International Journal of Scientific Research in Mechanical and Materials Engineering
© 2022 IJSRMME | ISSN : 2457-0435

A Review on Using Design of Experiments to Optimize Machining Parameters in Turning Operation

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Article Info
Volume 6, Issue 2
Page Number : 27-33

Publication Issue :
March-April-2022

Article History
Accepted : 01 March 2022
Published : 10 March 2022

ABSTRACT

Most industrial applications of machining are in metals. Turning is a process of machining to create external surfaces of rotation by means of a cutting tool on a rotating part, usually in a lathe. Lathe is a machine that rotates the workpiece on its axis for various operations such as cutting, knurling, drilling, threading, etc. with tools that are applied to the workpiece, to create an object that has symmetry around the axis rotation. Aluminum alloys can be processed quickly and economically due of their metallurgical structure. In the present study investigated the influence of all cutting parameters, such as feed rate, cutting speed, cutting depth, tool radius and angle of rotation on machinability factors when aluminium alloys. The purpose is to study the machining parameters and effect of them on surface roughness. In this paper, we study many good numbers of published papers and a literature review has been presented to identify and mention the gap for further research.

Keywords : Turning, Cutting, Metallurgical, Machining, Surface Roughness

I. INTRODUCTION

Turning is a process of machining to create external surfaces of rotation by means of a cutting tool on a rotating part, usually in a lathe. The lathe is a machine that rotates the workpiece on its axis for various operations such as cutting, knurling, drilling, threading, etc. with tools that are applied to the workpiece, to create an object that has symmetry around the axis rotation. Aluminum alloys can be processed quickly and economically due of their metallurgical structure. The influence of all cutting parameters, such as feed rate, cutting speed, cutting depth, tool radius and angle of rotation on machinability factors when aluminium alloys such as Al6063T6. Processing is large collection of manufacturing processes designed to remove unwanted material. Machining is used to convert castings, forgings with dimensions that meet the design requirements. Every product manufactured has components that require machining. The application of these processes in the industrial world is widespread. The machine operator has direct control of the input variables and selects them at processing process. The selection of the processes necessary to convert the source material to the finished product based on the geometry of the size and shape of the part, rotational or non-rotational, the required finish and tolerances and the quantity of the product to be manufactured. Dependent variables are defined by a

process based on the preliminary selection of input variables. Important dependent variables are the cutting force, the size of the finished product, tool wears etc. The lathe is a machine tool that rotates the workpiece on its axis for various operations such as cutting, knurling, drilling, cutting threads, etc. With tools that are applied to the workpiece, to create an object that has symmetry relative to the axis of rotation. Lathes are used in woodworking, metalworking, metal spinning, part regeneration. The automatic lathe machine controls the tools through all stages of the cycle without the operator after the machine has been set up. The workpiece rotates between the centers. The tools are placed on the blocks on the front and rear slides. The front self moves along the bed. And the tools make straight cuts along the workpiece removed at the end of the cut and taken original position. The rear tool slides to the center of the workpiece for lining but lateral movement can be given at the end of the cut. Cutting tool is used to remove material from a workpiece by means of shear deformation. Cutting can be done using single-point or multi-point tools. Single point tools are used for turning, forming, trimming for removing material with a single cutting edge. Cutting tools must be made of a material that is more rigid than the material to be cut and the tool withstand the heat generated during the cutting process.

II. LITERATURE REVIEW

a Surface treatment is one of the most important characteristics in the manufacturing industry which affect the characteristics of mechanical parts as well as cost price. In order to improve the quality and efficiency of products during turning processes. A good turning surface can lead to improved strength properties such as fatigue strength, corrosion resistance and heat resistance. The right choice of tool geometry and cutting parameters that affect surface roughness are important factors. Surface roughness increases with feed. With increase in cutting speed, the surface roughness of the of the parts increases due to increase friction between the workpiece and the tool interface. As the depth of cut change, the rate of material removal changes continuously during the process. So, the amount of material removed depends on the speed, feed rate and depth of cut. There have been numerous researches that had been performed in this field. The most relevant of those studies have been mentioned as.

Feng Tsang Xue et.al. [1] studied the influence of the rotation parameters on the surface roughness that influence of feed, speed and depth of cutting, the radius of the nose of the tool and the working material on the roughness of the working material on the roughness of the working material surface.

Manu Garg et.al. [2] have studied to optimize the effects of cutting parameters on surface finish and MRR of EN24 by using Taguchi techniques. Speed, Feed, Nose radius, Depth of cut are the process parameters chosen. It is identified that the least significant parameter is nose radius. surface roughness is mostly affected by feed rate.

Pankaj Sharma et.al.[3] have optimization of two response parameters (surface roughness and material removal rate) three machining parameters (cutting speed, feed rate and depth of cut) is investigated in high speed turning of H13 in dry conditions.

M Y Noordin et. al. [4] has influence of federate and cutting speed on the surface roughness and tangential force on turning AISI1045 steel was investigated. ANOVA has shown that feed is the most significant factor affecting the investigated response variable.

L B Abhang et. al. [5] have to find the optimal combination of process parameters based on S/N ratio and to know the significance of each parameter by performing ANOVA analysis and find out the effect of lubricant temperature in steel turning process on the response(surface roughness), obtain better surface finish by applying cooled lubricant.

R Davis et. al. [6] have concerned with the optimization of cutting parameters(depth of cut, feed rate, spindle speed) in turning of EN24 steel with hardness and obtained feed rate followed by depth of cut and spindle speed as the combination of the optimal levels of factors.

A K Mathew et. al. [7] The process parameters influencing the roughness of the surface of the machine roughness with emphasis of the feed rate and improving the quality of the surface. So, found that increase in feed rate occurs until the surface roughness.

Wang et. al. [8] have the orthogonal array of the taguchi method is used in combination with a gray relational analysis taking four parameters speed cutting depth, feed rate, nose for the tool etc. to optimize surface roughness, tool wear and material removal as accurately machine tool.

A. Saravan Kumar et. al. [9] have use to Taguchi's experimental design concept for optimizing the design parameters with three levels for better surface finish and minimizing surface roughness by spindle speed.

Md. Nasimuddin et. al. [10] have investigates the effect of turning parameters such as rotational speed, feed rate and depth of cut on surface roughness of high carbon steel. Taguchi method used for designing the experiments and optimization of turning parameters and find optimal parameter for minimum surface roughness.

Rifat A. Siddique et. al. [11] have optimization of machining parameters in turning AISI 304 using taguchi method and principal component analysis. Turning operations are carried out on AISI 304 in dry condition using a coated carbide insert. L27 orthogonal array of taguchi method is used to design the experiment with three input parameters (Cutting velocity, feed rate and overhang length) of three different levels to measure surface roughness and vibration amplitude.

P. Chenneswari et. al. [12] have carried out orthogonal array design for turning operation on Al 7175 using tungsten carbide tool with three input process parameters cutting speed, feed and depth of cut and effect of surface roughness reduced increasing spindle speed and MRR increased with increasing any three input parameters.

W.H. Yang et. al. [13] have discussed the application of taguchi method to optimize the cutting parameters for turning operations.

M. P. Garg et. al. [14] have study the effect of input parameters on the rate of material removal. From ANOVA analysis, parameters significant effect on material removal rate.

N. Srilatha et. al. [15] have study on varying cutting speeds, feed rates and depths of cut in different aluminium alloys that determine the optimal process parameters for minimizing the surface roughness during turning of three different aluminium alloys on CNC lathe machine by using coated carbide tool.

Nikul D. Patel et. al. [16] has shown three cutting parameters affect the surface roughness: Cutting speed, feed rate and cutting depth and found that the cutting speed has a maximum effect on the surface roughness.

M. Kanade et. al. [17] have focus on the optimisation of turning parameters using Taguchi technique to obtain minimum cycle time& surface finish and found that cutting speed is the most significant factor on the cycle time.

Shashi Kiran G. et. al. [18] have study on optimum cutting parameters for turning operations in Copper alloy. Spindle speed, feed rate and coolant taken to assess the machinability. Taguchi method is as selected tool to design optimization for quality at optimal cutting parameters for turning operation.

M. G. Rathi et. al. [19] have study the effect of cutting speed, feed rate and depth of cut on surface roughness of mild steel in turning operation and obtained the optimum level to get lowest surface roughness.

L B Abhang et. al. [20] have to find the optimal combination of process parameters based on S/N ratio and to know the significance of each parameter by ANOVA analysis. The cutting parameters feed rate, depth of cut and lubricant temperature varied to observe the effects on responses.

M S Ranganath et. al. [21] have investigates the parameters affecting the roughness of surfaces produced in the turning process and design of experiments conducted for the influence of the turning parameters such as cutting speed, feed rate and depth of cut on the surface roughness.

N. Jagannatha et. al. [22] have determine optimal combination of machining parameters and found that the depth of cut is the significant factor on material removal rate (MRR) and feed rate is roughness of machined surface.

T. Ganapathy et. al. [23] have to optimise machining and geometrical parameters in turning process. cutting speed, feed rate, depth of cut, material type, cutting-insert-shape, relief angle and nose radius is use and to ensure minimum flank-wear and surface roughness.

M. Murthy et. al. [24] have studied the effect of various cutting parameters on the surface finish of Al6061 aluminium alloy was investigated. It Based on Taguchi method of design of experiments L16 orthogonal array was selected for conducting turning experiments on Al6061 T6 using CNC LT-16 turner with carbide tipped tool and the cutting parameters selected were feed, spindle speed, depth of cut and tool nose radius.

C.V. Bhaskar et. al. [25] have the objective of the Taguchi method to investigate the effects of turning parameters such as cutting speed, depth of cut and feed rate on surface roughness, Material removal rate and Power consumption in dry Turning of EN 24 steel.

D. Kumar et. al. [26] have the effect and optimization of machining parameters (cutting speed, feed rate and depth of cut) on surface roughness is investigated using L 27 orthogonal array.

S. Jaiswal et. al. [27] have obtain the optimal value of turning process parameters in order to reduce the rejection rate during machining. The process parameters considered cutting speed, depth of cut, feed rate at three levels and required output is surface roughness.

T. Rajmohan et. al. [28] have optimization of material removal rate in turning operation is done by using nanoparticle-filled lubricant on an all geared center lathe at different cutting velocities and feeds and the machining performance of nano fluids is compared with the conventional cutting fluids.

III. Objective

Wear is an inherent occurrence in any machining process. Wear affects tool life and product quality and Surface Finish is also important of machined product. The objective of this studies based on research gaps have been following point that discuss below as:

- To study the influence of machining parameters viz. feed rate, speed, depth of cut and nose radius for turning operation on the surface roughness of machined material.
- To determine optimum machining parameter for minimize surface roughness using Taguchi techniques.
- To develop model for surface roughness within specified domain of parameters.
- To study the microstructure performed on the machined component that influence of machining parameters viz. feed rate, speed, depth of cut and nose radius.
- Conclusion: The conclusions of the research work are presented for its machinability under turning operations using the Taguchi technique. The Taguchi techniques facilitated the use of orthogonal arrays L9 which used to the cutting

parameters for the turning operations. The cutting parameters selected were Feed rate, speed, depth of cut and nose radius for turning operation. Minitab was used to compare the main effect and interaction effect to obtain some point discuss as:

- It is clear that most of the research work used speed, feed and depth of cut as input parameters for studying the surface roughness.
- Some of them we have considered nose radius as one of the parameter.
- In this work, the simultaneous effect of tool geometry and material properties on surface roughness.

IV. Future Scope

This research work can be used as present for a number of different works, which can be performed as the basis for them:

- Other machining operation can be used to carry out the research.
- It may be extended to the effect of other process parameters such as type of lubricant, cutting force, power consumption and wear rate etc.
- Other optimization approaches may be used in machining operation.

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Cite this article as :

Deepak Kumar Verma, Rupendra Kumar Marre, Lokesh Singh, "A Review on Using Design of Experiments to Optimize Machining Parameters in Turning Operation",International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 6 Issue 2, pp. 27-33, March-April 2022.

URL : https://ijsrmme.com/IJSRMME22625