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A Review Paper on Analysis of Thread Turning operation on Lathe Machine

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Abstract: In this paper, the thread turning on aluminium 6063 studied using two types of tools. One is coated and other one is uncoated and the literature review of various factors which affect the thread turning operation. In this paper the various parameters like depth of cut, feed rate and spindle speed are studied. This study is help in understanding of parameters effect for forces which act during operation.

***Index Terms* -** Thread Turning, Threading, Lathe, Aluminium, Annova, Cutting forces.

I. Introduction

Lathes are used for various applications in the manufacturing industry. A Large number of operations is performed on lathe machines by using different tools. In this work a threading operation is carried out on lathe machine. Thread cutting is a process of making a thread. It is used to produce threads on the outer surface of the cylinder or on the inner surface of the bore. There are many methods of generating threads, including subtractive methods (thread cutting and grinding) or deformative or transformative methods (rolling and forming; molding and casting). Tool used in lathe operation is 4.5ISO ER and the HSS tool and the workpiece is aluminium 6063 of cylindrical round shape. Lathe parameters that effecting the tool life are Spindle speed, feed and depth of cut are. Feed rate means the speed of the cutting tool's movement relative to the workpiece as the tool makes a cut. Spindle speed is the rotational speed of the spindle and the workpiece in revolutions per minute (rpm). Depth of cut is the depth of the tool along the axis of the workpiece as it makes a cut.

II. Types of Threading Method

1. Thread Turning

The basic principle of thread turning is depend on screw threads. A screw thread is defined as a ridge of uniform section in the form of a helix on the outer or the inner surface of the cylinder. Internal threads refer to nuts and tapped holes, whereas External threads are on bolts, studs or screws**.** The thread form is the configuration of the thread in an axial plane; or more simply, it is the profile of the thread, composed of the crest, root, and flanks. The thread production is done by turning on continuous linear Movement of the tool/insert relative to the rotational speed of the workpiece.

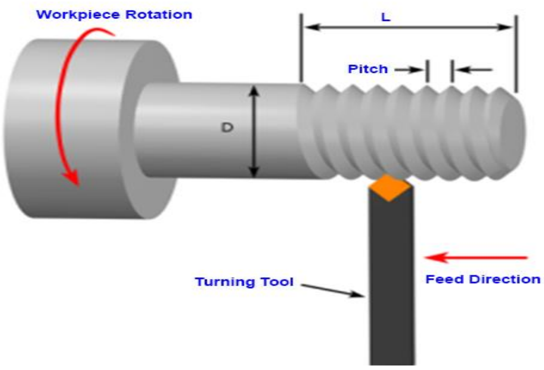

Fig 1 Thread turning

2. Thread milling

Thread milling is done on a thread milling machine with the help of a disc milling cutter. Disc milling cutters are mainly used for milling trapezoidal external threads on workpiece such as screw rods and worms. Thread milling is a metal removing process for cutting threads into various sizes by means of circular ramping movement of a rotating tool, the thread pitch being created by lateral movement in one revolution. Thread milling can cut threads on materials that are difficult to machine.

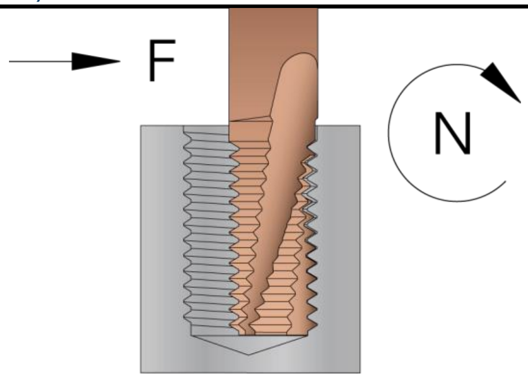

Fig 2 Thread milling

3. Thread rolling

Thread rolling is a type of threading process that involves deforming metal stock by rolling it through a die. This process creates external threads along the surface of the metal stock. Thread rolling is not a subtractive process. This means that it does not remove metal from the stock. Rolled threaded fasteners offer advantages such as strong threads, accurate final dimensions, good surface finish and low coefficient of friction. The high pressure die physically changes the properties of the rolled metal parts to make the base part and threads harder and stronger.

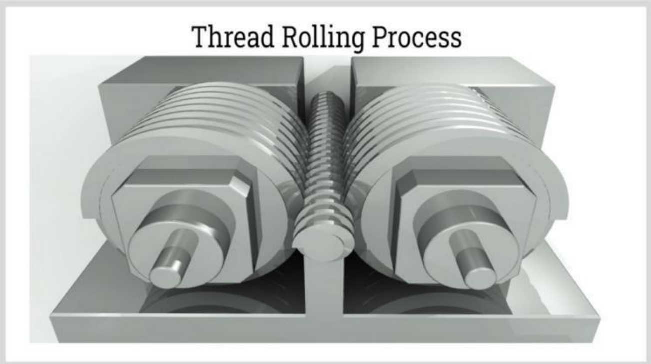

Fig 3 Thread rolling

4. Thread tapping

Tapping is the process of cutting a thread inside a hole so that a screw or bolt can be threaded into the hole. Along with this, it is also used to make thread on nuts and chamfered at the end, which is used to thread a screw or bolt into the hole. The tapping process is a highly efficient, productive, economical and easy threading method, especially for short threads, it can also produce threads on nuts.

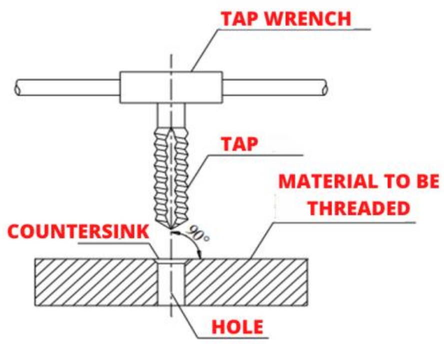

Fig 4 Thread tapping

III Advantages

A cut thread (also called machine thread or ground thread) is a thread that is made by cutting material through blanks. This can be achieved using a threading die or a single point cutting tool such as a lathe.

- Cut threads can be to almost all specifications including large diameter sizes.
- Suitable for parts with cavities such as pipes etc.
- Cost effective for low volume production.
- High accuracy achievable.
- In addition to hard materials, thread cutting is Preferred Method for Thick Blanks That Won't Roll to Fill die thread.

IV WORKING PRINCIPLE

The basic principle of thread turning is depend on screw threads. A screw thread is defined as a ridge of uniform section in the form of a helix on the outer or the inner surface of the cylinder. Internal threads refer to nuts and tapped holes, whereas External threads are on bolts, studs or screws. The thread form is the configuration of the thread in an axial plane; or more simply, it is the profile of the thread, composed of the crest, root, and flanks. At the top of the threads are the crests, at the bottom the roots, and joining them are the flanks.

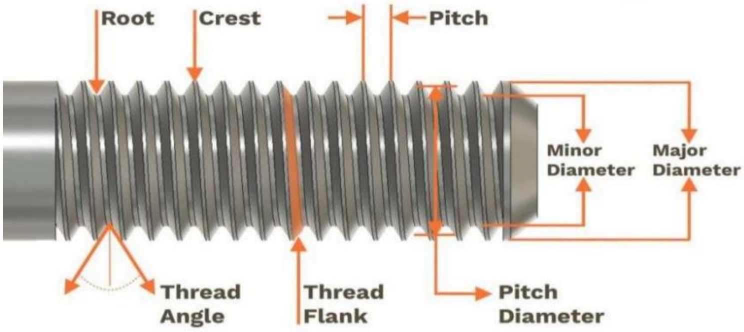

Fig 1.9 Basic terminology of threads

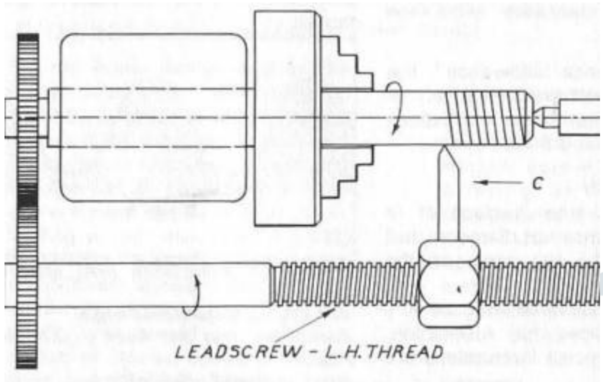

Fig 1.10 basic principle of thread cutting

The above figure shows the way of principle of thread cutting by means of a leadscrew. Here the spindle, which is revolving with the chuck and component to be threaded, drives the leadscrew through gearing in this example by two gears each having 45 teeth and therefore ratio of 1:1. it means the leadscrew will revolve at same speed as the piece to be screwed, and at the same time will the nut to move from right to left by a certain distance for each revolution leadscrew. If the leadscrew has 4 threads to the inch, or pitch of 1/4 inch. Exact revolution of the leadscrew will cause the nut to advance1/4 inch.
If the nut is made to carry a suitable holder and setup to fit tool, then a helix will be form on workpiece and the distance between any two adjacent helices will be 1/4 inch.

V Thread cutting procedure

The thread cutting procedure are in the following steps: -

- First, machine the workpiece to the larger diameter of the thread to be cut using the turning center.
- Now the workpiece is installed in the chuck for threading between the centers.
- So, set the quick-change gearbox according to the required pitch of the thread.
- Set the tool bit at right angles to the workpiece using the thread gauge.
- Now move the threading tool bit towards the workpiece using compound and cross feed.
- The micrometer of both feeds should be set to zero.
- The carriage is being moved to a predetermined distance per revolution of the job due to the rotation of the lead screw.This done by positioning the carriage's half nut to get engaged with the lead screw.
- The half nut or split nut must be applied at a precise predetermined time for proper cutting of successive cuts. This is done by using a thread chasing dial or graduate dial. This dial is being attached to the carriage and driven by a worm gear attached to a lead screw.
- Take a scratch on the component without lubricant. Detach the half nut at the edge of the cut, stop the lathe and return the tool using cross feed. Return the carriage to the starting point.
- Now check the thread pitch using a screw pitch gauge. If it is correct then proceed to the next step.
- The process continues or continues to cut continuously until the thread approaches the desired depth or is within .025 mm of the final depth.
- Now check the size using the thread gauge.
- After finishing all this chamfer, the end of the thread to avoid damage to the thread.

VI LITERATURE REVIEW

1. G.M.Sayeed Ahmeda (2015), Efficient turning of high performance Mild Steel material can be achieved through proper selection of turning process parameters to minimize surface roughness, feed and radial forces. In this present paper outlines an experimental study to optimize Feed and Radial forces and study the effects of process parameters in Lathe turning on Mild Steel work material in dry environment conditions using HSS tool. The orthogonal array, signal to noise ratio and analysis of variance are utilized to concentrate the execution qualities in Lathe machine turning operation. Three machining parameters are chosen as process parameters: Cutting Speed, Feed rate and Depth of cut. The experimentation plan is designed using Taguchi's L9 Orthogonal Array (OA) and Minitab-16 statistical software is used. Optimal values of process parameters for desired performance characteristics are obtained by Taguchi design of experiment. Prediction models are developed with the

help of regression analysis method using Minitab-16 software and lastly the ideal and computed results are additionally checked with the help of confirmation examinations. Surface roughness is measured on each run according to Taguchi design of experiment and finally average roughness (Ra) is measures on confirmation experiment to compare with previous given machining parameters according to the Taguchi design of experiment.

2. Ravindra Nath Yadav (2016), the optimum condition obtained from Taguchi Methodology has been used as central value in Response Surface Methodology for the modeling and optimization. The result shows the significant improvement in surface finish with hybrid approach as compared to the Taguchi analysis. Machining of the rotating surfaces is basic requirement of the manufacturing industries to get the desired shapes, sizes and surface quality of circular shaft used in various power transmission units. Such desired conditions are achieved by Turning Process, which is performed on the Lathe Machine. Turning Process can be defined as a metal cutting process in which desired depth-of-cut has been removed in form of chips from the rotating surfaces with application of the wedge shaped single point cutting tool penetrates toward the workpiece. It is capable to generate the different profiles such as cylindrical shaft, cone shaft and step shaft turning. It is also applicable to machine several complex surfaces/profiles like key hole, spline shaft, internal holes as well as threading, knurling, gear cut, cam profiles etc. with application of special attachments on Lathe Machine. To improve the productivity with better surface finish, the performance of the turning process were studied by various researchers in different conditions. Sarma and Dixit studied the effect of process parameter during turning of the cast iron in dry and air-cooled conditions with ceramic cutting tool. They found improved surface quality and low tool wear with air cooled turning as compared to the dry turning. The effect of lubricants on surface roughness and tool wear during turning of AISI-4340 steel were studied by Dhar et al. The multi-pass turning is an unique method to achieve the better surface finish in which finish cut turning performed after several rough cut turning. Even though, this process leads to increase in the setting times as a result the overall cast of products are increased. Instead of this, hard turning also comes into existence to get the surface finish up to grinding level with application of ceramic or cubic boron nitride (CBN) cutting tools at high speed on same Lathe Machine. Aslan experimental investigated the performance of the cutting tool during hard turning of the coldwork tool steel. Grzesik studied the effect of tool shapes on the wear and surface roughness in hard turning using different shaped ceramic tools. Asilturk and Akkus analyzed the effect of turning parameters on the surface quality during hard turning with application of Taguchi technique.
3. 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.
4. 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 themost significant factor on surface roughness.
5. 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.
6. 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.

7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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 on surface roughness and Cutting Force respectively.
13. Ilhan A., et al (2011) [21] have investigate the effect of cutting speed, feed rate and depth of cut using AISI 4140 (51 HRC) steel as a work material and Al_2O_3 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.
14. Li and Liang conducted an extensive study to analyze the performance of MQL machining with respect to the process parameters. It was found that application of MQL during machining reduced the tangential cutting forces upto a significant limit especially when machining is done at low cutting speeds. Temperature was found to get reduced significantly almost under all cutting speeds when machining is done at MQL environment.
15. Amrita et al. investigated and evaluated the performance of nano-graphite-based cutting fluid in turning and found that the use of MQL improved the cutting fluid's performance in comparison with conventional flood machining by reducing the surface roughness (30%), cutting forces (54%), cutting temperature (25%) and tool wear (71%). It also improved chip morphology.
16. Saini et al. used mineral oil for machining AISI 4340 steel, which resulted in cutting forces upto 17.07% & tool tip temperature upto 6.77%.
17. Saravanakumar et al. analyzed the dispersion of silver nanoparticle enriched cutting fluid and found that the cutting forces were reduced up to 8.8% and surface roughness up to 7.5% by the use of nanofluid with the MQL technique.
18. Ravindra Kumar Verma, Purushottam Kumar Sahu, Jagdish Saini “Multi-Objective Optimization of Machining Parameters by using Response Surface Methodology EN-31 Alloy Steel Metal” (2020) This paper has presented an application of parameter design of the taguchi method in the optimization of turning operations in centre lathe machine. Taguchi’s robust orthogonal array design method is suitable to analyze the machining time (metal cutting) as well as material removal rate problem.

VII LITERATURE REVIEW CONCLUSIONS

1. From analysis of variance, it is found that depth of cut affects the most in determining the quality and force.
2. As the depth of cut is reduced the chip will generating in continues form while increasing the depth of cut chip will in discontinuous form.
3. It was found that the spindle speed is less significant factor affecting the cutting forces.

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