Nomanclature of single point cutting tools and multi point cutting tools

Objectives: At the end of this lesson you shall be able to
- **name the types of cutting tool**
- **state the nomanclature of single point cutting tools**
- **state the nomanclaure of multi point cutting tools**

Lathe cutting tools are divided into two groups.These are

1 Single point cutting tools

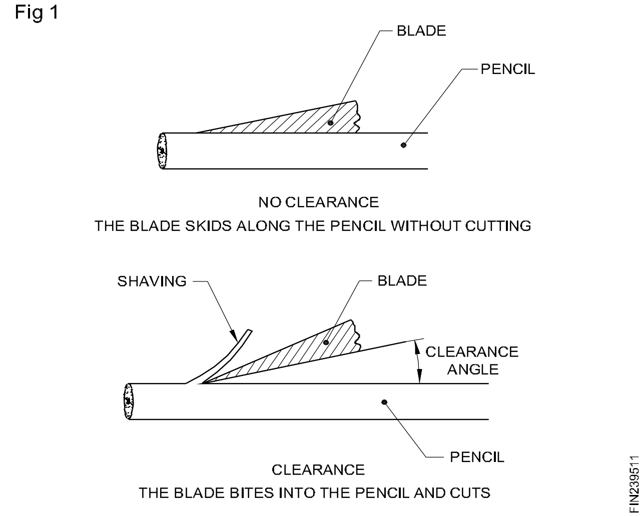
2 Multi point cutting tools

Single point cutting tool nomenclature

The tool acts like a wedge during turning. The wedge shaped cutting edge penetrates into the work and removes the metal. This necessitates the grinding of a tool cutting edge to a wedge shape.

When we sharpen a pencil with a pen knife by trial and error, we find that the knife must be presented to the wood at a definite angle, if success is to be achieved. (Fig 1)

Fig 1



If, in the place of a wooden pencil, a piece of soft metal such as brass is cut, it will be found that the cutting edge of the blade soon becomes blunt, and the cutting edge gets crumbled. For the blade to cut the brass successfully, the cutting edge must be ground to a less acute angle. (Fig 2)

The angle shown in Fig 1 is called as clearance angle and that shown in Fig 2 is a wedge angle.

Angles ground on a lathe cutting tool (Fig 3)

All the angles given below may not be located or found in every tool. As an example a roughing tool is chosen. The angles and clearances ground on this tool are:

1 Approach angle

2 Trail angle

3 Top rake angle

Fig 2

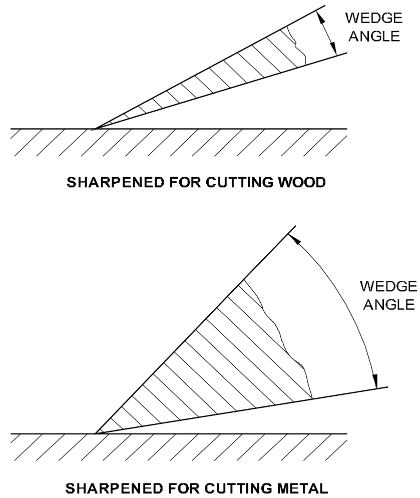
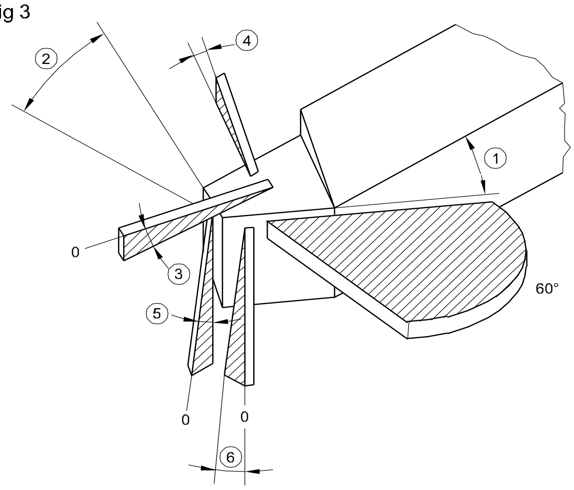


Fig 3



4 Side rake angle

5 Front clearance angle

6 Side clearance angle

Multi point cutting tools used in lathe are:

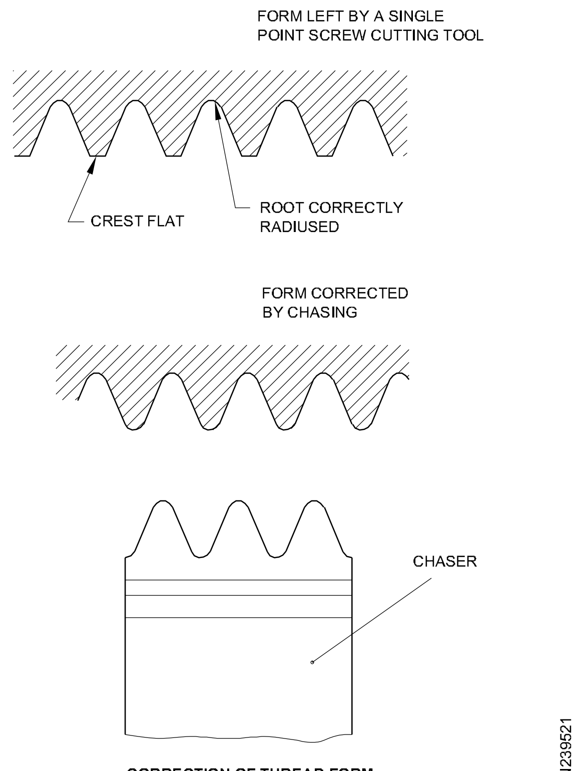
-	Drill	RT for Ex.No. 2.1.61
-	Reamer	RT for Ex.No. 2.1.67
-	Tap	RT for Ex.No. 2.1.70
-	Die	RT for Ex.No.2.1.71

Hand chasers and their uses

Objectives: At the end of this lesson you shall be able to
- **state what is a hand chaser**
- **state the constructional features of a hand chaser**
- **state the uses of a hand chaser.**

It is not possible to cut a full thread form with a single point cutting tool as errors like improper crest flat, root radius and profile etc are likely to occur. The same may be corrected by using a tool known as a chaser. (Fig 1)

Fig 1



CORRECTION OF THREAD FORM

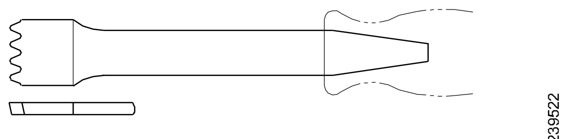
Hand chasers

Hand chasers are the devices which are used to remove less amount of material at the time of correcting and finishing a thread.

There are tow types of hand chasers.

- External thread chasers Fig 2

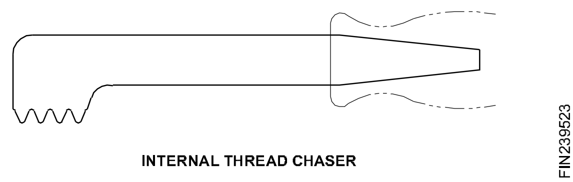
Fig 2



EXTERNAL THREAD CHASER

- Internal thread chasers Fig 3

Fig 3

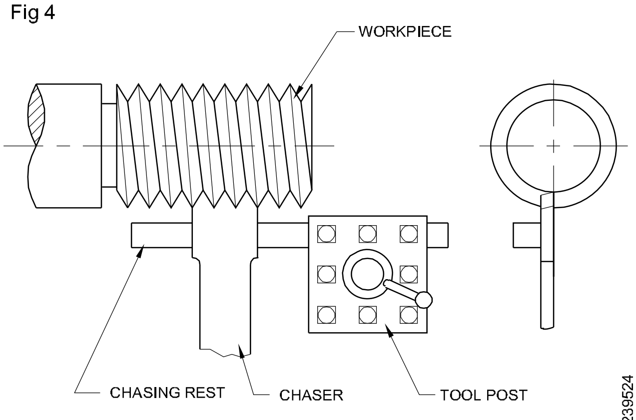


INTERNAL THREAD CHASER

Constructional features

They are made up of a rectangular cross-section of tool steel, hardened and tempered, and ground to correct size. At the front, multi-point cutting teeth are formed with a proper rake angle. On the other end it is narrower to fix the handle. The teeth pitch corresponds to the thread pitch on the work to be finished. The chasing rest must be kept close up to the workpiece, so that the chaser cannot be dragged down between the rest and the workpiece. (Fig 4)

Fig 4



THE CHASING REST

When chasing, the thread is cut slightly oversize, then trimmed down to size with the chaser; constantly check the thread with a thread ring gauge, if necessary.

Alternatively, a full thread may be cut from the solid, using a circular form tool. The form on the tool is slightly modified to allow for the distortion caused by the rake angle, so that the true form is cut. Such form tools are very expensive compared to a single point tool, and care must be taken not to chip them by incorrect usage. (Fig 5)

A button die held in a die-holder and mounted in the tailstock may also be used to finish threads to size and even cut them from the solild when threading low strength materials. (Fig 6)

Fig 5

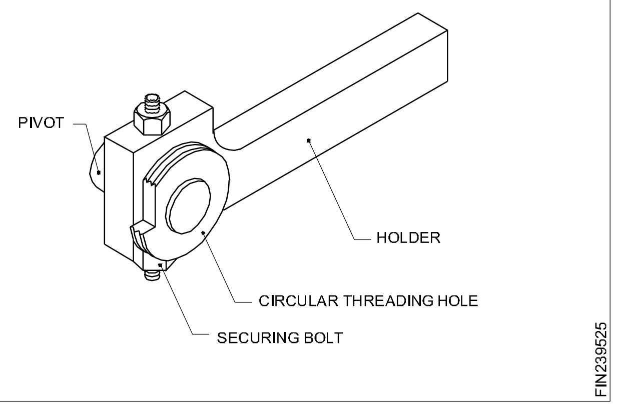
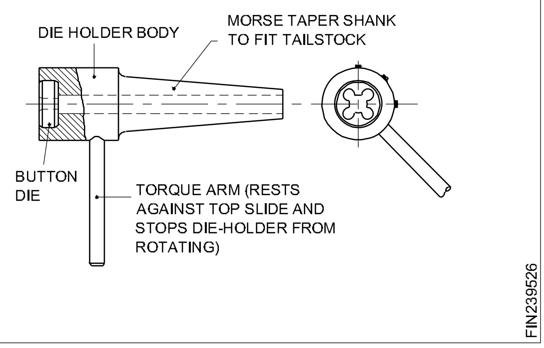

PIVOT
HOLDER
CIRCULAR THREADING HOLE
SECURING BOLT
FIN239525

Fig 6


DIE HOLDER BODY
MORSE TAPER SHANK
TO FIT TAILSTOCK
BUTTON
DIE
TORQUE ARM (RESTS
AGAINST TOP SLIDE AND
STOPS DIE-HOLDER FROM
ROTATING)
FIN239526

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Tool selection based on different requirements

Objectives: At the end of this lesson you shall be able to
- **state the qualities of good cutting tool material**
- **state the factors to be remembered when selecting tool**
- **name the different types of tool**
- **name the shapes of the tool**

Cutting tool materials

Tool materials should be:

- Harder and stronger than the material being cut
- Tough to resist shock loads
- Resistant to abrasion thus contributing to long tool life.

Cutting tool material should possess the following qualities.

- Cold hardness
- Red hardness
- Toughness

Cold hardness

It is the amount of hardness possessed by a material at normal temperature. Hardness is the property by which it can cut/scratch other metals. When hardness increases, brittleness also increases,and a material, which has too much of cold hardness, is not suitable for the manufacture of cuttting tools.

Red hardness

It is the ability of a tool material to retain most of its cold hardness property even at very high temperatures. While machining, the friction between the tool and the work, the tool and the chips, causes heat to be generated, and the tool loses its hardness, and its efficiency to cut diminishes. If a tool maintains its cutting efficiency even at increased temperatures during cutting, it can be said that it possesses the red hardness property.

Toughness

The property to resist breakage due to sudden load that results during metal cutting is termed as `toughness' This will reduce the breakage of the cutting edges of tools.

The following factors are to be considered, when selecting a tool material.

- Material to be machined.
- Condition of the machine tool.(rigidity and efficiency)
- The total quantity of production and the rate of production.
- The dimensional accuracy required and the quality of surface finish.
- The amount of coolant applied and method of application.
- Condition and form of material to be machined.

Grouping of tool material

The three groups under which tool materials fall are:

- ferrous tool materials
- non-ferrous tool materials
- non-metallic tool materials.

Ferrous tool materials

These materials have iron as their chief constituent. High carbon steel (tool steel) and high speed steel belong to this group.

Non-ferrous tool materials

These do not have iron, and they are formed by alloying elements like tungsten, vanadium and molybdenum. Stelite belongs to this group.

Carbides

These materials are also non-ferrous. They are manufacutred by powder metallurgy technique. Carbon and tungsten are the chief alloying elements.

Non-metallic materials

These tool materials are made out of non metals. Ceramics and diamonds belong to this group.

High carbon steel is the first tool material introduced for manufacuring cutting tools. It has poor red hardness property, and it loses its cutting efficiency very quickly. Alloying elements like tungsten, chromium and vanadium, are used to produce high speed steel tool material. Its red hardness property is more than that of high carbon steel.

High speed steel is used for making solid tools, brazed tools and inserted bits. It is costlier than high carbon steel. Carbide cutting tools can retain their hardness at very high temperatures, and their cutting efficiency is higher than that of high speed steel. Due to its brittleness and cost, a carbide tool cannot be used as a solid tool. It is used as a brazed tool and throw away tool bit.

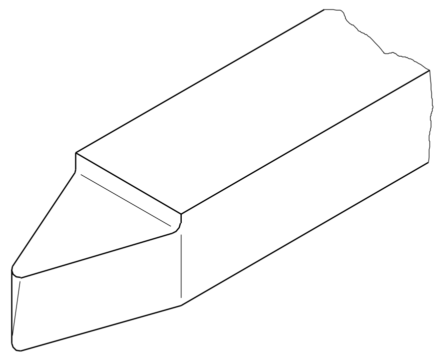
Lathe cutting tool types

The tools used on lathes are

- Solid type tools
- Brazed type tools
- Inserted bits with holders
- Throw-away type tools. (carbide)

Solid tools (Fig 1)

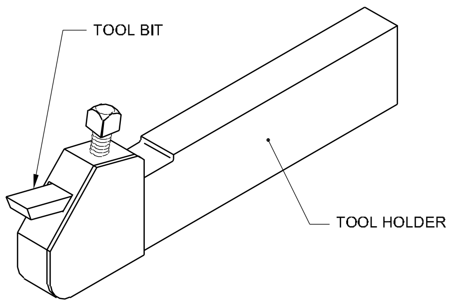
Fig 1



These are tools having their cutting edges ground on solid bits of square, rectangular and round cross-sections. Most of the lathe cutting tools are of the solid type, and high carbon steel and high speed steel tools are used. The length and cross-section of the tool depend upon the capacity of the machine, the type of tool post and the nature of the operation.

Inserted bits with holders (Fig 2)

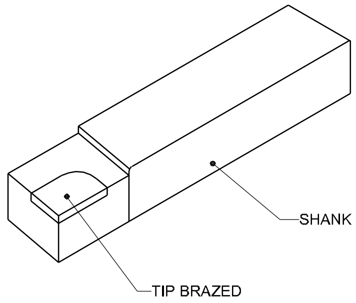
Fig 2



Solid high speed steel tools are costly; hence, they are sometimes used as inserted bits. These bits are small in sizes, and are inserted in the holes of the holder. These holders are held and clamped in the tool posts to carry out the operations.The disadvantage in this type of tools is that the rigidity of the tool is poor.

Brazed tools (Fig 3)

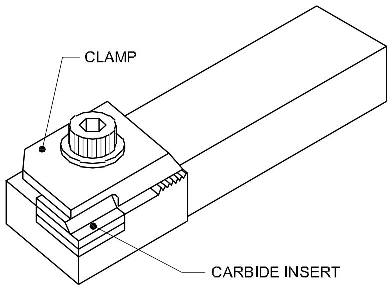
Fig 3



These tools are made up of two different metals. The cutting portions of these tools are of cutting tool materials, and the body of the tools do not possess any cutting ability, and are tough. Tungsten carbide tools are mostly of the brazed type. Tungsten carbide bits of square, rectangular and triangular shape are brazed to the tips of the shank. The tips of the shank metal pieces are machined on the top surface according to the shape of the fits so as to accomodate the carbide bits. These tools are economical, and give better rigidity for the tools than the inserted bits clamped in the tool-holders. This is applicable to high speed steel brazed tools also.

Throw-away type tools (Fig 4)

Fig 4



Carbide brazed tools when blunt or broken need grinding which is time consuming and expensive. Hence, they are used as throw-away inserts in mass production. Special tool- holders are needed and the carbide bits of rectangular, square or triangular shapes are clamped in the seating faces and machined on this type of special holders.

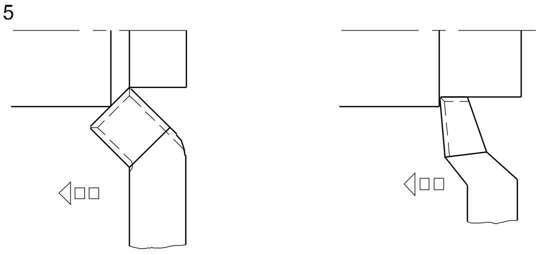
The seating faces are machined in such a way that the rake and clearances needed for the cutting bits are automatically achieved when the bits are clamped.

Lathe cutting tool shapes

Lathe cutting tools are available in a variety of shapes for performing different operations. Some of the lathe cutting tools generally used are:

- Facing tool (Figs 5a and 5b)

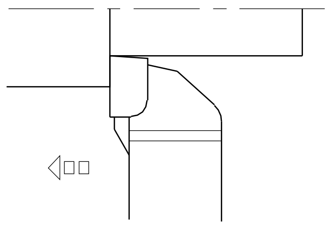
Fig 5



a) CRANKED TOOL b) OFFSET KNIFE TOOL

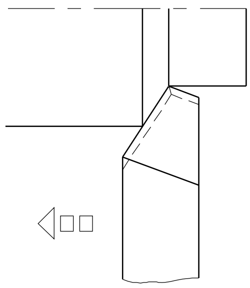
- Knife edge tool (Fig 6)

Fig 6



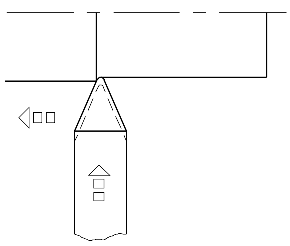
- Roughing tool (Fig 7)

Fig 7



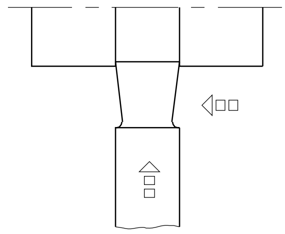
- Round nose finishing tool (Fig 8)

Fig 8



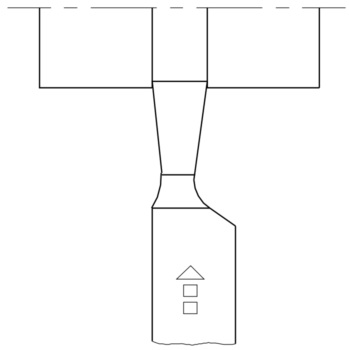
- Broad nose finishing tool (Fig 9)

Fig 9



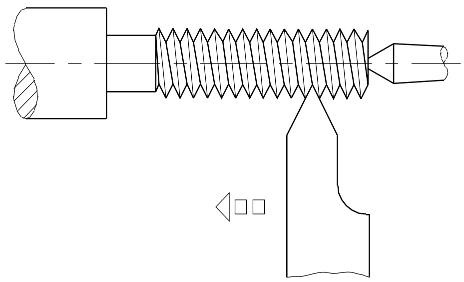
- Undercutting tool/parting off tool (Fig 10)

Fig 10



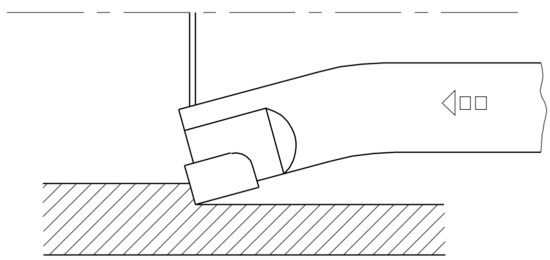
- External threading tool (Fig 11)

Fig 11



- Boring tool (Fig 12)

Fig 12

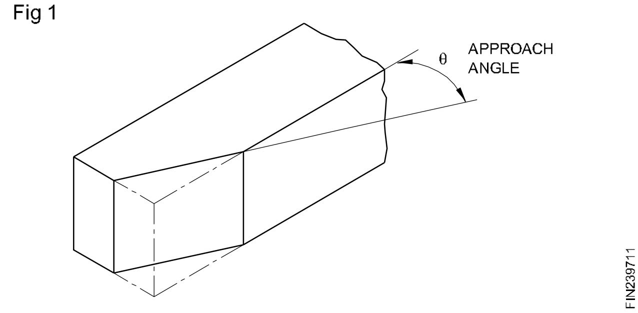


Necessity of grinding angles

Objectives: At the end of this lesson you shall be able to
- **name the different angle of the tool**
- **state use of the each angle**
- **state the effect of the incorrect angle.**

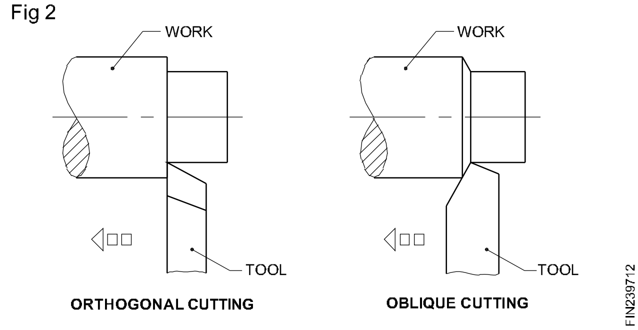
Approach angle (Fig 1)

Fig 1



This is also known as side cutting-edge angle. This is ground on the side of the cutting tool. The cutting will be oblique while cutting. The angle ground may range from 25° to 40° but as a standard a 30° angle is normally provided. The oblique cutting has the advantages over the orthogonal cutting, in which the cutting edge is straight. More depth of cut is given in the case of oblique cutting, since, when the tool is fed to the work, the contact surface of the tool increases gradually as the tool advances, whereas in the case of the orthogonal cutting, the length of the cutting edge for the given depth fully contacts the work from the begining itself which gives a sudden maximum load on the tool face. The area over which heat is distributed is greater in oblique cutting. (Fig 2)

Fig 2

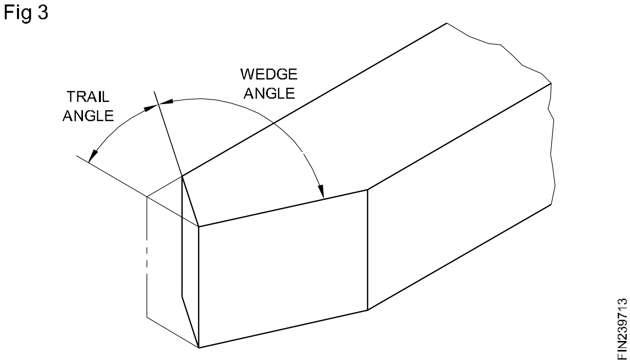


Trail angle (Fig 3)

It is also known as end-cutting edge angle, and is ground at 30° to a line perpendicular to the axis of the tool, as illustrated.

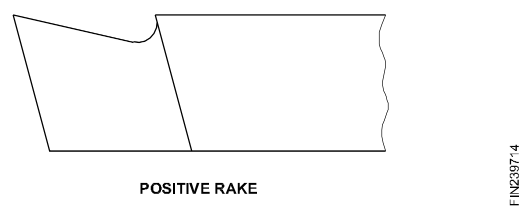
The approach angle and trail angle ground will form the wedge angle of 90° for the tool.

Fig 3



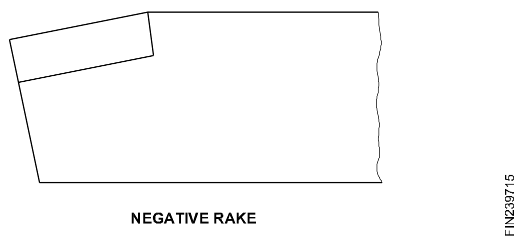
Top or back rake angle (Fig 4)

Fig 4



The rake angle ground on a tool controls the geometry of chip formation. Thereby, it controls the cutting action of the tool. The top or back rake angle of the tool is ground on the top of the tool, and it is a slope formed between the front of the cutting edge and the top of the face. If the slope is from the the front towards the back of the tool, it is known as a positive top rake angle, and if the slope is from the back of the tool towards the front of the cutting edge, it is known as a negative back rake angle. (Fig 5)

Fig 5

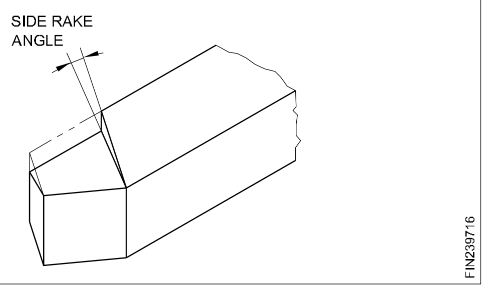


The top rake angle may be ground positive, negative or zero according to the material to be machined. When turning soft, ductile materials, which form curly chips, the positive top rake angle ground will be comparatively more than for turning hard brittle metals.

When turning hard metals with carbide tools, it is the usual practice to give a negative top rake. Negative top rake tools have more strength than tools with positive top rake angles.

Side rake angle (Fig 6)

Fig 6

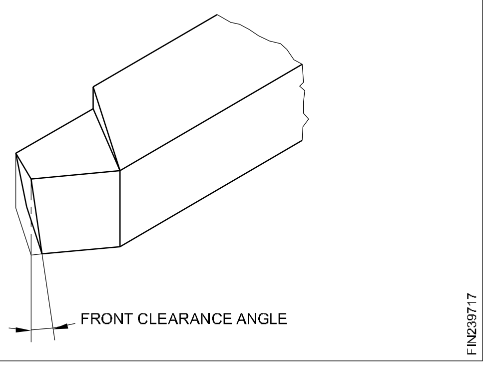


A side rake angle is the slope between the side of the cutting edge to the top face of the tool width wise. The slope is from the cutting edge to the rear side of the tool. It varies from 0° to 20°, according to the material to be machined.

The top and side rake, ground on a tool control the chip flow, and this results in a true rake angle which is the direction in which the chip that shears away from the work passes.

Front clearance angle (Fig 7)

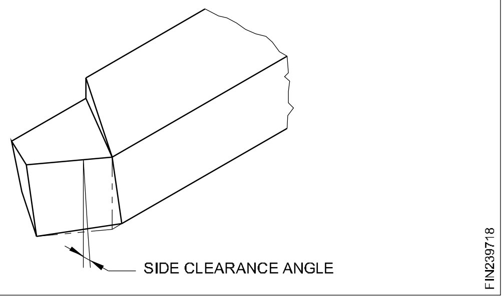
Fig 7



It is the slope between the front of the cutting edge to a line perpendicular to the axis of the tool drawn downwards which is known as the front clearance angle. The slope is from the top to the bottom of the tool, and permits only the cutting edge to contact the work, and avoids any rubbing action. If the clearance ground is more, it will weaken the cutting edge.

Side clearance angle (Fig 8)

Fig 8



The clearance angle is the slope formed between the side cutting edge of the tool with a line perpendicular to the tool axis drawn downwards at the side cutting edge of the tool. The slope is from the top of the side cutting edge to the bottom face. This is also ground to prevent the tool from rubbing with the work, and allows only the cutting edge to contact the work during turning. The side clearance angle needs to be increased when the feed rate is increased.

When grinding rake and clearance angles, it is better to refer to the standard chart provided with the recommended values and grind. However, actual operation will indicate the performance of the tool, and will indicate to us, if any modifications are needed for the angles ground on the tool.

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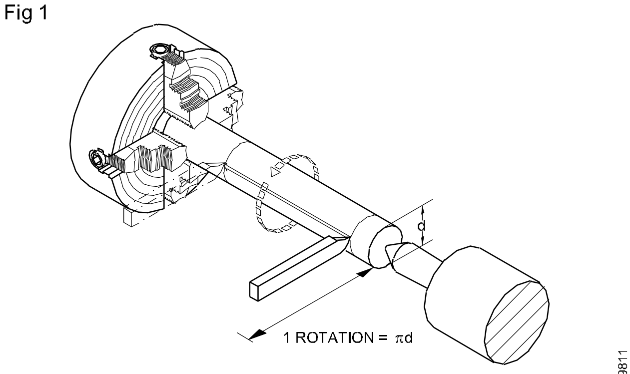
Lathe cutting speed and feed, use of coolants, lubricants

Objectives: At the end of this lesson you shall be able to
- **distinguish between cutting speed and feed**
- **read and select the recommended cuting speed for different materials from the chart**
- **point out the factors governing the cutting speed**
- **state the factors governing feed.**

Cutting speed is the speed at which the cutting edge passes over the material, and it is expressed in metres per minute. (Fig 1)

Fig 1



CUTTING SPEED FOR TURNING OPERATION

When a work of a diameter 'd' is turned in one revolution the length of the portion of work in contact with the tool is π x d. When the work is making 'n' rev/min, the length of the work in contact with the tool is π x D x n. This is converted into metres and expressed in a formula form as

$$V = \frac{\pi dn}{1000} \text{ metre/min}$$

where

V = cutting speed in m/min.

π = 3.14

d = diameter of the work in mm.

n = RPM.

When more material is to be removed in lesser time, a higher cutting speed is needed. This makes the spindle to run faster but the life of the tool will be reduced due to more heat being developed. The recommended cutting speeds are given in a chart. As far as possible the recommended cutting speeds are to be chosen from the chart and the spindle speed calculated before performing the operation. (Fig 2) Correct cutting speed will provide normal tool life under normal working condition.

Example

Find out the rpm of a spindle for a 50 mm bar to cut at 25 m/min.

$$V = \frac{\pi dn}{1000} \qquad n = \frac{1000V}{\pi xD}$$

$$\frac{1000x25}{3.14x50} = \frac{500}{3.14} = 159pm$$

Factors governing the cutting speed

- Finish required
- Depth of cut
- Tool geometry
- Properties and rigidity of the cutting tool and its mounting.
- Properties of the workpiece material
- Rigidity of the workpiece
- The type of cutting fluid used.

Feed (Fig 3)

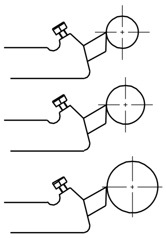
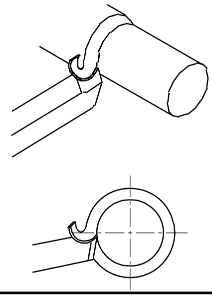
The feed of the tool is the distance it moves along the work for each revolution of the work and it is expressed in mm/rev.

The factors governing the feed are:

- Tool geometry
- Surface finish required on work
- Rigidity of the tool.

Rate of metal removal

The volume of metal removal is the volume of chip that is removed from the work in one minute, and it is found by multiplying the cutting speed, feed rate and the depth of cut.

Cutting speed 30 m / min	Length of metal passing over cutting tool in one revolution	Calculated RPM of spindle
Fig 2  ∅ 25 mm	----------------78.56 mm	1528 
∅ 50 mm	----------------157.12 mm	764
∅ 75 mm	----------------235.68 mm	509.3

Relationship of RPM to the cutting speed on different diameters.

TABLE 1

Cutting speeds and feeds for H.S.S tool

Material being turned	Feed mm/rev	Cutting speed m/min
Aluminium	0.2-1.00	70-100
Brass (alpha)-ductile	0.2-1.00	50-80
Brass (free cutting)	0.2-1.5	70-100
Bronze (phosphor)	0.2-1.00	35-70
Cast iron (grey)	0.15-0.7	25-40
Copper	0.2-1.00	35-70
Steel (mild)	0.2-1.00	35-50
Steel (medium-carbon)	0.15-0.7	30-35
Steel (Alloy-high tensile)	0.08-0.3	5-10
Thermo-setting plastics	0.2-1.00	35-50

Note

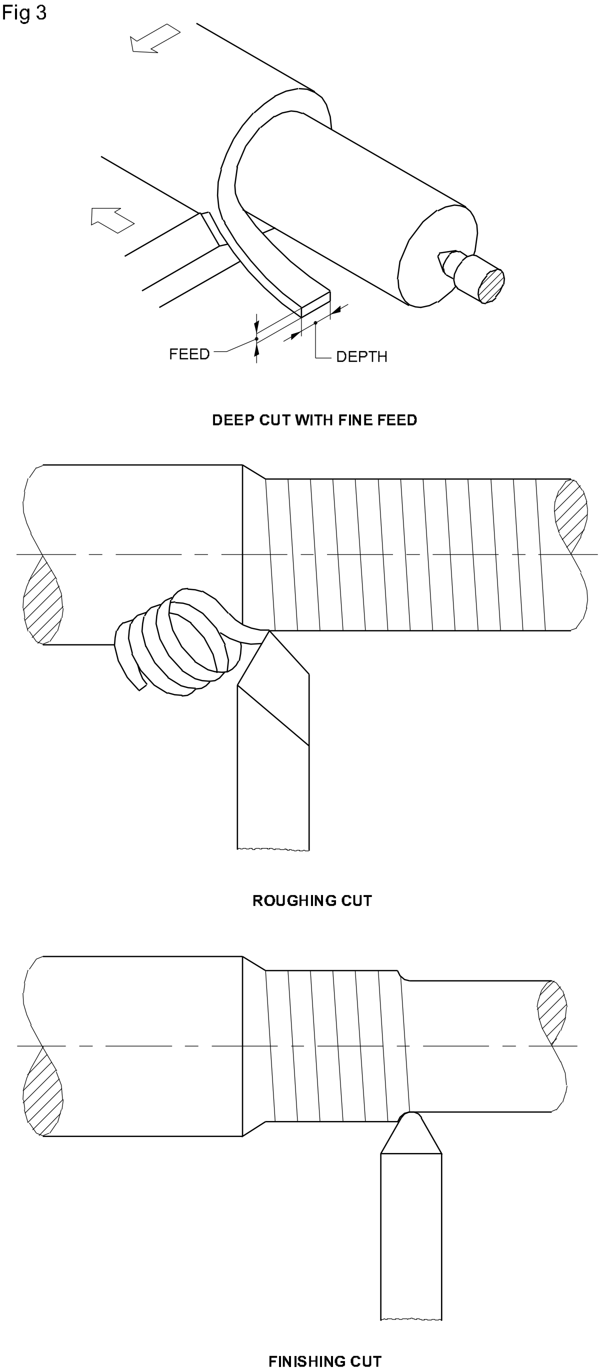
For super HSS tools the feeds should remain the same, but cutting speeds could be increased by 15% to 20%.

A lower speed range is suitable for heavy, roughing cuts. A higher speed range is suitable for light, finishing cuts.

The feed is selected to suit the finish required and the rate of metal removal.

When carbide tools are used, 3 to 4 times higher cutting speed to that required for H.S.S. tools may be chosen.

Fig 3



Comparison of HSS and Carbide Tools

HSS Tool	Carbide Tool
• Ferrous tool material have iron as their chief constituent.	• Non-Ferrous tool material do not have iron.
• Alloying tungstan, chromism and vanadium to high carbon steel, high speed steel tool material is produced.	• Carbide cutting tools can retain their hardness at very high temperature that of high speed steel.
• Cutting speed is low.	• Cutting speed is high.
• Solid tool.	• It is a brazed tool bit and throw away tool bit die to brittleness.
• Cost low.	• Cost high.

Coolants & lubricants (Cutting fluids)

Objectives: At the end of this lesson you shall be able to

- **state the properties of cutting fluids**
- **state the purpose of using a cutting fluid**
- **name the different cutting fluids**
- **distinguish the characteristics of each type of cutting fluids**
- **select a proper cutting fluid to suit various materials and machining operations.**

Coolants (Cutting fluids)

Coolants (Cutting fluids) play an important role in reducing the wear of cutting tools.

Coolants (Cutting fluids) are essential in most metal cutting operations. During a machining process, considerable heat and friction are created by the plastic deformation of metal occurring in the shear zone when the chip slides along the chip tool interface. This heat and friction cause the metal to adhere to the cutting edge of the tool, and the tool may break down. The result is poor finish and inaccurate work.

The advantages of a cutting fluid is it :

- Cools the tool and the workpiece
- Lubricates the chip / tool interface and reduces the tool wear due to friction
- Prevents chip welding
- Improves the surface finish of the workpiece
- Flushes away the chips
- Prevents corrosion of the work and the machine.

A good cutting fluid should have the following properties.

- Good lubricating quality
- Rust resistance
- Stability both in storage and in use
- Resistant to separation from solution after it is mixed with water
- Transparency
- Relatively low viscosity
- Non-flammability

The following are the main purposes of cutting fluids.

- To cool the cutting tool and the workpiece as heat is generated during cutting operation because of friction between the tool and the workpiece.
- To cool the cutting edge of the tool and to prevent any wear on the tool.
- To prevent the formation of chip welding.
- To give a good cutting efficiency to the tool.
- To give a good surface finish on the job.
- To act as a lubricant for the tool and the machine.

The different types of cutting fluids are:

- Soluble mineral oils
- Straight mineral oils
- Straight fatty oils
- Compounded or blended oils
- Sulphurised oils.

Cutting fluids - Types and Characteristics

Soluble mineral oils

They are made from mineral oils with emulsifying material added to make for mixing with water. Soluble oil is diluted with water to form an emulsion. The water cools whilst the oil lubricates. The extent of dilution depends upon the type of operation.

Straight mineral oils

They are purely mineral oils. Lighter oils are used when cooling and lubrication are required. Heavier oils are used when lubrication is mainly essential. They are used on automats. They protect the machine parts and workpieces from rusting.

Lard oils

Lard oils are usually blended with mineral oils to prevent deterioration, reduce cost and destroy the objectionable odour. For machining under extreme conditions, they are an excellent lubricant.

Sulphurised oils

To suit extreme cutting conditions of modern tools sulphurised oils have been devised. The addition of sulphur improves performance on difficult operations. Its lubricating property prevents the welding of chip on to the tool.

Coolants (Cutting fluids) plan an important role in reducing the wear of cutting tools.

Recommended cutting fluids for various metals

Material	Drilling	Reaming	Threading	Turning	Milling
Aluminium	Soluble oil Kerosene Kerosene and Lard oil	Soluble oil Kerosene Mineral oil	Soluble oil Kerosene and Lard oil	Soluble oil	Dry Soluble oil Lard oil Mineral oil
Brass	Dry Soluble oil Mineral oil Lard oil	Dry Soluble oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil
Bronze	Dry Soluble oil Mineral oil Lard oil	Dry Soluble oil Mineral oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil Mineral oil Lard oil
Cast iron	Dry Air jet Soluble oil Lard oil	Dry Soluble oil Mineral oil Lard oil	Dry Sulphurized oil Mineral oil Lard oil	Dry Soluble oil	Dry Soluble oil
Copper	Dry Soluble oil Mineral oil Lard oil Kerosene Oil	Soluble oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry Soluble oil
Steel Alloys	Soluble oil Sulphurized oil Mineral oil Lard oil	Soluble oil Sulphurized oil Mineral oil Lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Mineral Lard oil
General purpose	Soluble oil Sulphurized oil Lard oil	Soluble oil Sulphurized oil Lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Lard oil steel

Lubricants

Objectives: At the end of this lesson you shall be able to
- **state the purpose of using lubricants**
- **state the properties of lubricants**
- **state the qualities of a good lubricant.**

With the movement of two mating parts of the machine, heat is generated. If it is not controlled, the temperature may rise resulting in total damage of the mating parts. Therefore a film of cooling medium with high viscosity is applied between the mating parts which is known as a 'lubricant'.

A 'lubricant' is a substance having an oily property available in the form of fluid, semi-fluid, or solid state. It is the lifeblood of the machine, keeping the vital parts in perfect condition and prolonging the life of the machine. It saves the machine and its parts from corrosion, wear and tear and it minimises friction.

Purpose of using lubricants

- Reduces friction
- Prevents wear
- Prevents adhesion
- Aids in distributing the load
- Cools the moving elements
- Prevents corrosion
- Improves machine efficiency

Properties of Lubricants

Viscosity

It is the fluidity of an oil by which it can withstand high pressure or load without squeezing out from the bearing surface.

Oiliness

Oiliness refers to a combination of wettability, surface tension and slipperiness. (The capacity of the oil to leave an oily skin on the metal.

Flas point

It is the temperature at which the vapour is given off from the oil (it decomposes under pressure soon).

Fire point

It is the temperature at which the oil catches fire and contines to be in flame.

Pour point

The temperature at which the lubricant is able to flow when poured.

Emulsification and de-emulsibility

Emulsification indicates the tendency of an oil to mix immediately with water to form a more or less stable emulsion. De-emulsibility indicates the readiness with which subsequent separation will occur.

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