EXPERIMENTAL EFFECT OF VARIOUS MACHINING PARAMETERS ON OVALITY OF CYLINDRICAL SMC PART

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ABSTRACT

This paper deals with the Factors which is affected on ovality that is Cutting Speed, Depth of cut, Feed Rate, Clamping Forces. Beside that for the case study which is had Cutting process the requirement about the cutting condition and process parameter is highly important. To determine the Factors affecting on thin wall cylinder, to maintain an ovality of SMC part, how to control the Cutting parameter of SMC part which is studied in this paper. The Minitab 17 is used for the Optimization of process parameter of KTM bike SMC part. Also used Taguchi method for finding more Controllable factors of SMC part, Analysis of variance (ANOVA) and RSM is used for the Generating ovality Graphs it gives ideas about which factors more affected on KTM bike SMC part. The aim of this work reduced the ovality turned workpiece the ovality is output response and machining parameter is input parameter

Keyword: - *SMC, Taguchi method, ANOVA, Minitab 17, RSM, Optimization, KTM bike*

1. INTRODUCTION

The globalization of business. It is required to produce the quality product with precision and to be supplied to the customer at the right time. Moreover the quality of the job produced on the machines depends on the quality and performance of the machine. The KTM Bike SMC (starter motor cover) are used in the Automobiles, which has to be very precise and accurate in Dimensions. In addition these SMC are manufactured in lots. Therefore the production of these components has to be done at faster rate with higher precision. The accuracy of the components is in microns therefore the manufacturing processes have to be done very precise. [1]

The maintaining and control the position between the cutting tool and work piece is a way to get very good surface quality and positioning accuracy in the machine tool parameter and measurement. Control the factors that influence in the performance of this case study is a contributor to make some project achieved. By control and examine the characteristic during the operation from disturbance like the position of material(radial and feed), clamping force of machine tool, the cutting speed .[18]

The parameters of machine like the cutting speed, feed rate during the cutting operation, depth of cut and others small factors that influence the performance of project. By highlight and alert all of this characteristic will make the proposed of this case study succeeded in reducing the ovality and its performance. Force on the tool involve in the important aspect in machining to provide a good result of some project of case study. It means the right selection and correct measurement example like the clamping force, the tenacity of material and others can make project succeeded. For any manufacturer or who want to involve in machine tool producing, the knowledge and value added for the estimation of force specially in design of machine tool, the performance of machine the tool holder and fixtures and the strength of material is important to learned about the force. The cutting force is a priority in optimizing the tool with right angle and accurate measurement. [18]

The features during the turning operation are an important part to be mention clearly because it was a factor that can succeeded some case study or project. A good understanding of the behavior of machine, the relationship between the work piece metal and cutting tool material is a way to do in making a very good condition during the operation. For the case study which is had cutting process, the requirement about the cutting condition and process parameter is most highly important. To determine the cutting parameter, the understanding of ferrous metal behavior must be known first before we decide in material selection. The depth of cut, cutting speed, feed rate and effect of rake angle is a feature that we have to know in effective machining process. The selection of cutting tool materials for particular application is among the most important factors in machining operations. Characteristic of cutting tool is thermal shock resistance, wear resistance, chemical stability and inertness and lastly is toughness. The familiar cutting tool that have been used in industry nowadays is high speed steel (HSS), coated carbide, ceramics, diamond and many others. The characteristic, the application, and limitations of these tool materials in machining operation, including the required characteristic we outlined and including cost. High speed machining has been currently used in this high technology era. Since 1990"s, the estimation of high speed machining has been extensive. By applying the high speed machining to the ferrous metal using turning process to determine the effect of tool material, coating, and cutting operating parameter on cutting force, tool life, and workpiece surface. The majority of turning operations involve the use of simple single point cutting tools. [18]

Fig- 1: Geometrical View of SMC Part

2. LITERATURE REVIEW

Suleyman Neseli; Suleyman Yaldiz; Erol Turkes(2011), Some Studies on Reduction of Ovality in Turned Component by, Optimization of tool geometry parameters for turning operations based on the response surface methodology, Measurement 44, p.580-587, 2011, K. Palanikumar, Modeling and analysis for surface roughness in machining glass fiber reinforced plastics using response surface methodology, Materials and Design 28, p.2611-2618, 2007—In the competitive market and globalization phase, industries are required to manufacture good quality machine tools with optimized performance at the moderate cost. [2]

Hamden bin yahayudin (2011), The purpose of this research is investigating the effect of cutting parameters on thin wall machining accuracy. This effect is caused by cutting parameter of surface roughness in a cnc lathe operation. The effect of machining parameter are feed rate, depth of cut, clamping force and cutting speed. Beside that for the case study which is had cutting process, the requirement about the cutting condition and process parameter is most highly important. [18]

Garimella Sridhar 1, P. Ramesh Babu *2 (2013), cutting parameter optimization for minimizing machining distortion of thin wall thin floor avionic components using taguchi technique" Research Scholar, College of Engineering, OU, Hyderabad, India * Associate Professor, College Of Engineering, OU, Hyderabad, India (2013) Distortion of thin wall thin floor aluminium components during and after machining is one of the main challenges faced by aerospace manufacturing industries. [11]

N d ghetiya and saurin panchal (july-dec 2014), In the competitive market and globalization phase, industries are required to manufacture good quality machine tools with optimized performance at the moderate cost. Moreover, the industries are facing competition internationally due to worldwide globalization of business. This work aims to reduce the error called ovality in the turned work piece. [1]

Kawaljitsingh randhawa mechanical department, cspit, charusat, changa, gujarat, india (2017), Ovality generally known as 'Out of Roundness' is one of the most common defects in pipe manufacturing. Ovality in early stages makes manufacturing process time consuming and less efficient. After dispatching, because of improper handling, ovality turns into barrier of proper welding of two pipes on site. [19]

3. EXPERIMENTAL METHODOLOGY

3.1 Introduction

The SMC part is used in Bajaj KTM Bike. The material used of SMC part is Mild steel, we know that in industrial area required good quality product for customer satisfaction.so, aim of my project is to maintain the ovality of SMC part on CNC turning machine. On CNC turning machine the critical factors which are effect on the product that is cutting parameter this is more essential factors which is effect on the ovality of product so maintain the ovality of SMC part. I am studied about the cutting parameters, cutting tools, and external forces.

3.2 Experimental setup

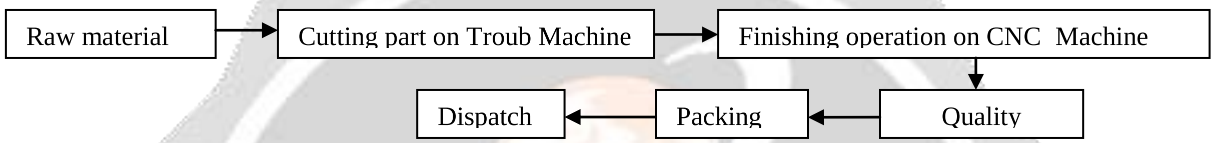

Fig -2: Flow chart of SMC part

3.3 Design of SMC Part

Fig -3: Creo Design of SMC part

3.4 Experimental setup Description

A) Raw material: as per the customer requirement industry select the mild steel as a raw material for SMC part. The industrial size of this raw material is Ø64.5 x 60 x 3.3, the shape of raw material is cylindrical hollow section thin wall pipe.

Fig- 4: Raw material of SMC

B) part cutting on traub machine: Automatic Lathes: TRAUB: The name that has grown synonymous with Single Spindle Automatic Lathes across the world. PMT Machines, a rechristened version of Traub India, manufactures the same machines in India with the complete original design and manufacturing techniques to the highest.

Fig- 5: Traub machine

C) Finishing operation on CNC turning machine : Computerized numerical control machine is the advancement over NC machines, CNC is the short form for Computer Numerical control. We have seen that the NC machine works as per the program of instructions fed into the controller unit of the machine. The CNC machine comprises of the mini computer or the microcomputer that acts as the controller unit of the machine. In CNC machine the program is stored in the memory of the computer**.**

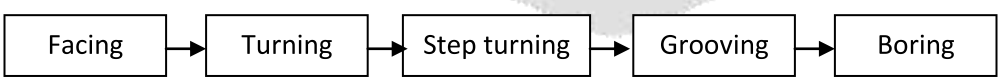

Fig- 6: Flow chart of sequence of operation SMC part

D) Quality of SMC part: Quality is the major factor of industry. Quality means customer satisfaction. If industry maintains the quality or produce good quality of product automatically increase profit and demand of product in market. Since for check the quality of SMC part uses different types of Gauges that is,

1) Go and No Go Gauge
A go/no go is an integral part of quality process that is used in manufacturing industries. To ensure interchangeability of parts process or even between different manuifacturer.
For the SMC part required inner Diameter is 58.00 ± 0.05

Fig- 7: Go And No Go Gauge

2) Spinn Gauge
Spinn Gauge is called Mechanical comparator. Useful for checking ovality. We have to used spinn gauge for checking ovality of SMC part. It have required 30 micron ovality.

Fig- 8: spinn Gauge

3) Verniear Height Gauge In the vernier height gauge, the graduated scale or bar is held in a vertical position by a finely ground and lapped base. A precision ground surface plate is mandatory while using a height gauge. The measuring jaw is mounted on the slider which moves up and down, but held in place by tightening of a nut. A fine adjustment clamp is provided to ensure very fine movement of the slide in order to make a delicate contact with the job. The vernier scale mounted on the slider gives readings up to an accuracy of 0.01 mm. the SMC part Required height is 58.00±0.03.

Fig- 9: Height Gauge

4. EXPERIMENTAL PROCEDURE

The Experiment Were performed on CNC Machine.

4.1 Method and Implementation

Table -1: Different Types of Factors which is affected on Ovality of SMC part

SR. NO.	**FACTORS**	**UNITS**	**VALUES OF DIFFERENT FACTORS**	**OVALITY (IN MICRONS)**
1.	Cutting speed	RPM	420	60
2.	Chuck pressure	BAR	8	50
3.	Feed rate	MM/REV	0.08	75
4.	Depth of cut	MM/REV	0.3	40
5.	Spindle Speed	RPM	2000	55
6.	Jaw length area	%	90%	60
7.	Inserts (Carbide)	TNMG	--------	70

4.2 Experimental Design

Number of Experiments to is decided with the help of Taguchi Method using Minitab-17 Software. Three Factors (Feed rate, Depth of cut, Cutting speed) at 3 levels each are as follows:

Table -2: Level of Experimental Parameters

SR. NO.	PARAMETERS	UNIT	LEVELS		
			[-1]	[0]	[+1]
1	FEED RATE [FR]	mm/rev	0.075	0.085	0.090
2	DEPTH OF CUT [DOC]	mm	0.3	0.35	0.4

3	CUTTING SPEED [CS]	mm/min	420	470	520

According to above input to the Design of Experiment using taguchi approach in Minitab-17 Software for optimum no. of experiment it gives 20 Runs For three levels of the three factors.

Table -3: Design Matrix

EXP NO.	FEED RATE [FR] [mm/rev]	DEPTH OF CUT [DOC] [mm]	CUTTING SPEED [CS] [mm/min]
1	[-1]	[-1]	[0]
2	[+1]	[-1]	[-1]
3	[-1]	[0]	[-1]
4	[+1]	[+1]	[-1]
5	[-1]	[-1]	[+1]
6	[0]	[-1]	[-1]
7	[-1]	[0]	[+1]
8	[+1]	[-1]	[+1]
9	[-1]	[0]	[0]
10	[+1]	[+1]	[-1]
11	[0]	[-1]	[0]
12	[-1]	[+1]	[0]
13	[-1]	[0]	[-1]
14	[+1]	[+1]	[+1]
15	[-1]	[-1]	[0]
16	[0]	[+1]	[0]
17	[-1]	[0]	[-1]
18	[-1]	[-1]	[0]
19	[+1]	[+1]	[+1]
20	[0]	[0]	[0]

4.3 Parametric Analysis

Ovality model has been obtained by analyzing the data and is given by,

Ovality =[-1089 + 25783 FR + 445 DOC - 0.085 CS- 164135 FR*FR + 95DOC*DOC + 0.000013 CS*CS-806 FR*DOC+ 4.43 FR*CS- 0.79 DOC*CS]

Where,

FR= Feed Rate

CS= Cutting Speed

DOC= Depth of Cut

Table -4: Output Response

EXP NO.	FEED RATE [mm/rev]	DEPTH OF CUT [mm]	CUTTING SPEED [mm/min]	OVALITY [micron]
1	0.075	0.3	470	40
2	0.09	0.3	420	54
3	0.08	0.35	420	70
4	0.09	0.4	420	65
5	0.075	0.3	520	53
6	0.085	0.3	420	42
7	0.08	0.35	520	75
8	0.09	0.3	520	63
9	0.076	0.35	470	64
10	0.093	0.4	420	62
11	0.085	0.26	470	65
12	0.075	0.43	470	60
13	0.08	0.35	385	61
14	0.09	0.4	554	66
15	0.08	0.3	470	63
16	0.085	0.4	470	67
17	0.075	0.35	420	67
18	0.080	0.3	470	68
19	0.090	0.4	520	70
20	0.085	0.35	470	69

4.4 ANOVA Analysis

Analysis of variance (ANOVA) of the overall set is done to show the important parameters. If the P value for a factor becomes less than 0.05 then that factor is considered as significant factor at 95% confidence level. Statistical software with an analytical tool of ANOVA is used to decide which parameter importantly affects the performance characteristics

Learning Objectives:

1. Be able to identify the factors and levels of each factor from a description of an experiment
2. Determine whether a factor is a between-subjects or a within-subjects factor
3. Define factorial design

Table -5: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	9	1018.06	113.118	2.32	0.0103
Linear	3	172.26	57.420	1.18	0.0366
Feed Rate	1	33.00	33.000	0.68	0.0430
Depth of Cut	1	149.45	149.449	3.07	0.0110
CS	1	21.55	21.553	0.44	0.05
Square	3	332.73	110.908	2.28	0.0142
FR*FR	1	316.11	316.106	6.49	0.029
DOC*DOC	1	9.09	9.089	0.19	00.342
CS*CS	1	0.01	0.009	0.00	0.0112
2-Way Interaction	3	31.71	10.568	0.22	0.0432
FR*DOC	1	0.88	0.883	0.02	0.0456
FR*CS	1	16.10	16.101	0.33	0.0389
DOC*CS	1	23.10	23.098	0.47	0.0289
Error	10	487.14	48.714		
Lack-of-Fit	9	474.64	52.738	4.22	0.362
Pure Error	1	12.50	12.500		
Total	19	1505.20			

The ANOVA of reduced model indicates that the model is significant as R-sqr statistics is 81.31

5. RESULT & DISCUSSION

A. Effect of Cutting speed and Depth of cut on Ovality:-

The figures 10 shows the effect of depth of cut and cutting speed on ovality while keeping feed rate constant. Surface plot shows that due to the increase in cutting forc the depth of cut is increased, ovality is also increased. With increase in cutting speed, ovality is increases gradually but increase is less than depth of cut.

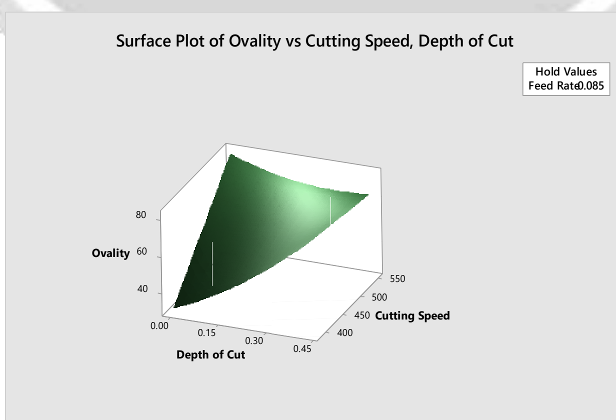

Fig- 10: Surface plot of Ovality Vs Cutting speed, Depth of Cut

B.Effect of Cutting speed and Feed rate on Ovality :

The figure 11 shows the effect of feed rate and cutting speed on ovality while keeping depth of cut constant. Surface plot shows that changing the cutting speed and feed rate, there is change in the ovality.

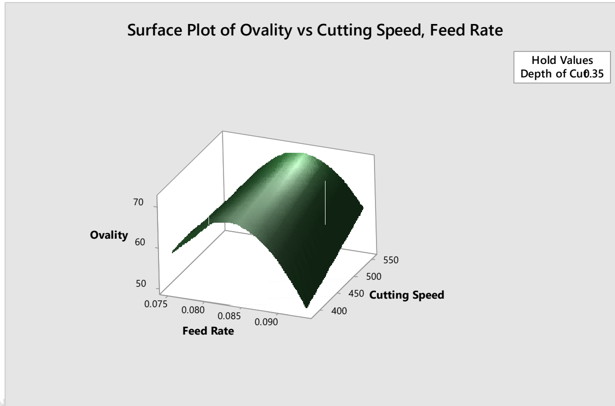

Fig- 11: Surface Plot of Ovality VS Cutting speed, Feed Rate

C. Effect of Depth of cut and Feed rate on Ovality:-

The figure 12 shows the effect of depth of cut and feed rate on ovality while keeping cutting speed constant. surface plot shows that as the depth of cut is increased the ovality is also increased..

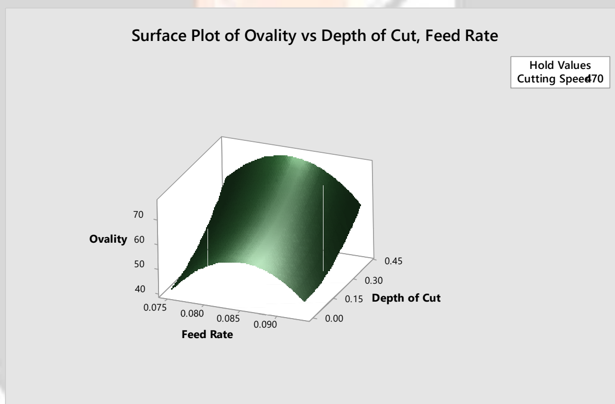

Fig- 12: Surface Plot of Ovality VS Depth of Cut, Feed Rate

D. Effect of Feed rate, Cutting Speed, Depth of cut on Ovality:

The effect of feed rate on ovality is shown in figure 13. In this graph the cutting speed and depth of cut is kept constant and the feed rate is varied. It is seen from the graph that as the feed rate increases, the ovality decreases this may be due to less heat is generated during cutting.

The effect of cutting speed on ovality is shown in fig 13. In this graph the feed rate and depth of cut is kept constant and the cutting speed is varied. ovality is decreasing, but after that ovality is increasing with the increase of cutting speed.

The effect of depth of cut on ovality is shown in figure 13. In this graph the feed rate and cutting speed is kept constant and the depth of cut is varied. It is seen from the graph that ovality is increasing with the increase of depth of cut. This might be happening due to the lower wall thickness of the workpiece. Turning the workpiece at higher depth of cut will cause the vibration. The vibration might cause the diametrical error.

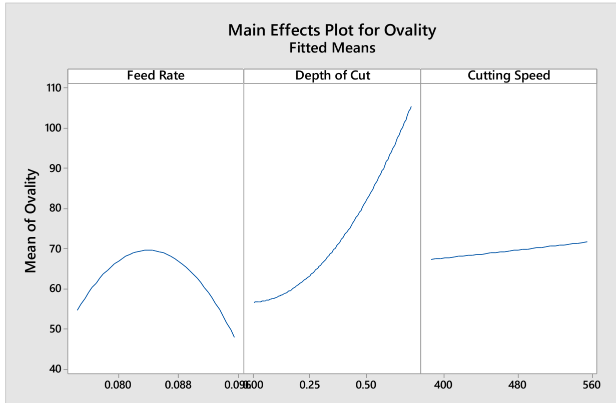

Fig- 13: Main Effects Plot for Ovality Vs Feed Rate, Depth of cut, Cutting Speed

6. CONCLUSIONS

1. The result shows, if Cutting speed (420) RPM, Chuck pressure (8) BAR, Feed rate (0.08) MM/REV, Depth of Cut (0.3) MM/REV, and Spindle speed (2000) RPM. There is decreasing ovality.

2. The results shows that the in the process of manufacturing the main task to achieve the final ovality up to 30 micron with other Geometrical and Dimensional aspects. The task is complicated due to the hollow cylinder, the process went through several trial before achieving the final ovality up to 30 micron. By optimizing variation of cutting parameter.

3. Taguchi's design of experimental technique was used to find the optimum levels of process parameters in Project. The optimum levels of the cutting parameter is feed rate (0.08), depth of cut (0.3), cutting speed (420).

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