International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

Review on Optimization of Cutting Tool and Cutting Parameters in CNC Turning of Aluminum Alloy 6063 through using the Taguchi method

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Abstract - *This paper presents the mathematical modelling and parametric optimization on material removal rate, Machining Time, and surface roughness in turning operation of AA6063 steel with cemented inorganic compound coated atomic number 74 insert tool underneath different cutting parameters. The improvement of grey relational grade from initial parameter combination (a3–be–c3) to the optimal parameter combination (a1–b1–c1) is found to be 0.520 using grey relational analysis coupled with Taguchi method for simultaneous optimization of responses.*

Keywords Centre lathe, AA6063 alloy steel, Material removal rate, Machining time, Surface Roughness, Carbide tools.

1. INTRODUCTION

In order to settled bridge between quality and productivity the current experimental study high light centre lathe machine method parameters to produce sensible surface end still as high material removal rate. Surface end and material removal rate has been known as quality attributes and square measure assumed to be directly associated with productivity.

This experimental study presents an efficient approach for the improvement of shaping machine exploitation MINITAB 18 and Taguchi Technique in varied condition. The knowledge concerning machining of inauspicious cutting materials is insufficient and difficult. So AN experimental study needs to be conducted to come back out with an optimum outcome. Out of the different parameters that may be considered because the producing goal, the material removal rate (MRR) was thought of for this work because the factor directly affects the value of machining and therefore the machining hour rate.

The machining parameters specifically cutting speed, feed rate and depth of cut were thought of. The objective was to seek out the optimized set of values for maximizing the MRR by Taguchi technique. Therefore the current work is targeted on finding the optimum parameters combination of cutting speed, feed and depth of cut for maximizing the rate of material removal during machining. The machining parameters elite for a turning operation is a crucial procedure so as to realize high performance.

Taguchi methods developed by Genichi Taguchi improve the quality of manufacturing roots are recently applied to the field of engineering, biotechnology, marketing and advertising. The Taguchi method is a very powerful carrying of experimental design, the main aim of the Taguchi methods is to produce an optimum result of analyzing the statistical data which have been given as input function. This technique permits restricted no of experimental runs by utilizing a well-balanced experimental style known as orthogonal array style and signal to noise magnitude relation.

Common US Grades of Stainless Steel

In general, the selection of a stainless steels are based on

Corrosion resistance

Fabrication characteristics

Availability

Mechanical properties over a specific temperature rangesProduct cost

Since stainless steel is corrosion resistant, it maintains its strength at high temperatures

TYPE304: The most frequently specified austenitic (chromium-nickel stainless class) stainless steel, accounting for more than 50 % of the stainless steel production in the world.

TYPE316: Primary solid solution (chromium-nickel untarnished class) stainless-steel containing 2 Chronicles - three nada metallic elements (whereas kind 304 stainless-steel has none). The inclusion of metallic element provides kind 316 stainless-steel, greater resistances to numerous sorts of deterioration.

TYPE409: Ferrite (plain metallic element stainless-steel category) stainless-steel suitable for prime temperature. This grade has rock bottom metallic element content of all untarnished steels and so is that the least high-ticket.

TYPE410: the foremost wide used martensitic (plain metallic element untarnished category with exceptional strength) stainless-steel, facultative a high level of strength advised by the martensitic stainless-steel. It's a

heat treatable grade of low cost that is appropriate for non-severe corrosion applications.

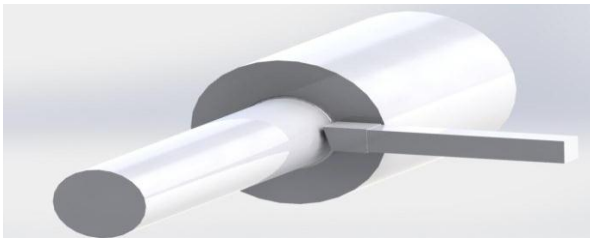

Fig.1. Rendered picture of turning operation (Drawn in Solid Works 2013)

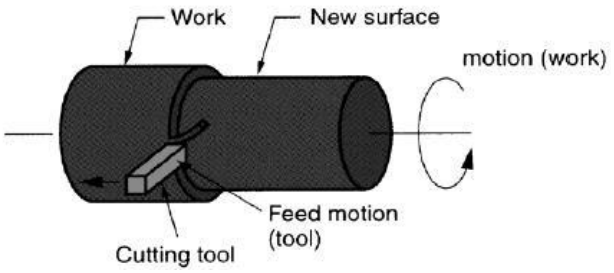

Fig.2. Turning operation [40]

Machining could be a part of the manufacture business of the many metal product, however it can even be used on materials like wood, plastic, ceramic, and composites. Machining is that the most significant of the producing processes. Machining is outlined because the method of removing material from a work piece within the type of chips. The term metal cutting is employed once the material is metallic.

Turning could be a type of machining, a material removal method, that is employed to make motion components by cutting away unwanted material.

2. LITERATURE REVIEW

Many research workers have investigated and demonstrated the effect of various cutting parameters viz. Spindle speed, feed, depth of cut etc. on the surface roughness and the MRR in orthogonal turning. The literature Explain the effect of above mentioned variable has been discussed below:

Dileep Kumar C., et al (2014) [4] focused on an experimental study to find the effects of cutting parameters on surface finish and optimize them for better surface finish and high Material Removal Rate (MRR) during turning of Ti-6Al-4V. Uncoated WC/Co inserts are used for the machining purpose. A combined Taguchi method and Grey Relational Analysis (GRA) is used for the optimization. Analysis of Variance (ANOVA) is employed to find out contribution of each parameter. Four parameters are chosen as process variables: cutting speed, feed, depth of cut and nose radius each at three levels. The experiment plan is designed using Taguchi's L9 Orthogonal Array (OA). The results show that feed rate and nose radius are the most important parameters that affect the surface finish. A model is also developed separately for both surface finish and MRR using multiple regression analysis.

Basim A. K. et al (2015) [6] have experimented to develop a predictive model for surface roughness and temperature in turning operation of AISI 1020 mild steel using cemented carbide in a dry condition using the Response Surface Method (RSM). In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. From the experiment it is found that Feed rate is the most significant factor on surface roughness.

Mohan S., Dharmpal D., et al (2010) [12] have investigated the robust design technique to minimize the variance of the response and orthogonal arrays. Experiments are designed and conducted based on Taguchi's L9 Orthogonal array design. This study discusses the use of Taguchi Parameter Design for optimizing surface roughness generated by a CNC turning operation.

J.B.Shaikh, J.S.Sidhu, et al (2014) [14] have determined the influence of lubricant on surface roughness and material removal rate (MRR) by using CNC LATHE Machine with AISI D2 steel as a work material and TiAIN coated carbide tool as a tool material. Different lubricant used on this experiment are Cotton seed oil, Servo cut and soya bean oil and machining parameters are cutting speed, feed rate and depth of cut. Experiments are designed and conducted based on Taguchi's L9 Orthogonal array design. After the Analysis of Variance was made, it is found that feed rate, Cotton seed oil, Servo cut and soya bean oil has got the greater influence on surface roughness.

M. Gupta, et al (2015) [15] they investigated the machinability of unidirectional glass fiber reinforced plastics (UD-GFRP) composite while carrying out turning operation. The parameters used to investigate their effect on output responses are tool nose radius, tool rake angle, feed rate, cutting speed, cutting environment (dry, wet and cooled) and depth of cut. Experiment are designed and conducted based on Taguchi's L18 Orthogonal array design.

S. A. Rizvi, et al (2015) [16] have analyzed that an effort was made to optimize the cutting parameters to achieve better surface finish and to identify the most effective parameter for cost evolution during turning by using CNC LATHE MACHINE with IS 2062 steel rods (35 mm diameter) as a work material and Chemical Vapour Deposition (CVD) coated carbide inserts as a tool material. In this work, the input parameters are cutting speed, Feed Rate and Depth of cut.

S. Sahu, B.B.Choudhury(2015) [17] have analyzed that the performance of multi-layer TiN coated tool in machining of hardened steel (AISI 4340 steel) as a work material under high speed turning uncoated tool use. In this work, the input parameters are cutting speed, Feed Rate and Depth of cut. Experiment are designed and conducted based on Taguchi's L16 Orthogonal Array design. From the Taguchi analysis it has been found that the feed is playing as a main parameter for reducing surface roughness, whereas depth of cut is having significant effect on the surface roughness.

T. Rajasekaran, K. Palanikumar, et al (2013) [19] during this work, the input parameter area unit cutting speed, feed rate and depth of cut in turning by victimisation typical shaper (MakeNAGMATI, INDIA). Experiment are designed and conducted based on Taguchi's L9 Orthogonal Array design. From the Taguchi analysis it has been found that primarily feed rate and secondarily cutting speed has got the greater influence on surface roughness.

Yusuf S., et al (2005) [20] have determined surface roughness model response surface methodology (RSM) with low-carbon steel as a piece material and TiN coated inorganic compound as a tool material. In this work, cutting parameters area unit cutting speed, feed rate and depth of cut. From the experiment it's

Ilhan A., et al (2011) [21] have investigate the effect of cutting speed, feed rate and depth of cut usingAISI 4140 (51 HRC) steel as a work material and Al2O3 and TiC coated carbide as a tool material. Experiment are designed and conducted based on Taguchi's L9 Orthogonal Array design. Through the experiment it is found that Feed rate is the most significant factor on surface roughness.

Satyanarayana K., et al (2015) [22] have determined that effect of process parameters on performance characteristics in finish hard turning of MDN350 steel using cemented carbide tool. In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L9 Orthogonal Array design. From the experiment it is found that Feed and Cutting speed are the most significant factor onsurface roughness and Cutting Force respectively.

Ashvin J. M., et al (2013) [23] have investigated the effect of turning parameters such as cutting speed, feed rate, tool nose radius and depth of cut on surface roughness with AISI 410 steel as a work material and ceramic as a tool material using Response Surface Methodology (RSM).In this study Feed rate is the most significant factor on surface roughness.

Tanveer H. B., Imtiaz A. (2014) [24] have experimented a study of cutting parameters of AISI1040 steel as a work material and uncoated carbide as a tool material using Genetic algorithm and Response Surface Methodology. In this work, the input cooling condition, cutting parameters are cutting speed, feed rate and depth of cut. In this experiment it is found that Feed rate is the most significant factor on surface roughness.

Sayak M., et al (2014) [26] have experimented that to develop the combination of optimum cutting parameters SAE 1020 mild steel as a work material and carbide as a cutting tool using Taguchi technique. In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L25 Orthogonal array design. From the experiment it is found that Depth of Cut has the most significant effect on MRR followed by Feed.

Ch. MaheswaraRao et al. [3] optimized the surface roughness in CNC turning using Taguchi method and ANOVA. The material AA7075 was turned using tungsten carbide insert. Experiments were designed using Taguchi technique. ANOVA was performed to study the significance of cutting parameters on surface roughness. The results showed that cutting speed and feed influenced the surface roughness the most.

Ashvin J. Makadia et al. [5] optimized the machining parameters for turning operations based on response surface methodology. Here AISI 410 steel was turned using the turning parameters cutting speed, feed rate, depth of cut and tool nose radius. Design of experiment was used to study the effect of these parameters on surface roughness. The effect of these parameters was investigated by using Response Surface Methodology (RSM). The study revealed that the feed rate followed by the tool nose radius were the main influencing factors on surface roughness.

Daniel Lawrence et al. [6] tried to optimize the machining parameters in turning of AISI 304 steel using Gray Relational Analysis (GRA) and RSM. The experiment was designed using Taguchi L9 orthogonal array, with the combination of three speeds (450,550 and 650 rpm), three feed rates (0.2, 0.25 and 0.3mm/rev) and three depths of cut (0.2, 0.3, and 0.4 mm). The values were analyzed using

Satyanarayana K., et al (2015) [10] have determined that effect of process parameters on performance characteristics in finish hard turning of MDN350 steel using cemented carbide tool. In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L9 Orthogonal Array design. From the experiment it is found that Feed and Cutting speed are the most significant factor on surface roughness and Cutting Force respectively.

Rahul D., et al (2014) [27] have determined the process parameters of turning operation using Taguchi DOE with EN 24 steel as a work material and Carbide P-30 as a tool

material. In this work, the input cutting parameters are spindle speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L9 Orthogonal array design. In this experiment it is found that Feed rate is the most significant factor on surface roughness.

Karthic S., et al (2015) [30] have investigated to reduce the lead time, increasing productivity and improve the surface roughness of EN 8 steel with tungsten carbide as a tool material using two cutting fluid namely coconut oil and mineral oil. In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. Experiment are designed and conducted based on Taguchi's L9 Orthogonal array design. From the experiment by comparing two cutting fluid we conclude that coconut oil have given better surface finish.

BalaRaju, J., et al (2015) [3] investigated the impact of cutting parameters like cutting speed, feed and depth of cut in turning soft-cast steel and atomic number 13 exploitation HSS cutter. it absolutely was distributed to realize higher surface end and to decrease power demand by flattening the cutting force in machining. The experiments were carried supported 2k factorial techniques. And multivariate analysis analysis was accustomed develop cutting forces needed for machining. It absolutely was found that feed has important impact on each surface roughness and cutting force.

Ramyasree K., et al (2015) [5] have experimented to grasp the relationships between input parameters i.e. cutting speed, feed and depth of cut and output parameter i.e. surface roughness (Ra) of AISI 1045 in Dry Machining with blockish B chemical compound (CBN) cutter. Experiment is style and conducted supported Taguchi's L9 Orthogonal array design. From the study, it's found that Feed rate is that the most influencing issue on surface roughness.

Suresh R.K., et al (2015) [34] created an endeavour to optimize the chosen turning cutting parameters (cutting speed, feed rate, depth of cut, nose radius of insert edge) to unravel the Multi Objective optimisation (MOO) downside. Hymenopter Colony optimisation (ACO), and biological process formula is employed to search out the best treatment and also the results ar compared against those of actual CNC turning. Input formula.

Sayak Mukherjee et.al [02] conducted experiments on SAE 1020 steel exploitation taguchi methodology to optimize cutting parameters with regard to material removal rate. L25 orthogonal array was employed in conducting experiments. The result shows that Depth of cut had important impact on Material Removal Rate followed by feed and speed.

R. Suresh, et.al [04] to developed a mathematical model correlating cutting parameters with Tool Wear and Surface Roughness. Turning operation was done hardened AISI H13 steel with PVT coated ceramic tool in dry condition. Experiments were conducted exploitation the construct of Response Surface Methodology. For Surface roughness, Feed was the dominating issue followed by Depth of cut and speed. For Tool wear, Speed and feed were the dom

Krishnakantet.al [07] conducted experiments on EN24 steel to optimize the fabric Removal Rate (MRR). Taguchi technique with L9 orthogonal array is employed with three factors and three levels. Response variation is studied exploitation S/N magnitude relation for larger-the-better characteristic. Material Removal Rate will increase with increase in feed, speed and depth of cut.

Gulhane, et.al [08] investigated the surface roughness in turning operation of 316L stainless-steel exploitation Taguchi technique. L9 orthogonal array was chosen for conducting experiments and also the results were verified with ANNOVA. The foremost important issue was feed followed by depth of cut and speed. Conjointly the optimum values for cutting parameters were known.

L B Abhang, et.al [09] conducted turning operation on EN31 steel exploitation atomic number 74 inorganic compound tool. Experiments were conducted exploitation Taguchi methodology and verified by analysis of variance. The result shows that lubricating substance has important impact on surface roughness compared to feed and depth of cut. The conclusion drawn was higher surface end will be obtained by applying cooled lubricant?

M. Kaladhar, et.al [10] investigated optimisation of method parameters of AISI202 stainless-steel in turning operation. They studied the impact of method parameter i.e speed, depth of cut, feed, and nose radius on surface roughness. Experiments were conducted exploitation Full Factorial style technique and to analyse the method parameter significance, ANNOVA was used. Feed and Nose radius were the dominant issue followed by speed and depth of cut.

W.H Yang, et.al [11] used Taguchi methodology to search out the optimum cutting parameters. They investigated the cutting parameters of S45C steel exploitation atomic number 74 inorganic compound tools by. For Tool Life, speed and feed were the many issue followed by depth of cut. For Surface roughness, Feed and depth of cut were the many factors followed by speed. Conjointly the optimum values of cutting parameters were known to extend tool life and surface roughness.

RESEARCH GAP

From reviewed different research paper it has been concluded that

1. Most of the research people have taken spindle speed, feed rate and depth of cut as input parameters. Spindle

speed, feed rate and depth of cut are the important parameters while studying the effects of process parameters on the required responding characteristics.

2.For any manufacturing industries the quality is the most important quality parameters. So, most of the research people have taken surface roughness as the quality parameters.

3. CONCLUSION OF LITERATURE REVIEW

Following points can be concluded by study of the above literature reviews from the above literature review

1. it is observed that various methods are used to minimize surface roughness by optimizing cutting parameters like Cutting speed, Feed rate, Depth of cut, tool angle, nose radius, Cutting Fluid, etc.

2. Among all these methods it is observed that Taguchi Method is the most widely used method. The use of other methods like Multiple Regression Analysis, Response Surface Method and Artificial Neural Network are gradually increasing. In optimization of surface roughness Feed Rate is found to be the most Significant factor followed by Depth of cut and cutting speed

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