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PARAMETERS OF MICROTURNING OF ALUMINIUM ROD AL6063 USING CNC MACHINE

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ABSTRACT

Micro turning is one type of the micro machining process which uses a solid tool and its material removal process is almost similar to conventional turning operation by operating at a micron scale of parameter to produce micro level machined components. In this work cylindrical work piece of aluminium ,25mm diameter is planned to micro turned with different cutting speed, depth of cut and feed using the TNMG.4 insert tool. Full factorial experiments were performed by using CNC machine. For every set of experiment, the output parameters such as surface roughness, material removal rate, machining time and chip thickness were measured by using surface roughness tester and tool maker's microscope. The experimental and theoretical studies on micro turning to achieve more efficient material removal rate coupled with less machining time and improved surface quality.

KEYWORDS - Micro turning, machining time, material removal rate, Surface finish, micro machining and chip thickness

INTRODUCTION

Machining is an important process in any manufacturing Industry. Machining removes unwanted material from the workpiece to give the required size and shape of the component. Many kinds of machining processes have been developed in the manufacturing field to suit the requirement of industries and to satisfy the quality requirement of the components produced. The quality requirement includes the dimensional accuracy and surface finish of the components. The machining processes are classified as conventional machining and unconventional machining processes.

LITERATURE SURVEY

R.Rudrapathi et al (2016) The aim of the present work is to analyse the significance of turning parameters on surface roughness in computer numerically controlled (CNC) turning operation while machining of aluminium alloy material. Spindle speed, feed rate and depth of cut have been consider as machining parameters. **Mohammed Yonus** et al (2016) To use hybrid taguchi desing method based grey relation analysis (GRA) for optimizing the control factors. The necessary experiments were carried out using taguchi L16 factorial design of experiment for analysis based on the larger the better signal to noise(S/N) ratio. The multi response/ output optimization and grading control factors were successfully carried out by GRA. **D Kanakaraja**et al (2016) Experimentation is carried out considering three machining parameters: cutting speed, feed rate and depth of cut as independent variable. Design of experiments (DOE) with taguchi L9 orthogonal array (OA) is used for finding the optimized solution. An attempt has been made to find the influence of turning parameters, feed, speed and depth of cut using Analysis of Variance (ANOVA). Finally, the ranges for best cutting conditions are proposed for serial industrial production. **Jyh-Rong Chou** (2015) kansei clustering plays a vital role in the implementation of KE. Conventional KE approaches rely heavily on the intuition of designers to cluster the Kansei adjectives; however, such classifications may be inconsistent with customer opinions. This paper presents a Kansei clustering approach using fuzzy and grey relation algorithms. In the proposed algorithms, topology-based grey relational analysis (TGRA) is used as an indicator function to derive a set of relational grades for constructing a fuzzy proximity matrix. **Aasheet Kumar** et al (2014) present approach ,Taguchi method and analysis of variance (ANOVA) is employed to develop a turning process model in terms of process parameters viz. cutting speed,feed rate and depth of cut for achieving the optimum surface finish. **C. L. Lin (2013)** this article addresses an approach based on the Taguchi method with grey relational analysis for optimizing turning operations with multiple performance characteristics. A grey relational grade obtained from the grey relational analysis is used to solve the turning operations with multiple performance characteristics. Optimal cutting parameters can then be determined by the Taguchi method using the grey relational grade as the performance index. Tool life, cutting force, and surface roughness are important characteristics in turning. Using these characteristics, the cutting parameters, including cutting speed, feed rate, and depth of cut are optimized in the study. Experimental results have been improved through this approach. **K.Saravanakumar**et al (2012) aimed at conducting experiments on INCONEL718 and investigation the influence of machining process parameters such as cutting speed, feed rate and depth of cut on the output parameters such as material removal rate and surface roughness. **Dr.Rajeshwar Sahai**et al **(**2012) Analysis of variance (ANOVA) is used to study the effect of process parameters on the machining process.The approach is based on Taguchi method , the signal-to noise (S/N) ratio and the analysis of variance(ANOVA) are employed to study the performance characterstics. **Raju Shri Hari** et al (2011) effective approach,Taguchi grey relational analysis has been applied to experiemental results in order to optimize the high-speed turning of INCONEL718 with consideration to multiple performance measures.The parameters: cutting speed,475 m/min;feed rate,0.10 mm/rev; depth of cut, 0.50 mm; and CW2 edge geometry have highest grey relational grade and therefore are the optimum parameter values producing better turning performance in terms of cutting forces and surface roughness. **Adeel H.Suhail**, et al (2010) In machining operation,the quality of surface finish is an important requirement for many turned work piece. Thus the choice of optimized cutting paarameters is very important for controlling the surface quality **John Kechagias** et al (2010) amulti-parameter optimization was carried out using the robust design. An L18 (21 x37) Taguchi orthogonal array experiment was conducted and the right bevel angle was measured, aiming at the investigation of the influence of plasma-arc cut process parameters on right side bevel angle of St37 mild steel cut surface. The selection of quality characteristics, material, plate thickness and other process parameter levels and experimental limits was based on the experience and current needs of the Greek machining industry.

METHODOLOGY

SELECTION OF WORK MATERIAL

The work material selected for the analysis was Aluminium(AL6063)

Element	Mg	Si	Fe	Cu	Mn	Cr	Zn	Ti	Al
Weight.%	0.45-0.9	0.2-0.6	0.35	0.1	0.1	0.1	0.1	0.1	Balance

TABLE 1: Chemical Composition of Al6063

Fig 1 : Aluminium Rod AL6063

EXPERIMENTAL PLAN AND CUTTING CONDITIONS

The experimental work was carried out on a CNC Turning center. Canned cycle was used for machining and the machining was done in absolute mode. Cutting conditions were selected based on some preliminary in investigations.

Input Parameter

The CNC machine have input parameters such as:

- Feed
- Depth of cut
- Cutting speed

Output Parameters

- Surface roughness
- Material removal rate
- Machining time
- Chip thickness

FACTOR	LEVEL 1	LEVEL 2	LEVEL 3
SPEED(rpm)	800	1200	1600
FEED (mm/rev)	0.1	0.2	0.3
DEPTH OF CUT(mm)	0.04	0.06	0.08

Table 2: Cutting Parameter

INPUT PARAMETERS			
SL.NO	**SPEED(rpm)**	**FEED(mm/rev)**	**DEPTH OF CUT(mm)**
1	800	0.1	0.04
2	800	0.2	0.06
3	800	0.3	0.08
4	1200	0.1	0.06
5	1200	0.2	0.08
6	1200	0.3	0.04
7	1600	0.1	0.08
8	1600	0.2	0.04
9	1600	0.3	0.06

Table 3 : Input Parameters

EXPERIMENT DETAILS

The main objective of the experiment is to study the feasibility of performing micromachining in Fanuc CNC lathe and the co-relation between cutting speed, feed, Depth of cut on Surface roughness, Metal Removal, MachiningTime, Chip Thickness.

Exp	INPUT PARAMETERS			OUTPUT PRAAMETERS			
	Speed (rpm)	Feed (mm/rev)	Depth of cut (mm)	Surface roughness	Machining time	chip thickness (mm)	MRR (mm3/s)
1	800	0.1	0.04	1.091	37.5	0.07	133.76
2	800	0.2	0.06	0.631	18.7	0.09	401.92
3	800	0.3	0.08	1.333	12.5	0.28	802.56
4	1200	0.1	0.06	0.661	25	0.71	452.16
5	1200	0.2	0.08	1.526	12.5	0.42	1203.84
6	1200	0.3	0.04	1.093	8.33	0.5	902.88
7	1600	0.1	0.08	0.748	18.7	0.25	1070.08
8	1600	0.2	0.04	1.425	9.37	0.22	1070.08

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9	1600	0.3	0.06	0.74	6.25	0.33	1808.64

Table 5.1: Output Values

GREY RELATION ANALYSIS

The optimization of parameters considering multiple performance characteristics of the micro turning process for AL6063 using CNC is presented. Performance characteristics including Surface Roughness, Chip Thickness, Material Removal Rate andmachiningtime are chosen to evaluate the machining effects. Those process parameters that are closely correlated with the selected performance characteristics in this study are the Cutting Speed, Feed and Depth Of Cut. Experiments based on the appropriate L9 OA are conducted first. The normalized experimental results of the performance characteristics are then introduced to calculate the coefficient and grades according to GRA. Optimized process parameters simultaneously leading lowest Surface Roughness, Machining Time and highest MRR, Chip Thickness will then be verified through a confirmation experiment. The details of the procedures are explained in the following sections.

EXP	OUTPUT PARAMETERS				SN RATIO			
	Surface roughness	Machining time	chip thickness(mm)	MRR (mm3/s)	SNRA1	SNRA2	SNRA3	SNRA4
1	1.091	37.5	0.07	133.76	0.75649	31.4806	23.098	42.5265
2	0.631	18.7	0.09	401.92	3.9994	25.4368	20.9151	52.0827
3	1.333	12.5	0.28	802.56	2.4966	21.9382	11.0568	58.0895
4	0.661	25	0.71	452.16	3.5959	27.9588	2.9748	53.1058
5	1.526	12.5	0.42	1203.84	3.671	21.9382	7.535	61.6113

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6	1.093	8.33	0.5	902.88	0.7724	18.4129	6.0205	59.1126
7	0.748	18.7	0.25	1070.08	2.5219	25.4368	12.0411	60.5883
8	1.425	9.37	0.22	1070.08	3.0762	19.4347	13.1515	60.5883
9	0.74	6.25	0.33	1808.64	2.6153	15.9176	9.6297	65.147

Table 3: SN Ratio

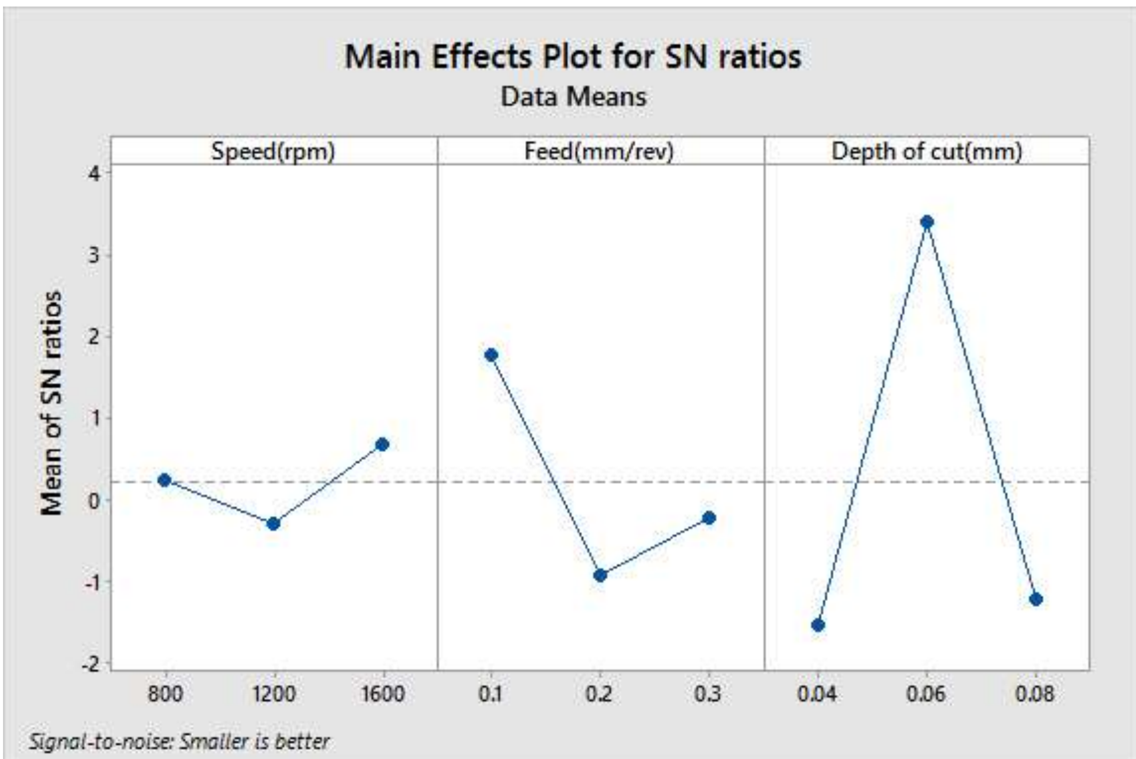

Fig 2: SN Curve For Surface Roughness

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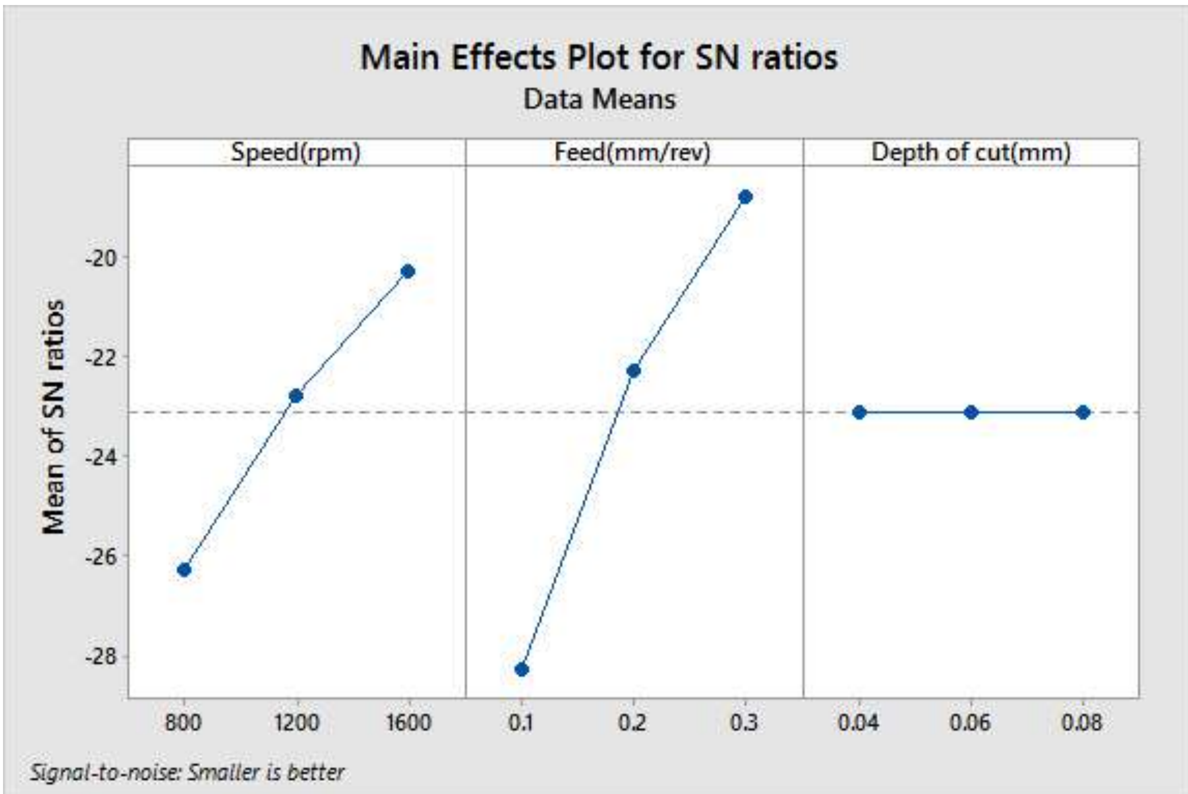

Fig 3: SN Curve For Machining Time

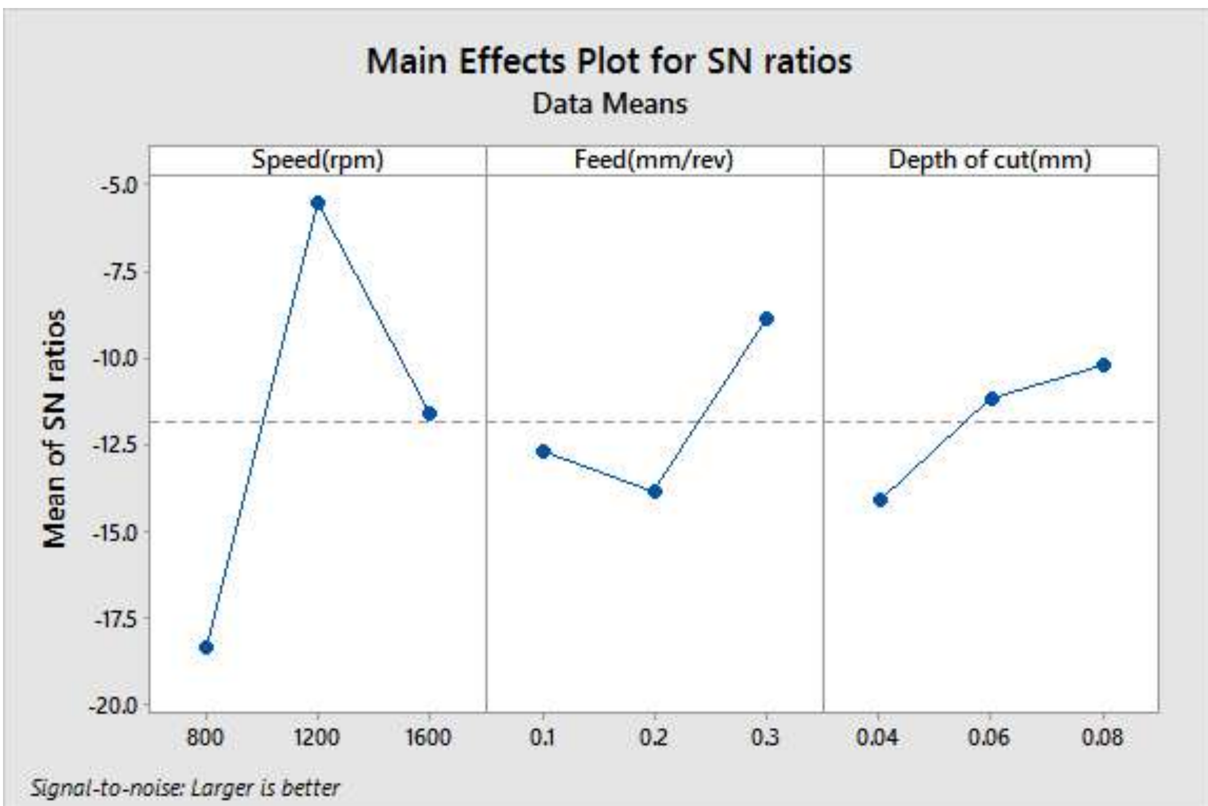

Fig 4: SN Curve For Chip Thickness

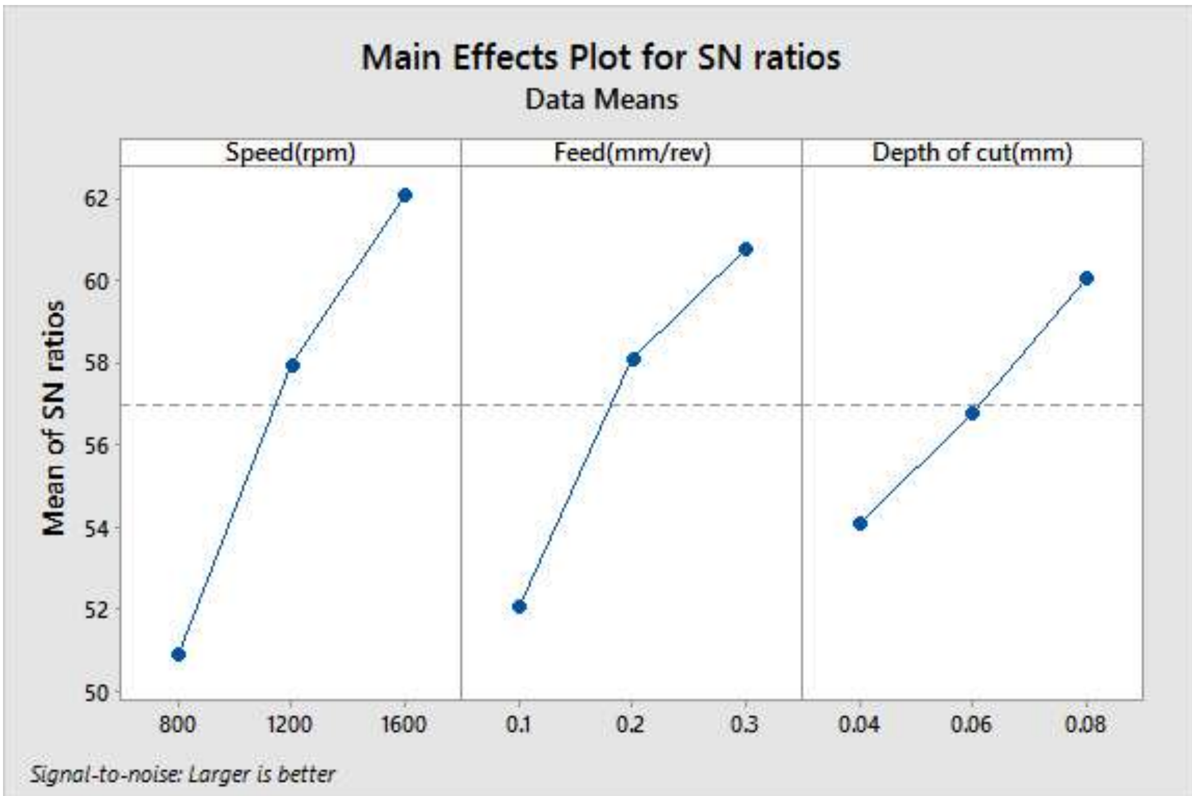

Fig 5: SN Curve For Material Removal Rate

Grey Grade Analysis:

In the study, a linear data preprocessingmethod for the tool life is the higher the-better and is expressed as.,

$$\mathbf{x_i(k) = \frac{y_i(k) - min y_i(k)}{max y_i(k) - min y_i(k)}}$$

Cutting force and surface roughness, which are the smaller- the-better can be expressed as,

$$\mathbf{x_i(k) = \frac{max y_i(k) - y_i(k)}{max y_i(k) - min y_i(k)}}$$

where $x_i(k)$ is the value after the grey relational generation, min $y_i(k)$ is the smallest value of $y_i(k)$ for the k_{th} response, and max $y_i(k)$ is the largest value of $y_i(k)$ for the k_{th} response.An ideal sequence is $x_0(k)$ (k = 1, 2, ..., 9) for tool life, cutting force, and surface roughness. The definition of the grey relational grade in the grey relational analysis is to show the relational degree between the nine sequences [$x_0(k)$ and $x_i(k)$, i = 1, 2, ..., 9; k = 1, 2, ... , 9]. The grey relational coefficient Ɛi(k) can be calculated as,

$$\varepsilon_i = \frac{\Delta_{min} + \varepsilon\Delta_{max}}{\Delta_{0i}(k) + \varepsilon\Delta_{max}}$$

Where Δ_{0i}=$\|x_i(k)-x_i(k)\|$=difference of absolute value between $x_0(k)$ and $x_i(k)$; `

ξ=distinguishingcoefficient(0~1);

$\Delta_{min} = \Delta_j^{min} €_i \Delta k^{min} \|x_0(k)-x_j(k)\|$=smallest values of Δ_{0i};

$\Delta_{max} = \Delta_j^{max} €_i \Delta k^{min} \|x_0(k)-x_j(k)\|$=largest value of$\Delta_{0i.}$

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Ex No.	GREY RELATION COEFFICIENT				GREY GRADE
	Surface roughness	Machining time	chip thickness(mm)	MRR (mm3/s)	
1	0.3333	1	1	0.3333	0.6666
2	1	0.5628	0.8217	0.4640	0.7121
3	0.5189	0.4491	0.4552	0.6157	0.5097
4	0.8007	0.6884	0.3333	0.4843	0.5767
5	0.8315	0.4491	0.3926	0.7618	0.6088
6	0.3344	0.3732	0.3707	0.6520	0.4326
7	0.5232	0.5628	0.4764	0.7127	0.5688
8	0.6372	0.3924	0.5028	0.7127	0.5613
9	0.5394	0.3333	0.4276	1	0.5751
					0.5791

Table 6.3.1: Grey Relation

parameters	level 1	level 2	level 3	main effect	rank	optimum value
cutting speed	0.6295	0.5393	0.5684	0.0901	2	0.7200
Feed	0.6040	0.6274	0.5058	0.1215	1	
depth of cut	0.5535	0.6213	0.5624	0.0677	3	

Table 6.4.2(a): Optimized Value

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Speed (Rpm)	2	0.0127	0.0127	0.0063	1.78	0.360
Feed(mm/rev)	2	0.0249	0.0249	0.0124	3.50	0.222
Depth of cut(mm)	2	0.0081	0.0081	0.0040	1.14	0.467
Residual error	2	0.0071	0.0071	0.0035		
Total	8	0.0529	0.0529			

Table 6.4.2(b): ANOVA value

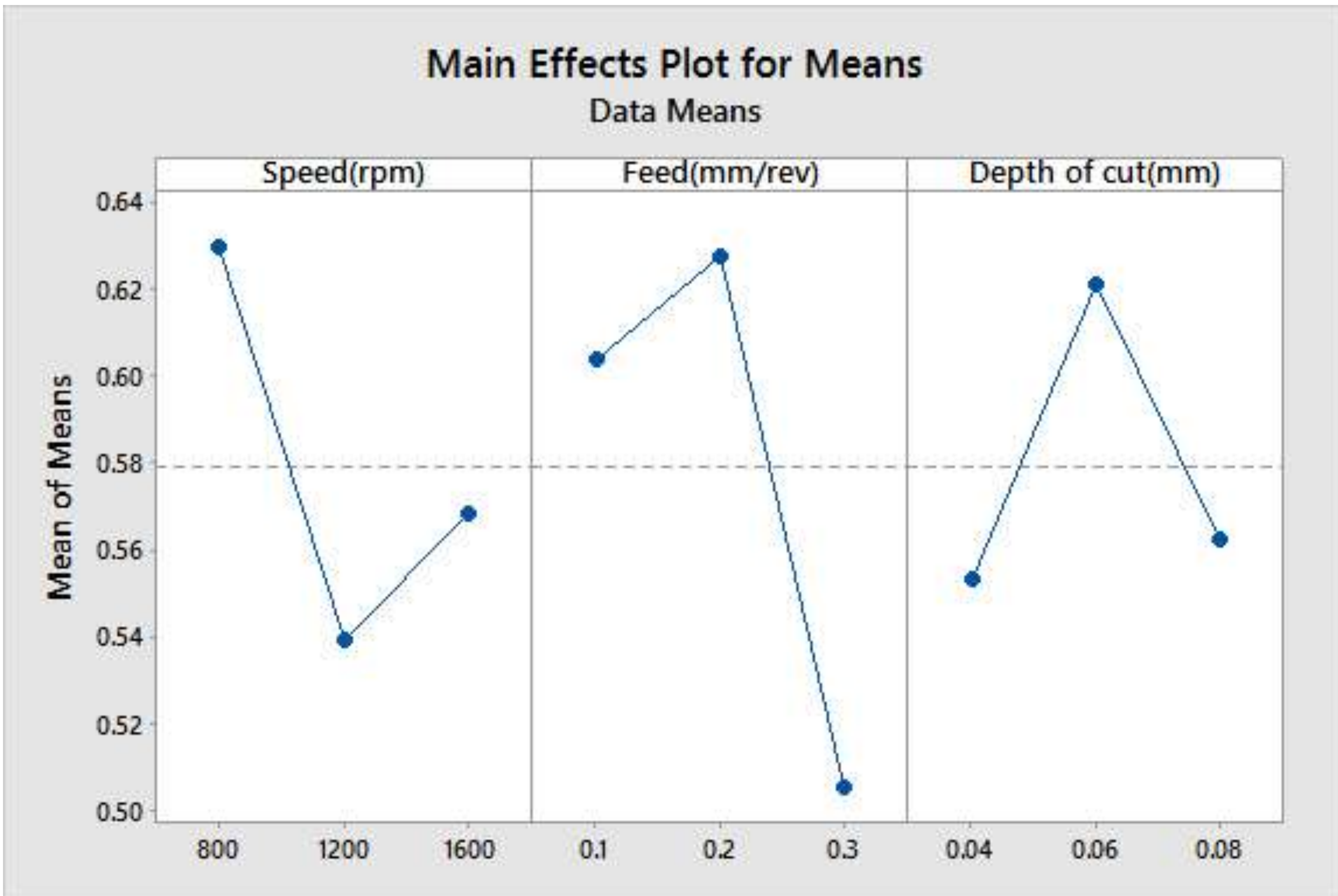

Fig6.4.2: ANOVA Mean Value Graph

CONCLUSION

In the presented work, experiment is carried out for response variables are surface roughness, material removal rate, chip thickness and machining time with process parameters as cutting speed, feed and depth of cut. There are 9 experimental readings taken for all variables to conduct the parametric study. For experimental Cutting speed is 800 rpm, 1200 rpm, and 1800 rpmfeed is0.1mm/rev,0.2mm/rev,0.3mm/rev anddepth of cut is 0.04mm,0.06mm,0.08mm.

Experimental result shows that for

- Cutting speed 800 rpm, feed 0.2 mm/rev, depth of cut 0.06mm

surface roughness is increased, Material removal rate increased and Machining Time is decreased. Now concentrate on effect of feed on surface roughness, it concludes that with increase in feed, surface roughness is decrease. So it concludes that for achieve good surface quality, feed required must be larger. Now concentrate on effect of cutting speed on surface roughness, it concludes that with increase in cutting speed, surface roughness is increase. So it concludes that for achieve good surface quality, cutting speed must be required less.

From the experimental results for ANOVA analysis it concludes that for surface roughness percentage contribution of feed is more in three response variables compare to other two process parameters.

In grey relational analysis total performance of multi objective optimization is depending on value of grey relational grade. According to performed experiment design, it observed that the 'Microturning' setting of

- cutting speed is 800 rpm, feed is 0.2 mm/rev and depth of cut is 0.06mm.

Thus, the parametric value gives the best multi-performance characteristics among the 9 experiments.

Thus the result concludes that the above parametric values are suggested in Piston manufacturing to get an improved surface quality.

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