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Study of Effect of Process Parameters on Quality of Workpiece in Turning Operation - A Review

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ABSTRACT

This paper deals with the literature review of various factors that affect the surface roughness during turning operation. Process parameters like speed, depth of cut, feed, nose radius, etc. are studied. This study will help us in understanding, which parameters is significant parameter for Surface Roughness, Material Removal Rate, Feed Force, Tangential Force, Tool Life, etc.

Keywords: Turning, Surface Roughness, Tangential force, Tool life.

I. INTRODUCTION

Machining operations such as turning, milling, drilling and grinding are material removal processes that have been widely used in manufacturing, since the industrial revolution of these processes. Turning is one of the most common machining operations in manufacturing. During a turning operation various parameters like speed, feed, depth of cut, tool material and coolant acts on the surface roughness, tool wear and material removal rate.

The utilization of Inconel has increased significantly over the last decades. Today many applications for Inconel 718 are found in aerospace and automobile as well as naval or underwater goods sector. Some of the parts made from Inconel are bearings, gears, bushing, pulley components, gas tanks, intake manifolds and washers among many others. Inconel 718 material is the most difficult material to machine. Improper selection of machining parameters causes cutting tools to wear and break quickly as well as economical losses such as damaged work piece and rejected surface quality. Machining parameters and tool geometry are the important parameters which affect the machinability properties Nalbant et. al [1].

II. LITERATURE REVIEW

A brief literature review of the research carried out for understanding the issues involved in machining. There are number of cutting parameters have general effect on quality of finished component and on machinability such as

tool wear, cutting chips, material removal rate (MRR) etc. so considerable research has taken place to study the effect of cutting parameters are as follows.

RavinderTonk and Jasbir Singh Ratol (2012), the study was aimed to investigate the effect of several input parameters of turning operation (cutting tool, cutting oil, cutting speed, feed and depth of cut) on the different response parameters such as thrust force and feed force in turning process on EN31. Experiments were conducted on conventional lathe machine in a completely random manner to minimize the effect of noise factors present while turning EN31 under different experimental conditions [2].

Suraj Dnyaneshwar Jadhav and Swapnil S. Kulkarni (2013), have studied on cutting speed, feed, depth of cut and various insert materials in wet condition on surface roughness (Ra) using Design of experiments (DOE) and statistical techniques for Al-SiC Metal matrix composite on specified compact CNC turning centre. Since, this material belongs to a special class i.e. MMC, not much research have been done on the same and this would be helpful in improving productivity at a reasonable level of quality [3].

Ashvin J. Makadiaand J.I. Nanavati (2013), have studied on optimization of machining parameters for turning operations based on response surface methodology. In this paper, application of response surface methodology (RSM) on the AISI 410 steel is carried out for turning operation. Response surface optimization shows that the optimal combination of machining parameters are (255.75 m/min, 0.1 mm/rev, 0.3 mm, 1.2 mm) for cutting speed, feed rate, depth of cut and tool nose radius respectively. He also concluded that 3D surface counter plots are useful in determining the optimum condition to obtain particular values of surface roughness [4].

Vikas B. Magdum and Vinayak R. Naik (2013), have studied on the optimization and evaluation of machining parameters for turning on EN8 steel on Lathe machine. This study investigates the use of tool materials and process parameters for machining forces for selected parameter range and estimation of optimum performance characteristics. Develop a methodology for optimization of cutting forces and machining parameters [5].

B.Tulasiramarao et. al (2013), have studied on the Effect of cutting parameters on Surface finish obtained in CNC Turning operation. In this paper to study the effect of process parameters on surface finish obtained in the machining process of materials like stainless steel and aluminum. The minimum surface roughness in stainless steel is obtained when the Spindle speed is 1200 rpm, Depth of cut 0.2 mm and Feed Rate 0.15 mm. In case of aluminum the minimum surface is obtained when the spindle speed is 800 rpm, Depth of cut 0.3 mm and Feed Rate 0.15 mm [6].

D.V.V. Krishan Prasad (2013), has studied in a turning process in which surface roughness depends on machining parameters and tool geometry. In this work considering three machining parameters and two tool geometrical

parameters 243 experiments were conducted for full factorial design. Using ANOVA analysis the influence of these parameters on surface roughness was studied. It is observed that minimum surface roughness is obtained at a speed of 550 rpm, feed of 0.1 mm/rev, depth of cut of 1mm, side rake angle of 18º and back rake angle of 14º the surface finish is 1.465µm and feed is the significant parameter influencing surface roughness and side rake angle is having very less effect on surface roughness [7].

Rahul Davis (2014), has done the experimental study is concerned with the optimization of cutting parameters (depth of cut, feed rate, spindle speed) in wet turning of EN24 steel (0.4% C) with hardness 40+2 HRC. In the present work, turning operations were carried out on EN24 steel by carbide P-30 cutting tool in wet condition and the combination of the optimal levels of the parameters was obtained. The Analysis of Variance (ANOVA) and Signal-to-Noise ratio were used to study the performance characteristics in turning operation. The results of the analysis show that none of the factors was found to be significant. Taguchi method showed that feed rate followed by depth of cut and spindle speed was the combination of the optimal levels of factors while turning EN24 steel by carbide cutting tool [8].

Mustafa Nursoy and Hamdi Sözöz, (2014), have studied that optimization of tool wear in CNC turning operations using taguchi method. This paper presents the optimization of cutting process parameters namely, cutting speed, feedrate, and depth of cut in turning of St 33 and St 52 steel materials with K20 carbide cutting tool. Using the application of Taguchi Method and Pareto ANOVA analysis, the conclusions are cutting speed at120 m/min, feed rate at 0.1 mm/rev, and depth of cut at 1.5 mm are found to be optimum for turning of St 33 steel material; cutting speed at120 m/min, feed rate at 0.1 mm/rev, and depth of cut at 1.0 mm are found to be optimum for turning of St 52 steel material. [9].

Neeraj Saraswat et.al, (2014), have done the work related to optimization of cutting parameter in turning operation of mild steel. By using conventional machine process the turning operation is carried out. Cutting parameters are depth of cut, feed rate and spindle speed have been optimized in turning of mild steel and He results that the combination of optimal levels of the factors was obtained to get the lowest surface roughness [10].

Ranganath M. S. and Vipin, (2014), have done the work related to optimization of cutting parameter in turning operation. In this paper Taguchi's Design of Experiment (DOE) approach used by many researchers to analyze the effect of process parameters like cutting speed, feed, and depth of cut on Surface Roughness and to obtain an optimal setting of these parameters that may result in good surface finish. He also concluded that, Taguchi optimization method revealed that cutting Speed should be kept at the highest level, while both feed rate and depth of cut should be kept at the lowest level [11].

Narendra Kumar Verma and Ajeet Singh Sikarwar, (2014), studied on Optimizing Turning Process by Taguchi Method under Various Machining Parameters. In this paper the experimental results shows that the optimal combination of parameters for surface roughness are at spindle speed of 620 rpm, feed rate of 0.3 mm/min, depth of cut of 0.7 mm while for material removal rate are at spindle speed of 620 rpm, feed rate of 0.5 mm/min, depth of cut of 0.9 mm. The optimum value of the surface roughness (Ra) comes out to be 2.35 μm. While the optimum value of the material removal rate (MRR) comes out to be 44.15 mm^3/min [12].

Priti S. Vairagi et.al, (2015), have done the work related to influence of process parameters and responses on performance of CNC machine turning operation by using multiple regression method. Influence of process parameters and responses on performance of CNC machine turning operation on EN-31 steel material in turning operations. Multiple regression method is used to analyze the performance of process parameter on response such as surface finish rate is done on CNC lathe on EN31 sample. Hence, multiple regression model for surface finish has been developed, as a function of spindle speed, feed rate and depth of cut. It was concluded that surface finish is highly dependent on spindle speed [13].

Arjun Pridhviji and Dr. Binu C Yeldose, (2015), have studied an experimental investigation of cutting parameters (cutting speed, feed rate and depth of cut) in turning operation of Aluminium alloy-2014 was done and influence of cutting parameters on surface roughness was studied. The machining was performed using two different tools such as carbide tool and TiN coated carbide tool. Orthogonal array, signal to noise ratio and ANOVA is used to study the performance characteristic in turning operation. The result shows that better surface finish is achieve at low feed rate (0.05mm/rev), high cutting speed (314m/min) and at high depth of cut. Experimental data collected are tested with regression model and ANN technique, and a comparison study of model has been done [14].

Mohd.Arif. I. Upletawala and Tushar Katratwar, (2016), have studied on a literature review on various factors affecting turning operation. This paper deals with the literature review of various factors that affect the turning operation. In this paper various process parameters like speed, depth of cut, feed, nose radius, etc. are studied. This study will help us in understanding, which parameters is significant parameter for Surface Roughness, Material Removal Rate, Feed Force, Tangential Force, Tool Life, etc.[15].

Patole P. B. and Kulkarni V. V. (2016), the aim of this research work is focused on optimization of process parameters under Minimum Quantity Lubrication (MQL) using nano fluid in turning of AISI 4340. In the experiment conducted, five values of feed rate, three values of depth of cut, two values of cutting speed and tool nose radius respectively, are used. The results were analyzed by using Analysis of variance. From result analysis, it

was found that, feed rate played a major role in producing lower surface roughness followed by depth of cut whereas cutting speed has least significance in producing lower surface roughness under MQL using nano coolant [16].

P.B. Patole and V.V. Kulkarni (2017), have studied on Experimental investigation and optimization of cutting parameters with multi response characteristics in MQL turning of AISI 4340 using nano fluid. This paper focus on an effective approach for the optimization of process parameters in Minimum Quantity Lubrication (MQL) turning of AISI 4340 with nano fluid by using Grey Relational Analysis (GRA). Sixty experimental trials based on full factorial design matrix were carried on CNC turning lathe machine to optimize best level. Analysis of experimental results for response variable such as surface roughness and cutting force was performed using Grey Relational Grade (GRG). From GRA the optimal conditions are obtained as cutting speed (75 m/min), Feed (0.04 mm/rev), Depth of cut (0.5 mm) and Tool nose radius (0.8 mm) for optimal response variable surface roughness (1.26 μm) and cutting force (7.69 kgf) [17].

Table 1: Research Summary

Sr. No.	Author	Material	Parameters								Ref No.
			S	FR	DOC	Ra	MRR	Force	TW	T	
S = speed, FR= Feed Rate, DOC = Depth of Cut, MRR= Material Removal Rate, TW = Tool wear T = Temperature											
1	Ravinder Tonk (2012)	EN 31 Alloy	√	√	√	√	–	–	√	–	2
2	Suraj Dnyaneshwar Jadhav(2012)	Al-SiC Metal	√	√	√	√	–	–	–	–	3
3	Ashvin J. Makadia (2013)	AISI 410	√	√	√	√	–	–	√	–	4
4	Vikas B. Magdu (2013)	EN 8	√	√	√	√	–	–	–	–	5
5	B.Tulasiramarao (2013)	Stainlesssteel and aluminum	√	√	√	√	–	–	–	–	6
6	D.V.V. Krishan Prasad (2013)	AISI 4140	√	√	√	√	–	–	√	–	7
7	Rahul Davis (2014)	EN 24	√	√	√	√	–	–	–	–	8
8	Mustafa Nursoy (2014)	St 33 and St 52	√	√	√	√	–	–	√	–	9
9	NirajSaraswat (2014)	M.S.	√	√	√	√	–	–	–	–	10
10	Ranganath M.S.(2014)	AISI 1045	√	√	√	√	–	–	–	–	11

11	Narendra Kumar Verma (2014)	AISI 1045	√	√	√	√	√	–	–	–	12
12	Arjun Pridhvijit (2015)	Al-alloy-2014	√	√	√	√	–	–	–	–	14

III. CONCLUSION

From the above literature review it is observed that, Surface Roughness: The most significant factor is feed and depth of cut followed by speed. Material Removal Rate: Depth of cut and feed are significant factor followed by speed. Tool wear: Feed and depth of cut are dominant factor followed by speed. Tool Life: Speed and feed are significant factor followed by depth of cut. Surface Temperature: Depth of cut and feed are significant factor followed by speed. Also from the literature review it is found that most of the researchers have worked on the machining processes by using speed, feed rate and depth of cut as process parameter but very less work is done to study the effect of process parameters on surface roughness and tool wear of Inconel 718 material yet.

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