A Review Paper on Metal Cutting Process in Production Technology

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Abstract- *Production technology is the technology which is used to minimize the human effort by making high efficiency.*

For metal cutting process cooling agent must be required. that's why the purpose of metal cutting process is to maintain or to provide cooling. It also helps to reduce the Friction between tool and work piece at the shearing zone. At the time of dry cutting process, Air acts as the cooling agent for the work piece. For giving the shape metal cutting process is too much important. There are so many processes are discovered as per human effort. Metalworking process is also used to create individual parts of metal or it also used to assemble the part of metal.

Keywords- Types of metal cutting, Types of chip formation.

I. INTRODUCTION

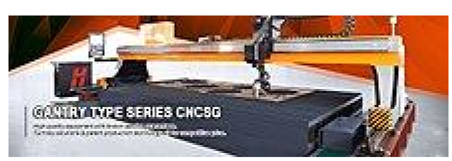
Metal cutting is the process which is done by removing a layer of unwanted material from workpiece. Below Fig. shows the schematics of a typical metal cutting process in that a wedge shaped, sharp edged tool is set to a certain depth of cut and moves relative to the workpiece.Under the action of force, pressure is exerted on the workpiece metal causing its compression near the tip of the tool. The metal undergoes shear type deformation and a piece or layer of metal gets repeated in the form of a chip.If the tool is continued to move relative to workpiece, there is continuous shearing of the metal ahead of the tool. The shear occurs along a plane called the shear plane.All machining processes involve the formation of chips; this occurs by deforming the work material on the surface of job with the help of a cutting tool. Depending upon the tool geometry, cutting conditions and work material, chips are produced in different shapes and sizes. The type of chip formed provides information about the deformation suffered by the work material and the surface quality produced during cutting.

II. TYPES OF METAL CUTTING

The various forms and processes of metal cutting involve:

1. **Turning** – It cuts and shapes job top layers of metal to pre-determined sizes.
2. **Drilling** – It is a combination of rotation and force cuts holes of required sizes in metals.
3. **Grinding** – It n uses an abrasive wheel that rotates with force against the metal creating a smooth and high quality surface.
4. **Welding** – uses the application of high-temperature and focused heat to cut metal along certain lines or folds.
5. **Oxy-acetylene or flame** – heats the metal to melting point where a directed stream of oxygen makes the metal melt.
6. **Laser** – an advanced technology which involves the use of an intensely concentrated light-beam that can be 'beamed' to tiny points of high temperature under controlled conditions to cut metal into required shapes or objects.
7. **Plasma** – a very contemporary technique that uses a plasma torch to pump oxygen or any other inert gas at high speed through a nozzle which is then electrified with an electrical arc creating plasma that is hot to not only cut or slice the metal but also remove any molten metal thereby giving a clean cut.

III. CUTTING PROCESSES



A CNC plasma cutting machining
Main article: Cutting

Cutting is a collection of processes wherein material is brought to a specified geometry by removing excess material using various kinds of tooling to leave a finished part that meets specifications. The net result of cutting is two products, the waste or excess material, and the finished part. In woodworking, the waste would be sawdust and excess wood. In cutting metals the waste is chips or swarf and excess metal.
Cutting processes fall into one of three major categories:

- Chip producing processes most commonly known as machining
- Burning, a set of processes wherein the metal is cut by oxidizing a kerf to separate pieces of metal
- Miscellaneous specialty process, not falling easily into either of the above categories

Drilling a hole in a metal part is the most common example of a chip producing process. Using an oxy-fuel cutting torch to separate a plate of steel into smaller pieces is an example of burning. Chemical milling is an example of a specialty process that removes excess material by the use of etching chemicals and masking chemicals.

There are many technologies available to cut metal, including:

- Manual technologies: saw, chisel, shear or snips
- Machine technologies: turning, milling, drilling, grinding, sawing
- Welding/burning technologies: burning by laser, oxy-fuel burning, and plasma
- Erosion technologies: by water jet, electric discharge, or abrasive flow machining.
- Chemical technologies: Photochemical machining

Cutting fluid or coolant is used where there is significant friction and heat at the cutting interface between a cutter such as a drill or an end mill and the workpiece. Coolant is generally introduced by a spray across the face of the tool and workpiece to decrease friction and temperature at the cutting tool/workpiece interface to prevent excessive tool wear. In practice there are many methods of delivering coolant.

Milling

A milling machine in operation, including coolant hoses.
Main article: Milling (machining)

Milling is the complex shaping of metal or other materials by removing material to form the final shape. It is generally done on a milling machine, a power-driven machine that in its basic form consists of a milling cutter that rotates about the spindle axis (like a drill), and a worktable that can move in multiple directions (usually two dimensions [x and y axis] relative to the workpiece). The spindle usually moves in the z axis. It is possible to raise the table (where the workpiece rests). Milling machines may be operated manually or under computer numerical control (CNC), and can perform a vast number of complex operations, such as slot cutting, planing, drilling and threading, rabbeting, routing, etc. Two common types of mills are the horizontal mill and vertical mill.

The pieces produced are usually complex 3D objects that are converted into x, y, and z coordinates that are then fed into the CNC machine and allow it to complete the tasks required. The milling machine can produce most parts in 3D, but some require the objects to be rotated around the x, y, or z coordinate axis (depending on the need). Tolerances come in a variety of standards, depending on the locale. In countries still using the imperial system, this is usually in the thousandths of an inch (Unit known as Thou), depending on the specific machine. In many other European countries, standards following the ISO are used instead.

In order to keep both the bit and material cool, a high temperature coolant is used. In most cases the coolant is sprayed from a hose directly onto the bit and material. This coolant can either be machine or user controlled, depending on the machine.

Materials that can be milled range from aluminum to stainless steel and almost everything in between. Each material requires a different speed on the milling tool and varies in the amount of material that can be removed in one pass of the tool. Harder materials are usually milled at slower speeds with small amounts of material removed. Softer materials vary, but usually are milled with a high bit speed.

The use of a milling machine adds costs that are factored into the manufacturing process. Each time the machine is used coolant is also used, which must be periodically added in order to prevent breaking bits. A milling bit must also be changed as needed in order to prevent damage to the material. Time is the biggest factor for costs. Complex parts can require hours to complete, while very simple parts take only minutes. This in turn varies the production time as well, as each part will require different amounts of time.

Safety is key with these machines. The bits are traveling at high speeds and removing pieces of usually scalding hot metal. The advantage of having a CNC milling machine is that it protects the machine operator.

Turning

A lathe cutting material from a workpiece.
Main article: Turning

Turning is a metal cutting process for producing a cylindrical surface with a single point tool. The workpiece is rotated on a spindle and the cutting tool is fed into it radially, axially or both. Producing surfaces perpendicular to the workpiece axis is called facing. Producing surfaces using both radial and axial feeds is called profiling.

A *lathe* is a machine tool which spins a block or cylinder of material so that when abrasive, cutting, or deformation tools are applied to the workpiece, it can be shaped to produce an object which has rotational symmetry about an axis of rotation. Examples of objects that can be produced on a lathe include candlestick holders, crankshafts, camshafts, and bearing mounts.

Lathes have four main components: the bed, the headstock, the carriage, and the tailstock. The bed is a precise & very strong base which all of the other components rest upon for alignment. The headstock's spindle secures the workpiece with a chuck, whose jaws (usually three or four) are tightened around the piece. The spindle rotates at high speed, providing the energy to cut the material. While historically lathes were powered by belts from a line shaft, modern examples uses electric motors. The workpiece extends out of the spindle along the axis of rotation above the flat bed. The carriage is a platform that can be moved, precisely and independently parallel and perpendicular to the axis of rotation. A hardened cutting tool is held at the desired height (usually the middle of the workpiece) by the toolpost. The carriage is then moved around the rotating workpiece, and the cutting tool gradually removes material from the workpiece. The tailstock can be slid along the axis of rotation and then locked in place as necessary. It may hold centers to further secure the workpiece, or cutting tools driven into the end of the workpiece.

Other operations that can be performed with a single point tool on a lathe are:

Chamfering: Cutting an angle on the corner of a cylinder. Parting: The tool is fed radially into the workpiece to cut off the end of a part.

Threading: A tool is fed along and across the outside or inside surface of rotating parts to produce external or internal threads.

Boring: A single-point tool is fed linearly and parallel to the axis of rotation to create a round hole.

Drilling: Feeding the drill into the workpiece axially.

Knurling: Uses a tool to produce a rough surface texture on the work piece. Frequently used to allow grip by hand on a metal part.

Modern computer numerical control (CNC) lathes and (CNC) machining centres can do secondary operations like milling by using driven tools. When driven tools are used the work piece stops rotating and the driven tool executes the machining operation with a rotating cutting tool. The CNC machines use x, y, and z coordinates in order to control the turning tools and produce the product. Most modern day CNC lathes are able to produce most turned objects in 3D.

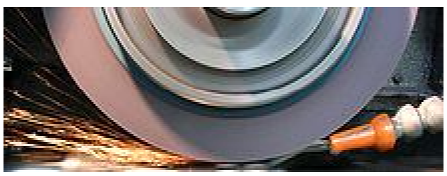
Nearly all types of metal can be turned, although more time & specialist cutting tools are needed for harder workpieces.

Threading

Three different types and sizes of taps.
Main article: Threading (manufacturing)

There are many threading processes including: cutting threads with a tap or die, thread milling, single-point thread cutting, thread rolling, cold root rolling and forming, and thread grinding. A *tap* is used to cut a female thread on the inside surface of a pre-drilled hole, while a *die* cuts a male thread on a preformed cylindrical rod.

Grinding



A surface grinder
Main article: Grinding (abrasive cutting)

Grinding uses an abrasive process to remove material from the workpiece. A **grinding machine** is a machine tool used for producing very fine finishes, making very light cuts, or high precision forms using an abrasive wheel as the cutting device. This wheel can be made up of various sizes and types of stones, diamonds or inorganic materials.

The simplest grinder is a bench grinder or a hand-held angle grinder, for deburring parts or cutting metal with a zip-disc.

Grinders have increased in size and complexity with advances in time and technology. From the old days of a manual toolroom grinder sharpening endmills for a production shop, to today's 30000 RPM CNC auto-loading manufacturing cell producing jet turbines, grinding processes vary greatly.

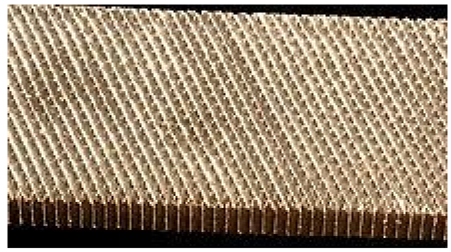
Grinders need to be very rigid machines to produce the required finish. Some grinders are even used to produce glass scales for positioning CNC machine axis. The common rule is the machines used to produce scales be 10 times more accurate than the machines the parts are produced for.

In the past grinders were used for finishing operations only because of limitations of tooling. Modern grinding wheel materials and the use of industrial diamonds or other man-made coatings (cubic boron nitride) on wheel forms have allowed grinders to achieve excellent results in production environments instead of being relegated to the back of the shop.

Modern technology has advanced grinding operations to include CNC controls, high material removal rates with high precision, lending itself well to aerospace applications and high volume production runs of precision components.

Filing

Main article: Filing (metalworking)



A file is an abrasive surface like this one that allows machinists to remove small, imprecise amounts of metal.

Filing is combination of grinding and saw tooth cutting using a file. Prior to the development of modern machining equipment it provided a relatively accurate means for the production of small parts, especially those with flat surfaces. The skilled use of a file allowed a machinist to work to fine tolerances and was the hallmark of the craft. Files can vary in shape, coarseness, and whether the teeth or single cut or double cut depending on what application the file is to be used for. Today filing is rarely used as a production technique in industry, though it remains as a common method of deburring.

Types of Chips:

Continuous chips: While machining ductile materials, large plastic deformation of the work material occurs ahead of the cutting edge of the tool. The metal of the workpiece is compressed and slides over the tool face in the form of a long continuous chip.

Discontinuous (segmented) chips: A discontinuous chip is a segmented chip produced in the form of small pieces. The discontinuous chips are produced when cutting brittle materials like cast iron, bronze and brass. The working on ductile materials under poor cutting condition may also sometimes lead to the formation of discontinuous chips.

Continuous chips with built-up-edge: The term built-up-edge refers to the small metal particles that stick to the cutting tool and the machined surfaces as result of high temperature, high pressure and high frictional resistance during machining. The building up and breaking down of the built-up-edge is periodic; its size first increases, then decreases and again increases-the cycle gets repeated rapidly.

Today there are several types of cutting tools for different applications and purposes; largely, they form two classifications –

1. Single-point – e.g. knives, scissors
2. Multi-point – e.g. drilling, grinding, milling etc.

The manufacture of cutting tools falls into three major uses:

1. Leather cutting
2. Metal cutting
3. Glass cutting

These tools cater to different needs of cutting and hence they have specific geometry to provide 'clearance angles' for neater and precise cutting. The characteristics required to produce good quality tools and parts are:

- **Hardness –** which includes the hardness and strength of the tool at elevated temperatures, which is referred to as 'hot hardness'
- **Toughness –** tools should not chip or fracture, which is a possible occurrence in interrupted cutting operations
- **Wear-resistance** – cutting tools have to be conform to accepted 'attainment of life' before they are replaced

IV. CONCLUSION

1) The efficiency of laser cutting machine is much more than other processes
2) Giving the shape to the metal, then turning, drilling, grinding processes are used.
3) Grinding process is very useful for maintaining the softness of meta

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