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A REVIEW PAPER ON MACHINING OPITMIZATION USING TAGUCHI METHOD FOR CNC TURNING OPERATION

Prof. Nitin Ulmek ,
Prajwal Gotmare,
Dipak Sarode,
Vishal Chaudhari

ABSTRACT

In this study, a try is made to take a look at that how is we able to improve the machining limits in turning methods. On this, we're essentially doing the usage of optimization approach on CNC machines. There's one of the best technique of optimization, which is the Taguchi approach. Taguchi techniques are statistical methods, or once in a while referred to as sturdy layout methods. However, here we are able to be the usage of Taguchi approach for its more simpleness. Taguchi technique is a new engineering design optimization way(s) of doing things that improve the excellent of present merchandise and tactics and reduces their prices right away. Taguchi technique makes the product or process strong and healthful and consequently is also known as a robust layout. In this paper, the application potential of CNC turning process has been classified under certain criteria. Turning is a machining technique used to obtain the favored length of spherical metallic and the most beneficial decreasing parameters are to be recognized first.

Keywords: CNC, turning operation, Taguchi method, surface roughness, parameter optimization.

I. INTRODUCTION

In particular, there are sensible problems that engineers face in a manufacturing technique. First actual talks about the values of the technique limits/guidelines, so one can produce the preferred product exceptional and the second is to make as massive as feasible production gadget overall performance. Distinct selections made by production engineers are based no longer only on their revel in and conventions that show up at some point of processing. Whilst machining, a lot of those are exceptionally complex and have interaction with a large range of factors, this manner excessive system performance being reached, additionally whilst overcoming these troubles, the suggest fashions that attempt to check out the situations for the duration of machining and establish purpose and effect relationships among various factors and desired product . Need for deciding on and placing into use fine machining situations and the maximum top slicing tool has been felt from ultimate twenty years. We apprehend that Taylors early artwork on starting and building on terrific decreasing speeds in single bypass turnings, progress has been slow since all the system limits/pointers need to be lots-stepped forward to get real answers many regulations met in practice, which includes low machine device strength, torque, pressure limits and floor roughness, ought to be triumph over. [1], [2]

Consequently, it is needed for a properly-concept-out methodological technique with the aid of the usage of experimental strategies and associated with analyzing numbers. Design of experiments (DOE) is a (producing loads with little or no waste) process for the motive of planning experiments. Furthermore, the statistics can be cautiously studied to get legitimate and consequences. The Taguchi technique is a (related to studying numbers) tool, adopted experimentally to (ask lots of questions about/try to discover the reality about) have an effect on of floor roughness by means of cutting limits such as speed, feed, and depth of cut. The Taguchi process allows choosing or determine the fine slicing conditions for turning technique. The difference/distinct model within the material hardness, blending (metals) factors present inside the work piece material and other factors affecting floor finish and MRR (Material removal rate). Taguchi approach is a brand-new engineering design optimization manner(s) of doing matters that improve the rate of current merchandise and techniques and (at the same time) reduces their expenses right away, with minimum engineering useful things/precious resources and quality man-hours. [3], [4]

The Taguchi method accomplishes (or earnings with effort) this by way of making the product or technique performance "insensitive" one-of-a-kind versions in factors such as materials, production machine, work remarkable and going for walks situations. Taguchi method makes the product or manner strong and healthy and therefore is also called a robust layout. In turn, the velocity and movement of the slicing device are actual through limits. We will try to improve (as lots as feasible) extraordinary limits/guidelines for better floor completing. [5], [6]

II. METHODOLOGY

There are numerous methodologies can be used for CNC machining operation which may be optimized to enhance the first-rate of a product or system. The "construct-check restoration" is the primal technique to behavior the procedure consistent with the assets available, rather than optimize it. on the opposite hand, the goal of "one-factor-at-a-time" method is to optimize the system by means of strolling an experiment at one unique circumstance and repeating the equal experiment by way of changing one aspect until the impact of all of the elements are known.

In the CNC turning process we are Taguchi method to optimize its parameters it can be followed as follows:

A. Steps involved in TAGUCHI

Using taguchi's parameter layout includes the following steps .

Identify the main feature and its facet outcomes.

B. Discover the noise elements, testing situation and great characteristics.

C. Identify the objective feature to be optimized.

D. Recognize the manipulative elements and their ranges.

E. Pick an appropriate orthogonal array and assemble the matrix.

F. Conduct the matrix experiment.

G. Study the information; predict the most reliable control aspect stages and its performance.

H. Conduct the verification experiment.

III. TURNING PROCESS

CNC Turning is a manufacturing process in which bars of material is held in a chuck and rotated while a tool is fed to the piece to remove material to create the desired shape. A turret (shown center), with tooling attached, is programmed to move to the bar of raw material and remove material to create the programmed result. This is also called "subtraction machining" since it involves material removal. If the center has both tuning and milling abilities, such as the one above, the rotation can be stopped to allow for milling out of other shapes. The starting material, though usual round, can be other shapes such as squares or hexagons. Depending on the bar feeder, the bar length can change/differ. This affects how much handling is needed/demanded volume jobs. CNC lathes or turning centers have tooling mounted on a turret which is computer-controlled. The more tools that the turret can hold, the more options are available for difficulties on the part. CNC's with "live" tooling options, can stop the bar rotation and add added/more features such as drilled holes, slots and milled surfaces. Some CNC turning centers have one spindle, allowing work to be done all from one side, while other turning centers, such as the one shown above, have two spindles, a main and sub-spindle. A part can be partially machined on the main spindle, moved to the sub-spindle and have added/more work done to the other side this setup. There are many different kinds of CNC turning centers with different types of tooling options, spindle options, outer (distance or line from one edge of something, through its center, to the other edge) limits as well as power and speed abilities that affect the types of parts that can be(moneybased)/cheaply made on it.

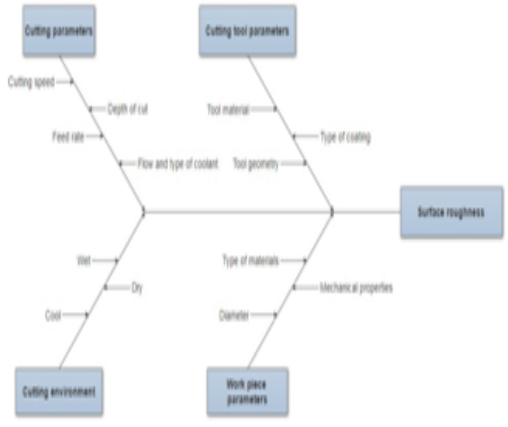

Fig. 1. Factors affecting surface roughness

IV. MATERIAL SELECTION

Turning can be performed on a variety of materials which can contain following materials or can be its alloys

- Aluminum
- Brass
- Magnesium
- Nickel
- Steel
- Thermoset plastics
- Titanium
- Zinc

While selecting a material, several factors must be considered, including the cost, strength, resistance to wear, and machinability. The machinability of a material is difficult to quantify, can also have following characteristics:

- Results in a good surface finish
- Promotes long tool life
- Requires low force and power to turn
- Provides easy collection of chips

But the different range of materials offers various properties which can be used according to its advantage at any particular application. In the paper we studied the materials included are as follows :

Michael Jacobson, Patrik Dahlman, Fredrik Gunnberg has studied on **Bainite steel**, they found out that tough turned bainite metallic constantly shows the equalresidual pressure profile along the depth. the quantity of compressive pressure will increase to a most of 775 MPA round 10 mm under the surface. at an intensity of 100 mm,the impact from tough turning on residual strain is small.

The reducing speed definitely influences the amount of residual strain generated in difficult turning. most compressive stress is generated at a slicing velocity of 230 m/min.

The level of compressive residual pressure produced is, thinking about the literature, on the proper stage to have a fine impact on rolling fatigue lifestyles. [7]

N.R. Dhar, M. Kamruzzaman, Mahiuddin Ahmed has studied on **AISI 4340**, they have found that ,

i. Cutting performance of MQL machining is better than that of dry and conventional machining with flood reducing fluid supply due to the fact mql affords the benefits mainly with the aid of decreasing the reducing temperature, which improves the chip–tool interaction and keeps sharpness of the reducing edges.

ii. MQL jet supplied decreased device wear, improved tool life and higher floor end in comparison to dry and wet machining of metallic.

iii. Floor finishes progressed especially due to the discount of wear and tear and damage on the tool tip with the aid of the software of MQL.such reduction in tool wear could both development in tool lifestyles or enhancement of productiveness permitting better reducing
speed and feed. [8]

R.S. Pawadea, Suhas S. Joshia, P.K. Brahmankarb has studied on **Inconel 718**,they observed that in an

analysis of machining induced residual stresses shows that the dominance of mechanical or thermal type deformation in machining is governed by the ability of chips to dissipate heat, which is mainly dependent on the volume removal rate. It is especially true in the case of super alloy Inconel 718 since it has poor thermal conductivity. Therefore, at the highest cutting speed

(Vc1 475 m min1), and lowest feed rate (f 1 0.05 mm__ 4141

Above mentioned, are the different materials which are used in the Dry Turning (CNC), Dry & Wet Turning (Lathe Machine) processes. rev1) and moderate depth of cut (a_{p4} 0.75 mm) and honed edge geometry (CH) the induced residual stresses are compressive in nature. These machining conditions promote mechanically dominated deformation during machining.
[9]

D.I. Lalwani, N.K. Mehta, P.K. Jain has studied on **MDN250 18Ni(250)**, they have found out that,

- The sequential approach in central composite design is beneficial as it saves the number of experimentations required. This was observed in force analysis.
- The linear model is fitted for feed force, thrust force and cutting force whereas the quadratic model is fitted for surface roughness.
- There is no significant effect of Cutting speed on cutting forces and surface roughness.

[10]

S. Bissey-Bretona, J. Gravier, V. Vignal has studied on **Copper**. They found out that machining affects the surface and subsurface characteristics of pure copper. Such changes may have a significant impact on the physical electrochemical behavior (corrosion resistance, for instance,) of parts. [11]

Lavish Sharma, Jai Prakash Sharma,Nitin Sharma has studies on **EN 47** . they've found that after variance analysis became carried out to s/n ratio to discover the impact of slicing parameters on surface roughness. according to the anova analysis it changed into located the intensity of reduce have an impact on the surface roughness the most on the reliability stage of 95%.
[12]

P Subhash, Chandra Bose & C S P Rao has worked on **NIMONIC 75.**

- They found that The surface roughness follows the quadratic trend in the given ranges of speed (100 to 250 m/min), feed (0.02 to 0.04 mm/rev) and depth of cut (0.1mm to 0.15mm).
- The material removal rate undergone natural log transformation and fitted to the quadratic model in the given range of parameters. [13]

Mehmet Alperince, Ilhan Asilturk has studied on **Co28Cr6Mo** they founded that the relationship between cutting speed and surface roughness is inversely proportional. Normally, growing the cutting speed decreases the floor roughness. The relationship between feed fee and surface roughness is proportional. Typically, growing the feed charge increases the floor roughness. The relationship between the intensity of reducing and surface roughness is proportional. Commonly, increasing the intensity of reducing increases the floor roughness. The relationship among nose radius and surface roughness is inversely proportional. Normally, increasing the nose radius decreases the surface roughness. [14]

V. LITERATURE REVIEW

P. G. BENARDOS and G.C. VOSNIAKOS has finished test on "predicting floor roughness in machining". Optimization of cutting conditions for a certain surface roughness is another field that has not received too much attention. GAs and other optimization algorithms could be ideally used in conjunction with the developed models for the prediction of surface roughness but as is evident from the above, very few similar approaches have been found. It must a be noted that despite the fact that accurate models have been developed there are still issues to be dealt with. Certain cases like high accuracy machining, where surface roughness is of great importance, are still under investigation and factors such as the cutting tool's deflection or the thermal conditions must be introduced to future models for a more realistic depiction of surface roughness creation. The integration of the existing models to a more general advisory system, which could be used by a machine tool operator for example, could be another very useful and practical application.[15]

Vandana N.Mahajan, Punam Patil, Parag Yadav have observed on the optimization techniques of various machining parameters of the milling machine. They believes that a lot of research has been done on process parameters like cutting speed, feed, depth of cut, materials and its dimensions on CNC. From investigation survey maximum level of cutting speed with the minimum level of feed and depth of cut is recommended for better surface roughness. The most used technique for optimization is Taguchi method but other methods such as hybridization of RSM and GA is also effective. The investigation shows percentage decrease in surface roughness of different materials like EN8 steel, stainless steel, titanium,chromium can be obtained by using a different combination of cutting speed, feed rate and depth of cut via different software technologies. [16]

Dharindom Sonowal,Thuleswar Nath, Dhrupad Sarma have collectively studied on optimization of cutting parameters on turning. They have concluded that various strategies are used to limit floor roughness via optimizing parameters like spindle speed, feed rate, depth of cut, tool perspective. Among most of these techniques, it is discovered that the Taguchi method is the most broadly used method.Using other methods like genetic algorithm, reaction surface technique and artificial neural community increases complexity. In the optimization of surface roughness feed is found to be the maximum affecting aspect followed with the depth of cut and cutting speed. [17]

Navneet K Prajapati, S.M. Patel has studied on

optimization of process parameters for surface roughness and MRR forS.S. 316 on CNC. They found out that there is very less research is done on optimization techniques for process parameter for surface roughness and material removal rate. In that also , there is very little research done on SS316 stainless steel. [18]

Manu Garg, Sandeep Sangwan, Munish Kainth has studied about Machining Parameters of EN8 & EN24 in CNC Lathe. They concedes 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 tiptemperature whereas material removal rate, surface roughness, and tool wear as the output variable. By studying the literature they concluded that for material removal rate the most significant parameters are the depth of cut, feed rate, and speed. The Least significant parameter is nose radius. [19]

Vikas Dhiman and Deepak Guptahas studied on optimization of process parameters. In this they found that most effected parameters to cutting condition are cutting speed, feed rate and depth of cut and they are easily controlled by operator at the machine at same time. All turning operation will be performed on CNC face milling machine. In which input parameters are cutting speed, feed and depth of cut and the response parameters are material removal rate and surface roughness. They used surface roughness tester to measure surface roughness and MRR was measured by mathematical equation. They used SS202 work piece material for face milling operation. [20]

K. Lipin and Dr. P. Govindanhas looked at on multi-goal optimization of drilling parameters using Taguchi methods. They observed out thatTaguchi method has been used to determine the main effects, significant factors and optimum machining conditions to obtain better performance characteristics. The multiple performance characteristics such as tool life, cutting force, surface roughness and the overall productivity can be improved by useful tool of Taguchi method. The optimum speed for a particular setup is affected by many factors, including Composition, hardness & thermal conductivity (k) of material, Depth of hole Efficiency of cutting fluid type, condition and stiffness of drilling machines, Stiffness of workpiece, fixture and tooling (shorter is better) Quality of holes desired, Life of tool before regrind or replacement. Feed to be used depending on the following factors, finish required, Power available, Condition of machine and its drive etc. Surface roughness is determined by several factors which include cutting parameters such as cutting speed, feed, depth of cut, Tool geometry, the material of the cutting tool, Machining condition etc. [21]

Surabhi Lata, Ashish Gupta, Aditya Jain, Sonu Kumar, Anindya Srivastava, Ramakant Rana and Roop Lalhas collectively studied on experimental investigation of machining parameters at some stage in CNC machining of OHNS (Oil Hardened Non-Shrinking) . In this turning operation, the machining parameters i.e. cutting speed, feed rate and depth of cut play a major role in deciding the performance parameters such as surface roughness, power consumption, tool wear and material removal rate. The material removal rate (MRR) and power consumption shows a significant effect of depth of cut followed by feed rate and then by cutting speed. Increase in any of the input parameter increases the MRR as well as power consumption hence, optimization process requires any of the two performance parameters to be considered in one combination. Surface roughness (SR) was found to be dependent on all these machining parameters. A decrease was exhibited by SR with an increase in cutting speed and feed rate while an increase was noted with the increase in depth of cut. Depth of cut has the major impact on tool wear followed by cutting speed and feed rate. The exact look at of diverse techniques suggests that response surface method (RSM) is the maximum appropriate approach for machining operation because of its excessive accuracy and capacity to recall enter the parameter in a specific variety in place of at particular points for optimization. It similarly proves to be beneficial as a variety of records may be derived with a few simulations. The main problem became to turn OHNS with excessive floor end and occasional tool wear. The viable way to this was the usage of both CBN and PCD as a turning tool. Within the paper, it became observed that machining of OHNS turned into difficult and turned into usually achieved for milling operation. Turning of OHNS turned into done with the help of either CBN or PCD turning tools. Turning of OHNS the usage of carbide tip as turning tool material though reduced the price of machining, however, this becomes finished on the value of floor finish. Identifying appropriate mixture of machining parameters to optimize turning of OHNS the use of carbide turning tool can increase the application of OHNS in small industries. [22]

Neeraj Kumar, Prof. K.K. Chhabra has studied also on optimization strategies for CNC milling machine. They determined out that numerous optimization techniques like Taguchi method, reaction floor method, a genetic set of rules and many others. They have been efficiently carried out operation for optimizing the numerous cutting process parameters of milling machining. Taguchi technique, reaction floor method, and genetic algorithm are the feasible optimization techniques which are being implemented successfully in commercial programs for the most desirable choice of technique parameters with economic production rate inside the place of machining for making the procedure insensitive to any uncontrollable factors which include environmental variables. On the premise of literature, theymade a set of rules for milling machine parameter optimization with economic consideration. [23]

Mohit K Pandya Ravi Patel Kiran Patel Dushyant Patel has studied on Optimization of Process Parameter for CNC Lathe on Titanium Alloy with Carbide Insert. They studied that the most of researchers are interested in the optimization of machining condition with the corresponding surface. In this paper discusses the performance of surface roughness of Ti-6Al-4V using the coated (PVD & CVD)

and uncoated carbide insert during machining of Ti-6Al-4V alloy under dry machining in CNC turning . [24]

Swapnil Jagade, Pankaj Patole, Sumit Patil, Suraj Pawar, Shalaka kulkarni,Omkar Kulkarni has studied on optimization of reducing parameters for surface roughness in turning technique. They have found out that input parameters like cutting speed, feed rate, depth of cut and reaction variables like surface roughness, material removal rate etc. are key determining factors in production of product . Also they searched that only a few researchers have studied on parameters like nose radius, tool life, tool material, coolant kind, and many others. Most of the researchers have used the Taguchi method for experimentation and additionally ANOVA and the SN ratio is used to study the performance characteristics in turning operation. It becomes observed that the primary issue affecting the fabric elimination charge is feed charge, in the end, observed by way of pace and intensity of cut and additionally number one aspect affecting the surface roughness is feed free, eventually observed through the depth of cut and speed. [25]

VI. CONCLUSION

The paper has demonstrated a systematic approach of optimal cutting conditions has shown a potential in process quality improvement of the metal cutting process. This review, shows that all of the researchers have worked on the input parameters like cutting speed, feed rate ,tool material, tool force, coolant, depth of cut and response variables like surface roughness, material removal rate. Regardless of the category of the performance characteristics the optimal level of the machining parameters is key determining factor in any betterment machining process.

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