at 0.6mm feed rate, the MRR is decrease at 0.6mm depth of cut and then after increase at 0.9mm depth of cut.

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