Effect of Cutting Parameters and Cutting fluids in Turning of Aluminium Alloy

Submitted in partial fulfilment of the requirements
Of the degree of

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

By

FARHAN AKHTAR	**1614101067**
SAKIM HASAN	**1614101153**
AMIT KUMAR	**1614101034**
KAMLENDRAKUMAR	**1614107001**

Supervisor:

MR. SHRIKANT VIDYA

SCHOOL OF MCHANICAL ENGINEERING
GALGOTIAS UNIVERSITY
GREATER NOIDA

2019 – 2020

CERTIFICATE

This is to certify that the Research work titled **"Effect of Cutting Parameters and Cutting fluids in Turning of Aluminium Alloy"** that is being submitted by **Farhan Akhtar, Sakim Hasan, kamlendra kr. and Amit kr.** is in partial fulfilment of the requirements for the award of **Bachelor of Technology**, is a record of bonafide work done under my guidance. The contents of this research work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma.

………………

Supervisor

…………………….. **…..…………**

Internal Examiner **External Examiner**

Approval Sheet

This thesis/dissertation/project report entitled **"Effect of Cutting Parameters and Cutting fluids in Turning of Aluminium Alloy"** by **Farhan Akhtar, Sakim Hasan, kamlendra kr. and Amit kr. is** approved for the degree of bachelor of technology in mechanical engineering.

Examiners

____

____

____

Supervisor

____

Dean

____

Date: _____________

Place: ____________

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(Signature) ________________________________

(Name of the student) ________________________________

(Enrolment. No.) ________________________________

Date: __________

ACKNOWLEDGEMENT

The contributions of many different people, in their different ways, have made this possible. I would like to extend my gratitude to the following.

We are grateful to my supervisor.

Farhan Akhtar

kamlendra kr.

Sakim Hasan

Amit kr.

(Department of Mechanical engineering)

ABSTRACT

Taguchi method has been employed to investigate the effects of cutting parameters (cutting speed, feed rate, depth of cut and cutting fluid) on surface roughness and material removal rate (MRR) in turning 6063-T6 Aluminium alloy, using manually operated lathe machine. Experiments have been conducted using L16 orthogonal array and each test used a new cutting tool, High-Speed Steel (HSS), to ensure accurate readings of the surface roughness and MRR. The statistical methods of the Signal-to-Noise (S/N) ratio applied to investigate the effects of cutting speed, feed rate, and depth of cut on surface roughness under different cutting fluids. Minitab software was used to analyse the effect of variables on the surface roughness and MRR.

TABLE OF CONTENT

List of abbreviations

1. **MRR** — **Material Removal Rate.**
2. **HSS** — **High Speed Steel.**
3. **DOE** — **Design of Experiment.**
4. **RSM** — **Response surface Method.**

List of Figures

CHAPTER 1

INTRODUCTION

1.1 WHAT IS MACHINING?

Matching is one of the various processes that cut a piece of raw material into the desired final shape and size through a controlled material-removal process. It is the process of generalization, disposal of controlled substances, today collectively known as standard manufacturing, which is called additive manufacturing, as opposed to controlled substance aggregation processes. The "controlled" part of the definition may sound exactly the same, but it almost always refers to the use of machine tools (rather than just power tools and hand tools).

Matching is a part of many metal products, but can also be used on materials such as wood, plastics, ceramics and alloys. A machinist is someone who specializes in machining. A machining shop is a machining room, building, or company. Most modern-day machining is done by computer numerical control (CNC), in which computers are used to control the speed and operation of milling, latches, and other cutting machines.

Machining System Consist of the following parts:

Workpiece - Workpiece is a piece of raw material that is in the process of forming a part.
Cutting Tool - The cutting tool is a wedge-shaped and sharpening tool that is used to remove the excess layer from the workpiece by cutting during machining to achieve the desired shape, size and accuracy.

Cutting Fluid - Liquid is a type of coolant and lubricant designed specifically for metallic processes such as machines and stampings.
Stability-Fixtures in machine tools are usually used to hold the work piece accurately.

1.2 History and terminology

The exact meaning of the word machining has evolved over the past century and a half. In the 18th century, the term machine simply meant someone who built or repaired machinery. Most of this person's work was done by hand, using processes such as wood sculpture and hand forging and metal handwork. At that time, millwrights and new types of engines (meaning, more or less, any kind of machinery) of builders like James Wright or John Wilkinson fit the definition. Noun machine tool and machine for action (machine, machining) do not exist yet.

In the mid-19th century, the latter words were widely used as concepts. Therefore, during Machine Edge, machining (as we call it today) is "traditional" machining processing turning, boring, drilling, milling, brushing, sawing, shaping, shaping, planning, reaming and tapping. These "traditional" or "traditional" machining processes, such as lathes, milling machines, drill presses or others, are used with a sharp cutting tool to remove the material to obtain the desired geometry.

Since the advent of new technologies such as electrical discharge machining, electrochemical machining, electron beam machining, photochemical machining and ultrasonic machining during the Second World War, the use of retroionic "traditional machining" to differentiate those classic technologies from the new People. In current usage, the term "matching" without qualification usually means traditional machining processes.

Since aggregation manufacturing (AM) has evolved beyond its former laboratory and rapid prototyping scenarios and is common in all phases of manufacturing, in the 2000s and decades, the term differential manufacturing was a simple rethinking of the term AM. Done, surely any elimination process is covered by pre-term matching. These two terms are effectively synonymous, although the term matching has long been used. This can be compared to the idea that a sense of action has developed due to the expansion of the means of contacting one another (telephone, email, IM, SMS and so on), but do not completely replace calls like the previous rule, so to speak. Or write

1.3 Machining Tool

A machine tool is used for machining metal or other hardened materials, usually through cutting, boring, grinding, shearing, or other forms of deformation. Machine tools use some form of cutting or shaping. There are some ways to tighten the workpiece to all machine tools and provide guidance to machine parts. Thus the relative movement between the workpiece and the cutting tool (called the toolpath) is completely controlled or constrained by the machine rather than "offhand" or "freehand". It is an electric driven metal cutting machine that helps maintain the relative movement required between the cutting tool and the job, which changes the size and shape of the job material.

The exact definition of the term machine tool varies among users, as discussed below. While all machine tools are "machines that help people to make things," not all factory machines are machine tools.

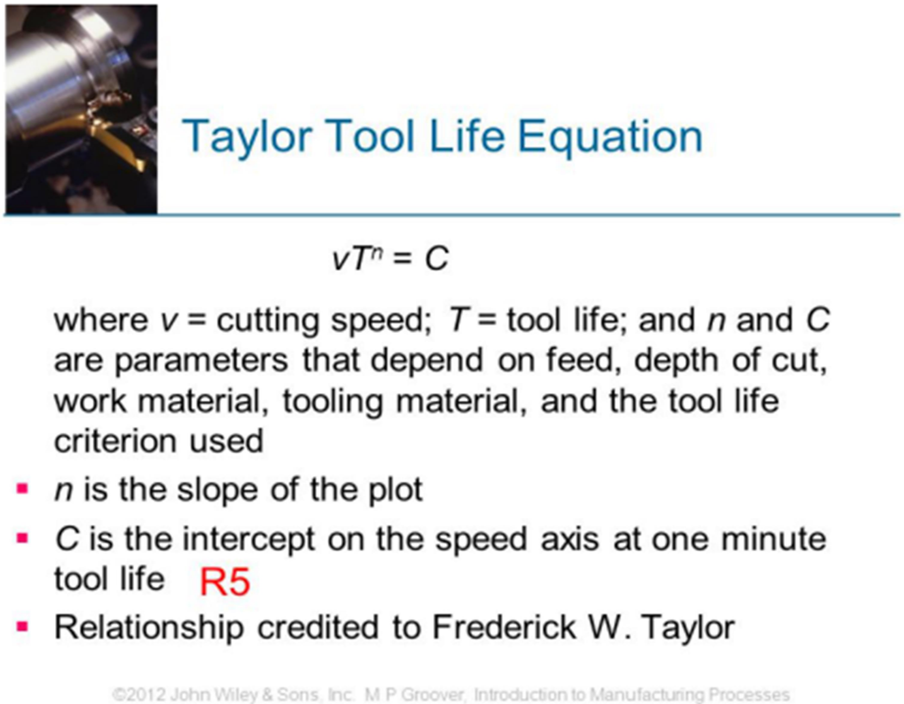
Today machine tools are usually handled by human muscles (eg, by means of electrical, hydraulic or line shafts), which are used to make parts (parts) that are manufactured in a variety of ways, including cutting or some other type of deformity. With their inherent certainty, machine tools have begun to produce economies of interchangeable parts.

1.4 Tool Life

The tool life is the original cutting time, after which the tool is no longer used. There are many ways to define tool life, and the simplest way to determine the end of tool life is the maximum allowable lateral wear limit. The accepted term however is subjective and can vary from process to process. For example, permissible wear on hard milling inserts is greater than the end milling inserts. Through-out the life of the tool the tool wear is not the same. The wear is fast at first, then settles at a uniform rate, and is accelerated at a much higher rate until the eventual catastrophic failure, which is the fracture of the tool.

Some general effects of tool wear include:

- increased cutting forces
- increased cutting temperatures
- poor surface finish
- decreased accuracy of finished part
- May lead to tool breakage
- Causes change in tool geometry



1.5 Classification of machining tools

Single point cutting tool: The single point cutting tool has only one main cutting edge, which can remove the material at once. It should be noted that in the case of insertion cutting tools, a tool has multiple cutting edge, However only one cutting edge can participate in the material removal process at a time.

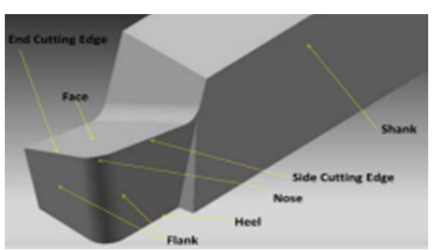


Fig 1 Single point cutting tool

Advantages of single point cutting tool

- Design and fabrication of single point cutter is quite simple and less time consuming.
- Such tools are comparatively cheaper.

Disadvantages of single point cutting tool

- There is only one cutting edge in physical contact with the working material during machining. So the tool ware rate is also high and as a result tool life is short.
- Due to continuous contact, the temperature rise rate of the equipment is high. This will speed up the tool wear in one hand and cause the heat loss of the finished / machined surface in the other.
- Excessive temperature rise can cause the tool tip to degrade, leading to lower accuracy in machining.
- Since a cutting edge for a pass only takes the full depth of the cut (chip load), the Material Removal Rate (MRR) is very low. Thus productivity is low.

The single point cutting tool geometry or nomenclature :-

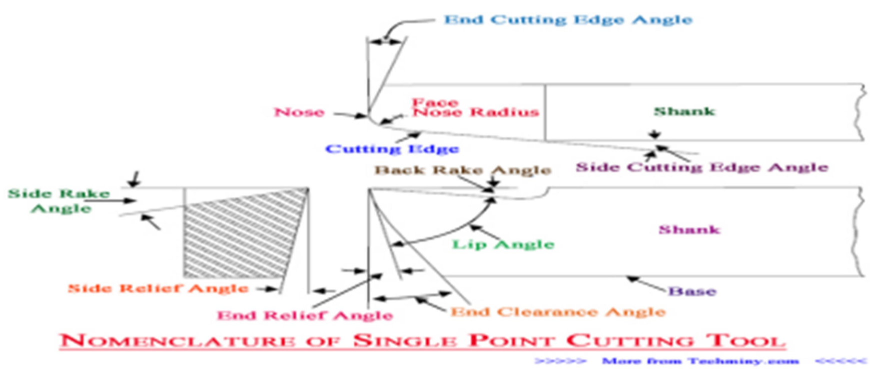


Fig 2: single point cutting tool nomenclature.

Shank: This is the body of tools, called granulated.
Face: The surface on the metal side chip is called the face.
Base: This is the lower surface of the leg. Usually it makes a flat forming.
Nose: It is called the nozzle at the end of the side junction and the cutting edge.
Cutting Edge: This is the junction of the face and flank. It has two types,

- end cutting edge
- side cutting edge

Angle of single point cutting tool:

- **Back rake angle:** Also known as Top Rack Angle. The angle between the tool face and the line is parallel to the base of the tool. The slope is given to the surface (or) face of the slope. The slope is provided by the nozzle along the length of the tool. The angle can be positive or negative depending on the amount of edge.

- Side rake angle: The angle between the tool and the line parallel to the origin of the tool. The slope is given a face (or) tool top. The slope is provided by the nozzle along the length of the tool. When the angle is positive, the slope is given to the edge and the rock angle is considered negative, the slope is given to the edge.
- When the slope is downloaded by giving the edge. It is divided into two types of clearance angles.

Relief angle or clearance angle:

When the slope is download by giving the edge. It is divided into two types of clearance angles. They are

- side relief or side clearance angle
- end relief or end clearance angle

Cutting edge angle: There are two types of cutting angles, such as the side cutting edge and the end cutting edge. The angle of the cutting edge is the angle between the edge of the cutting edge and the edge of the tool. Alternatively, the angle between the edge and the Longitudinal axis of the device. These avoid the side cutting edge, built edge formation and cutting force distribution used to control the flow of the chip.
The angle of the cutting edge is the angle between the cutting end and the tool is perpendicular to the shank. Alternatively, the Angle Between the Instrument face and the plane toward the Shank. Allow only the short end of the end to contact the machining surface, and the vibration and screams are also prevented. The angle ranges from 5 degrees to 15 degrees.

Nose radius: The radius of the nose is the angle between the cutting edge and the cutting edge. Which side of the cutting edge and the end cutting edge point to line lead to high heat density. Good configuration to increase the life of the cutting tool and achieve a better surface finish when joined by smaller radii.
By a large radius, the tool is reinforced and it is used on cast iron and is also transmitted where the cut is interrupted.

Effects of back rake angle:

The choice of the shape of the angle depends on the mechanization of the material. If the material is soft, a larger angle is given. When the material is rigid, small angles are required. For example, aluminum requires a higher rear angle than cast iron. In terms of material selection any back rack angle can be either positive or negative or neutral.

- **Multi-point cutting tool:** The multi-point cutting tool has more than two main cutting edges that simultaneously engage in the cutting process in one pass. Sometimes, a cutter with two cutting edges (more than one) is also considered a multi-point cutting tool (instead of a double point cutter). The number of cutting edges in a multi-point cutter can range from three to a few hundred. Since the cutting edge appears at the intersection of the rake surface and the lateral surface, the rake surface and lateral surface are also present for each cutting.

Advantages of multi-point cutting tool

- Because the total feed rate or cut depth is evenly distributed across all cutting edges, the chip load at each cutting edge is greatly reduced. Therefore, high feed rates or cut depths can be used to improve material removal rates to increase productivity.
- Due to the chip load distribution, the acting at each cutting edge is significantly reduced. Sometimes, the entire cutting force component is automatically depleted / reduced (the cutting force component in a particular direction may lead to zero).
- During machining, none of the cutting edges are constantly in contact with the work piece; Instead, engagement and disengagement occur repeatedly. This tool provides ample time to heat the body, protecting the cutter from overheating and plastic deformation. Hence the low rate of rise in the temperature of the tool due to intermittent cutting.
- Due to the reduced duration of engagement and less heat accumulation in the tool body, the tool ware rate also decreases. As a result, the life of the cutter increases.

Disadvantages of multi-point cutting tool

- Due to intermittent cutting, the cutting edges or teeth may fluctuate. This creates cutter noise, vibration and endurance failure.

The design and construction of the cutter is very difficult. This makes such cutters more expensive.

CHAPTER 2

MACHINING OPERATION

Machining operation can be classified into two types

2.1 On the basis of single point cutting tool

- **Turning:** Turning is a machining process in which the cutting tool, usually a non-rotary tool bit, defines the helix toolpath by moving the workpiece more or less linearly.

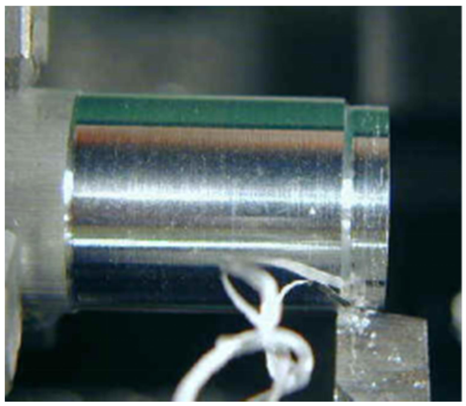


Fig3 Turning operation

Turning processes are usually carried out on lath, which is considered one of the oldest machine tools and can be of various types such as straight turning, taper turning, profiling or external grooving. These types of turning processes can produce a variety of materials such as straight, conical, curved or oval workpieces. Generally, turning uses simple single point cutting tools. Each set of workpiece materials has the right set of tool angles developed over the years.

- **Facing:** point of rotation of the work is to rotate the cutting tool to the axis of the workpiece rotation at right angles. This can be done by operating a cross-slide, if appropriate, rather than a longitudinal feed (bend). This is often the first operation in the production of workpieces, and often the phrase "ends".

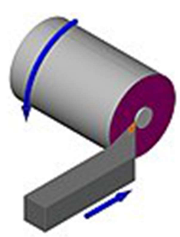


Fig 4 Facing operation

- **Grooving:** As long as the grooves are cut to a certain depth without the long / part-full portion being separated from the stack. Grooving can be done on both interior and exterior surfaces, as well as on the face of the part (facial grooving or trapping).

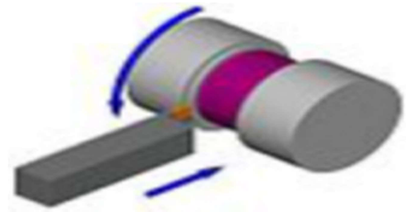


Fig 5 Grooving operation

- **Threading:** Standard and non-standard screw threads can be turned on the lath using the appropriate cutting tool. (Usually 60, or 55 ° nasal angle) externally, or inside a bore. Commonly known as single point threading.
  Pressing thread nuts and holes a) Using hand taps and tailstock centre b) Using a tapping device with a slipping clutch to reduce the risk of tape breakage.
  Threading operations a) Cone threads, double start threads, multi start threads, worms used in worm wheel reduction boxes, occur with single or multi-start threads. B) Using a threading box fitted with 4 form tools, it is possible to find a box up to 2 diameter threads but larger than that.

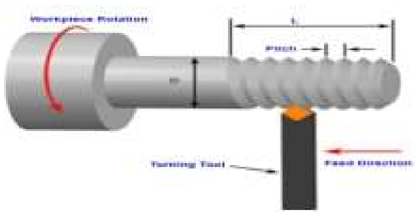


Fig 6 Threading operation

2.2 On the basis of multi- point cutting tool

- **GRINDING:** Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool.

A wide variety of machines are used for grinding:

- Hand-cranked knife-sharpening stones *(*grindstones*)*
- Handheld power tools such as angle grinders and die grinders
- Various kinds of expensive industrial machine tools called grinding machines
- Bench grinders

The practice of grinding is a large and diverse field of manufacturing and equipment making. It produces very fine finishes and very precise dimensions; Yet in mass production cases it is very quick to extract the metal. It is generally good to make very rigid materials, such as "regular" machining (ie. cutting large chips with large tools such as cutting tool tools or milling cutters), and it has been used to operate the machine for decades. Only Practical way, Materials in the form of hardened steels.

Fig 7 Grinding operation

MILLING: Milling is the process of machining using rotary cutters to remove material by moving the cutter forward in a process. This can be done in different directions on one or several axes, cutter head speed and pressure. Milling involves a variety of operations and machinery, from small to large parts, large and heavy gang milling operations. This machining is one of the most commonly used procedures for precise tolerance for custom components.

Milling can be done with a wide range of machine tools. Milling machines (often called mills) are the primary class of machine tools for milling. Since the advent of Computer Numerical Control (CNC) in the 1960s, milling machines have evolved into machining centres: automatic tool changer, tool magazine or carousel, CNC capability, refrigerated milling machine.

CHAPTER 3

LITERATURE SURVEY

Some researchers use this method to optimize the cutting parameters. The optimization of machining parameters in the steel turning operation by the Taguchi method is studied by **LB Abang et al. [1]** They investigated that the lubricant temperature and feed rate are the main parameters between the three controllable factors (feed rate, cut depth, and smoothing temp.), Which influence the surface roughness in bending steel**. Sujit Kumar et al [2]** When using steel bars using Taguchi method and ANOVA they tried to optimize process parameters for optimal MRR and based on F-test their results show that feed rate cuts have a greater impact on performance and depth of cut. **Karan A. Cottley et al [3]** studied the effect of fluid and cutting parameters on MRR in turning operation and they investigated whether cutting fluid is not an effect on MRR and that cut depth is an important factor for MRR in reversing operation. Is. **Deepak D et.al [4]** studied the optimization of machining parameters to turn on AI6061 using a robust design principle to reduce surface roughness, and he investigated that feed rate is the most effective process parameter, which affects surface roughness**. Researchers [5–6]** tried to optimize the cutting parameter to obtain the lowest surface roughness using the Taguchi method. **Kamal Hasan et.al [7]** attempted to optimize the MRR by using twenty-seven experimental runs based on the L'27 orthogonal array of the Taguchi method, to obtain objective functions to optimize the MRR when the MRR was optimized. The MRR only departed 8.91. The optimal levels of process parameters for simultaneous optimization of the MRR have been identified. Correct results were confirmed by confirmatory experiments. **Kishore Tuppe et.al [8]** tried to optimize the MRR using the L9 orthogonal array and they investigated that the MRR values of the original and M are nearly identical, and the percentage error between the actual MRR and the MRR of MRR is 1.82%. **Devesh Pratap Singh et.al (9)** tried to optimize surface roughness using the Iowa-based Taguchi method using Mini-Tab 15 software and investigated that the feed rate was the highest surface roughness of all selected parameters. And finally affected. The result shows that the feed rate is 54.65%, the cutting speed is only 34.67% and the depth of cut contribution is low with 10.47%.

Singh et.al [10] conducted an experimental research to determine the effects of cutting conditions and tool geometry on the surface roughness in the rough bends of steel (AISI 52100). Composite ceramic inserts made of aluminum oxide and titanium carbon nitride (SNGA) with different nozzle radii and different effective rake angles have been used as a cutting tool. This study shows that the radius of the feed nozzle and the cutting speed are the major factors that determine the surface of the feed. Although the effect of effective rake angle on the surface end is small, the interaction of nozzle radius and effective rake angle is important. Mathematical models for surface roughness have been developed using the reaction surface method. Experiment was designed using Taguchi method and 18 experiments were designed by this process and experiments conducted. The results are analysed using analysis of variance (ANOVA) method. Findings: Taguchi method has shown that the depth of cut has significant role to play in producing lower surface roughness followed by feed. The Cutting speed has lesser role on surface roughness from the tests. Research limitations/implications: The vibrations of the machine tool, tool chattering are the other factors which may contribute poor surface roughness to the results and such factors ignored for analyses. Originality/value: The results obtained by this method will be useful to other researches for similar type of study and may be eye opening for further research on tool vibrations, cutting forces etc.

Maruda.et.al[11] : This study provides a device wear analysis of P25 cemented carbide inserts in the final turn of AISI 1045 carbon steel for different cooling conditions: phosphate ester based / dry cutting with AW additives, minimum volume cooling-lubrication (MQCL) and MQCL. Inserts using the MQCL + EP / AW method have been shown to reduce 40% in weight compared to dry cutting and 25% less than MQCL. This development has been demonstrated to be a consequence of the formation of phosphate ester-dependent tribofilm. In addition, SEM analysis has shown that active compounds present in this tribofilm reduce the rate of synthesis and proliferation of tool wear processes. In addition, the analysis also includes drip diameter, which can also have a significant impact on wear. Drip diameter has been shown to have a greater effect on wear rate. Smaller droplets provide better penetration in the cutting area, especially for micro-machining applications. Therefore, this work shows that its optimal application through the MQCL medium and the generation of a controllable gauze can provide significant improvements in the wear rate and / or reduction in the productivity of the cutting tool.

B.Srinivash.[12] The dry bend of AISI 4140 steel is analyzed by experiments and finite element simulations using DNMA 432 without carbide inserts. 3D finite element simulation results are used to evaluate the evolution of the cutting forces, the vibration displacement amplitude, and the wear of the tool in a vibration induced turn. In the present paper, the primary concern is the relative vibration and wear of equipment with the modification of process parameters. These changes lead to fast tool wear and breakage. The cutting forces in the feed direction are also icted and compared to the experimental trends. The laser Doppler vibrometer is used to demonstrate the use of the Kistler 9272 dynamometer to detect vibration amplitude and to record the cutting forces during the cutting process. An honest effort is made to investigate the effect of tool lateral wear on varying degrees of spindle speed, feed rate, depth of cut on vibration amplitude and workpiece visibility. Empirical models have been developed using second-order polynomial equations to correlate the higher-order effects of the interactions and the different process parameters. Analysis of variance (ANOVA) is performed to identify the important factors of vibration amplitude and lateral wear of the equipment.

Mer.Bonifac ia .et.[13] Experiments have been carried out to monitor the change in workpiece surface roughness due to the increasing wear of the tool under different cutting conditions and vibration variation in the end bend. Vibration is measured by two accelerometers connected to the device and the parameter correlated with surface roughness is R.M. Signal. An experimental tool to describe the behavior of surface roughness according to wear time and cutting time was photographed at different stages of cutting. Mechanical material AISI 4340 Steel and equipment coated carbide inserts. The results indicate that online monitoring is a good way to increase surface roughness to eliminate the vibration of the tool and, therefore, it can be used in these tasks to establish the end of tool life. Another conclusion is that when coating tools are used, the time of the surface roughness is very different from that of the cutting time, when using non-shielded tools.

N.Dhar et.al[14] The use of cutting liquids in the machining process is a significant threat to the environment and the health of the operator. The application of minimum volume lubrication (MQL) to the machining operation leads to a decrease in the volume of the fluid with a decrease in the mechanical forces. MQL also affects the surface integrity of machine workpieces. The present work investigates the effectiveness of MQL application as a tool with surface integrity issues such as surface integrity and surface roughness when rotating hardened 31 N steel using a coated tungsten carbide insert. It can be seen that cutting under MQL conditions provides better surface finish and less lateral wear than machining without MQL. A study of the microgravity profile in the sub-surface area revealed that the workpiece replaced with MQL has a lower crust than the workpiece without MQL. This leads to a higher fatigue life of the hard part.

CHAPTER 4

DESIGN OF EXPERIMENT

- These are the most common method for optimising the process.

4.1 ANOVA Method

Variance (ANOVA) analysis is a statistical method used to test the difference between two or more means. It may seem strange to call this method rather than "diagnostic tools". As you can see, the name is appropriate because suspicions about routes are made by analysing the difference.

ANOVA is used to test normality rather than specific differences between means. This can be best seen by example. In the case study "Smiles and Lenency", the effect of different types of smiles on a person's tilt was investigated. Four types of smiles (apathy, false, feel, and sad) were examined. The chapter "Comparisons between all pairs" shows how differences between means are tested.

4.2 Taguchi Method

Taguchi techniques, also known as statistical techniques, or sometimes robust design techniques, have been developed to improve the quality of the products made by Genichi Taguchi and have recently been applied to engineering, biotechnology, marketing and advertising. Professional statisticians have welcomed the aims and improvements brought about by Taguchi's methods, notably through the development of Taguchi's design for the study of diversity, but also criticized the inability of some of Taguchi's proposals.

Taguchi*'s* work includes three principal contributions to statistics:

- A *specific loss function*
- The philosophy of *off-line quality control*; and
- Innovations in the *design of experiments*.

Steps involve in Taguchi's rule for manufacturing

- Decide the all input parameters.
- Decide which parameter is more affect the experiment (by literature survey).
- Select the appropriate orthogonal array and assign the parameter to its various column.
- Conduct the experiment and note down the response parameter.
- Repeat the each experiment three times.
- Analysis and point the optimum combination.
- Calculate the best value of response.

4.3 Response Surface Method (RSM):

In statistics, the response surface methodology RSM explores the relationship between several

explanatory variables and one or more response variables. Law 1951 George E. B and the K-box. B. Wilson was introduced. The main idea of RSM is to use a sequence of experiments designed to achieve optimal response. Box and Wilson suggest using a second-degree polynomial model to do this. They agree that this model is only an approximation, but they use it because although there is little information about this process, such a model is easy to estimate and implement.
Statistical approaches such as RSM can be used to increase the production of a particular substance through the optimization of operational factors. Unlike traditional methods, interactions between process variables can be determined by statistical methods.

4.4 WORKING PLAN

Material selection

▼

Parameter selection

▼

Perform Turning

▼

Analysis

4.5 Material Selection for tool

As we know that tool selections parameter play very important role in determining the overall performance of machine.
So, we will choose High Speed Steel (HSS) tool for the turning operation of the following reason.

- HSS works very well on all types of materials.
- HSS is the most widely used type of high-speed machining (HSM) tool material produced by powder metallurgy, consisting of 18% tungsten, 4% Chromium, 1% Vanadium, 0.7% carbon and the rest, Iron. HSS tools have a harness of 62-64 Rc. The Addition of 5% to 8% cobalt to HSS imparts higher strength and Wear resistance.

Properties of High Speed Steel

- High wear resistance
- Excellent Toughness
- High melting temperature (4680°C)

4.6 Material selection for the workpiece

For the turning operation we choose 6061 T6 aluminum alloy, containing magnesium and silicon as its major alloying elements. Originally called "Alloy 61S", it was developed in 1935.It has good mechanical properties, exhibits good weldability, and is very commonly extruded (second in popularity only to 6063). It is one of the most common alloys of aluminum for general-purpose use.

It is commonly available in pre-tempered grades such as 6061-O (annealed), tempered grades such as 6061-T6 (solutionized and artificially aged) and 6061-T651 (solutionized, stress-relieved stretched and artificially aged).

Applications

- Alloy 6061 is typically used for heavy duty structures in:
- Rail coaches
- Truck frames
- Ship building
- Bridges and Military bridges
- Aerospace applications including helicopter rotor skins
- Tube
- Pylons and Towers
- Transport
- Boiler making
- Motorboats
- Rivets

4.7 Parameter selection

Parameter selection also play very important role in performance of turning operation.and these are the parameter which affect the turning operation.

- **Cutting Speed:** It is the speed at which the metal is removed by the tool from the workpiece.
- **Feed rate:** Distance travelling by the tool during one revolution called feed rate

Effects of Feed rate on tool life and efficiency:

1. Decreasing feed rate results in flank wear and shortens tool life.
2. Increasing feed rate increases cutting temperature and flank wear. However, effects on the tool life is minimal compared to cutting speed.
3. Increasing feed rate improves machining efficiency.

Depth of Cut: Depth of cut is the thickness of metal that is removed during machining. The perpendicular distance measured between the machined surface and the uncut surface of the workpiece is taken. It is expressed in mm or in inches.

Effect of Depth Cut

1. Changing depth of cut doesn't affect tool life greatly.
2. Small depths of cut result in friction when cutting the hardened layer of a workpiece. Thus tool life is shortened.
3. When cutting uncut surfaces or cast iron surfaces, the depth of cut needs to be increased as much as the machine power allows in order to avoid cutting impure hard layers with the tip of cutting edge to prevent chipping and abnormal wear.

Parameters and their Levels

The initial Process parameters were as follows: cutting speed, feed rate, depth of cut, and cutting fluid. In this process parameter design, two levels of the process parameter were selected for each, shown in table 2

Process parameter	Unit	Level 1	Level 2
Cutting speed	mm/min	75	125
Feed Rate	mm/rev	4	5
Depth of Cut	mm	0.5	1.0
Cutting Fluid	▬	mustard oil	Castor oil

Table 2: - Cutting Parameters and their Levels.

CHAPTER 5

EXPERIMENTAL SETUP

The experiment as conducted using workpiece material namely 6063-T6 Aluminium Alloy is a medium strength alloy commonly used for intricate extrusions. It has good corrosion resistance and is readily suited for welding and can be anodized with the tool (High-speed steel-101 HSS M-2) during the machining different cutting fluids are used like castor oil and mustard oil works as a coolant and reduce the power consumption while central lathe machine (C0363X1000MM) is used for machining the workpiece and machine has two fixed cutting speed (75 mm/min and 125 mm/min). During the turning operation, there are four different factor (Cutting Speed, Feed rate, Depth of cut, and Cutting fluids) and each have two Levels.

Experimental Setup Details

Machine	CO636X1000MM conventional lathe
Work piece	6060-T6 Aluminium alloy. Diameter = 32 mm Length = 40 mm
Mechanical properties	Density = 2.69 g/cm^3 Young's modulus: 70 GPa
Tool	High-speed steel-101 HSS M-2

Table 1

Fig8. Lathe machine's setup

We used a "SURFCOM Flex" measuring system to measure surface roughness. It displays the measured results numerically and graphically and can print these results. The unit is easy to control and analyze with an integrated printer. Due to its portable size and durability, it can be easily shipped and used anywhere.

5.1 Taguchi Orthogonal Array Experiment

Taguchi Orthogonal Array (OA) design is a kind of simple semi-realistic design. This is a very different orthogonal design, based on the design matrix proposed by Dr. Ginichi Taguchi and allows you to consider a select subset of multiple factor combinations at multiple levels. Taguchi orthogonal ranges are balanced so that all levels of all factors are considered equal. For this reason, factors can be estimated independently of each other despite the variation of the design. This article shows how Taguchi uses Orthogonal array design.

A suitable orthogonal array has been designed for experiments based on the degrees of freedom. The experimental plan has been designed based on Taguchi L16 orthogonal array as given in Table 3.

Exp. No.	Cutting Speed	Feed Rate	Depth of cut	Cutting fluid
1	75	4	0.5	mustard
2	75	4	0.5	Castor
3	75	4	1	mustard
4	75	4	1	Castor
5	75	5	0.5	mustard
6	75	5	0.5	Castor
7	75	5	1	mustard
8	75	5	1	Castor
9	125	4	0.5	mustard
10	125	4	0.5	castor
11	125	4	1	mustard
12	125	4	1	castor
13	125	5	0.5	mustard
14	125	5	0.5	castor
15	125	5	1	mustard
16	125	5	1	castor

Table 3: - L16 orthogonal design matrix

CHAPTER 6

Result and Analysis

6.1 Analysis of Surface Roughness.

Exp. No	Surface Roughness (µm)	S/N Ratio
1	4.847	-13.7095
2	3.411	-10.6576
3	4.880	-13.7684
4	3.521	-10.9333
5	5.100	-14.1514
6	3.821	-11.6435
7	5.130	-14.2023
8	3.892	-11.8035
9	4.841	-13.6987
10	3.492	-10.8615
11	4.920	-13.8393
12	3.611	-11.1525
13	5.180	-14.2866
14	3.838	-11.6821
15	5.180	-14.2866
16	3.900	-11.8213

Table 4 Experimental result and corresponding S/N ratio for surface roughness.

Effects of Input Factor on Surface Roughness

The S / N ratio is obtained using the Taguchi method. The S / N ratio represents the amount of variance in the performance attribute. The desired goal here is to optimize surface roughness (RAW). Therefore the ratio of small to good type noise is applied to convert the raw data to the smallest values of Raw for raw roughness. The S / N ratio value corresponding to the different launch runs is shown in Table 4.

For Ra. the calculation of S/N ratio follows“ Smaller-the Better”.

Level	Cutting speed	Feed Rate	Depth of Cut	Cutting fluid
1	**-12.61**	**-12.33**	**-12.59**	**-13.99**
2	**-12.70**	**-12.98**	**-12.73**	**-11.32**
Delta	**0.09**	**0.66**	**0.14**	**2.67**
Rank	**4**	**2**	**3**	**1**

Table 5: - Response Table for Signal to Noise Ra

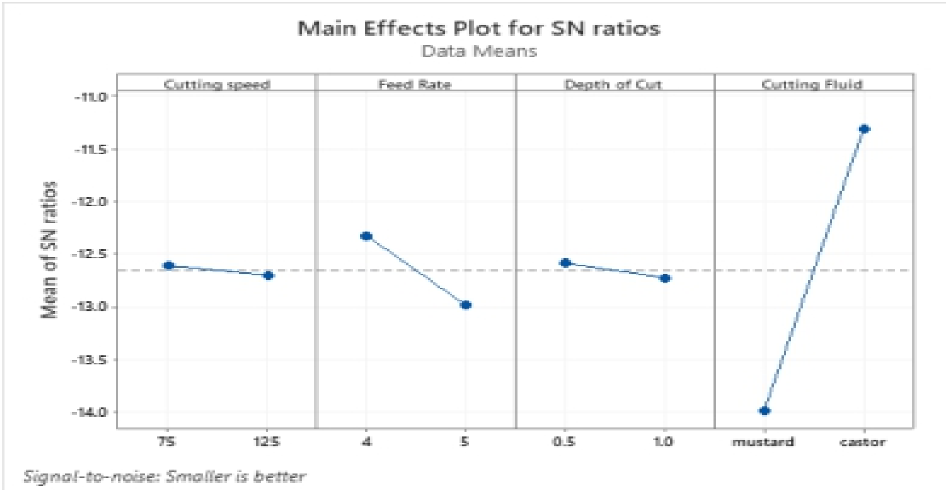


Fig 3: S/N graph for Surface Roughness.

6.2 Analysis of Material Removal Rate.

Taguchi technique is used for the optimization of Material Removal Rate (MRR). As mentioned earlier, there are three categories of performance attribute, i.e., low-good, high-good, and nominal-good, to obtain optimal machining operations, the high-performance function attribute must be the correct machine for MRR. Is taken to get performance

The Experimental formula which is used for Material Removal Rate is

$$\text{MRR} = \frac{wf - wi}{\rho \times t}$$

Where *Wi* is the initial weight of the workpiece in grams, *Wf* is the final weight of the workpiece in grams, ρ is the density of the material in grams / mm3, and t is the time (8 sec for each experiment) taken for machining. In practice MRR should be high, thus Taguchi method refers to select the process parameter having more S/N ratio. The values of the S/N ratio corresponding to different experiment runs have been shown in Table 5.

Exp. No	Material Removal Rate (mm^3/min)	S/N Ratio
1	9409.6	79.4714
2	9409.6	79.4714
3	21767.9	86.7563
4	21767.9	86.7563
5	13581.0	82.6586
6	13581.0	82.6586
7	29889.4	89.5103
8	29889.4	89.5103
9	9680.2	79.7177
10	9680.2	79.7177

11	23876.1	87.5593
12	23876.1	87.5593
13	14278.1	83.0934
14	14278.1	83.0934
15	32082.9	90.1255
16	32082.9	90.1255

Table 6. Experimental result and corresponding S/N ratio for MRR

Effect of Input Factor on Material Removal Rate

For MRR the calculation of S/N ratio follows "higher-the Better"

Level	Cutting speed	Feed Rate	Depth of Cut	Cutting fluid
1	**84.60**	**83.38**	**81.24**	**84.86**
2	**85.12**	**86.35**	**88.49**	**84.86**
Delta	**0.52**	**2.97**	**7.25**	**0.00**
Rank	**3**	**2**	**1**	**4**

Table No.7 Response Table for Signal to Noise Ratio

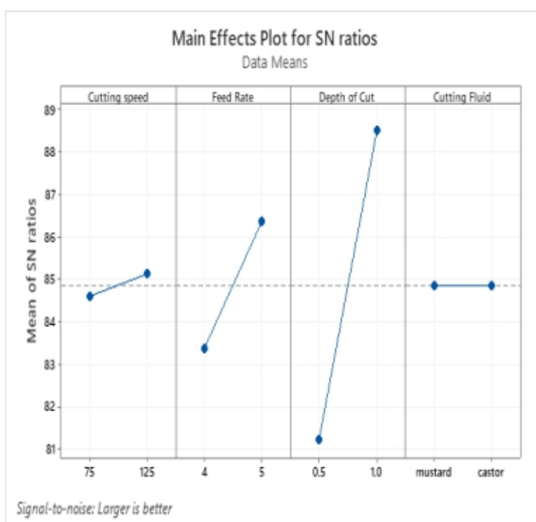


Fig No. 4:- S/N Ratio for MRR

6.3 Results

- From Table- 5 and Fig- 3, it can easily be observed that optimal operating conditions for surface roughness, when at a combination of speed 75 mm/min, Feed 4 mm/rev, Depth of cut 0.5 mm, and castor oil as cutting fluid.

- Similarly, from table 7 and fig 4, it can easily be observed that optimal operating condition for MRR, when at a combination of speed are 125 mm/min, Feed of 5 mm/rev, Depth of cut 1.0 mm and there is no effect of cutting fluid on MRR.

Conclusion

The present study was carried out to study the Optimization of Cutting Fluid and Cutting Parameter for Surface Roughness and Material Removal Rate. The following conclusions have been drawn from the study:

- ★ It is found that the design of the Taguchi Method provides a simple, systematic, and efficient methodology for the optimizations of the cutting fluid and cutting parameter.

- ★ Experimental results show that cutting fluid and feed rate are the main parameters of the four factors that affect surface roughness, While MRR, Depth of cut and feed are the main parameter.
- ★ In turning for minimum surface roughness, use of lower cutting speed (75mm/min), Lower feed rate (4mm/rev), lower depth of cut (0.5 mm), and castor oil as a cutting fluid.
- ★ For maximum MRR, use of higher cutting speed (125 mm/min), higher feed rate (5 mm/rev), higher depth of cut (5 mm).
- ★ This experiment also shows that there is no effect of cutting fluid on MRR.

- ★ The minimum surface roughness at the optimum cutting parameter and cutting fluid is 3.411 µm.

- ★ The maximum material removal rate at the optimum cutting parameter is 32082.9 mm^3/min.

- ★ This research demonstrates how to use the Taguchi parameter design for optimizing machine performance with minimum cost and time.

References

1. L B Abhang, M Hameedullah "Optimization of machining parameters in steel turning operation by Taguchi method" 38(2012) 40-48.
2. Sujit Kumar Jha, Sujit Kumar Jha "Optimization of Process Parameters for Optimal MRR During Turning Steel Bar Using Taguchi Method and Anova" Vol. 3, No. 3, July, 2014, ISSN 2278 – 01.
3. Karan A. katle, Abhishek Rehpade, Faruk Qureshi "influence of cutting condition and cutting parameter on material removal rate in straight turning process." 03 (2017) 2395-0056
4. Deepak D Rajendra B (2016) "Optimization of machining parameter for turning AI6061 using robust design principle to minimize the surface roughness" 24 (2016) 372 – 37.
5. M. Nalbant, H. Gokkaya, G. Sur "Application of Taguchi method in the optimization of Cutting parameter for surface roughness in turning" 28(2007)1379-1385.
6. S. Thamizhmanii*, S. Saparudin, S. Hasan "Analyses of surface roughness by turning process using Taguchi method" Volume 20 Issues 1-2 January-February 2007.
7. Kamal Hassana, Anish Kumar, M.P.Garg "Experimental investigation of Material removal rate in CNC turning using Taguchi method" Vol. 2, Issue 2,Mar-Apr 2012, pp.1581-1590.

8. Kishor Tupe, Vijay Zanje, Sadik Shaikh, Avinash Shigwan, Omkar Kulkarni, Shalaka Kulkarni "Optimization of Cutting Parameters for MRR in Turning Process of EN31 Steel Using Taguchi Approach" Volume: 04 Issue: 06 | June -2017 -ISSN: 2395 -0056.
9. Devesh Pratap Singh, R. N. Mall "OPTIMIZATION of Surface Roughness of Aluminium by Anova Based Taguchi Method Using Minitab 15 Software" Volume 2, Issue 11, July-2015 ISSN (Online): 2347 – 4718.

PUBLICATION DETAILS

2nd international Conference on Future Learning Aspects of Mechanical Engineering (Flame–2020 SCOPUS INDEXED) Organised by Department of Mechanical Engineering , Amity School of Engineering & Technology Uttar Pradesh, Noida.

Conference Date: 5th Aug 2020

PROOF OF CONFERENCE

- **Here Attached With Screenshot of conformation mail.**

FLAME - 2020 submission 556
1 message

FLAME - 2020 <flame2020@easychair.org> Wed 29 Apr, 2020 at 11:09 PM
To: Farhan Akhtar <farhan85mag@gmail.com>

Dear authors,

We received your submission to FLAME - 2020 (2nd International Conference on Future Learning Aspects of Mechanical Engineering):

Authors : Farhan Akhtar, Sakim Hasan, Shrikant Vidya, Kamlendra Kumar and Amit Kumar
Title : Effects of Cutting Parameters and Cutting Fluids in Turning of Aluminium Alloy
Number : 556

The submission was uploaded by Shrikant Vidya <skvrsm@gmail.com>.
You can access it via the FLAME - 2020 EasyChair Web page

https://easychair.org/conferences/?conf=flame2020

Thank you for submitting to FLAME - 2020.

Best regards,
EasyChair for FLAME - 2020.