Review of Machining Parameters of EN8 & EN24 in CNC Lathe

Manu Garg, Sandeep Sangwan, Munish Kainth

Abstract— **The experimental study to optimize the effects of cutting parameters on surface finish and MRR of EN24/EN8/EN36 by using Taguchi techniques. The orthogonal array, signal to noise ratio and analysis of variance were used to study the performance significance of turning operation. Five parameters were chosen as process variables: Speed, Feed, Nose radius, Depth of cut. The experimentation plan is designed using Taguchi's L18 Orthogonal Array and Minitab 16 statistical software is used. Optimal cutting parameters for, maximum material removal rate and minimum surface roughness are obtained. It is quite possible to minimize production cost in an automated manufacturing process and increase machine utilization.**

Index Terms*— *Material removal rate(MRR), surface roughness (SR), Analysis of variance (ANOVA), American Iron and Steel Institute (AISI)

I. INTRODUCTION

Increasing the quality of the machined parts and the productivity are the main challenges of metal-based industry. Turning is the most widely utilized among all the cutting processes. The increasing importance of turning operations is improving new dimensions in the present industrial processes, in which the growing competition calls for all the efforts to be monitored against the economical manufacture of machined parts and surface finish is one of the most critical quality measures in mechanical products.

A. EN8 Material

En 8 finds wide varieties of application not only for Forging, casting, Connecting rods, axel shaft and crank shaft but also used for low cost die Material in tool

and die making industries. This material can be tempered and hardened to provide a greater strength and wear resistance in comparison in low carbon steels.

B. EN24 Material

EN24 is a high quality, high tensile, alloy steel and combines, high tensile strength good ductility, shock resistance and resistance to wear. EN24 is most suitable for the manufacture of parts such as shafts, gears, bolts, heavy-duty axles and studs. EN24 is capable of retaining good impact values at low temperatures.

Manu Garg, Master of Technology Scholar, , Mechanical Department, Universal Group of Institutes (UGI), Lalru, Punjab.

Sandeep Sangwan, Head of Department, Mechanical Department, Universal Group of Institutes (UGI), Lalru, Punjab.

Munish Kainth, Assistant Professor, Mechanical Department, Universal Group of Institutes (UGI), Lalru, Punjab

C. Taguchi Method

Basically, traditional experimental design procedures are too Complex and not easy to use. A large number of experiments number of the process parameters increases with their levels. To solve this problem, a specially Designed orthogonal arrays is used with the help of Taguchi method to study the entire parameter only with few of experiments. The major advantage of this method is to save the effort in performing experiments to save the experimental time, to minimize the cost, and to find out relative factors fast. Taguchi robust design method is a most powerful tool to the design the high-quality system. He considered three steps in a processes and product's development system design, tolerance design and parameter design. In system design, the engineer uses scientific and engineering principles to determine the fundamental configuration.

D. Surface Roughness Parameters

Surface roughness most commonly refers to the variations in the height of the surface relative to a reference plane. It is measured either along a set of parallel line profiles (surface maps) OR along a single line profile. It is usually characterized by one of the two statistical height descriptors advocated by the International Standardization Organization (ISO) and the American National Standards Institute (ANSI) and These are (1) Ra, CLA (centre-line average), or AA (arithmetic average) and (2) the standard deviation or variance (σ), Rq or root mean square (RMS). Two other statistical height descriptors are skewness (Sk) and kurtosis (K); these are rarely used. Another measureable perameter of surface roughness is an extreme-value height descriptor Rt (or Ry, Rmax, or maximum peak-to-valley height or simply P–V distance). Four other extreme-value height descriptors in limited use, are: Rp(maximum peak height, maximum peak-to-mean height or simply P–M distance), Rv(mean-to-lowest valley height or maximum valley depth), Rz (average peak-to-valley height), and Rpm (average peak-to-mean height). The height parameters Ra and Rt are widely specified for machine components. For the complete analysis of a surface or a profile, none of the parameters discussed in past to satisfactory level. These parameters are seen to be essentially concerned with the relative variation of the profile in the vertical direction only; they do not provide any information about the slopes, shapes, and sizes of the asperities or about the frequency and regularity of their appearance. There are two methods can be used for measuring surface roughness. Surface inspection by comparison method e.g. visual inspection, tough inspection, scratch inspection, reflected light intensity microscopic inspection, visual inspection, surface photography etc. and 2. Direct instrument method e.g. Tomlinson surface roughness meter, light section method, Forster surface roughness tester, Profilograph, , Telysurf etc.

E. Material Removal Rate

Material Removal rate (MRR) is the factor in turning is the material/metal that is removed per unit time in mm3/sec. On each revolution of the job, a circular shaped layer of material is removed.

Material Removal Rate (MRR) = v × f × d mm3/sec

Where,

v = cutting speed in mm/sec

d = depth of cut in mm

f = feed in mm/rev

A process which removes metal at faster rate may not be the reasonable process, since the power consumed and cost factor taken in experimental report. Due to this, to compare two processes, the volume of material removed per unit of power consumed is determined. This is called "specific metal removal rate" and is indicate as, mm3/W/min, if the power consumption is measured in watts.

II. LITERATURE REVIEW

(1)**Mustafa Gunaya and Emre Yucel** [1] (2012) investigated the cutting conditions for the average surface roughness (Ra) got in machining of high alloy white cast iron (Ni- Hard) at two different hard-ness levels (50 HRC and 62 HRC). Machining investigation were performed at the CNC lathe using ceramic and Cubic Boron Nitride (CBN) cutting tools on Ni Hard materials. Feed rate, Cutting speed and depth of cut were chosen as the cutting parameters. Table 5 shows the variables and their levels used in this work.

Taguchi L18 Orthogonal Array was used to design of experiment. Best cutting conditions was firmly using the Signalto- Noise (S/N) ratio which was calculated for Ra according to the-smaller-the-better approach. The effects of the cutting variables and tool materials on surface roughness were evaluated by ANOVA. The statistical analysis shows that the parameters that have the biggest effect on Ra for Ni hard materials with 62 HRC and 50 HRC are the feed rate and cutting speed , respectively.

(2)**Anirban Bhattacharya et al.** [2] (2009) have carried out the effect of cutting parameters on surface finish and power consumption during high speed machining of steel (AISI 1045) using Taguchi design and ANOVA. The result showed a remarkable effect of cutting speed on power consumption and surface roughness, while the other parameters have not substantially affected the response.

(3)**Ashish Bhateja, Maninder Singh , Jyoti Bhardwaj and Sandeep Kumar Pal** [3],the first aim of this paper is selection of cutting tool material & geometry & work tool material, selection of various process and performance parameters after parameter selection objectives to study various methods for the optimization for that purpose literature review and industrial survey is obtained. The machining parameters and process for the performance characteristics of turning operation on CNC using different types of grades of Tungsten Carbide tool and with varying properties & surface roughness testing of work piece material to be accomplish after machining. After carrying out optimization and compare the Effect of cutting parameters on surface roughness of dissimilar chosen geometry on EN-24 alloy steel by using empirical approach i.e. Taguchi Analysis using Statistical Software.

(4) **Marinkovic Velibor and Madic Milos** [4] presents the Taguchi robust parameter design for optimization and modeling of surface roughness single-point turning of cold rolled alloy steel 42CrMo4/AISI 4140 using TiN-coated tungsten carbide inserts was introduced. Three cutting parameters, the cutting speed (80, 110, 140 m/min), the depth of cut (0.5, 1.25, 2 mm) and the feed rate (0.071, 0.196, 0.321 mm/rev), were used in the experiment. Each of the additional parameters was chosen as constant. The average surface roughness (Ra) was chosen as a measure of surface quality. The experiment was planned and accomplished on the basis of standard L27 Taguchi orthogonal array. The surface roughness was extremely influenced by cutting speed. The impact of feed rate was somewhat smaller, while the influence of depth of cut was least marked. On the other hand, in qualitative terms, the influence of feed rate and depth of cut on the surface quality was dissimilar in relation to cutting speed. In fact, while the increase of cutting speed results better surface quality, the rise in feed rate and depth of cut led to the decrease of surface quality.

(5) **M. Kaladhar et. al.** [5]have used AISI 304 austenitic stainless steel for their experiments and used Chemical Vapour Deposition (CVD) coated cemented carbide Duratomic cutting insert at four levels (Speed, feed, DOC and nose radius) of cutting parameters and employed Taguchi technique for determining the optimal levels of process parameters and ANOVA approach to determine which process parameters are most significant. They utilised L16 mixed array for the analyzing the data and cutting speed comes out to be the most significance variable superseded by nose radius for surface roughness. In case of MRR, the most significant one is the depth of cut followed by the feed.

(6)**M. Nalbant et. al.** [6]have studied the performance characteristics in turning operations of AISI 1030 steel bars using TiN coated tools by taking into account the signal-to-noise ratio, orthogonal array, and annova. Three parameters namely nose radius, depth of cut and feed rate were taken for optimizing the surface roughness. L9 orthogonal array was used by them for the study. They found the percent of contributions of feed rate, insert radius and D.O.C. for surface roughness to be 48.54, 46.95 and 3.39, respectively.

(7)**Ilhan Asilturk et. al.** [7]investigated the effects of process parameters like depth of cut, feed and cutting speed on Surface roughness (Ra and Rz) in turning of AISI 4140 with coated carbide cutting tools. They used L9 orthogonal array of the Taguchi method for the optimization of surface roughness and used nine experimental runs. It's been seen that the feed rate has the most effect on Ra and Rz. A model is developed that can be used in order to determine the optimum cutting parameters for minimum surface roughness in the metal machining industries.

(8)**Aman Aggarwal et. al.** [8]suggested that there are a number of parameters like depth of cut, feed rate, cutting speed, nose radius and cutting environment which effects in power consumption in CNC turning of AISI P-20 tool steel. They used L27 orthogonal array and face cantered central composite design conducting the experiments and utilised Design of experiment techniques, response surface methodology (RSM) and Taguchi's technique in analyzing the data. The cryogenic environment emerges to be the most significant factor in minimizing power consumption followed by depth of cut and cutting speed as shown by the 3D surface plots of RSM as well as by Taguchi's technique.

(9)**P.Madhava Reddy et al.** [9](2014) the paper presented the optimization of CNC turning parameters for EN16 steel bar applying the Grey Taguchi Method. The investigates based on Taguchi"s L"27 orthogonal array were selected and turning investigations were carried out with prefixed cutting variables for EN16 steel bar using tungsten carbide tool. The turning variables were feed rate, cutting speed, and depth of cut and the responses were material removal rate and surface finish. Taguchi"s signal-to noise (S/N) ratio was carried out based on their performance characteristics. A grey relational grade was carried out by using S/N ratio. Formed on grey relational grade value, optimum levels of parameters have been identified by applying response Table and response graph and the significant contributions of controlling parameters were estimated using analysis of variances (ANOVA).

(10)**Birhan Isik** [10] (2008) Has worked on the turning operation on reinforced glass fiber plastics (GFRP) on CNC turning machine with CERMET cutting implement. Cutting parameters (depth of cut, cutting speed and implement geometry) and the resulting cutting forces have great effects on the machinability surface roughness of one directional glass-fiber reinforced plastic composite. Result shows that the surface roughness reduces with the increase in cutting speed. The surface roughness decreases with the incrementation of implement radius and cutting speed. The surface finish increases with the incrementation of rake angle and victual rate. An increase in cutting depth does not have a consequential reaction on the surface roughness.

(11) **Poornima et al.** [11] (2012) did turning operation on artensitic stainless steel (SS40) steel utilizing CNC machine implement. Optimized the turning process variables(cutting speed, aliment, and depth of cut) for replication factor (surface roughness) utilizing RSM and Genetic Algorithm. Result obtained from Replication Surface Methodology (RSM) and Genetic Algorithm which designates that machining process parameters (speed, aliment and depth of cut) have significantly affected the replication.

(12) **Sahoo et al.** [12](2008) studied for optimization of machining variables combinations emphasizing on fractal features of surface profile produced in CNC turning operation. The method used L27 Taguchi Orthogonal Array design with machining variables: feed , speedand depth of cut on three different materials viz. mild steel, alluminium and brass. It was decideded that feed rate was more significant effecting surface finish in all three materials.

(13) **Jitendra Vermaet. al.** [13]have taken ASTM A242 type-1 ALLOY steel of 250 mm long with 50 mm diameter of material for examination using a CNC lathe machine. L9 array used and to analyze the data Taguchi and ANOVA approach used. They decided that speed (57.47% contribution) is the most recognized factor affecting surface roughness and followed by feed (23.46% contribution). Cutting speed is the least recognized factor affecting surface roughness.

(14) **Rahul davis et al.** [14]They have used Taguchi method to identify the effect of turning variables on surface roughness. The experimental material En24 steel is selected for this experimentation. The ANOVA and signal to noise ratio were used for study the operation. The cutting speed , depth of cut and feed rate were selected as input parameters.

(15) **R S Pawade et. al.** [15]has found that analysis of AE Signal during the machining could help to obtain the quality of the machined surface finish. Frequency amplitude of the AE signal is effected by the cutting speed. The edge geometry and feed rate are found to effect the number of count generated during machining deformation.

III. CONCLUSION

From the above research paper we found that most of the researchers had taken speed, feed, depth of cut as input parameter and in some cases nose radius, cutting environment and tool tip temperature whereas material removal rate, surface roughness, and tool wear as output variable. By studying the above literature we concluded that for material removal rate the most significant parameters are depth of cut, feed rate, and speed. Least significant parameter is nose radius. We found that feed rate is most significant factor affecting the surface roughness followed by depth of cut. For tool flank wear speed, depth of cut and feed are significant factors. We also found that Taguchi gives systematic simple approach and efficient method for the optimum operating conditions.

REFERENCES

[1] Mustafa Gunaya and Emre Yucel (2012), Application of Taguchi Method for Determining perfect Surface Roughness using Turning of High-Alloy White Cast Iron", *Elsevier Measurement*.

[2] Anirban Bhattacharya, Santanu Das , Ajay Batish and Majumder P (2009), Estimating the impact of Cutting variables on power Consumption and Surface Finish During High Speed Machining of Steel (AISI 1045) Using Taguchi Design and ANOVA", *Prod. Eng. Res. Devel.*, Vol. 3, pp. 31-40.

[3] Y. S. Tarng , W. H. Yang, Design Optimization of cutting variables for turning operations depends on the Taguchi method, Journal of Materials Processing Technology, 84 (1988), 122–129

[4] X. D. Fang , Y. Yao, Modelling of multivariate time loops for tool wear evaluation in finish turning, Int. J. Mach. Tools Manuf., 32 (1992) 4, 495–508

[5] M. Kaladhar, Ch. Shrinivasa Rao, K. Venkata Subbaiah Determination of Optimum Process variables during turning of AISI 304 Austenitic Stainless Steels using ANOVA and Taguchi method, International Journal of Lean Thinking, 3(1), 2012

[6] J. Verma, P. Agrawal, Lokesh Bajpai, Turning variables Optimization for Surface finish of ASTM A242 type-1 Alloys Steel by Taguchi Method, International Journal of Advances in Engineering & Technology, 2012

[7] M. Nalbant, H. Go¨kkaya, G. Sur, Application of Taguchi method in the optimization of cutting variables for surface finish in turning, Elsevier Journal, Materials and Design, 28, 2007, 1379–1385

[8] A. Aggarwal, H. Singh, M. Singh, , P. Kumar Optimizing power consumption for CNC turned parts using response surface methodology and Taguchi's method- A comparative analysis, Elsevier Journal, Journal of materials processing technology, 2008, 373–384

[9] P. Madhava Reddy, P. Vijaya Bhaskara Reddy, Y. Ashok Kumar Reddy and N. Naresh "Optimization of machining variables for turning the EN16 steel using grey based taguchi method" ARPN journal of engineering and applied sciences ISSN 1819-6608 vol. 9, no.3, march 2014

[10] Birhan Isik,"Experimental optimization of surface roughness in orthogonal turning of onedirectional glass-fiber reinforced plastic composites", International Journal Advance Manufacturing Technology, 37:42-48,**2008.**

[11] Poornima, Sukumar, "Optimization of machining variables in CNC turning of martensitic stainless steel using RSM and GA", International journal of modern engineering research (IJMER), 2: 539-542,**2012.**

[12] Sahoo P, Routara B C and Barman T K (2008), "Taguchi depended Practical Dimension Modelling and Optimization in CNC Turning",

Advance in Manufacturing Engineering and Management, Vol. 3, No. 4, pp. 205-217

[13] JitendraVerma, LokeshBajpai and Pankaj Agrawal, "Turning variables Optimization for Surface finish of ASTM A242 type-1 Alloys Steel by Taguchi Method", International Journal of Advances in Engineering & Technology field, March 2012.

[14] Rahul Davis, Jitendra Singh Madhukar, Vikash Singh Rana, Prince Singh (Oct 2012) "Optimization of Cutting Parameters in Dry Turning Operation of EN24 Steel, International Journal of Emerging and Advanced Technology, Vol.2, Issue.10, pp.559-563, Oct 2012.

[15] R S Pawade, S S Joshi, "Analysis of acoustic emission signals and surface integrity in the high speed turning of inconel 718" Journal of Engineering Manufacture Sage Journal. 2011.