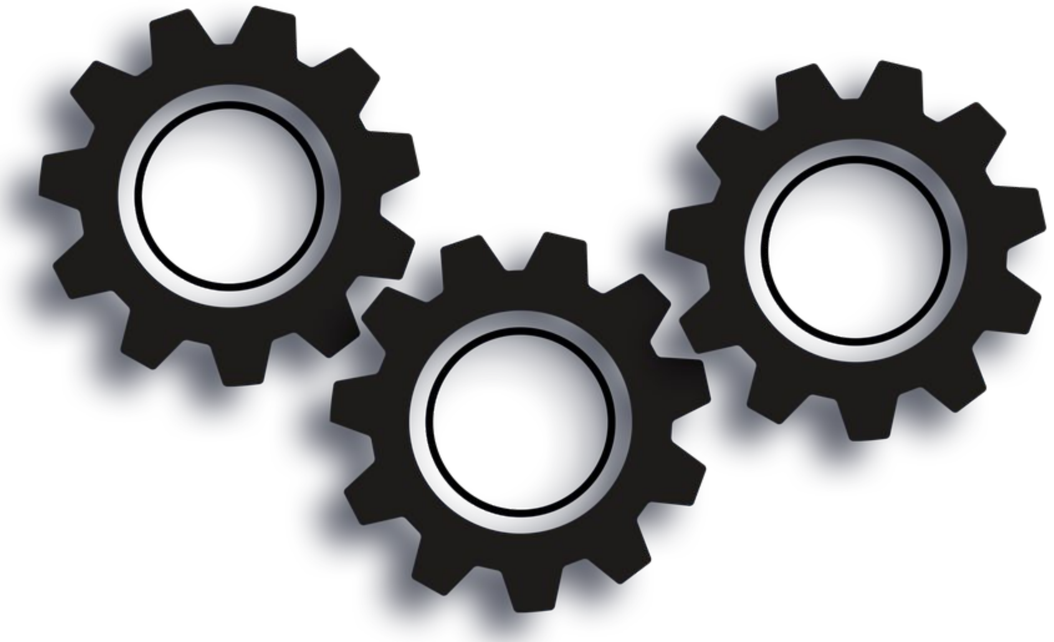
MANUFACTURING PROCESSES SEMESTER 1



SYLLABUS

Unit I

Definition of manufacturing, Importance of manufacturing towards technological and social economic development, Classification of manufacturing processes, Properties of materials.

Metal Casting Processes: Sand casting, Sand moulds, Type of patterns, Pattern materials, Pattern allowances, Types of Moulding sand and their Properties, Core making, Elements of gating system. Description and operation of cupola.

Working principle of Special casting processes - Shell casting, Pressure die casting, Centrifugal casting. Casting defects. [10Hrs]

Unit II

Joining Processes: Welding principles, classification of welding processes, Fusion welding, Gas welding, Equipments used, Filler and Flux materials. Electric arc welding, Gas metal arc welding, Submerged arc welding, Electro slag welding, TIG and MIG welding process, resistance welding, welding defects. [10Hrs]

Unit III

Deformation Processes: Hot working and cold working of metals, Forging processes, Open and closed die forging process. Typical forging operations, Rolling of metals, Principle of rod and wire drawing, Tube drawing. Principle of Extrusion, Types of Extrusion, Hot and Cold extrusion.

Sheet metal characteristics -Typical shearing operations, bending and drawing operations, Stretch forming operations, Metal spinning. [10Hrs]

Unit IV

Powder Metallurgy: Introduction of powder metallurgy process, powder production, blending, compaction, sintering

Manufacturing Of Plastic Components: Types of plastics, Characteristics of the forming and shaping processes, Moulding of Thermoplastics, Injection moulding, Blow moulding, Rotational moulding, Film blowing, Extrusion, Thermoforming. Moulding of thermosets- Compression moulding, Transfer moulding, Bonding of Thermoplastics.

[10Hrs]

Unit 1
Introduction to Manufacturing Process & Casting Process

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Topics Included

- Definition And Importance Of Manufacturing Towards Technologic And Social Development
- Classification Of Manufacturing Process
- Mechanical Properties Of Material
- Sand Casting And Sand Moulds
- Types Of Patterns
- Pattern Materials And Pattern Allowances
- Types Of Moulding Sands
- Description And Operation Of Cupola Furnace
- Working Principle Of Special Casting Process (Shell, Pressure Die, Centrifugal)
- Casting Defects

TOPIC- DEFINITION AND IMPORTANCE OF MANUFACTURING TOWARDS TECHNOLOGIC AND SOCIAL DEVELOPMENT

MANUFACTURING

Manufacturing *is the process of turning basic materials into more valuable commodities in big quantities. Manufacturing industries in the secondary sector are those that produce finished goods from raw materials.*

IMPORTANCE OF MANUFACTURING

Increase in Quality - Quality enhancement is by far one of the main beneficial components of manufacturing technology. With production software, humans are needed less in all aspects of production planning and scheduling, as well as the actual production process itself. Automation in the creation of schedules and production line means an optimized schedule that reduced the number of inefficiencies, defects, and other mishaps. This is because humans are more prone to error than programmed machines are, so it is obvious why many production facilities are choosing to use robots and automation instead of having a large number of workers within the plant.

Cost Reduction - Cost reduction is one of the key goals of manufacturing technology. This is because of the correction of inefficiencies and waste being reduced within the production process, which saves a drastic amount of money in the long run. Manufacturing technologies improve overall productivity, which increases profit immensely as well. In addition, technology and automation usually mean that you require fewer workers in the plant, which is typically the largest cost incurred by a manufacturing company.

Reduction in Overall Production Time

-The longer the production process is - the more it is going to cost. Manufacturing technologies drive the production process and get products out in a much more efficient manner. This is all thanks to machines automating the process, in which production time is drastically reduced between product batches, ultimately allowing for the manufacturing operation to increase profits. In addition, using machines to automate the production process means that you have a consistent run rate for production that can be used to more accurately predict when you can deliver your goods.

CONTRIBUTION OF INDUSTRIES TO NATIONAL ECONOMY

- *Manufacturing's portion of GDP has remained stable at 17% of GDP, out of a total of 27% for the industry, which includes 10% for mining, quarrying, power, and gas.*
- *India's GDP is substantially lower than that of several East Asian economies, which range from 25 to 35 percent.*
- *Manufacturing has grown at a rate of roughly 7% per year on average over the last decade.*
- *With proper government policy interventions and increased efforts by industry to improve productivity, the desired growth rate over the following decade is 12%.*
- *The National Manufacturing Competitiveness Council (NMCC) was established solely for this purpose.*

Classification of Manufacturing Process

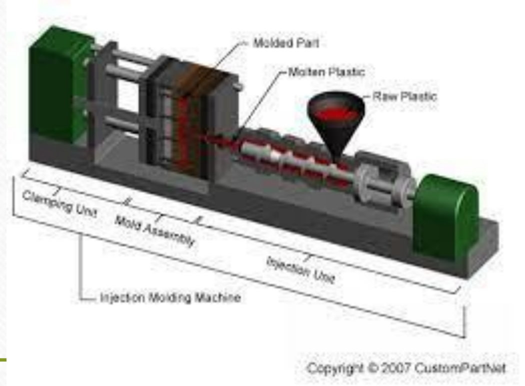
Forming

- **1.** Forming is the process of applying forces or pressure to material and plastically deforming it to get the desired shape. It is frequently used with metals. The majority of forming operations may be performed on metals that are either above or below their recrystallization temperature. This is referred to as hot or cold working. Hot-working makes it easier to bend the metal plastically. However, cold working results in strain hardening, which enhances the material's strength. Forging, rolling, and extrusion is three common forming techniques.
- – **Forging**: the metal is placed between two closed dies. Repeated hammer strokes shape the metal into the dies. Unlike cast components, forging generates excellent mechanical properties. Forging, however, requires fine tolerances and expensive equipment. Junying is a China top company that is capable of making a wide range of custom forged parts based on your specifications
- – Rolling: a common forming process. It involves rolling metal between two or more rollers that exert pressure and reduce metal thickness. Rolling may also be used to make complex shapes like I-beams. Rolling improves mechanical properties and can be mechanized, making it a feasible choice for big volume manufacturing. However, tooling costs might be high, and it cannot generate complex shapes.
- – Extrusion: a continuous operation that involves heating metal in a chamber and pushing it through a die with a ram. Extrusion is best suited for two-dimensional shapes and has excellent surface quality.

Casting

- Casting is the process of putting liquid metal into a mold and allowing it to cool. This is referred to as the main shaping process. Typically, a secondary operation such as machining is required to provide the appropriate surface polish. Casting, like forming, is most frequently employed with metals. Die casting, sand casting, and investment casting are the three most common types of casting.
- – Die casting: a process in which molten metal is pressed under great pressure into reusable metal dies. The molten metal is removed from the mold once it has hardened. Die casting is primarily used for non-ferrous metals like aluminum and zinc. However, because of high start-up costs, it is only suited for large production runs.
- – Sand casting: by using a design, you may make a single-use mold from moist sand. The sand is usually confined in the cope and drag mold boxes. The molten metal is poured into the mold through a sand channel. It may be retrieved from the sand when the metal has hardened. Many metals, even those with high melting temperatures, can be cast in sand. It can create big, complicated parts at minimal startup costs, making it suitable for small batches. It produces a rough surface and is less precise than other casting techniques.
- – Investment casting: a sprue holds several wax patterns of the same item. In this case, the wax tree serves as a ceramic mold. The wax is melted with heat. The molten metal is poured into the ceramic mold, which cools and breaks off the casting. Investment casting is ideal for complicated geometries and precise tolerances components. But it is costly and time-demanding.

Molding

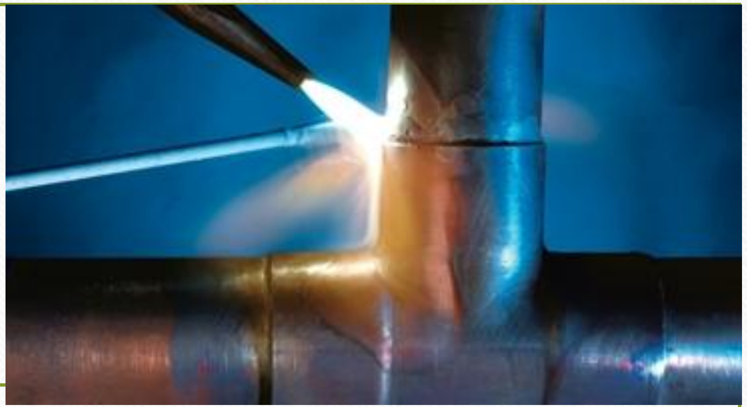


- Molding is a process that is quite similar to casting. It entails using a mold to shape a liquid or flexible substance. Molding is frequently used to shape polymers. Injection molding, compression molding, and blow molding are all common molding methods.
- – **Injection molding**: the most used plastic production process. Polymer granules are fed into the hopper, then pushed under pressure into the mold by a screw. Injection molding is most commonly used for thermoplastics, which soften when heated and solidify when cooled. It is a quick procedure that can be entirely automated, lowering labor expenses. Due to the high start-up expenses of the costly molds, it is only cost-effective for big production runs.
- – Compression molding: a specific amount of material is molded. Close the mold and apply pressure and heat. Mostly used for thermosets, which are polymers that harden when heated. Tooling costs are inexpensive, making it excellent for short batches, but it is sluggish and not suitable for complicated designs.

Machining

- Machining is a material removal technique in which material is removed from the block material item using a tool. It is frequently used for secondary shaping after a primary technique like casting has been employed to produce the part. Machining is a versatile process that may be utilized on a variety of materials, including metals, polymers, and wood. Drilling, turning, milling, and reaming are all examples of machining.
- – Drilling is the process of creating a circular hole in a solid object by pushing a spinning drill bit against it.
- – Turning is the process of shaping a spinning object using a cutting tool.
- – Milling is the process of removing material from a workpiece by advancing a cutter into it.

Joining



- Joining is the process of assembling numerous independent components into a bigger assembly. Joining, like machining, is a secondary process. Joining methods such as welding, riveting, brazing, soldering, and fastening are all distinct. Welding is a process that employs extremely high heat to weld disparate metal components together. Unlike soldering and brazing, welding causes the base metal to melt.
- – Welding is a manufacturing technique that fuses materials, often metals or thermoplastics, together with by melting them together and allowing them to cool.
- – Riveting: the technique of attaching structural components to one another with rivets, resulting in a permanently riveted junction.
- – Soldering is a joining technique that involves melting solder to connect several types of metals together.

Additive manufacturing

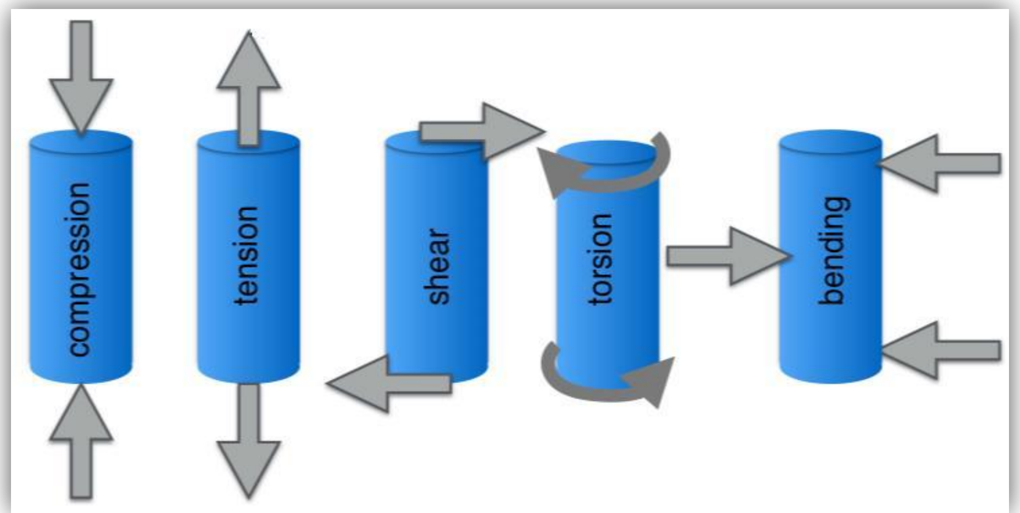
- Additive Manufacturing is a process that includes layering material to create the desired item. Additive manufacturing processes include 3D printing, selective laser sintering, and vat polymerization.
- – 3D printing: an object is successfully constructed layer by layer using a computer. 3D printing is a lengthy procedure with a restricted material selection. As a result, it is more frequently utilized for prototyping than mass manufacturing.
- – Selective laser sintering: an additive manufacturing process that utilizes a laser to sinter powdered material by autonomously directing the laser at places in space described by a 3D model, therefore bonding the material together to form a solid structure.

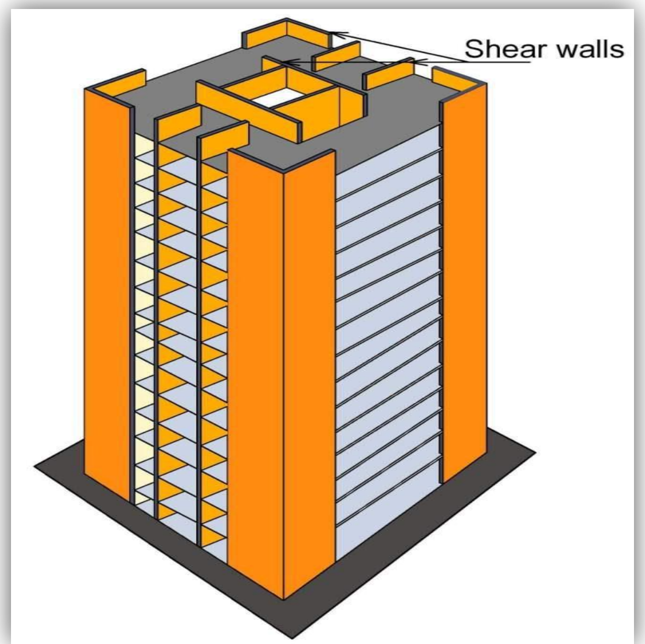
MECHANICAL PROPERTIES OF MATERIAL

The mechanical properties of materials **define the behavior of materials under the action of external forces called loads**.

1.STRENGTH

Strength of a material may be defined as the ability to sustain loads without failure or distortion. Material should have adequate strength when subjected to tension, compression, shear, etc.



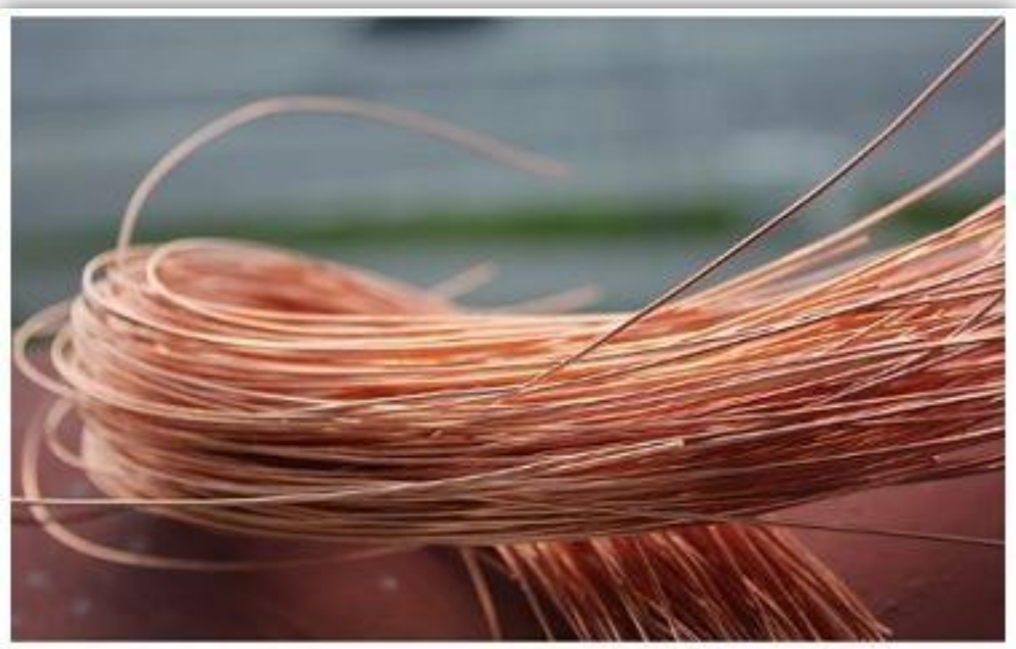


2.STIFFNESS

Stiffness is the capacity of a mechanical system to sustain external loads without excessive changes of its geometry (deformations). It is one of the most important design criteria for mechanical components and systems.

3.ELASTICITY

Elasticity, ability of a deformed material body to return to its original shape and size when the forces causing the deformation are removed. A body with this ability is said to behave (or respond) elastically.

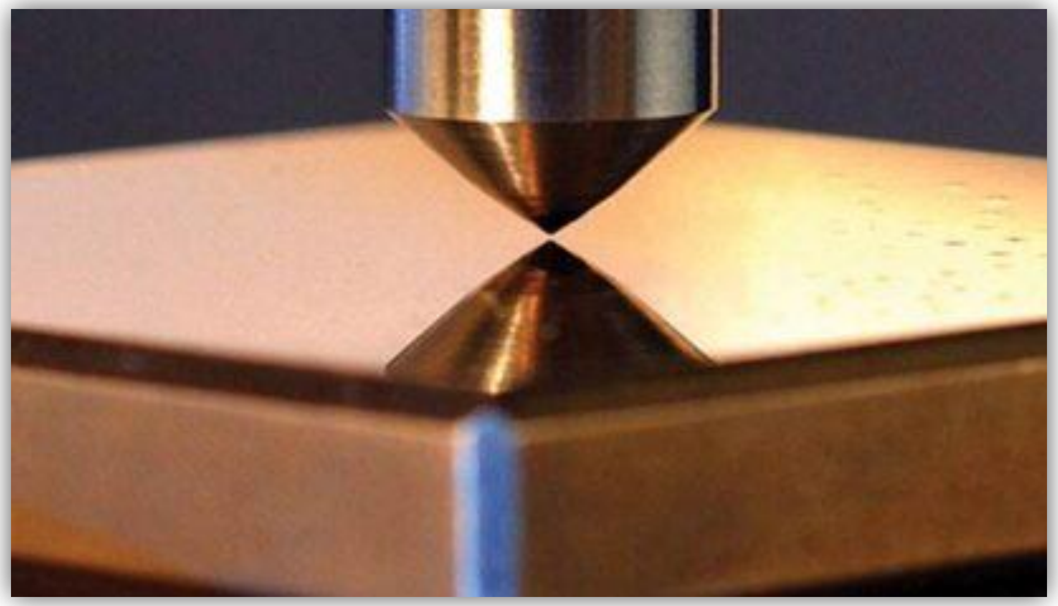


4.DUCTILITY

Ductility is the ability of a material to sustain a large permanent deformation under a tensile load up to the point of fracture, or the relative ability of a material to be stretched plastically at room temperature without fracturing.

5.MALLEABILITY

Malleability is the physical property of a solid to bend or be hammered into another shape without breaking. If malleable, a material may be flattened into a thin sheet by hammering or rolling

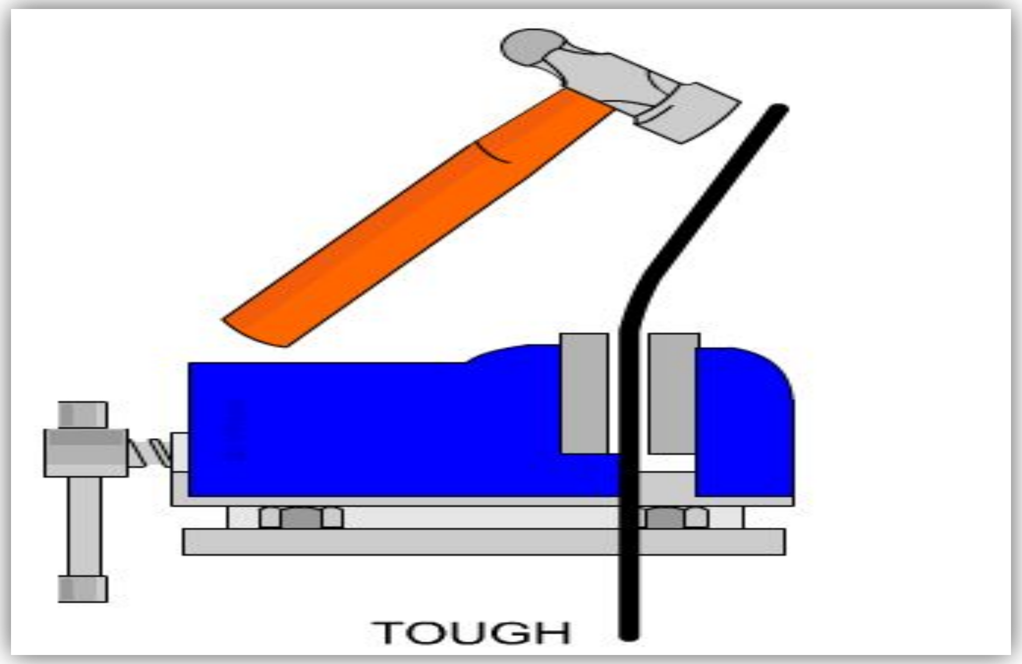


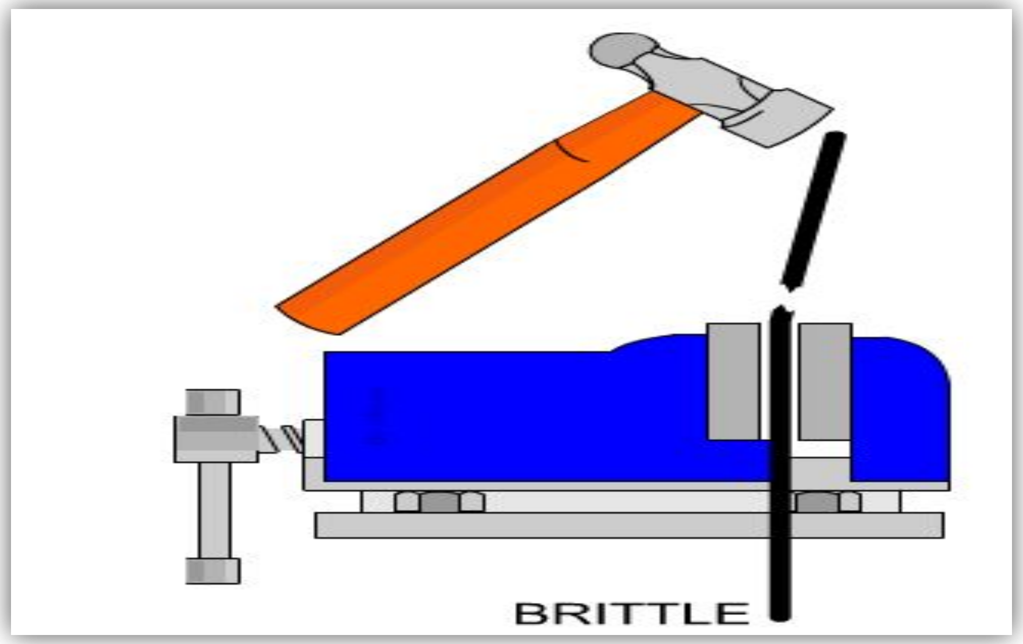
6.HARDNESS

Hardness is the resistance of a material to localised plastic deformation. Hardness ranges from super hard materials such as diamond, boron-carbide to other ceramics and hard metals to soft metals and down to plastics and soft tissues.

7.TOUGHNESS

Toughness is the strength with which the material opposes rupture. One definition of material toughness is the amount of energy per unit volume that a material can absorb before rupturing.

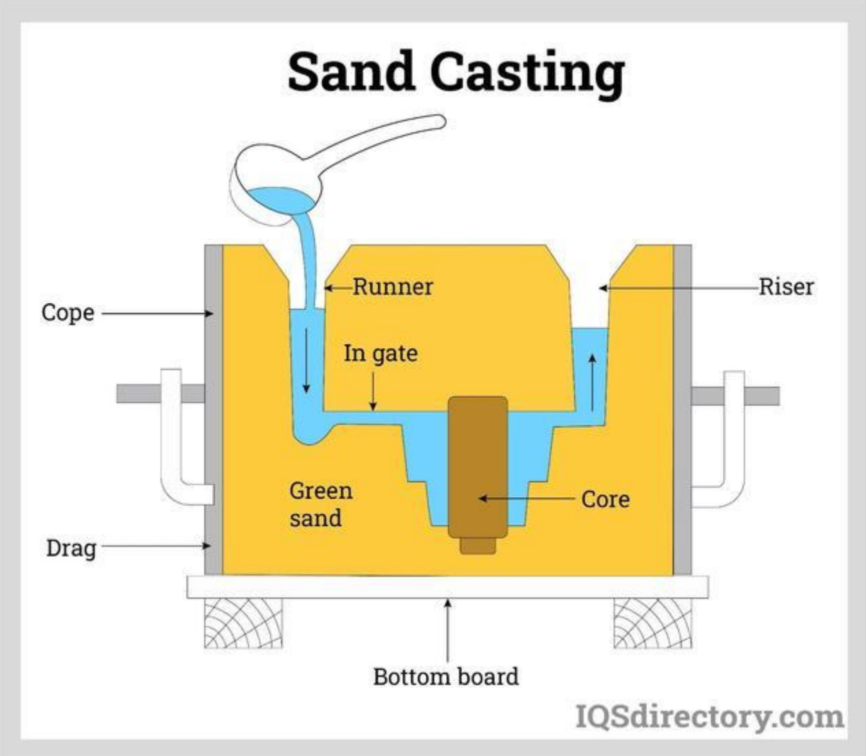




8.BRITTLENESS

Brittleness describes the property of a material that fractures when subjected to stress but has a little tendency to deform before rupture. Brittle materials are characterized by little deformation, poor capacity to resist impact and vibration of load, high compressive strength, and low tensile strength.

SAND CASTING



Sand casting, also known as sand molded casting, is a metal casting process characterized by using sand as the mold material. The term "sand casting" can also refer to an object produced via the sand casting process. Sand castings are produced in specialized factories called foundries. Over 60% of all metal castings are produced via sand casting process.

SAND MOULDS

A sand moulds may be defined as-a preformed sand container into which molten metal is poured and allowed to solidify. After casting it is removed from the sand mould, sand mould is generally destroyed. The moulds is filled by pouring the molten metal into an opening at the top of the mould and proper passages are made to allow the metal to flow to all the parts of the mould by gravity.

TYPES OF PATTERN

1. **Solid or single piece pattern**

- A pattern that is made without joints, parting or any loose pieces - called a single piece or solid pattern.
- It is not recommended except for limited production like large and small size castings of simple shapes.

2. **Split pattern**

- Most widely used type of pattern for intricate castings.
- Used When The depth of the casting is too high.
- The pattern is split into two parts.
- The two halves of the pattern should be aligned by making use of the dowel pins.

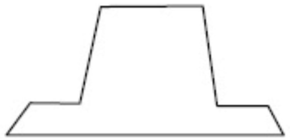
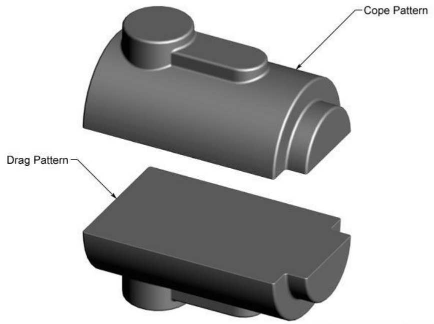
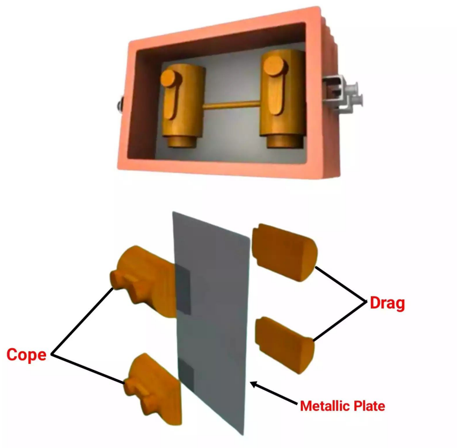


Fig. 10.1 Single piee pattern



3. Match plate pattern

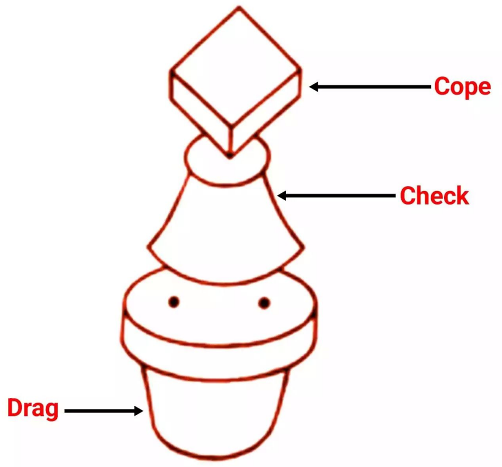
- Patterns are made in two pieces one piece mounted on one side and the other on other side of plate called match plate.
- Plate may carry one or group of patterns mounted on match plate.
- Along with pattern gates and runners are also attached.
- Produces accurate castings at faster rates.



Match Plate Pattern

4. Multi-piece pattern

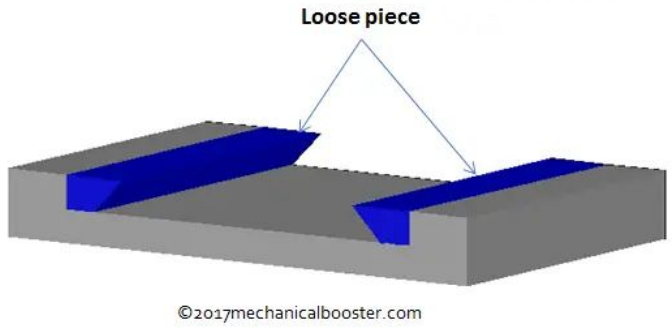
- Pattern is split into more than two parts.
- Facilitates an easy moulding and withdrawal of pattern.
- Pattern may consists 3,4 or more numbers depending
- Used in Lap joints, Dowel joints.



Multi-Piece Pattern

5. Loose piece pattern

- Used when:
- Withdrawal of pattern from mould is not possible.
- Castings is having projections, undercuts and etc.



Loose Piece Pattern

- The obstructing part of the contour is held as loose piece by a wire.
- After the molding -the main part is removed -loose pieces are recovered through the gap.
- Patterns consists of loose pieces for easy withdrawal, These loose pieces form integral part of pattern during molding, After mold is complete pattern is withdrawn leaving this loose pieces.

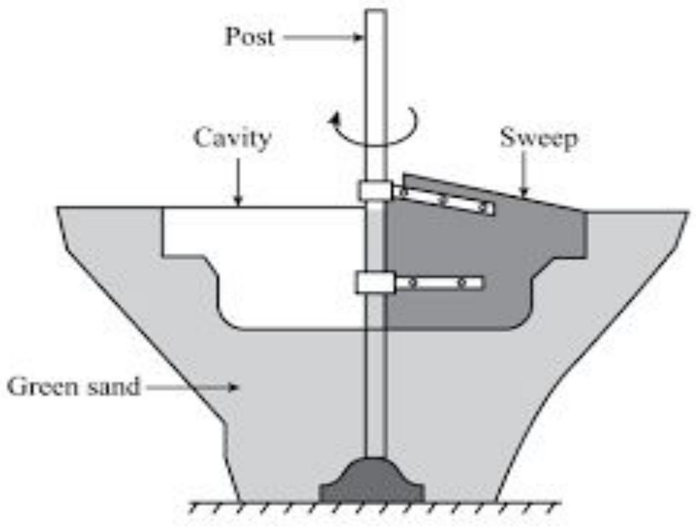
APPLICATIONS: Pattern having projections or hanging parts, Rotor hub, Axel pin.

6. Sweep pattern

- It is generally used for preparing large symmetrical castings.
- It is made on wooden board and its sweeps the sand in casting shape all around the circumference.
- Hence it saves lot of labour and time.
- It is used for production of large circular sections and symmetrical s

APPLICATIONS: Symmetrical shapes such as wheels, rims, large kettles

cast irons & bell shapes.



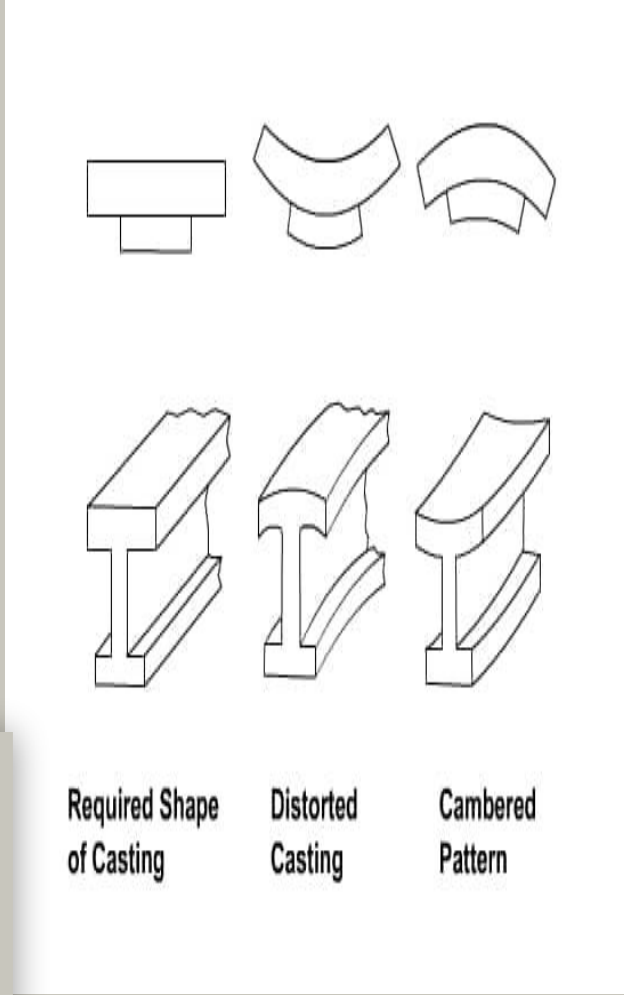
PATTERN MATERIALS

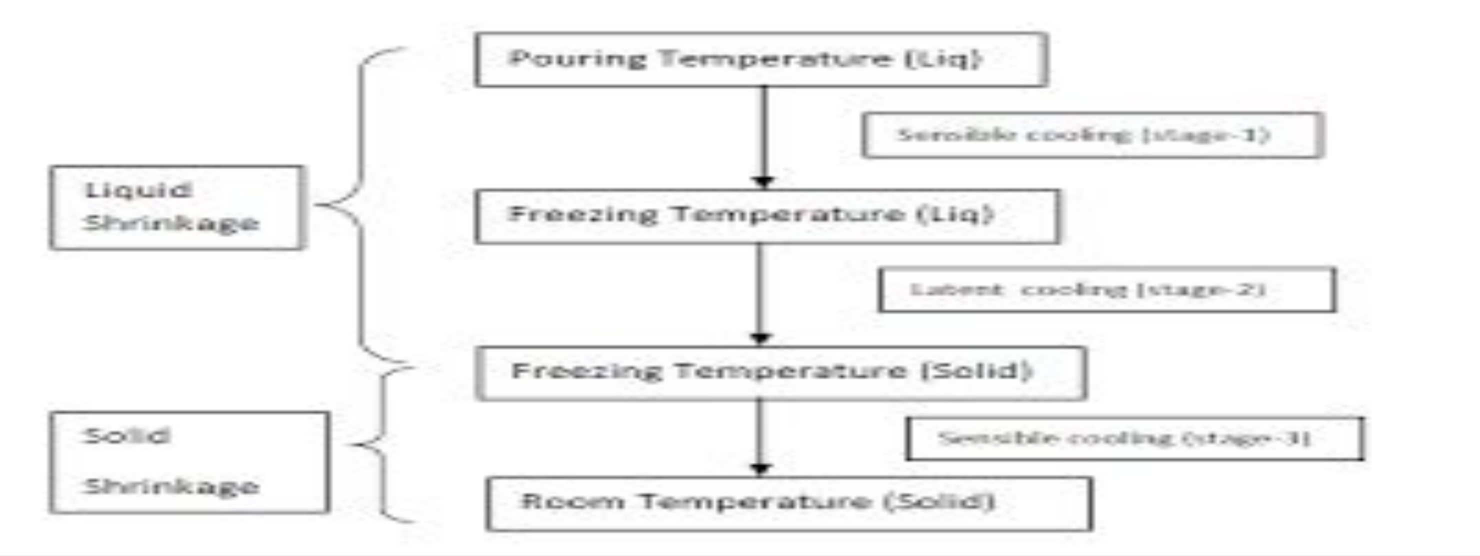
The top and bottom halves of a sand casting mould showing the cavity prepared by patterns. Cores to accommodate holes can be seen in the bottom half of the mould, which is called the *drag*. The top half of the mould is called the *cope*.

- Typically, materials used for pattern making are wood, metal or plastics. Wax and Plaster of Paris are also used, but only for specialized applications. Sugar pine wood is the most commonly used material for patterns, primarily because it is soft, light, and easy to work. Honduras mahogany was used for more production parts because it is harder and would last longer than pine. Once properly cured, it is about as stable as any wood available, not subject to warping or curling. Once the pattern is built, the foundry does not want it changing shape.

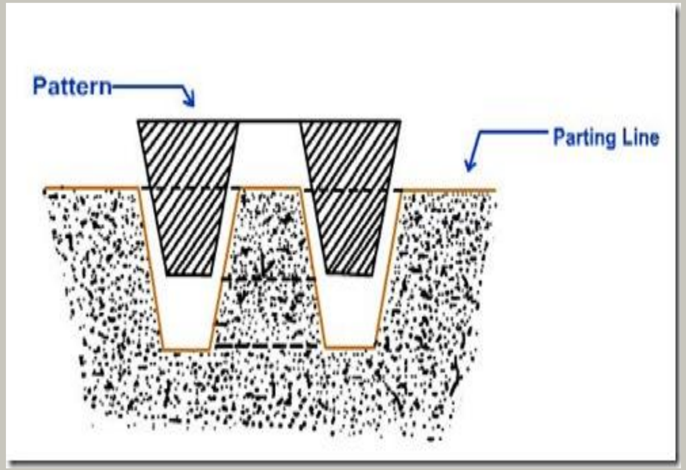
Pattern allowances

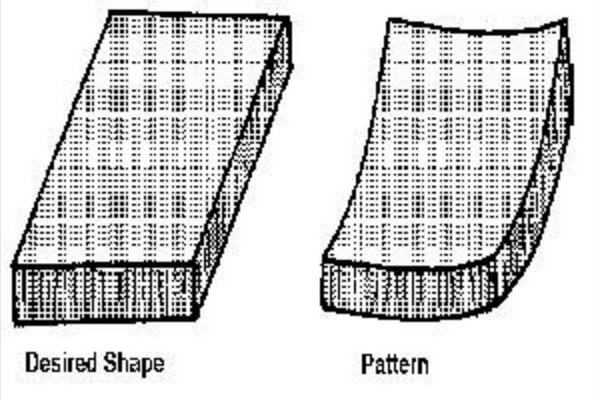
- A pattern is a replica of casting which is used to make a mold cavity but it has slightly large dimensions.
- This change in the pattern is due to when the cast solidifies, it shrinks at some limit due to metal shrinkage property at the time of cooling.
- So to compensate for this, a pattern is made a little bigger.
- These slight changes in the pattern are known as pattern allowance.





Types of Pattern Allowances





- There are the following types of pattern allowances are used in the casting process.
- **Shrinkage Allowance**: Shrinkage is defined as the reduction during the cooling or solidification process.
- **Draft Allowance**: During removing the pattern from the mold cavity, the parallel surfaces in the direction in which the pattern is withdrawn are slightly damaged and also converted into slightly tapered surfaces.
- **Machining Allowance** :As we know that the product of the casting process gives a very poor surface finish, so the surface of the final product of casting always is rough.
- **Deformation or Camber Allowance**: When the metal is in the cooling process, stress is developed during the solidifying of this metal due to uneven metal thickness in the casting process.
- **Shake or Rapping Allowance**: a slight shake is required to remove the pattern from the sand and this will increase the dimension of the casting slightly.

Moulding Sand

- Moulding sand, also known as foundry sand, is a sand that when moistened and compressed or oiled or heated tends to pack well and hold its shape. It is used in the process of sand casting for preparing the mold cavity.
- Sand used to manufacture a mould for casting process is held by mixture of sand and clay.
- A typical mixture by volume could be 89% sand,

  7% clay and 4% water.

Types of Moulding sand

1. Green sand
2. Dry sand
3. Loam sand
4. Parting sand
5. Facing sand

Green Sand

- Green sand is a mixture of silica sand and clay. It constitutes 18 % to 30 % clay and 6 % to 8 % water.
- The water and clay present is responsible for furnishing bonds for the green sand.
- It is slightly wet when squeezed with hand and has the ability to retain the shape and impression given to it under pressure.
- It is easily available and has low cost.
- It is commonly used for producing ferrous and non-ferrous castings

Dry Sand

- After making the mould in green sand, when it is dried or baked is called dry sand.
- It is suitable for making large castings.
- The moulds which is prepared in dry sand is known as dry sand moulds.
- If we talk about the physical composition of the dry sand, than it is same as that of the green sand except water.

Loam Sand

- It is a type of moulding sand in which 50 % of clay is present.
- It is mixture of sand and clay and water is present in such a quantity, to make it a thin plastic paste.
- In loam moulding patterns are not used.
- It is used to produce large casting.

Parting Sand

- Parting sand is used to prevent the sticking of green sand to the pattern and also to allow the sand on the parting surface of the cope and drag to separate without clinging.
- It serves the same purpose as of parting dust.
- It is clean clay free silica sand.

Facing Sand

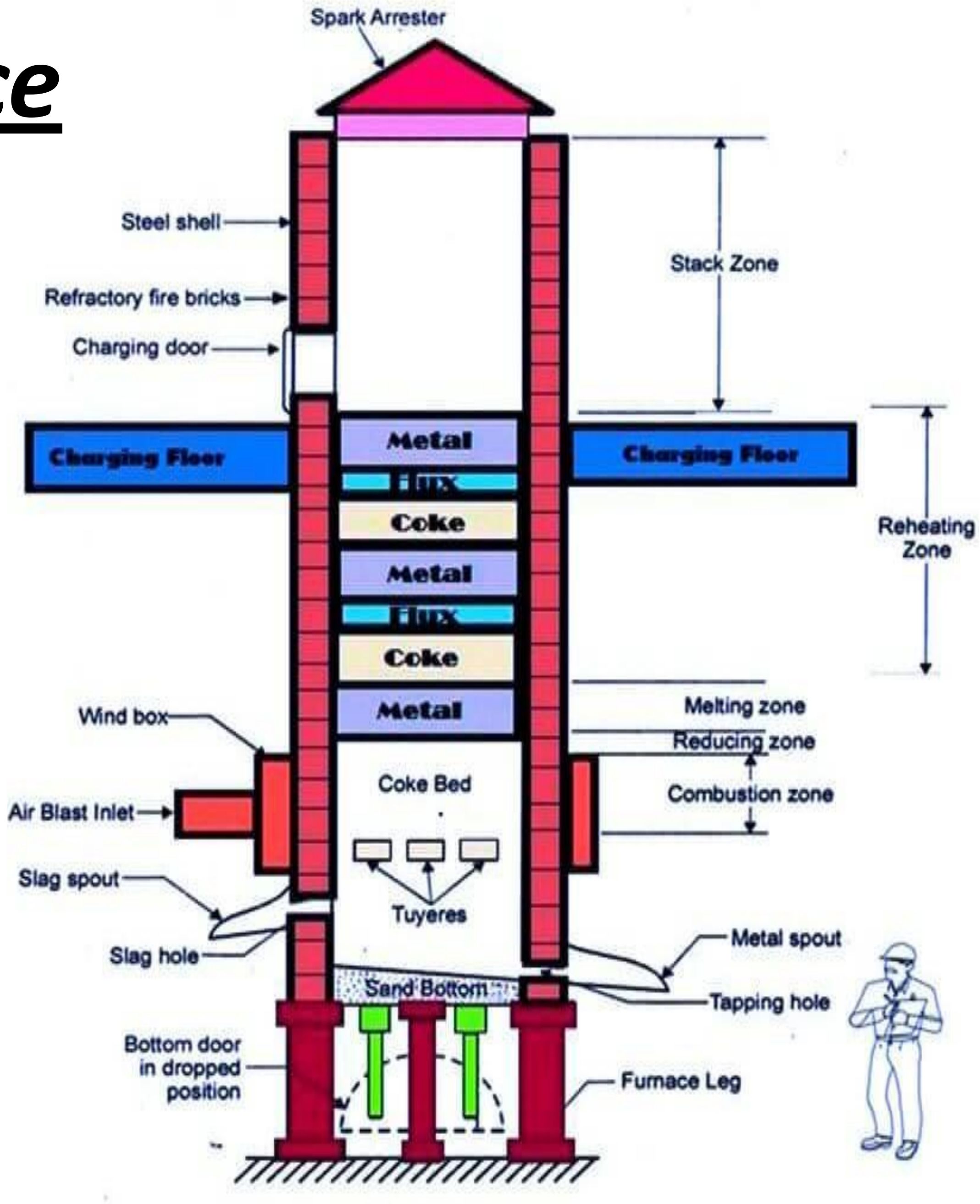
- The face of the mould is formed by facing sand.
- Facing sand is used directly next to the surface of the pattern and it comes in direct contact with the molten metal, when the molten metal is poured into the mould.
- It possesses high strength and refractoriness as it comes in contact with the molten metal.
- It is made of clay and silica sand without addition of any used sand.

Cupola furnace description

A cupola furnace is a type of melting furnace commonly used for casting metals such as iron, steel, and brass. It consists of a cylindrical, refractory-lined chamber with multiple tuyeres (small openings) near the base through which air is blown to support combustion. The charge (raw materials) is melted by the heat generated from burning coke or other fuels, and the molten metal is then tapped off at the bottom of the furnace through a tapping spout. The cupola furnace is known for its ability to produce large amounts of molten metal in a single batch and its relatively low cost of operation.

Operations of Cupola furnace

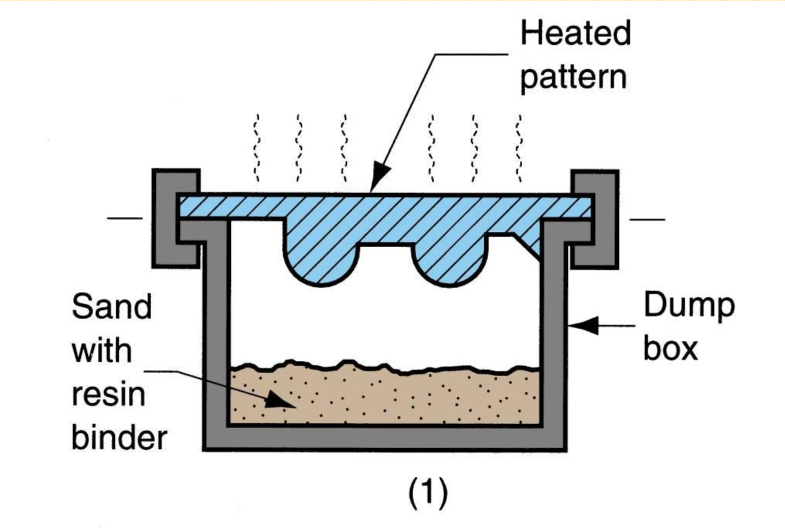
- The cupola is charged with wood at the bottom.
- On the top of the wood a bed of coke is built.
- Alternating layers of metal and ferrous alloys, coke, and limestone are fed into the furnace from the top.
- The purpose of adding flux is to eliminate the impurities and to protect the metal from oxidation.
- Air blast is opened for the complete combustion of coke.
- When sufficient metal has been melted that slag hole is first opened to remove the slag. Tap hole is then opened to collect the metal in the ladle.



Cupola furnace

SHELL MOLDING

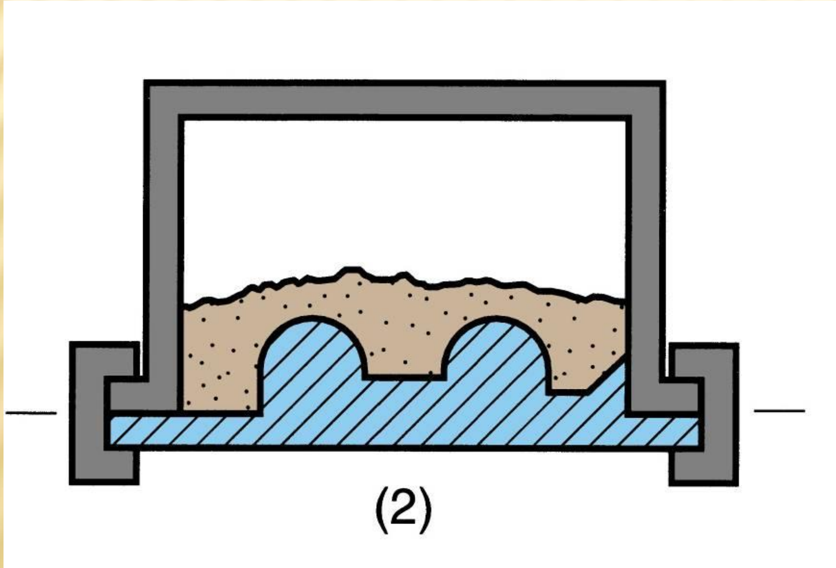
Casting process in which the mold is a thin shell of sand held together by thermosetting resin binder

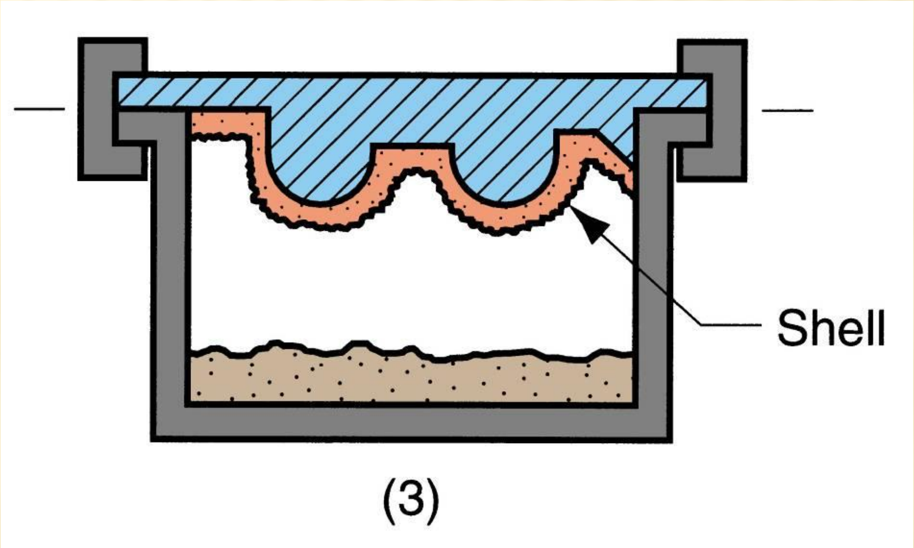


Steps in shell-molding: (1) a match-plate or cope-and-drag metal pattern is heated and placed over a box containing sand mixed with thermosetting resin.

SHELL MOLDING

Steps in shell-molding: (2) box is inverted so that sand and resin fall onto the hot pattern, causing a layer of the mixture to partially cure on the surface to form a hard shell; (3) box is repositioned so that loose uncured particles drop away;





SHELL MOLDING

- Steps in shell-molding: (4) sand shell is heated in oven for several minutes to complete curing; (5) shell mold is stripped from the pattern;
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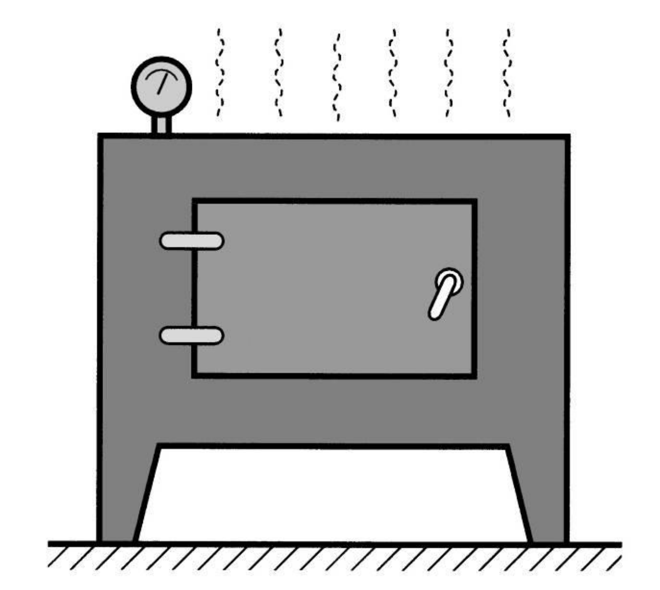

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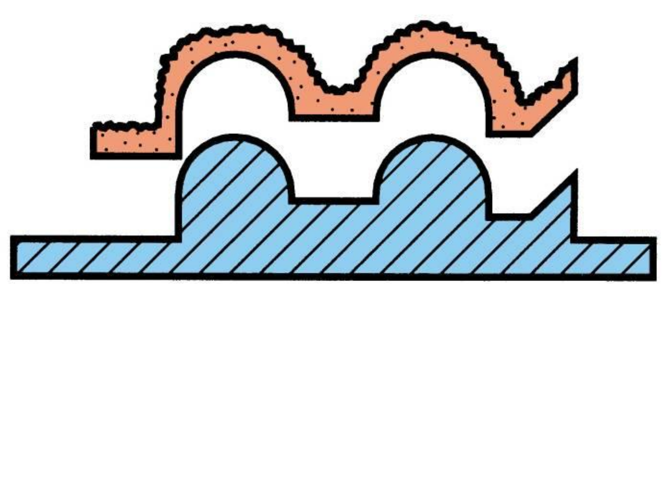

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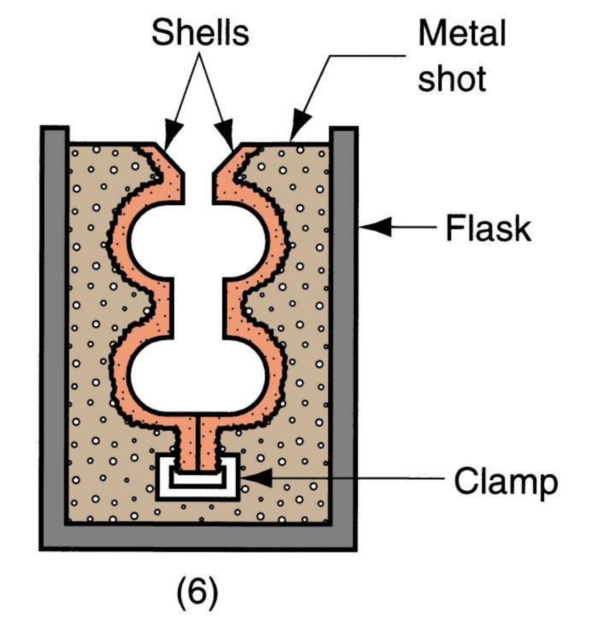
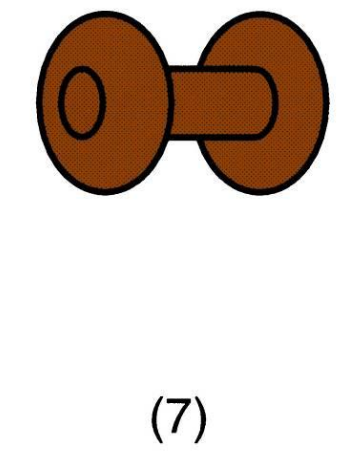
SHELL MOLDING





Steps in shell-molding: (6) two halves of the shell mold are assembled, supported by sand or metal shot in a box, and pouring is accomplished; (7) the finished casting with sprue removed.

ADVANTAGES AND DISADVANTAGES

- Advantages of shell molding:
  - Smoother cavity surface permits easier flow of molten metal and better surface finish
  - Good dimensional accuracy - machining often not required
  - Mold collapsibility minimizes cracks in casting
  - Can be mechanized for mass production
- Disadvantages:
  - More expensive metal pattern
  - Difficult to justify for small quantities

DIE CASTING

A permanent mold casting process in which molten metal is injected into mold cavity under high pressure

- Pressure is maintained during solidification, then mold is opened and part is removed
- Molds in this casting operation are called *dies*; hence the name die casting
- Use of high pressure to force metal into die cavity is what distinguishes this from other permanent mold processes

DIE CASTING MACHINES

- Designed to hold and accurately close two mold halves and keep them closed while liquid metal is forced into cavity
- Two main types:

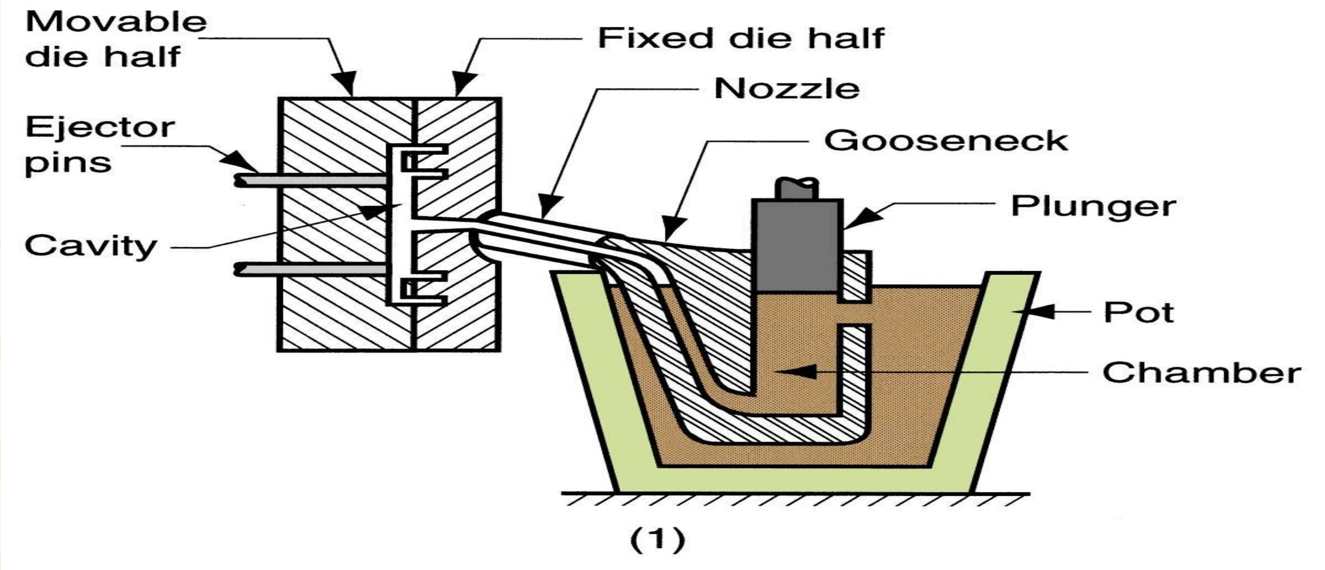
1. Cold-chamber machine
2. Hot-chamber machine

HOT-CHAMBER DIE CASTING

Metal is melted in a container, and a piston injects liquid metal under high pressure into the die

- High production rates - 500 parts per hour not uncommon
- Applications limited to low melting-point metals that do not chemically attack plunger and other mechanical components
- Casting metals: zinc, tin, lead, and magnesium

HOT-CHAMBER DIE CASTING



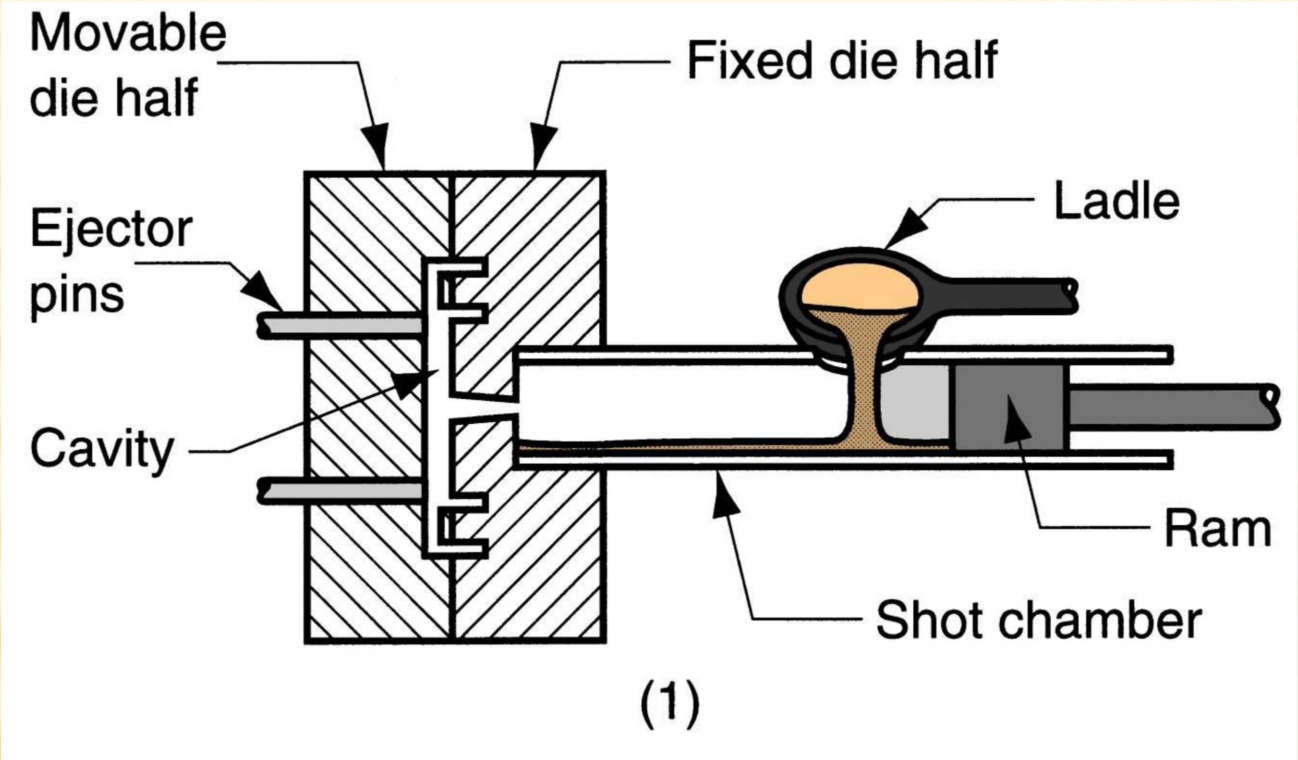
Cycle in hot-chamber casting: (1) with die closed and plunger withdrawn, molten metal flows into the chamber (2) plunger forces metal in chamber to flow into die, maintaining pressure during cooling and solidification.

COLD-CHAMBER DIE CASTING MACHINE

Molten metal is poured into unheated chamber from external melting container, and a piston injects metal under high pressure into die cavity

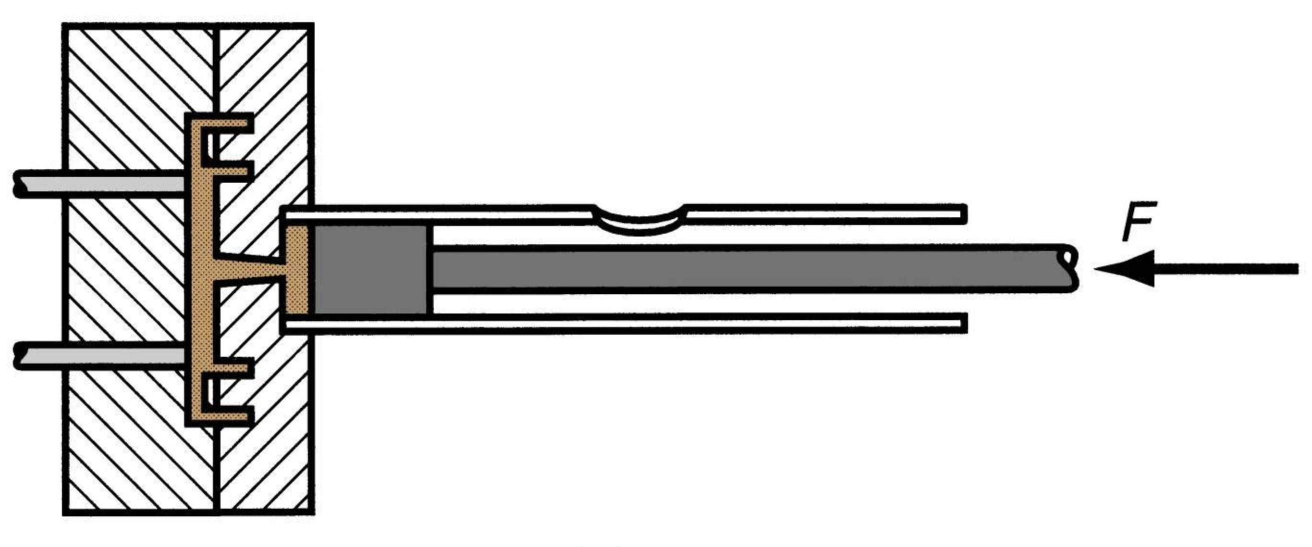
- High production but not usually as fast as hot-chamber machines because of pouring step
- Casting metals: aluminum, brass, and magnesium alloys
- Advantages of hot-chamber process favor its use on low melting-point alloys (zinc, tin, lead)

COLD-CHAMBER DIE CASTING



Cycle in cold-chamber casting: (1) with die closed and ram withdrawn, molten metal is poured into the chamber

COLD-CHAMBER DIE CASTING



(2)

Cycle in cold-chamber casting: (2) ram forces metal to flow into die, maintaining pressure during cooling and solidification.

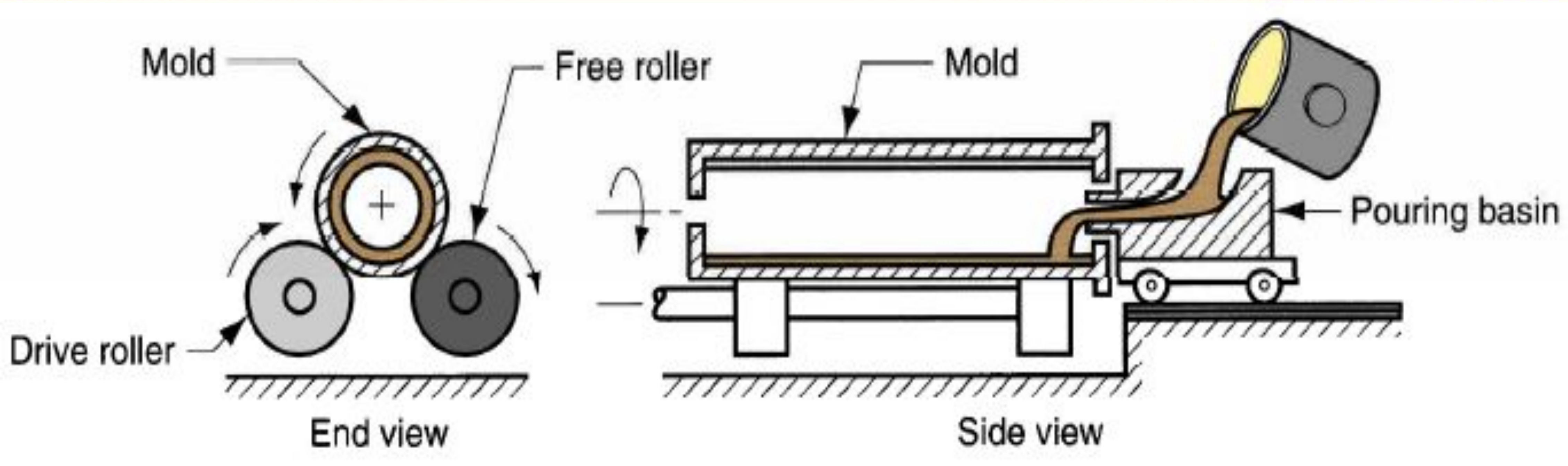
ADVANTAGES AND LIMITATIONS

- Advantages of die casting:
  - Economical for large production quantities
  - Good accuracy and surface finish
  - Thin sections are possible
  - Rapid cooling provides small grain size and good strength to casting
- Disadvantages:
  - Generally limited to metals with low metal points
  - Part geometry must allow removal from die

CENTRIFUGAL CASTING

- For centrifugal casting, molten metal is introduced into a mould that is rotated during solidification.
- The centrifugal force improves the feed and filling consistency achieving surface detail.
- This method has been specifically adapted to the production of cylindrical parts and eliminates the need for gates, risers and cores.
- The process is typically unsuitable for geometries that do not allow a linear flow-through of metal.

CENTRIFUGAL CASTING



Setup for true centrifugal casting

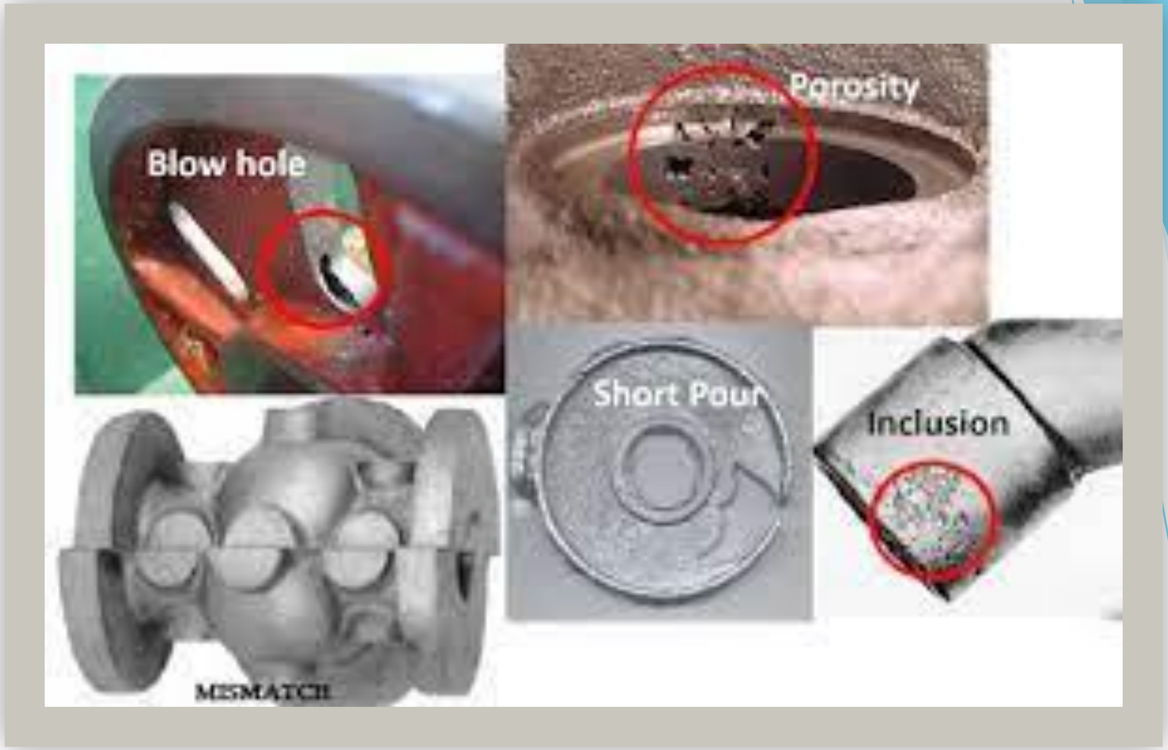
ADVANTAGES:

- Centrifugal casting improves homogeneity and accuracy in special circumstances.
- High surface finish.
- Eliminates the need for gating systems.
- High production rate.

Limitations:

- The process imposes limitations on the shape of castings, and is normally restricted to the production of cylindrical geometric shapes.
- Expensive set-up.

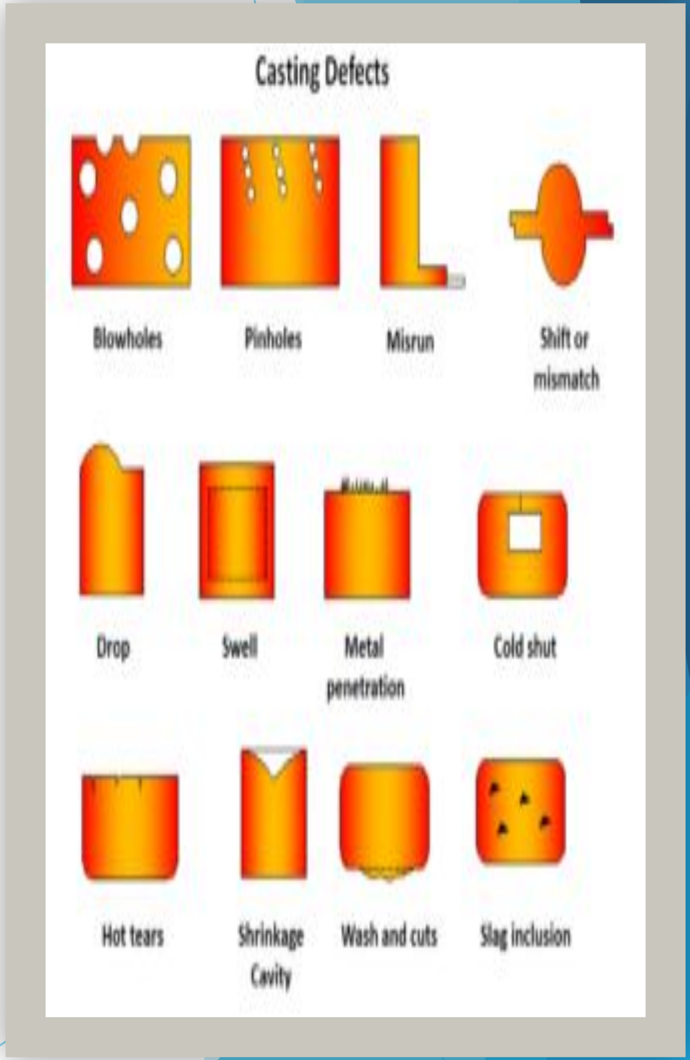
Casting defects



- It is an unwanted irregularities that appear in the casting during metal casting process. There is various reason or sources which is responsible for the defects in the cast metal. Here in this blog we will discuss all the major types of casting defects. Some of the defects produced may be neglected or tolerated and some are not acceptable, it must be eliminated for better functioning of the parts.

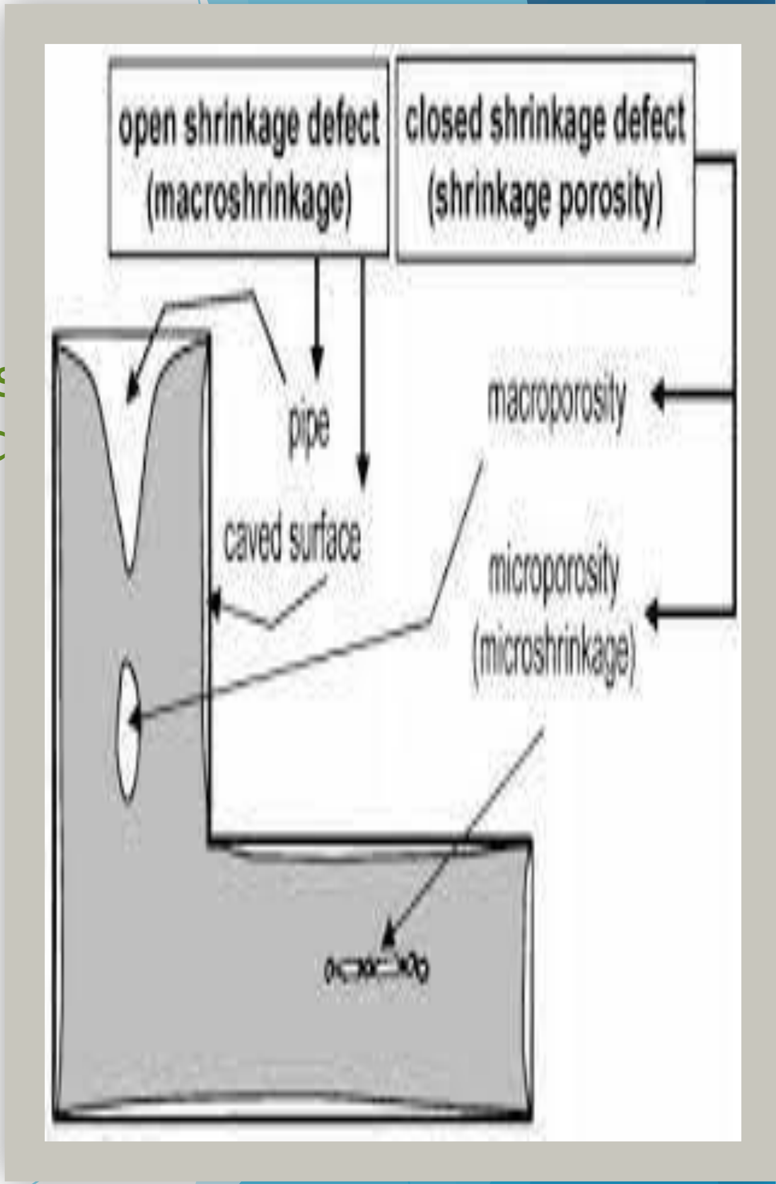
Types of casting defects

1. **Gas Porosity:** Blowholes, open holes, pinholes
2. **Shrinkage defects:** shrinkage cavity
3. **Mold material defects:** Cut and washes, swell, drops, metal penetration, rat tail
4. **Pouring metal defects:** Cold shut, misrun, slag inclusion
5. **Metallurgical defects:** Hot tears, hot spot.



CONCLUSION

- Knowledge of casting defects and causes is essential to managing casting quality.
- You should set clear defect tolerances and quality expectations with your suppliers before production to help them understand your quality standards.
- Defect tolerance can vary between products and types of casting defects. Determining your tolerance for these casting defects can help your supplier better understand your standards and prevent future misunderstandings and quality issues.
- Ultimately, the manufacturer must strictly control quality of each casting process. Experienced importers rely on quality control inspections to limit casting defects in their products before they leave the factory.



Thank You

UNIT-2

WELDING

LEADERS-ALOK JHA, ADITYA SINGH, AMAN RAJ, AMAN SINGH,AMAN MALIK

JOINING PROCESS - ADITYA SINGH(16)

WELDING - ADITYA TIWARI(17)

CLASSIFICATIONS OF WELDING - ADVIK DAYAL(18)

TYPES OF WELDING JOINTS - AGAM SINGHAL(19)

GAS WELDNG - AISHWARYA BHARTI(20)

GAS WELDING EQUIPMENTS - AKRITI SINGH (21)

ADVANTAGES DISADVANTAGES - ALINA MALIK(22)

ELECTRIC ARC WELDING - ALOK JHA (23)

TUNGSTEN INERT GAS WELDING - AMAN CHAUHAN (24)

METAL INERT GAS WELDING - AMAN MALIK (25)

SUBMERGED ARC WELDING - AMAN RAJ (26)

ELECTROSLAG WELDING - AMAN SINGH (27)

RESISTANCE WELDING - AMMAR ALI (28)

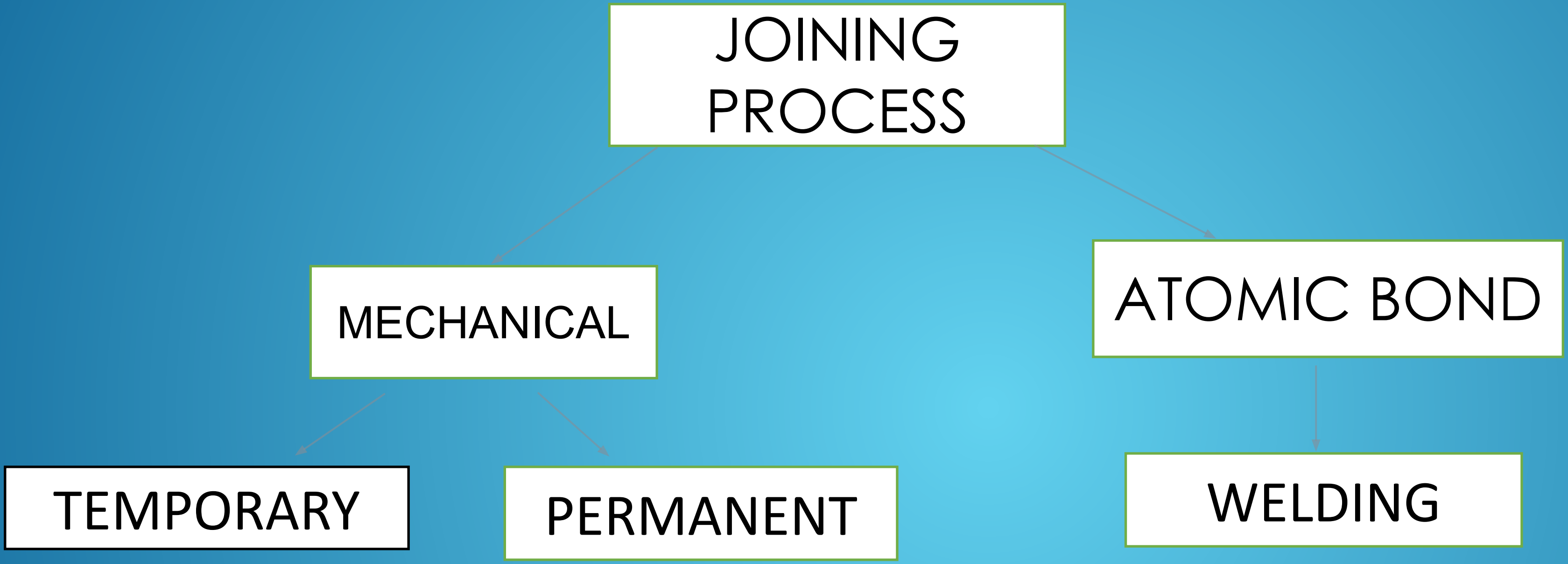
TYPES OF RESISTANCE WELDING - ANKIT RAJ (29)

WELDING DEFECTS - ANSHUL SINGH RAWAT(30)

JOINING PROCESS

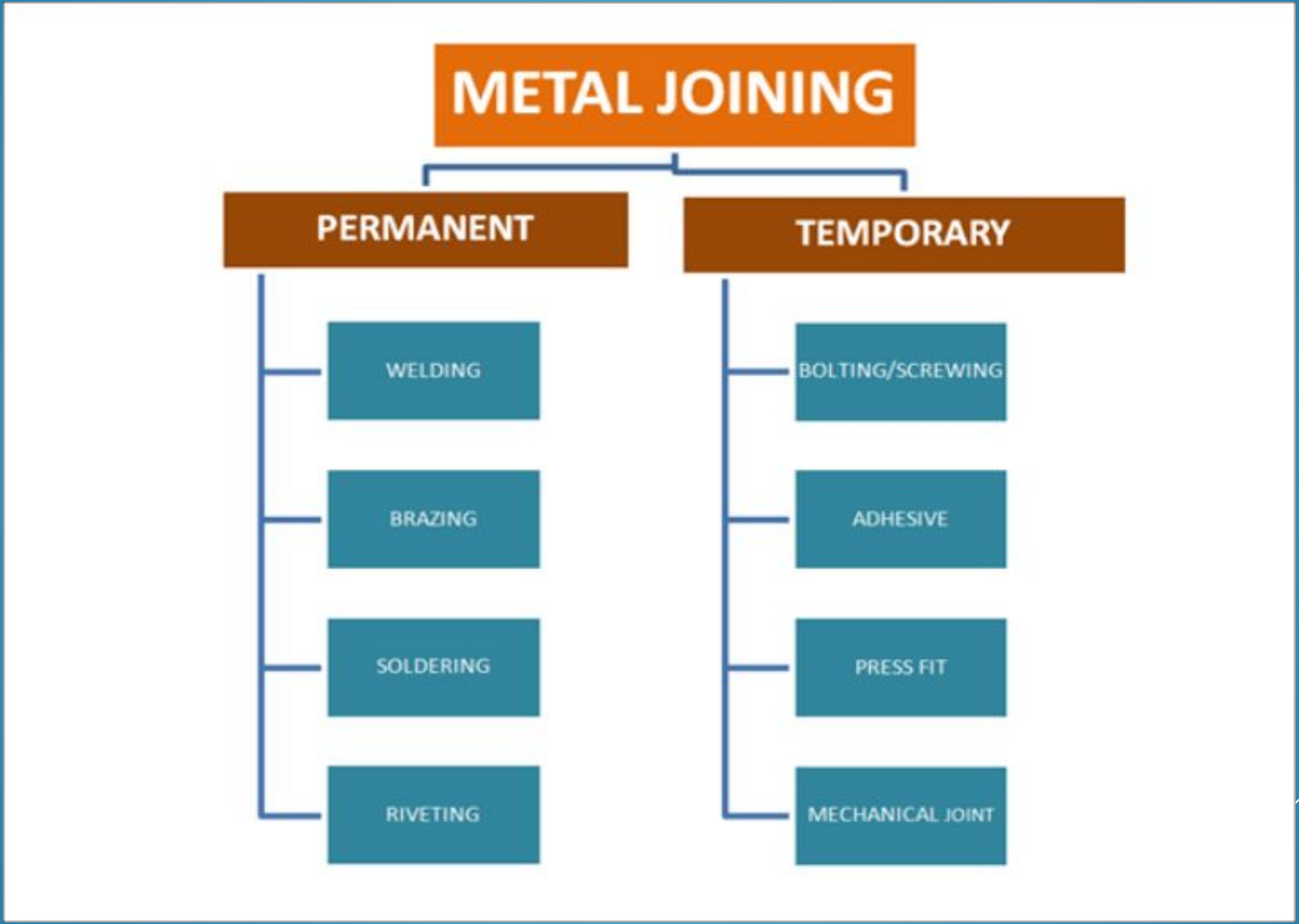
IT IS A PROCESS OF JOINING TWO SIMILAR AND DISSIMILAR METALS BY FUSION WITH OR WITHOUT USING THE APPLICATION OF PRESSURE AND WITH OR WITHOUT USING FILLER METAL.

THE FUSION OF METAL TAKES PLACE DUE TO HEAT THE HEAT CAN BE OBTAINED FROM ELECTRICAL ARC,CHEMICAL REACTION,FRICTION ETC



WELDING IS A ATOMIC BOND PROCESS AND HAVE METALLURGICAL BOND.

METALLURGICAL BOND IS ACCOMPLANISHED BY ATTRACTING FORCES BETWEEN ATOMS

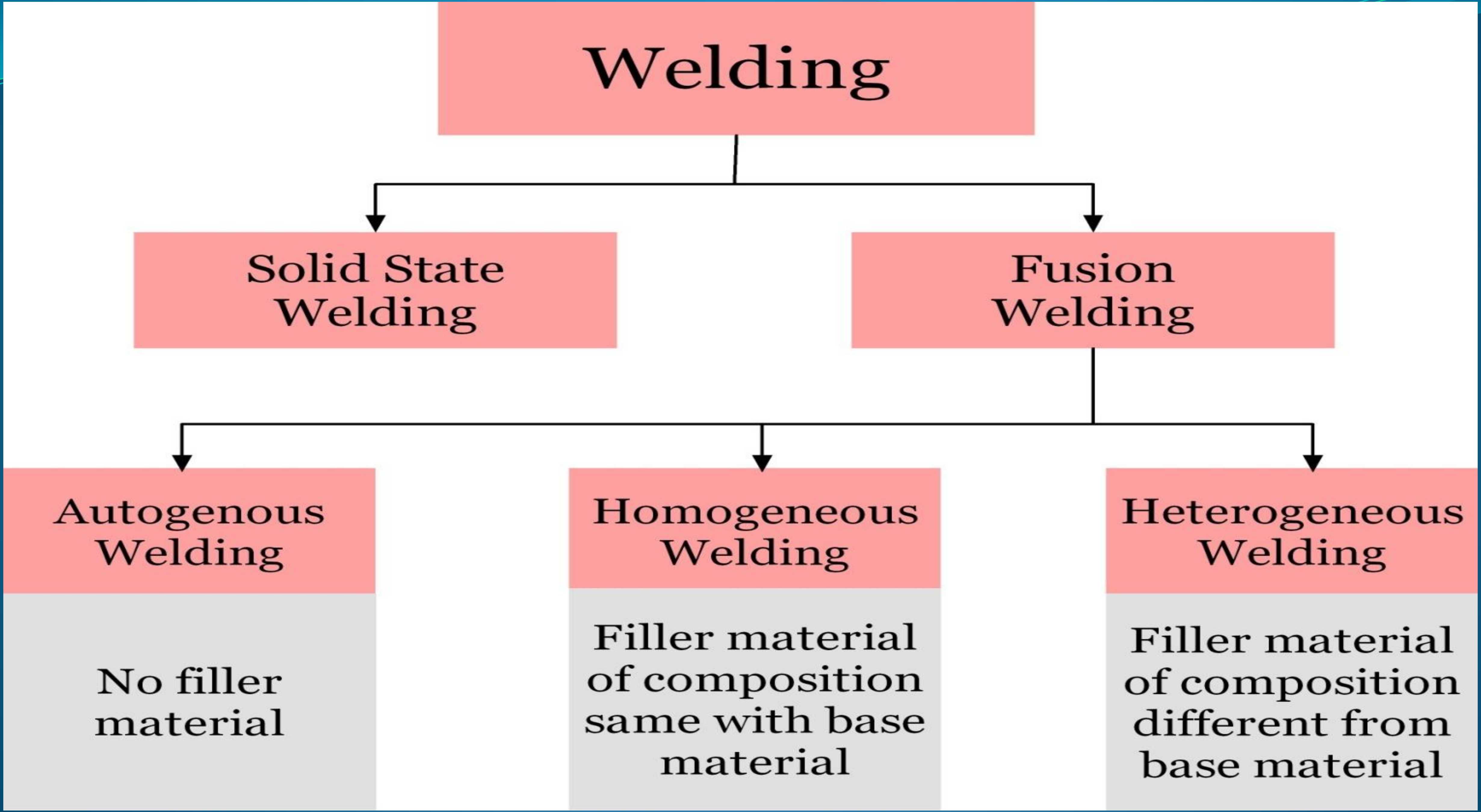

METAL JOINING
PERMANENT
TEMPORARY
WELDING
BRAZING
SOLDERING
RIVETING
BOLTING/SCREWING
ADHESIVE
PRESS FIT
MECHANICAL JOINT

WELDING

BY: ADITYA TIWARI

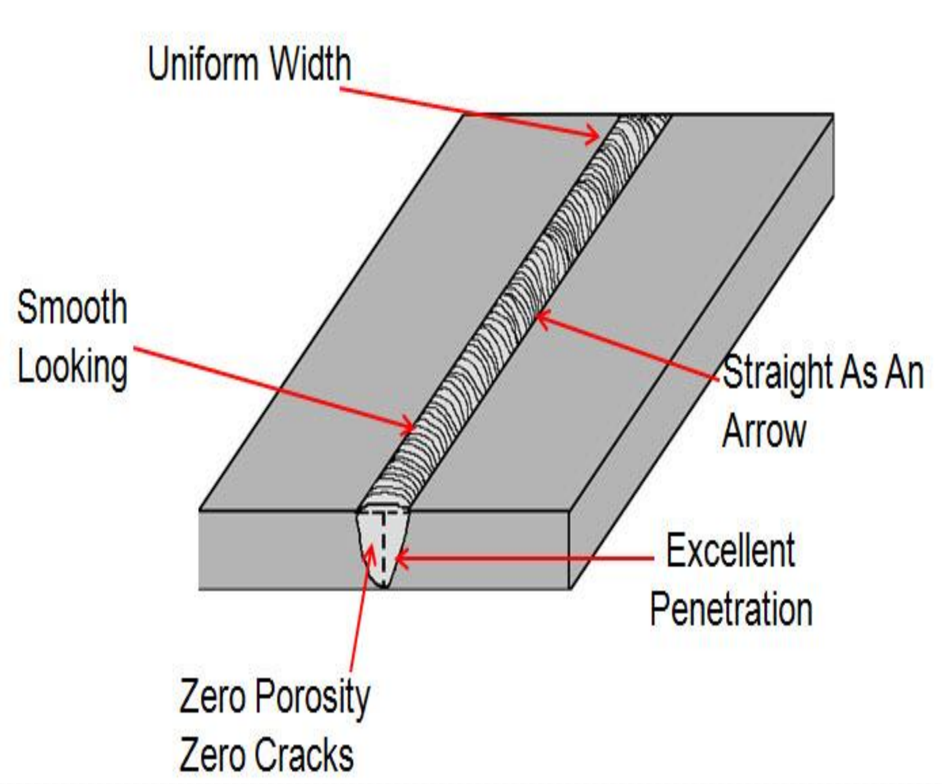
IMPORTANT TERMS USED IN WELDING

- *HOMOGENEOUS WELDING*
- *HETROGENEOUS WELDING*
- *AUTOGENEOUS WELDING*
- *BEAD*


Welding
Solid State Welding
Fusion Welding
Autogenous Welding
Homogeneous Welding
Heterogeneous Welding
No filler material
Filler material of composition same with base material
Filler material of composition different from base material

BEAD

- **A weld bead is created by depositing a filler material into a joint between two pieces of metal. As you melt a filler material into the workpiece, how you move the torch will impact how you advance the puddle and the type of bead you leave in the joint.**



CLASSIFICATION OF WELDING

What is welding?

- *Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool. Welding is usually used on metals and thermoplastics but can also be used on wood.*

Types of welding processes

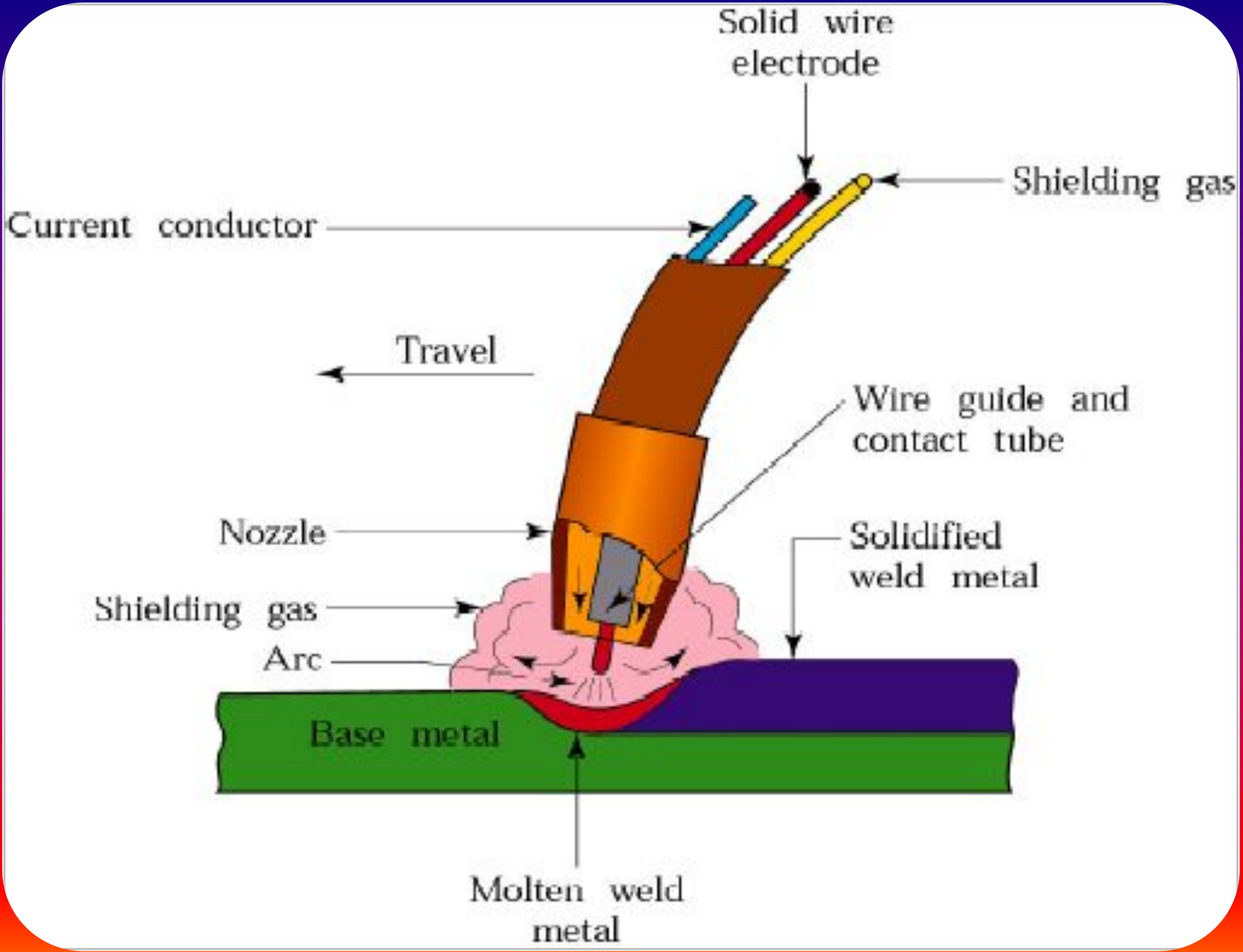
The four main types of welding are-

- Gas Metal Arc Welding (GMAW/MIG)
- Gas Tungsten Arc Welding (GTAW/TIG)
- Shielded Metal Arc Welding (SMAW)
- Flux Cored Arc Welding (FCAW)

Gas Metal Arc Welding

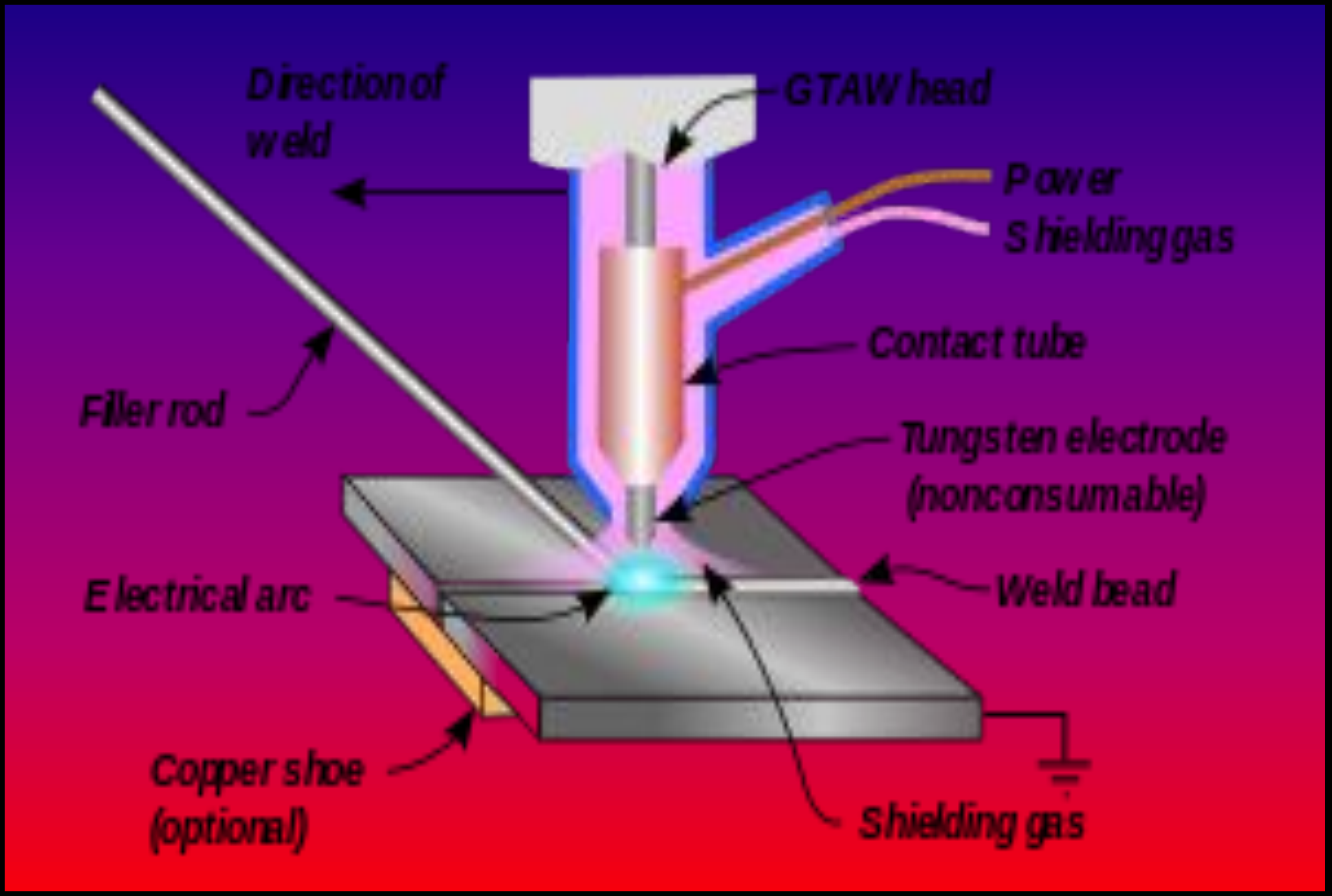
- *Gas metal arc welding is a welding process in which an electric arc forms between a consumable MIG wire electrode and the workpiece metals, which heats the workpiece metals, causing them to fuse*
- *A constant voltage, direct current power source is most commonly used with GMAW*

.


Solid wire electrode
Shielding gas
Current conductor
Travel
Wire guide and contact tube
Nozzle
Solidified weld metal
Shielding gas
Arc
Base metal
Molten weld metal

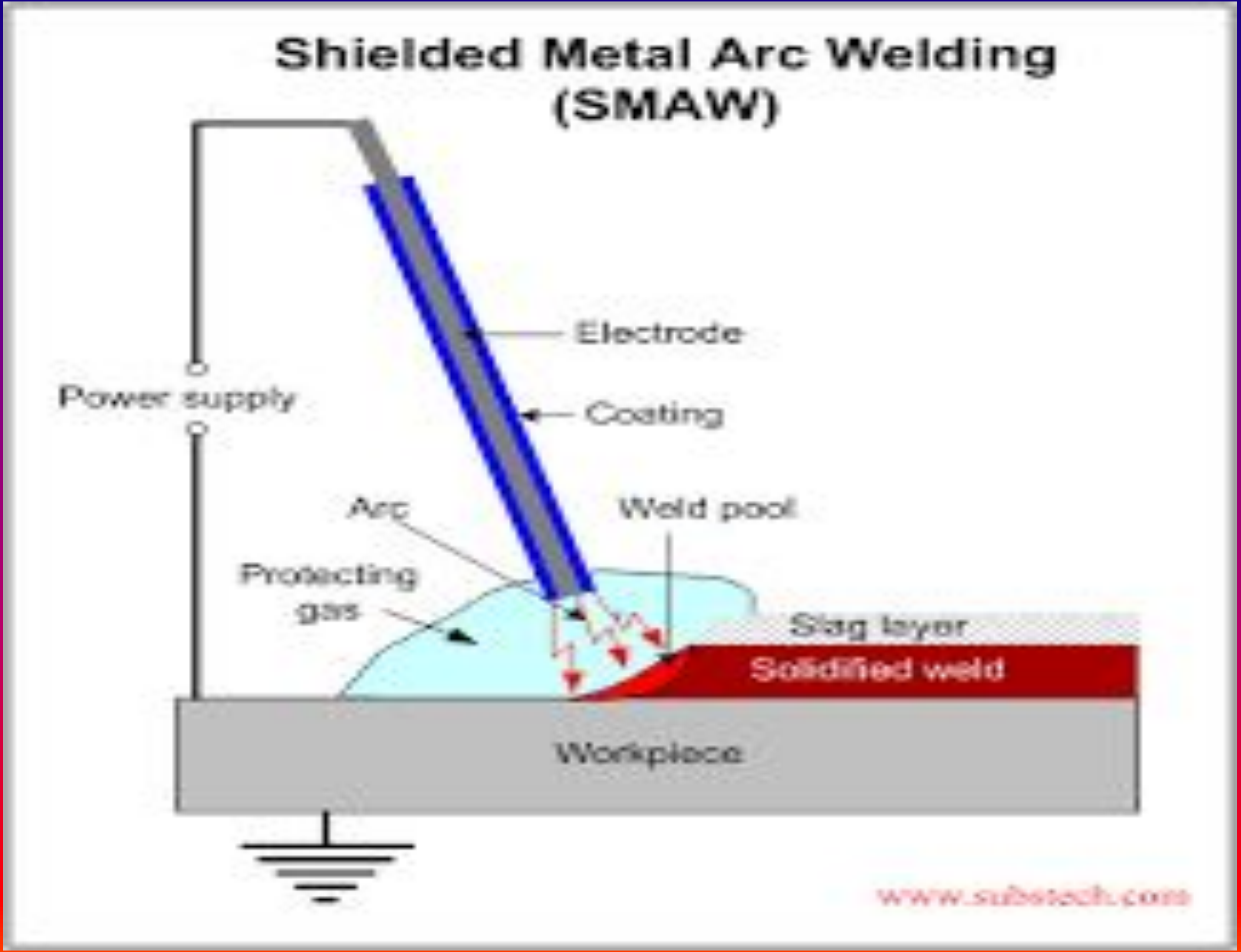
Gas Tungsten Arc Welding

- *Gas tungsten arc welding also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld.*
- *The weld area and electrode are protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium).*


Direction of weld
GTAW head
Power
Shielding gas
Contact tube
Filler rod
Tungsten electrode (nonconsumable)
Electrical arc
Weld bead
Copper shoe (optional)
Shielding gas

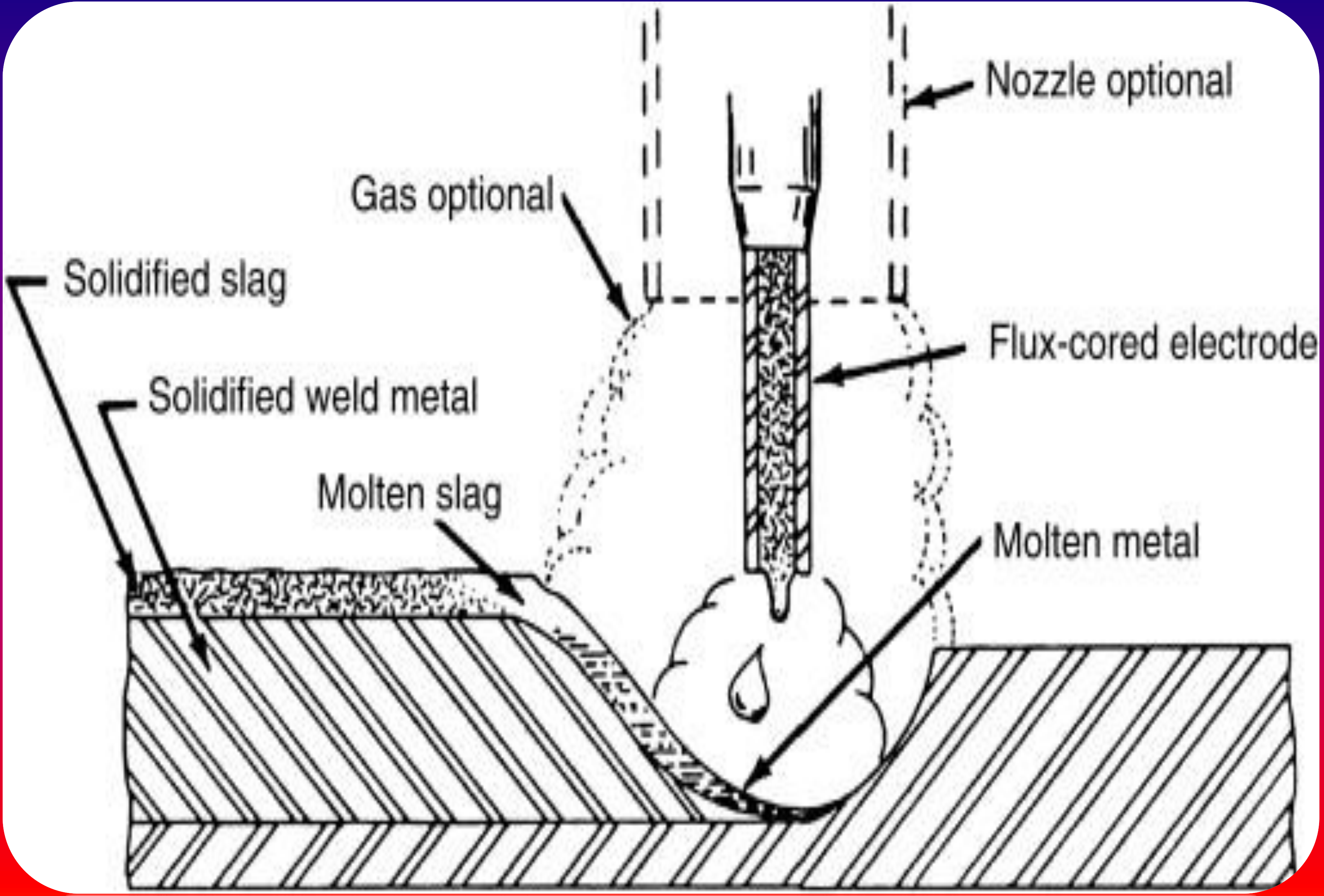
Shielded Metal Arc Welding

- *Shielded metal arc welding (SMAW), also known as manual metal arc welding, is* ***a manual arc welding process that uses a consumable and protected electrode****.*
- *As the electrode melts, a cover that protects the electrode melts and protects the weld area from oxygen and other atmospheric gases.*


Shielded Metal Arc Welding
(SMAW)
Electrode
Power supply
Coating
Arc
Weld pool
Protecting
gas
Slag layer
Solidified weld
Workpiece
www.substech.com

Flux Cored Arc Welding

- *Flux cored arc welding* ***uses heat generated by an electric arc to fuse base metal in the weld joint area****. This arc is struck between the metallic workpiece and the continuously-fed tubular cored consumable filler wire, with both the wire and the metallic workpiece melting together to form a weld joint.*


Nozzle optional
Gas optional
Solidified slag
Flux-cored electrode
Solidified weld metal
Molten slag
Molten metal

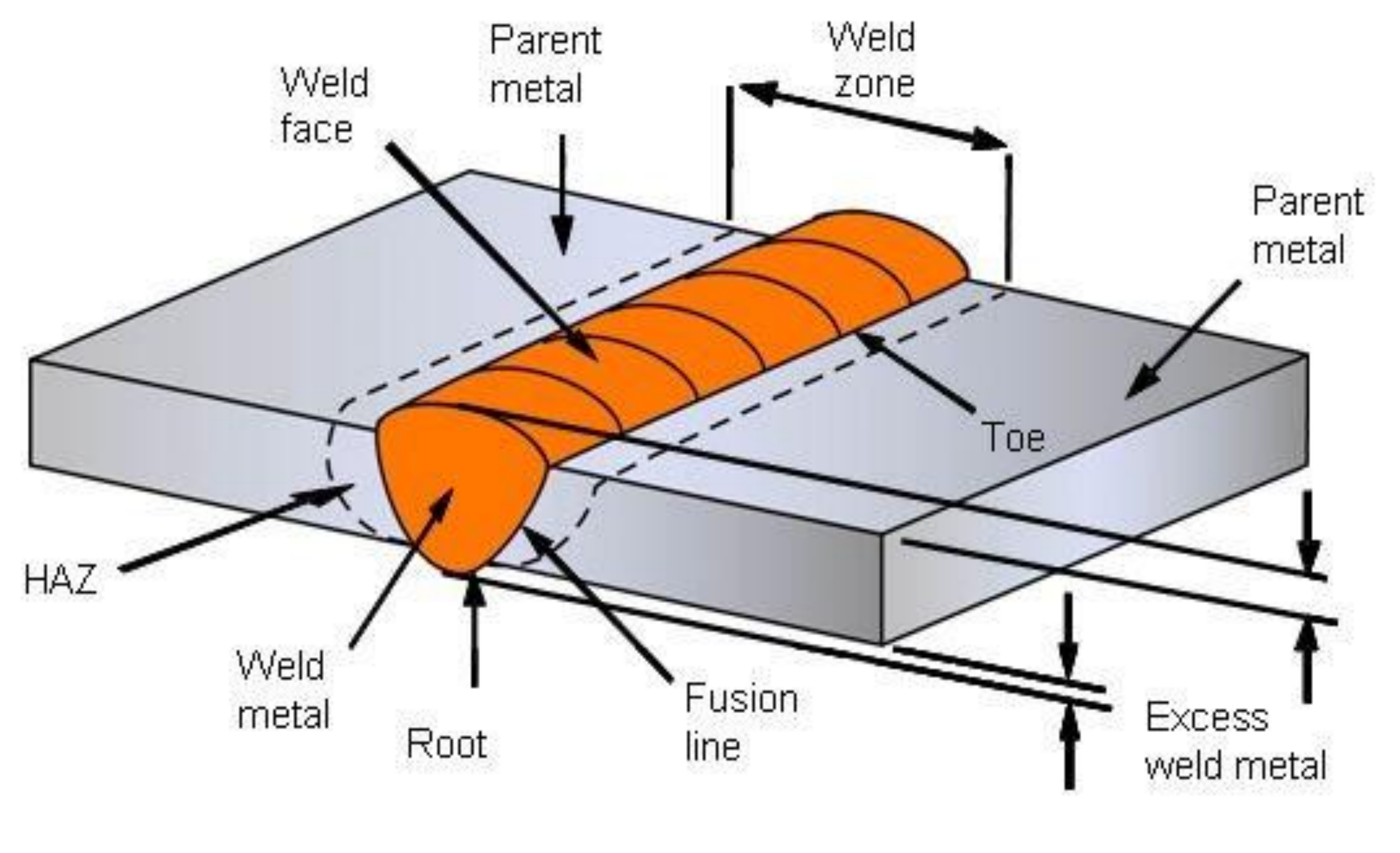
Types of welding joints

WELDING JOINTS TYPES

- Butt joint welding
- Lap joint welding
- Tee joint welding
- Edge joint welding
- Corner joint welding

BUTT JOINT WELDING

- **A butt weld is one of the simplest and versatile types of weld joint designs. The joint is formed simply by placing two pieces of metal end-to-end and then welding along the join.**
- **Importantly, in a butt joint, the surfaces of the workpieces being joined are on the same plane and weld metal remains within the planes of the surfaces. Thus, workpieces are nearly parallel and do not overlap, unlike lap joints.**


Parent metal
Weld zone
Weld face
Parent metal
Toe
HAZ
Weld metal
Root
Fusion line
Excess weld metal

ADVANTAGES

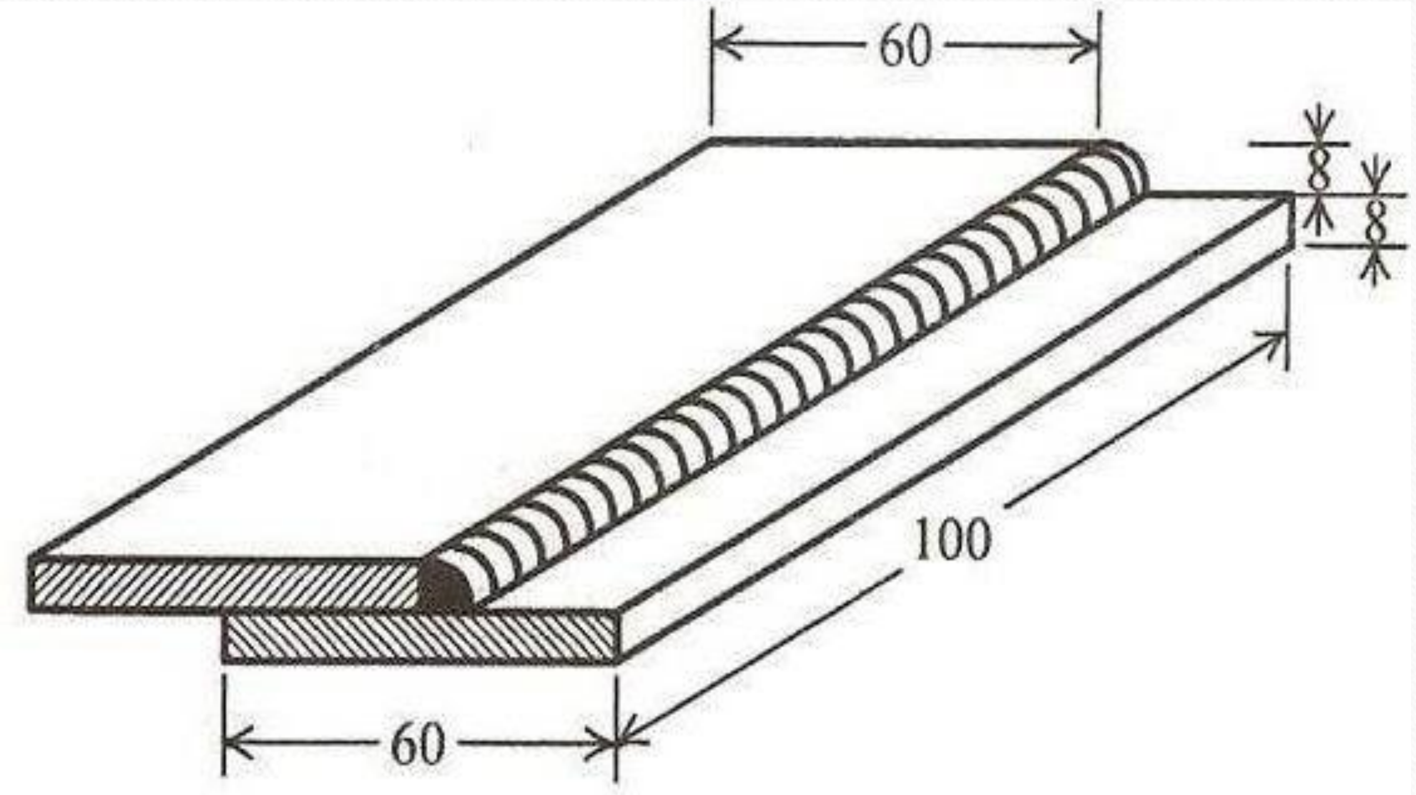
- High strength with complete fusion
- Easy to machine
- Distortion control
- Easy to inspect

Disadvantages

- Welding geometry can limit applications
- Fixturing or backing may be required
- Sensitive to faying surface conditions

Lap Joint Welding

- Lap welding joints are essentially a modified version of the butt joint. They are formed when two pieces of metal are placed in an overlapping pattern on top of each other.
- They are most commonly used to joint two pieces with differing thicknesses together. Welds can be made on one or both sides.


60
8
8
100
60

ADVANTAGES

- Easy to prepare as it does not require the cut faces to be parallel or perfectly flat.
- It is useful for joining thin metals such as diaphragms and foils.
- The metals do not need to be the same level of thickness to be joined.

DISADVANTAGES

- The overlap caused can be undesirable for mechanical or aesthetic reasons.
- If the wrong welding speed is used cracks and cavity defects can happen.
- The weld can be less rigid than the metals used because it can act as a pivot.

TEE JOINT WELDING

- Tee welding joints are formed when two pieces intersect at a 90° angle. This results in the edges coming together in the center of a plate or component in a 'T' shape.
- Tee joints are considered to be a type of fillet weld, and they can also be formed when a tube or pipe is welded onto a base plate.
- With this type of weld, it's important to always ensure there is effective penetration into the roof of the weld.

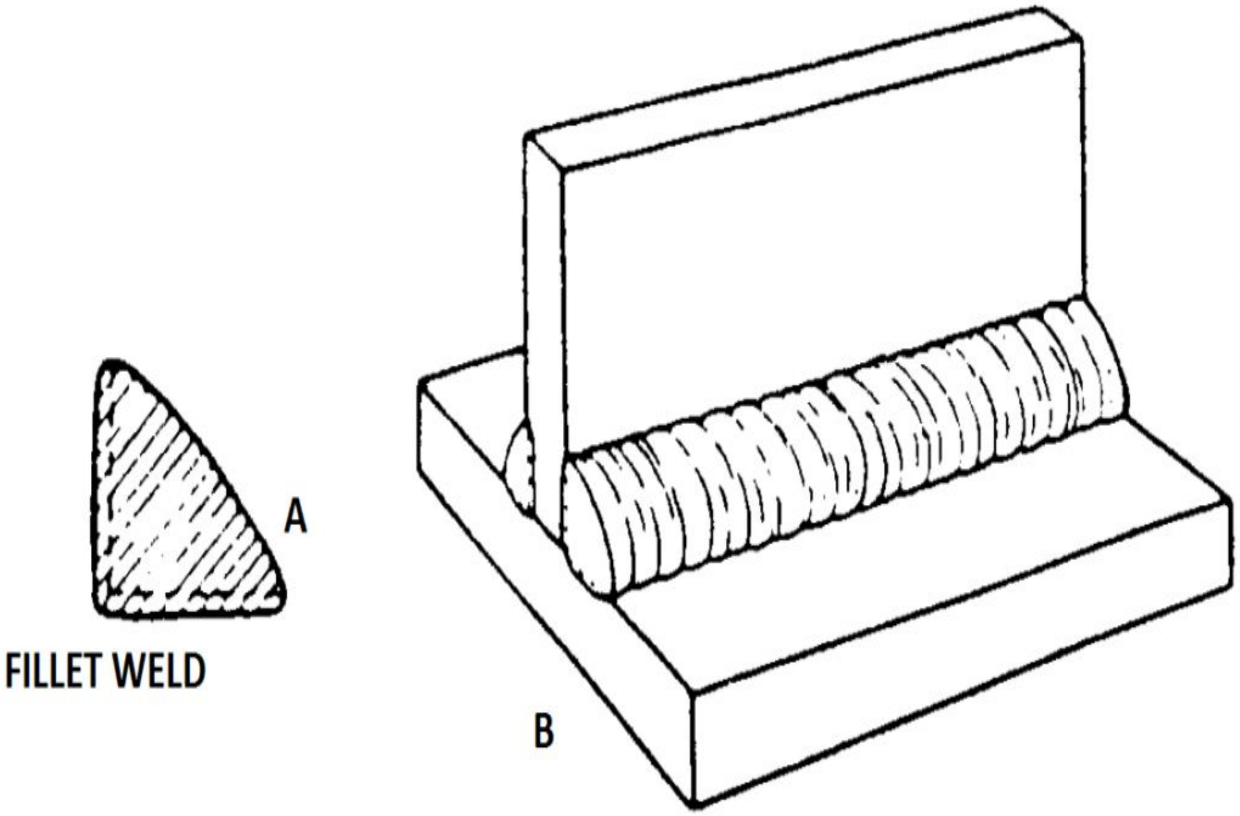


Figure 1: Tee joint - single pass fillet weld.

ADVANTAGES

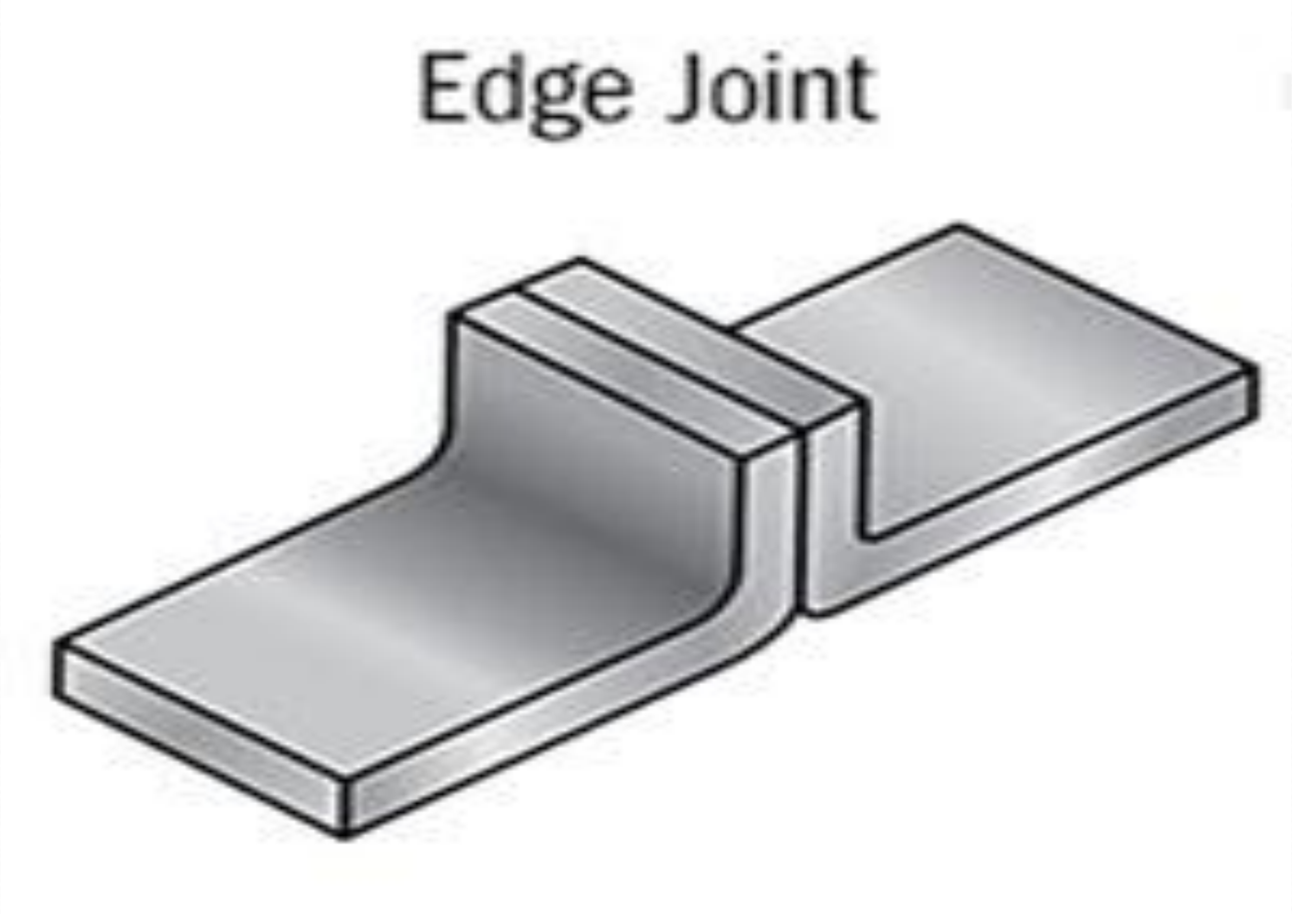
- Welded joint has high strength, sometimes more than the parent metal.
- Different material can be welded.
- It can be automated.

DISADVANTAGES

- Tee joints are not usually prepared with groove, unless the base metal is thick and welding on both sides cannot withstand the load the joint must support.
- A common defect that occurs with tee joints is lamellar tearing—which happens due to restriction experienced by the joint.

EDGE JOINT WELDING

- In an edge joint, **the metal surfaces are placed together so that the edges are even**.
- One or both plates may be formed by bending them at an angle.
- The purpose of a weld joint is to join parts together so that the stresses are distributed.


Edge Joint

ADVANTAGES

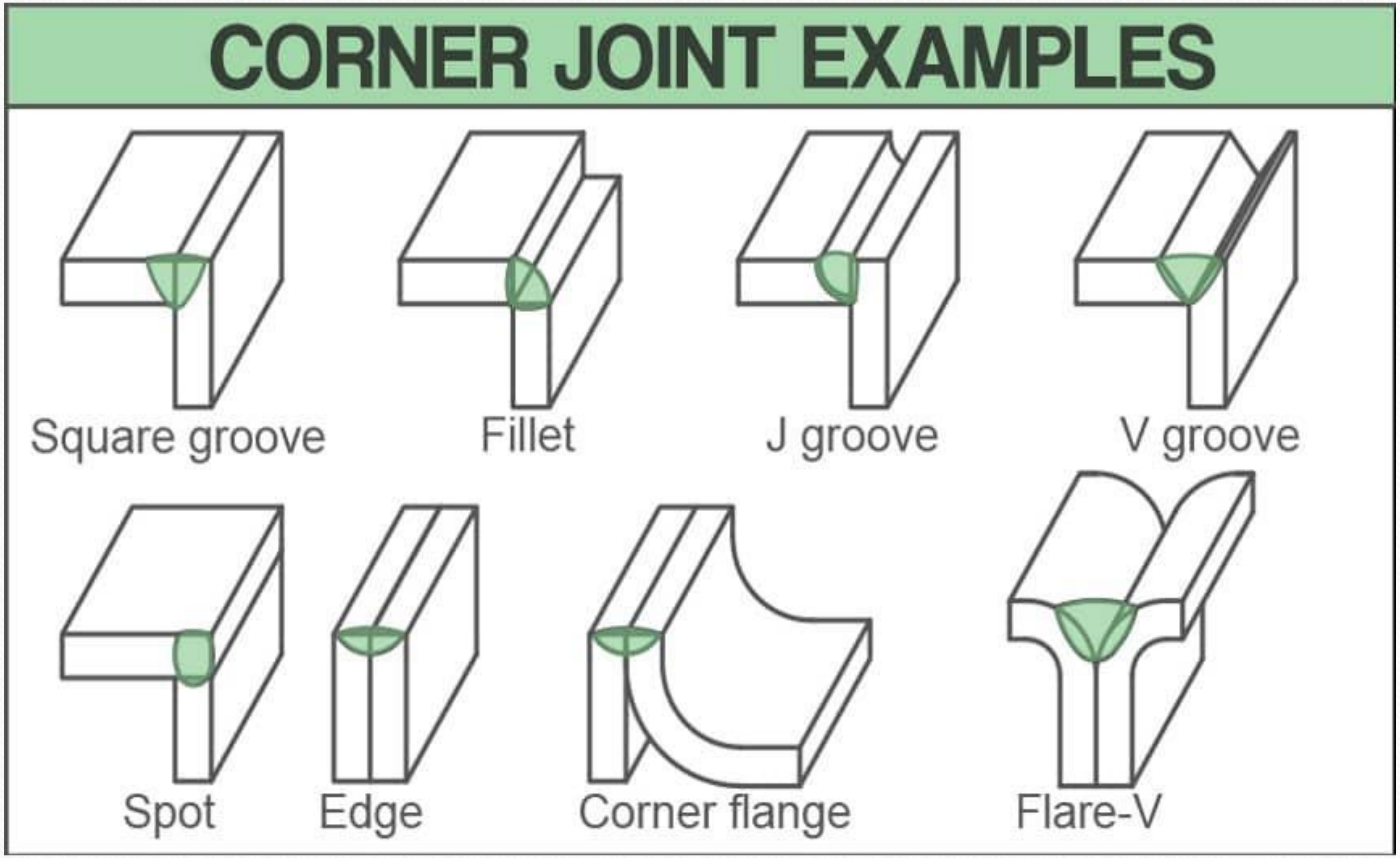
- It can be done very quickly and easily.
- Increase production efficiency
- Gain proper penetration
- Good joint strength

DISADVANTAGES

- Due to overlapping parts, this type of joint is more prone to corrosion.
- Welders must keep in mind other defects like slag inclusion, lack of fusion and porosity, which can also occur.

CORNER JOINT WELDING

- The corner joint welding is used to join two members that are located at approximately right angle to each other in the form of a 'L'.
- The corner welding joint is similar to tee-joints, except that in this, one of the parts is fitted at the *corner* of the second part (hence the name, corner joint).


CORNER JOINT EXAMPLES
Square groove
Fillet
J groove
V groove
Spot
Edge
Corner flange
Flare-V

ADVANTAGES

- It is an easy to assemble joint.
- The edge-preparation for this joint is quite uncomplicated.
- It can be used to produce joints in thin as well as thick sections.
- It is used for applications that require a square frame such as tanks, box frames, sheet metal work, etc.

DISADVANTAGES

- One disadvantage of corner joint welding is that it can be difficult to achieve a good weld. This is because the angle of the weld can make it difficult to get the right amount of heat and pressure on the metal. This can lead to a weld that is not strong enough or one that has gaps.
- Another downside to Corner Joint Welding is that it can be time-consuming, especially in open corner joint.

Gas Welding

WHAT IS **GAS WELDING**?

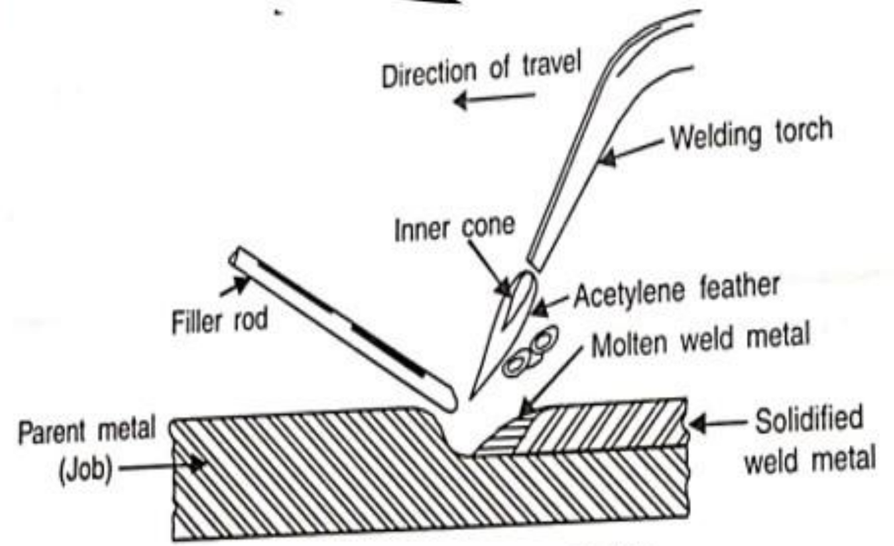


Fig. 20.1. *Oxy-Acetylene Welding.*

-Gas welding also called an oxy-fuel (or oxy-acetylene) gas welding, derives the heat from the combustion of a fuel gas such as acetylene in combination with oxygen. The process is a fusion welding process wherein joint is completely melted to obtain the fusion. The fuel gas generally used is acetylene because of the high temperature generated in the flame.

Principle: When acetylene is mixed with oxygen in correct proportions in the welding torch and ignited, the flame is produced which is sufficiently hot to melt and join the parent metal. Temperature of flame is about 3100 C. A filler rod is generally added to build up the seam for greater strength. Oxy-acetylene welding may be classified as:

1. **HIGH PRESSURE OXY-ACETYLENE WELDING:** In case of high pressure Oxy-acetylene gas welding, the acetylene gas is supplied from the acetylene cylinder in compressed form.

2. **LOW PRESSURE OXY-ACETYLENE WELDING:** In case of low pressure Oxy-acetylene gas welding, the acetylene gas is supplied from the generator at low pressure. In the generator calcium carbide stone is added in the chamber in which water is already present. Calcium carbide stone reacts with the water and produce acetylene gas. This gas can be easily collected from the top of the water and can be used for welding purpose. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

Advantages:-1. It can be applied to a wide variety of manufacturing and maintenance situations.

2. Rate of heating and cooling of weld deposit and job is slow.

3. Operator is having better control because sources of heat and filler metals are separate.

4. Cost and maintenance of the welding equipment is low, and no electric current is required

5. Operator is having better control because sources of heat and filler metals are separate.

Disadvantages:- 1. Flame temperature is less than the temperature of the arc.

2. Refractory metals (e.g., tungsten, molybdenum, tantalum etc.) and reactive metals (titanium and zirconium) cannot be gas welded.

3. Gas flame takes a long time to heat up the metal than an arc. & Heat affected zone is wider.

4. Acetylene oxygen gases are rather expensive.

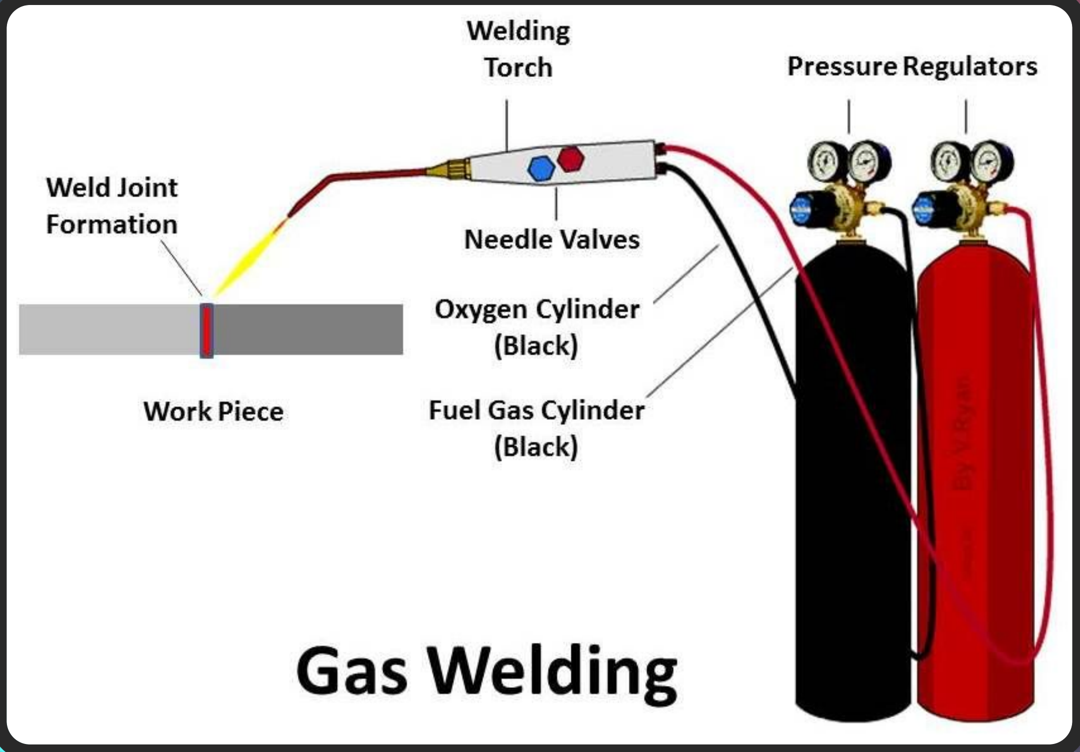
5. Storage of gases is not safe. More safety is needed.

6. More skilled operators are needed.

Applications of Gas Welding

1. Used for welding of mild steel, stainless steel, copper, cast iron, high carbon steels etc.
2. For joining thin metals
3. In automotive & aircraft industries.
4. In sheet metal fabricating plants.

GAS WELDING EQUIPMENTS



BY-AKRITI SINGH

GAS WELDING EQUIPMENTS

1. OXYGEN CYLINDER:

Oxygen cylinder is usually painted in **black** colour. In this cylinder, oxygen is stored under a pressure of 1550 N/m2.

2. ACETYLENE CYLINDER:

Acetylene cylinder is usually painted in **maroon** colour. In this cylinder, acetylene is stored under a pressure of 175 N/m2.

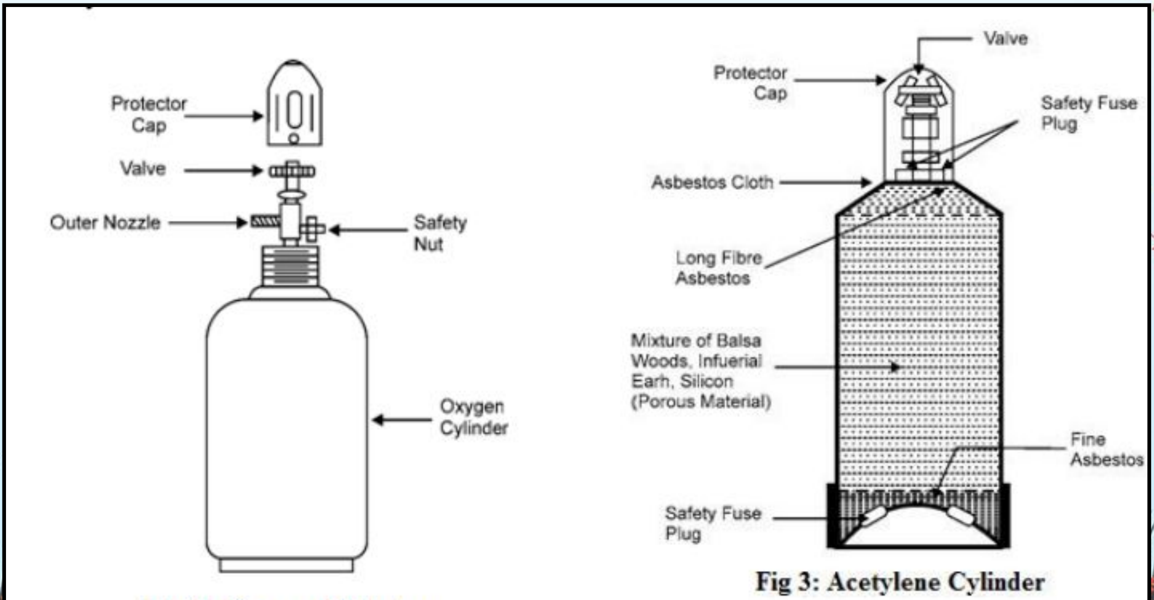


Fig 2: Oxygen Cylinder

Fig 3: Acetylene Cylinder

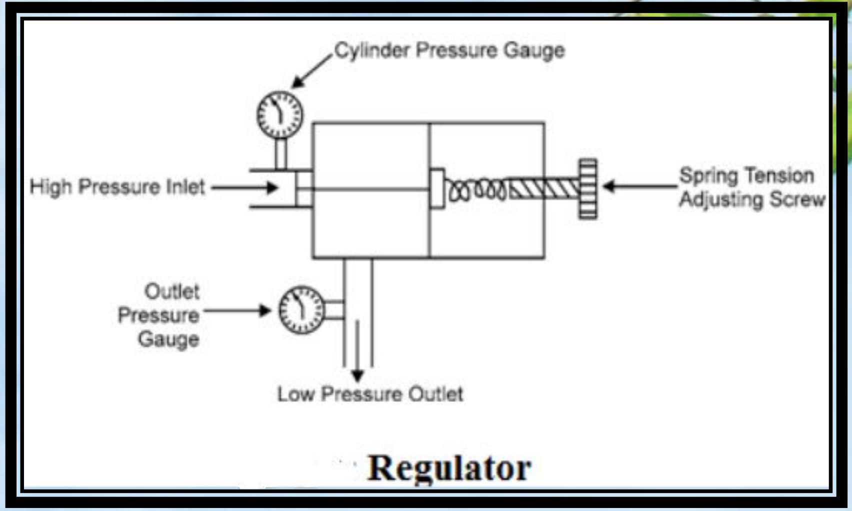
3. REGULATOR:

Regulator is used to control the flow of gases from high pressure cylinder.

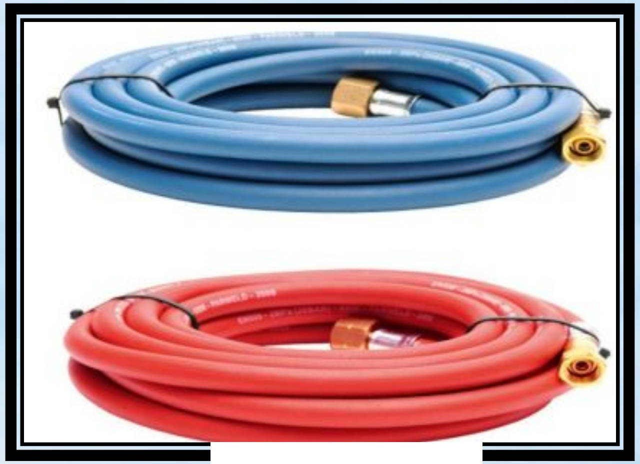
4.HOSES:

In oxy-acetylene gas welding the oxygen and acetylene are carried from the oxygen and acetylene cylinders to the welding torch through hoses. The color coding is used to identifying the hose carrying the gas.

The hose having **blue color** carries **oxygen** and **red color** is used for **acetylene** hose.



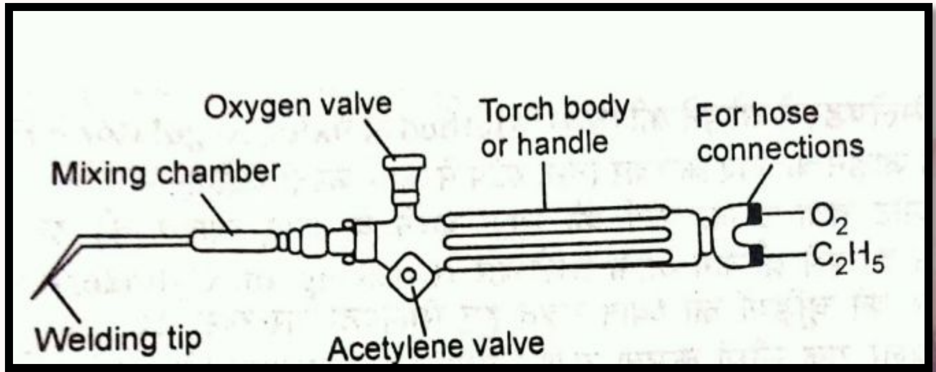
Regulator


Hoses

5. WELDING TORCH:

This oxy-acetylene equipment plays a very important role as it helps to accomplish the following;

- **Mix oxygen and acetylene properly before releasing**
- **Produce a controlled flame from its tip**
- **Prevent flashback**
- **Obtain a specific flame**



6. LIGHTER:

For starting the flame, the spark should be given by a lighter. Match sticks should not be used, as there is risk of burning hand.

Types of flames

- Neutral flame
- Oxidising flame
- Reducing flame

Neutral Flame.

A neutral flame is produced when oxygen to acetylene ratio is 1.1 to 1.

- The temperature is of the order of about 5900°F(3200°C).
- The flame has nicely defined inner core(light blue in colour) and is surrounded by outer envelope which is darker blue.
- Does not oxidise or comburise the metal.
- It is used for
  - **Mild Steel**
  - **Stainless Steel**
  - **Copper**
  - **Cast Iron**
  - **Aluminium**

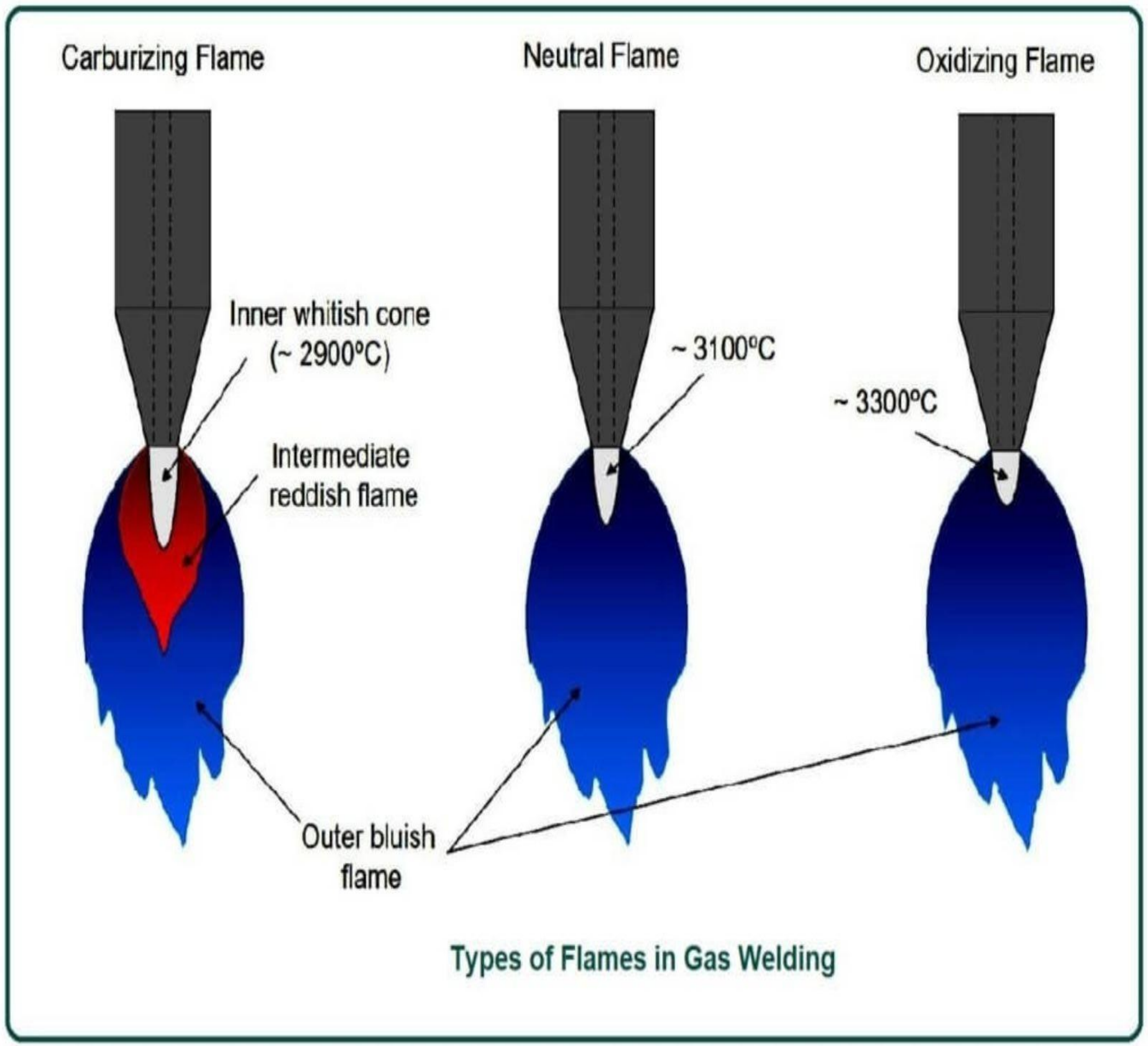
Oxidising Flame.

When the amount of acetylene reduces from natural flame or amount of oxygen increases, the inner cone tend to disappear and the flame obtain is known as oxidizing flame. It is hotter than natural flame and has clearly defined two zones. The inner zone has very bright white color and has temperature of about 3300 degree centigrade. The outer flame has blue in color. This flame is used to weld oxygen free copper alloy like brass, bronze etc.

Reducing or Carburizing flame.

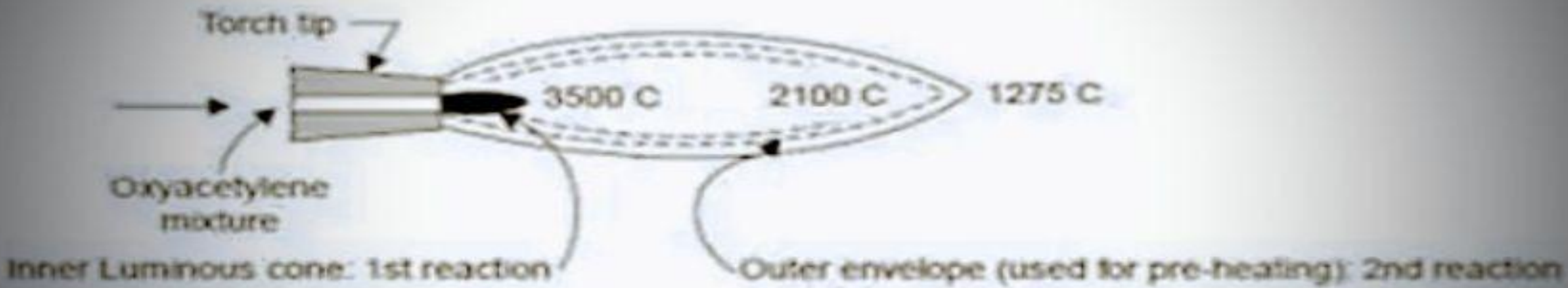
If the volume of oxygen supplied in neutral flame is reduced then we get Carburizing or reducing flame.

- Temp is the order of 5500°F
- Carburizing flame is used for surface hardening and welding of lead.
- Reducing flame is used with low alloy steel rod for welding high carbon steel.
- Carbon absorbing metals should not be welded with reducing flame.
- Acetylene quantity(Carburizing>Reducing flame).
- Acetylene feather exist b/w



Reactions in Oxy-acetylene welding

- Flame in OAW is produced by the chemical reaction of C_2H_2 and O_2 in <u>two stages</u>



Stage 1 $C_2H_2 + O_2 \rightarrow 2CO + H_2 + \text{Heat (1)}$

Stage 2 $2CO + H_2 + 1.5O_2 \rightarrow 2CO_2 + H_2O + \text{Heat (2)}$

Heat (1) > Heat (2)

Techniques of Gas Welding:

Leftward welding

The welding rod is held in the left hand and the blowpipe is held in the right hand.

Leftward welding is used for the metal plate thickness up to 3 mm.

Welding proceeds from right to left.

It is also known as forwarding or forehand welding.

The inclination of the welding rod with plate is 30° to 40° and the inclination of the blowpipe with plate is 60° to 70°.

Rightward welding

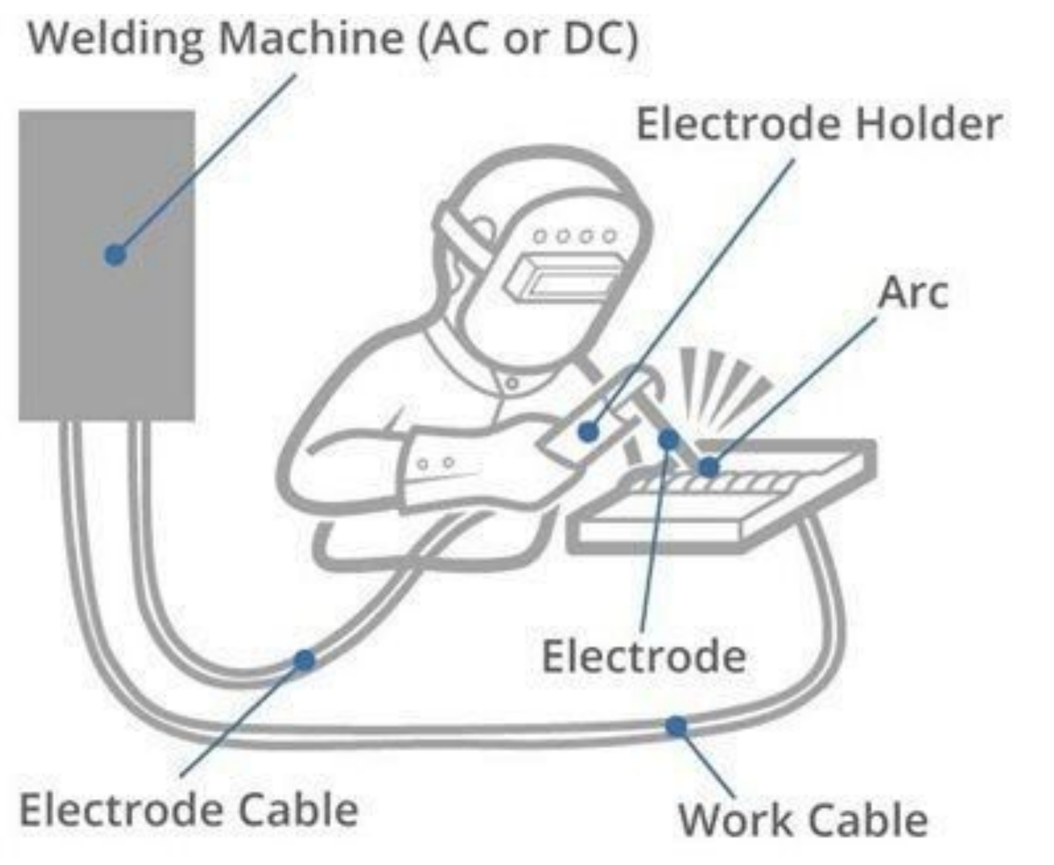
Rightward welding is used for thicker plates and proceeds from left to right.

The inclination of the welding rod is the same as in the leftward welding but the inclination of the blowpipe is 10° to 20° less than that in the leftward welding, i.e. at 40° to 50°.

It is also known as backward or backhand welding.

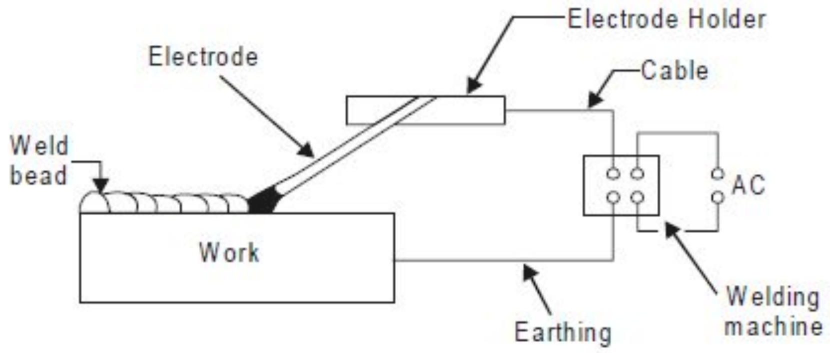
ELECTRIC ARC WELDING

Arc welding is a group of welding processes wherein heating is produced with an electric arc or arcs, mostly without the application of pressure and with or without the use of filler metal, depending upon the base plate thickness.



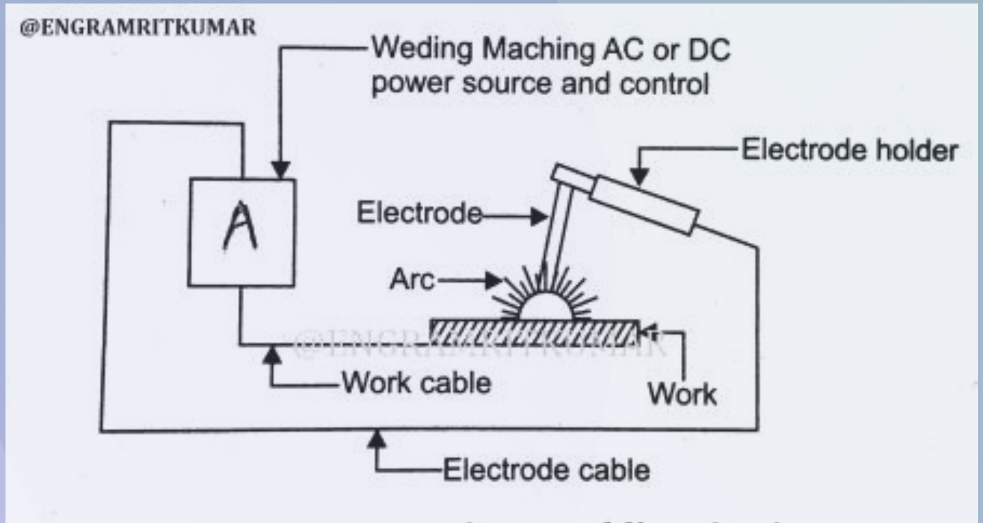
PRINCIPLE

In arc welding, arc is generated between the positive pole of D.C. (direct current) called anode and negative pole of D.C. called cathode. When these two poles are brought together and separated for a small distance (1.5 to 3 mm) such that the current continues to flow through a path of ionized particles, called plasma, an electric arc is formed. Since the resistance of this ionized gas column is high, so more ions will flow from anode to the cathode. Heat is generated as the ions strike the cathode.



ARC WELDING EQUIPMENT

- The most used equipment's for arc welding are:
  - A.C. or D.C. power supply source Electrode holder
  - Electrode
  - Cable, cable connectors
  - Cable lug
  - Chipping hammer
  - Earthing clamps
  - Wire brush
  - Helmet
  - Safety goggles
  - Hand gloves
  - Aprons, sleeves etc.



Basic arc-welding circuit.

POLARITY

- Polarity is defined as the type of potential given to the workpiece or electrode. In case of direct current (DC.) power source, positive and negative terminals are fixed whereas in case of alternating current (A.C.) power source, positive and negative terminals are not fixed i.e., the terminal which is positive during one half of cycle becomes negative in another half. So, polarity principle is applicable only in case of direct current power source.

ELECTRODES

The electrodes are used for providing heat input in arc welding. Electrodes can be classified on the following basis:

Consumable : consumable electrodes are those electrodes, which are consumed during welding.

Non-consumable :

Non-consumable electrodes are those electrodes, which are not consumed during welding.

PRECAUTIONS IN ARC WELDING

- All instructions supplied by the manufacturer should be strictly followed.
- Working area and floor should be kept clean and clear of electrode stubs, metal scrap etc.
- Power supply source should be isolated from the main supply.
- Before starting welding, ensure that the welding equipment is properly earthed
- One should not look at an electric arc with naked eye. Use helmet or hand shield.
- Eye trouble may be relaxed by washing with the following solution:
- Sodium bicarbonate 340 gm. + purified water 1000 ml.
- Welder should not leave the electrode holder on the table or in contact with the metallic surface.
- Welder should use goggles with clear glasses while he is chipping off scale, slag etc.
- Welding operation should be carried out in clean, dry, well-ventilated locations.
- Welding cables should be completely insulated. The welding cable should be flexible, dry, and free from grease and oil, free from repair up to a minimum distance of 3 m from the electrode holder.
- Electrode holder should be soundly connected to the welding lead. Hot electrode holders shall not be permitted to dip in water because the retained moisture may cause an electric shock.

ADVANTAGE

- Affordable cost for equipment and doesn't need much due to the lack of gas.
- Portability; very easy to transport.
- Versatile and works well on metal that's dirty.
- Shielding gas not necessary, meaning the process can be completed in all types of weather (including wind or rain)

DISADVANTAGE

- Lower efficiency – more waste is generally produced during arc welding than many other types, which can increase project costs in some cases.
- High skill level – operators of arc welding projects need a high level of skill and training, and not all professionals have this.

TIG Welding Introduction

Conclusion

- TIG welding is an exciting skill that proves itself useful in countless applications
- Because it welds more metal and metal alloys than any other process, TIG welding should be regarded as an important tool where experience is the teacher
- Welding parameters and tungsten electrode selection tables are recommended values and should be used as a guideline
- Information presented here is only the tip of the iceberg, and further research and hands-on involvement should be pursued to be comprehensive

Background

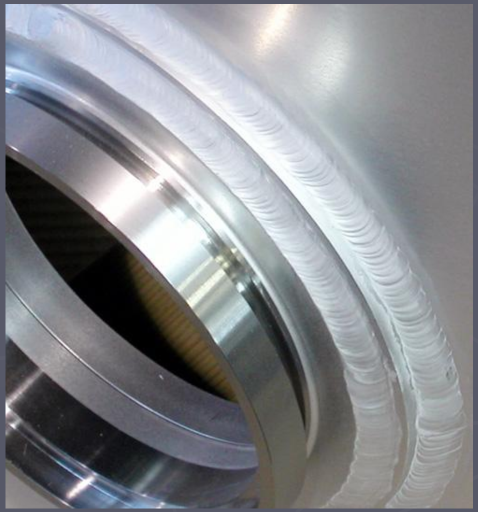
- What is TIG?
  - Tungsten Inert Gas
- Also referred to as GTAW
  - Gas Shielded Tungsten Welding
- In TIG welding, a tungsten electrode heats the metal you are welding and gas (most typically Argon) protects the weld from airborne contaminants

Background

- TIG welding uses a non-consumable tungsten
- Filler metal, when required, is added by hand
- Shielding gas protects the weld and tungsten

Advantages

- Welds more metals and metal alloys than any other process
- High quality and precision
- Pin point control
- Aesthetic weld beads
- No sparks or spatter
- No flux or slag
- No smoke or fumes



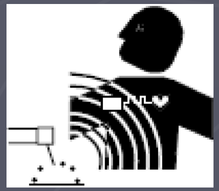
Disadvantages

- Lower filler metal deposition rates
- Good hand-eye coordination a required skill
- Brighter UV rays than other processes
- Slower travel speeds than other processes
- Equipment costs tend to be higher than other processes

Safety

- Hot parts can cause injury.
  - Allow cooling period before touching welded metal
  - Wear protective gloves and clothing

- Magnetic fields from high currents can affect pacemaker operation.



- Flying metal can injure eyes.
  - Welding, chipping, wire brushing, and grinding cause sparks and flying metal; wear approved safety glasses with side shields

Techniques for Basic Weld Joints

Manual Torch Movement

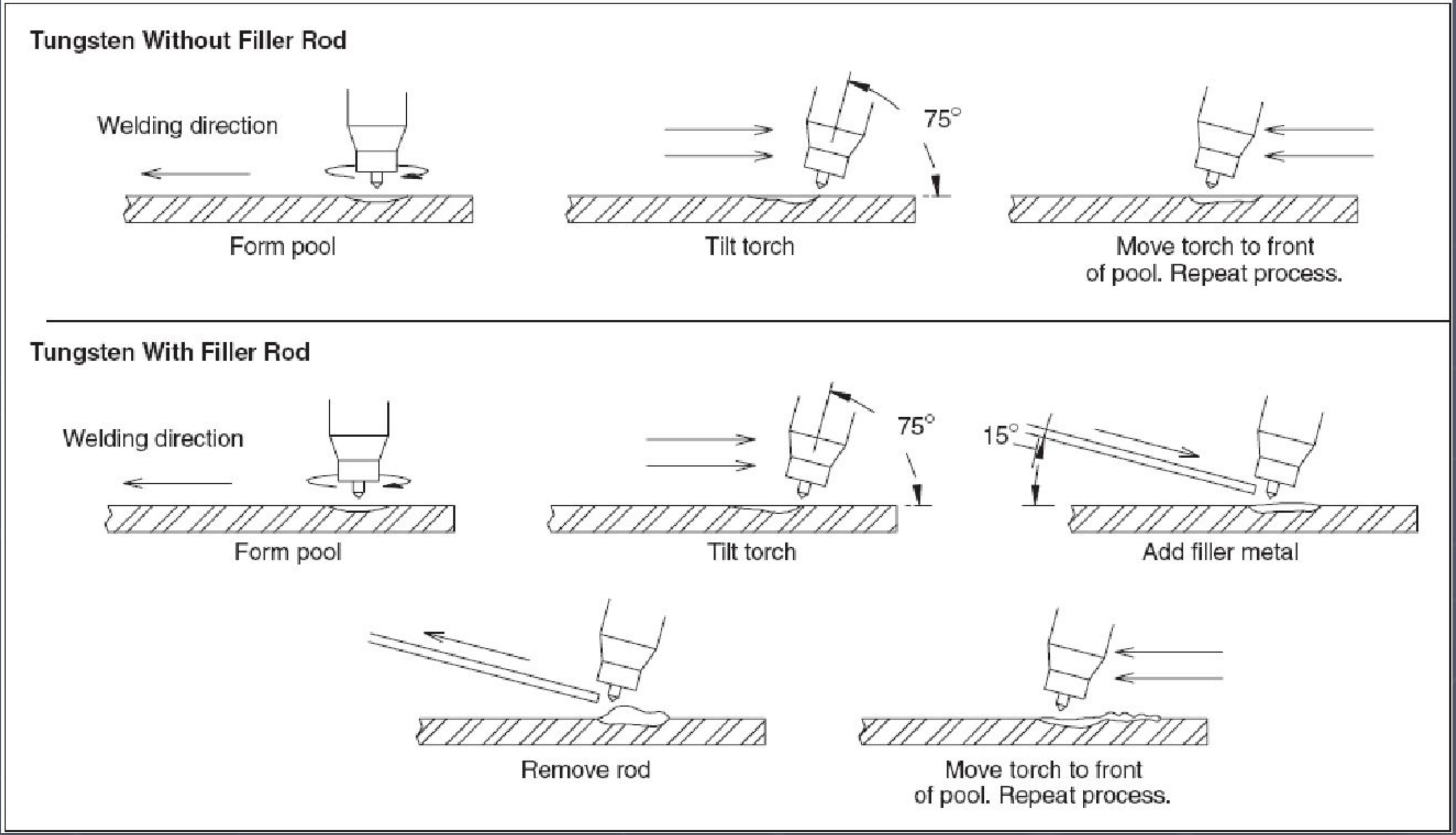


*Figure copied from "TIG Handbook"

TIG Shielding Gases

- Argon
- Helium
- Argon/Helium Mixtures

TIG Shielding Gases

Argon

- Good arc starting
- Good cleaning action
- Good arc stability
- Focused arc cone
- Lower arc voltages
- 10-30 CFH flow rates

Helium

- Faster travel speeds
- Increased penetration
- Difficult arc starting
- Less cleaning action
- Less low amp stability
- Flared arc cone
- Higher arc voltages
- Higher flow rates (2x)
- Higher cost than argon

TIG Shielding Gases

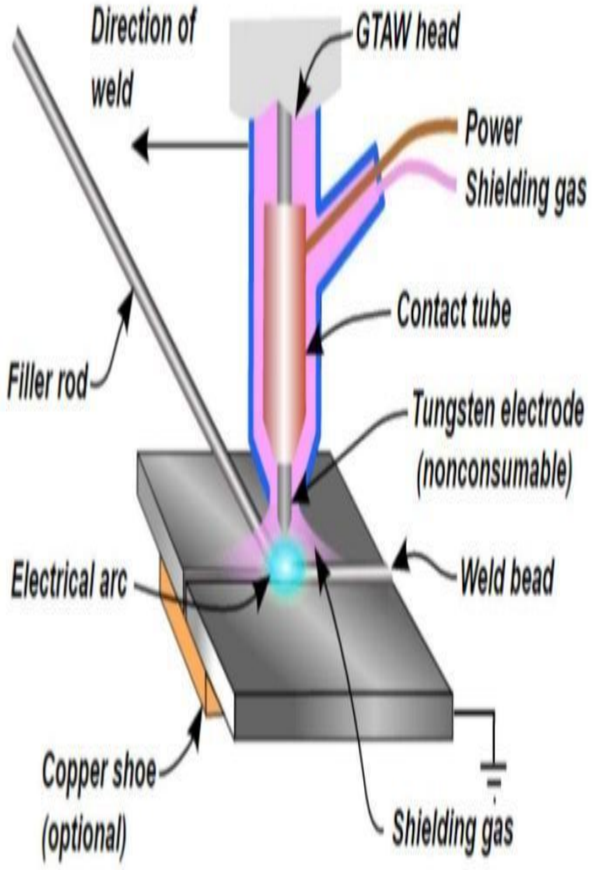
Argon/Helium Mixtures

- Improved travel speeds over pure argon
- Improved penetration over pure argon
- Cleaning properties closer to pure argon
- Improved arc starting over pure helium
- Improved arc stability over pure helium
- Arc cone shape more focused than pure helium
- Arc voltages between pure argon and pure helium
- Higher flow rates than pure argon
- Costs higher than pure argon

METAL INERT GAS WELDING PROCESS

Aman
Malik
A-025

❖ Schematic Representation of MIG Welding Process



❖ Welding

- It is defined as localized coalescence of metal or alloy produced either by heating the materials to the welding temperature with or without using pressure or by application of pressure alone, with or without the use of filler metal.

- Types of welding

❑ Submerged Arc Welding
❑ Tungsten Inert Gas Welding
❑ Metal Inert Gas Welding
❑ Friction Welding

❖ Tools and equipment used in MIG Welding

1. Power source : MIG welding uses a dc constant voltage transformer.

2. Wire Feeder : A wire feeder is required to feed the electrode wire continuously and smoothly to the welding gun.

❖ Advantages of MIG Welding

- High quality welds can be produced much faster
- Since a flux is not used, there is no chance for the entrapment of slag in the weld metal resulting in high quality welds.
- The gas shield protects the arc so that there is very little loss of alloying elements. Only minor weld spatter is produced.
- MIG welding is versatile and can be used with a wide variety of metals and alloys.
- MIG process can be operated several ways, including semi and fully automatic.

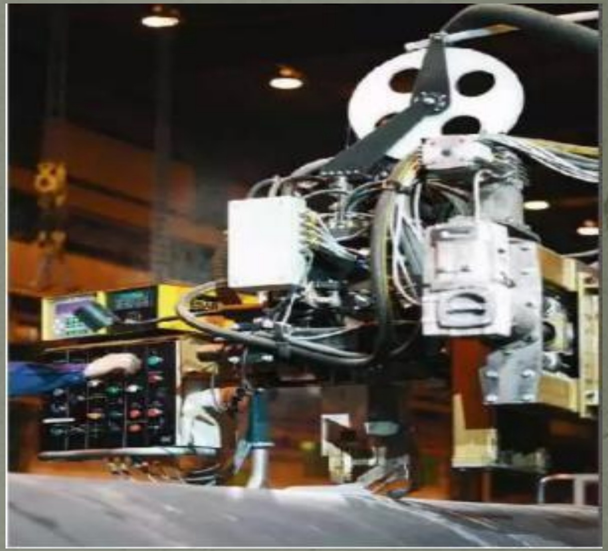
❖ Disadvantages of MIG Welding

- Cannot be used in vertical or overhead positions because of the high heat input and the fluidity of the puddle.
- The equipment is complex.
- Arc is less stable
- Generates more spatter
- Not suitable for base metal contamination
- Limited to short circuit mode of metal transfer

❖ Application of MIG Welding

- The most common application of MIG welding is automotive repair.
- Special welding equipment can be used to weld pipes.
- It can be used to reinforce the surface of a worn railroad truck.
- Because of its high economy and utility it is widely used in various industries.
- Rebuilding equipment
- Overlay of resistant coating

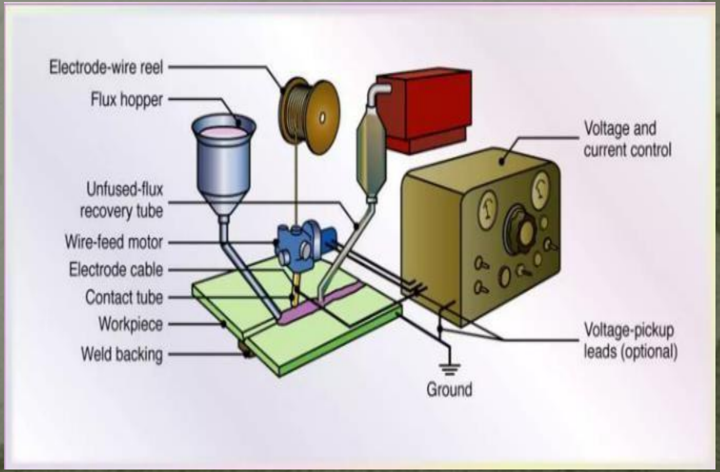
SUBMERGED ARC WELDING (SAW)



- Submerged arc welding (SAW) is a welding process where the tubular electrode is fed continuously to join two metals by generating heat between electrode and metal.

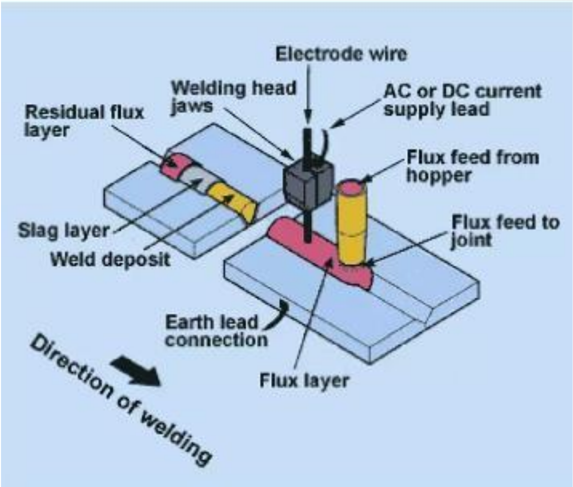
- There is no visible arc and no sparks , spatter or fume. The electrode may be a solid or cored wire or a strip.

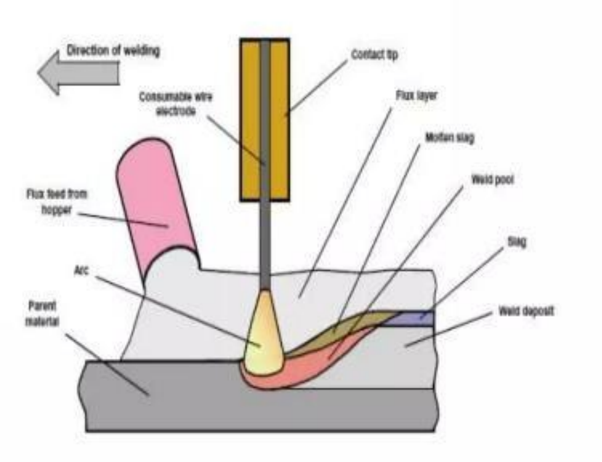
- SAW is normally a mechanized process.



Process of SAW

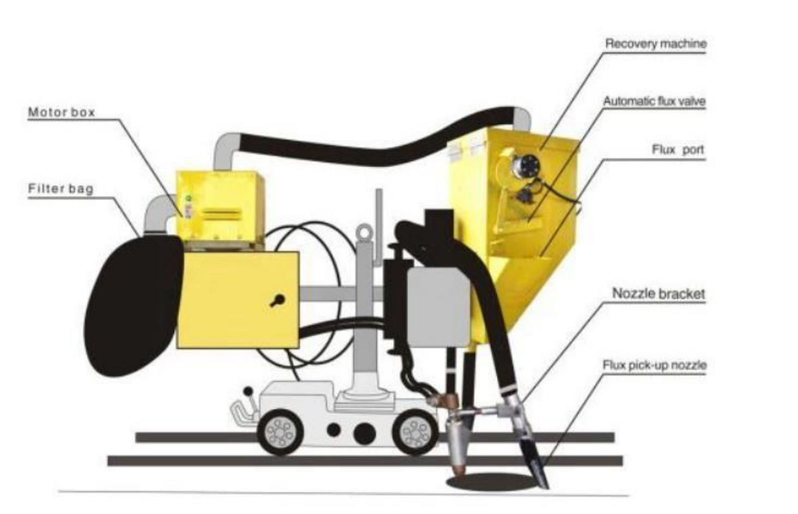
- The molten weld and the arc zone are protected from atmospheric contamination being “submerged” under a blanket of granular fusible flux.
- Flux consists of lime, silica, manganese oxide, calcium fluoride, and other compounds.
- When molten, the flux becomes conductive and provides a current path between the electrode and the work.
- This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense spatter and sparks as well as supressing the intense ultraviolet radiation and fumes that are a part of the shielded metal





SAW Equipment

- Power source
- Welding torch/gun and cable assembly
- Electrode
- Flux hopper and its feeding
- Travel mechanism for automatic welding



Advantages of SAW

- High quality
- Little risk of undercut and porosity
- No spatter
- High deposition rate
- Minimal metal distortion
- Hardly any smoke

Limitations of SAW

- Precise joint preparation required
- High operational effort
- Normally not suitable for thin material
- Slag removal required
- Flux handling equipment
- Flux consumption is high

Applications

- Fabrication of Boiler Pressure Vessel
- Automotive, Aviation, Ship building
- Structural shapes and cylinders
- Circular welds
- Beam Production

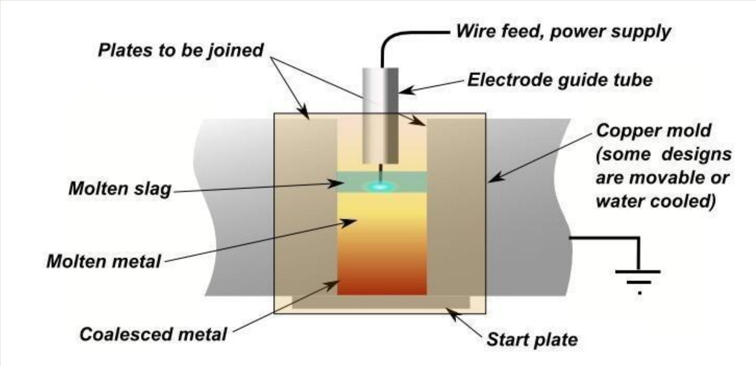
ELECTROSLAG WELDING

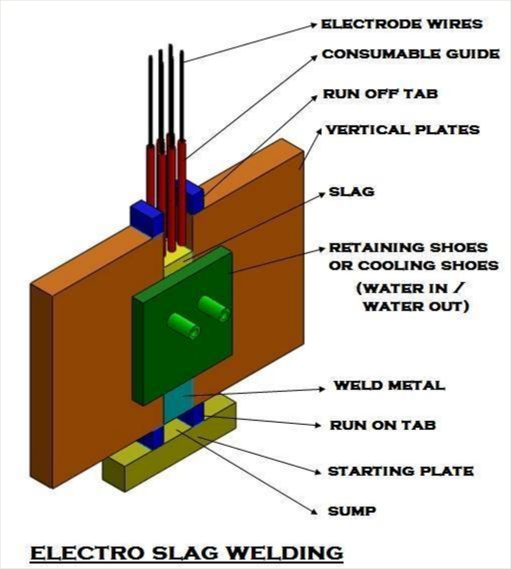
AMAN SINGH

A-027

INTRODUCTION

- Electroslag welding is a type of arc welding process wherein the coalescence is produced by molten slag which melts the filler metal ans the surface of the work to be welded electro slag welding is quite similar to vertical submerged arc welding





WORKING PRINCIPLE

- 1.Electroslag welding is a grandular flux is placed in the gap between the plate being welded and as the current is turned on welding take place in a water cooled copper shoes that bridge amd the gap of the joint as the flux melts a slag blanket from 25. 1 to
  38.8 mm thickness is formed high resistance of the slag causes welding in a progressive process of melting and sodification from the bottom to upward.
- 2.The maximum thickness that can be weld by this process is upto 100mm
- 3. Molten metal and slag are retained in the joint by means of copper shoes that automatically move upward as the weld progresses by means of a temperature sensitive mechanism.

ADVANTAGES

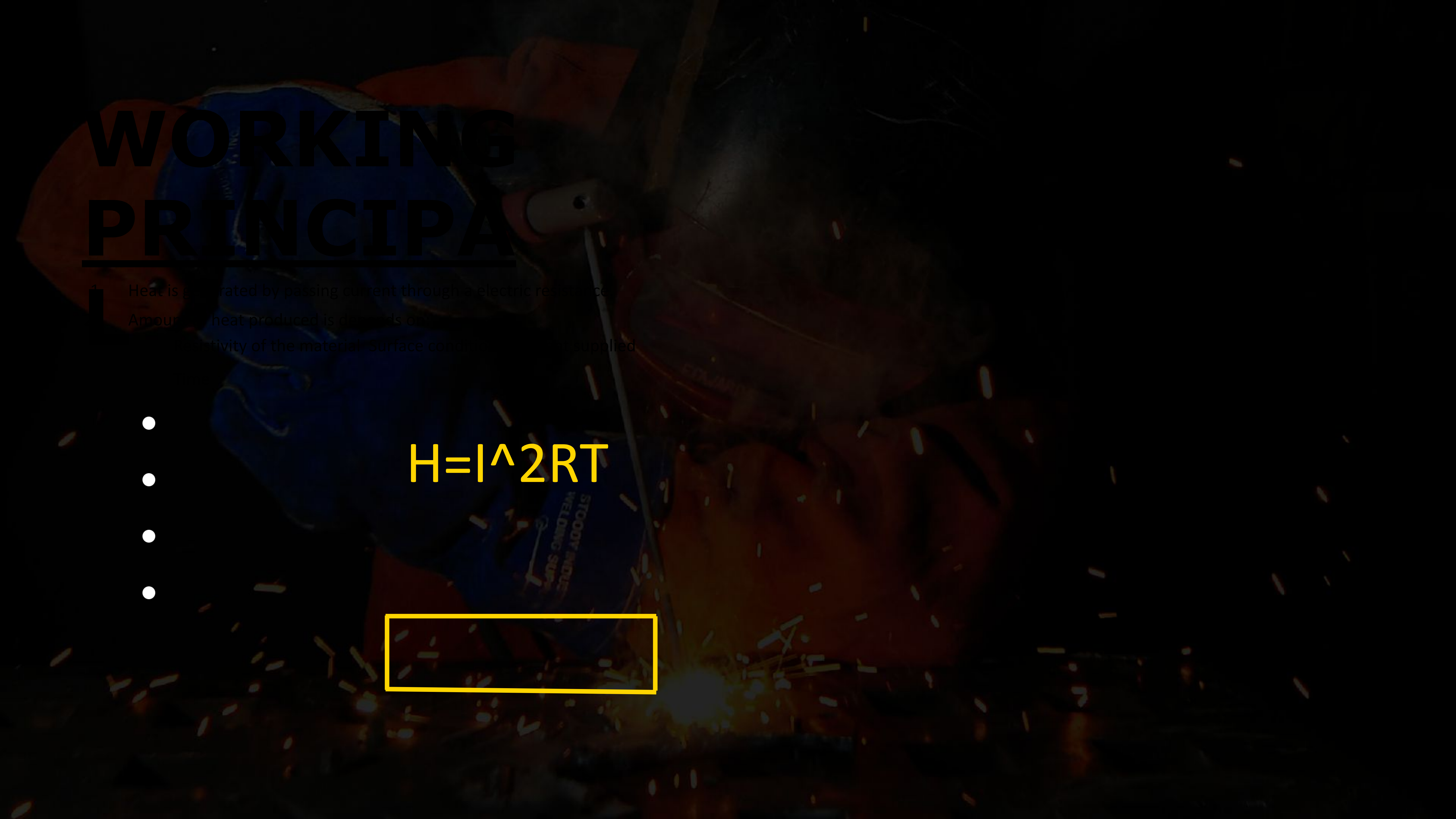
- 1.Joint temperature is quite simple as compared to other welding processes
- 2.Very high thickness plate can be very easily welded in a single pass more economically
- 3. It gives extremely high deposition rate
- 4. Distortion and thermal stresses are in very low percentage
- 5. Flux consumption is very low

DISADVANTAGES

- 1.Process is only limited to vertical position
- 2. Electroslag welding tends to produce rather large grain size
- 3. Complex shapes joint cannot be welded by this process
- 4. More chances of hot cracking and notch sensitivity in the heat affected zone

RESISTANCE WEILDING

- A liquid state weilding process
- It is Thermo-electric proces
- It uses electric resistance to generate heat.


WORKING PRINCIPA
Heat is g...rated by passing current through a electric re...ce
Amoun... heat produced is de...ds on
...istivity of the material Surface condi... ...t supplied
H=I^2RT

ADVANTAGES

01 It can weild thin (0.1mm) as well as thick (20 mm) metals.

02 Both similar disimilar metals can be weild.

03 It doesn't require any filler metal, flux and sheilding gases.

DISADVANTAGES

01 The thickness of work piece limited due to current requirement.

02 It is less efficient for high conductive material.

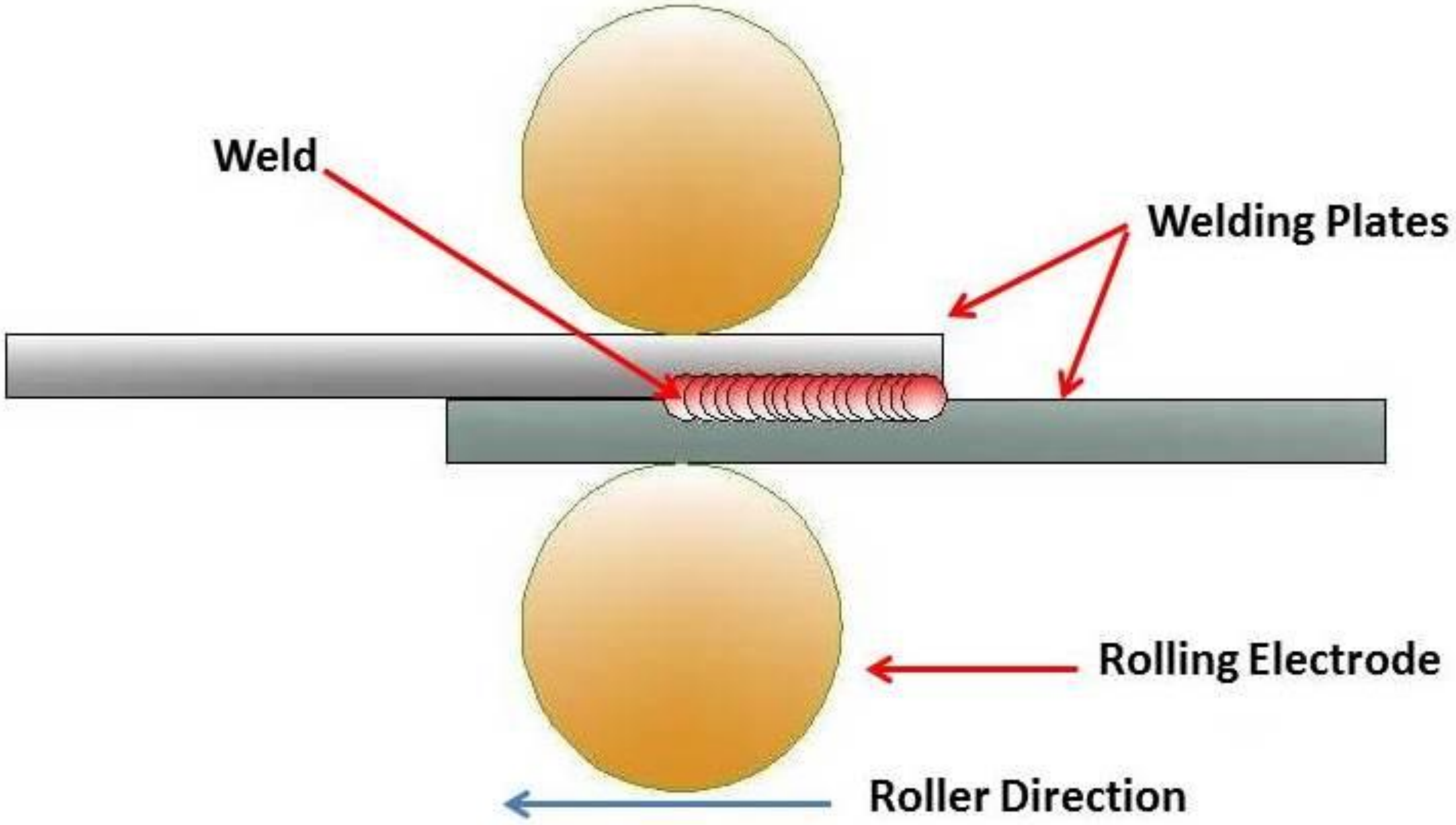
03 Wei d joints have low tensile fatigue str h.

Types of resistance welding

1. Resistance Seam Welding
2. Resistance Projection Welding
3. Precussion Welding Operation

Resistance Seam Welding

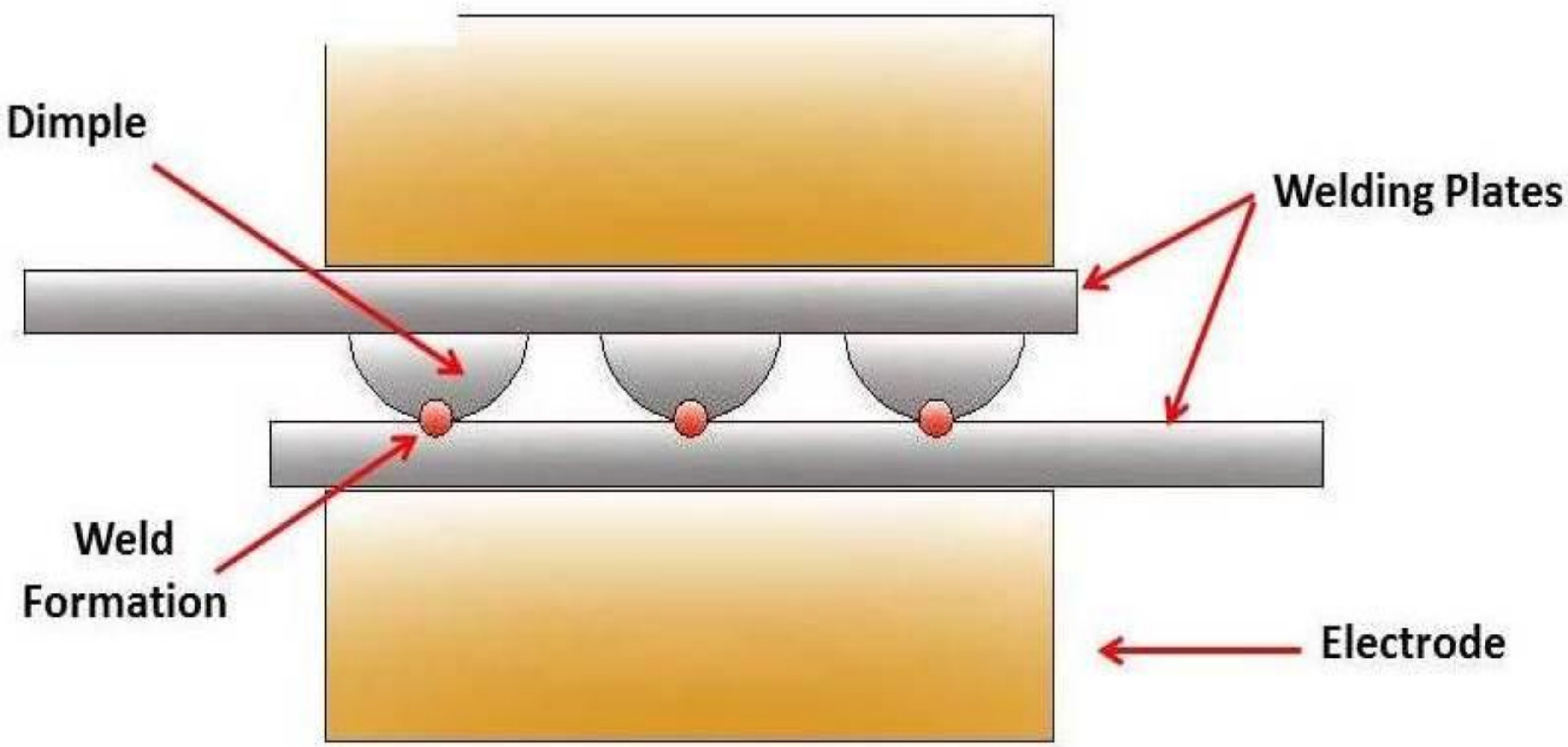
- The continuous resistance welding between the two plates to be joined.
- Disc shaped electrodes are used.
- The problem of shunting of electricity is very severe and it cannot be eliminated.
- To get the required amount of current joint whatever the amount of current which is bypassing, the corresponding amount of current has to be increased at the supply conditions itself.



Seam Welding

Resistance Projection Welding

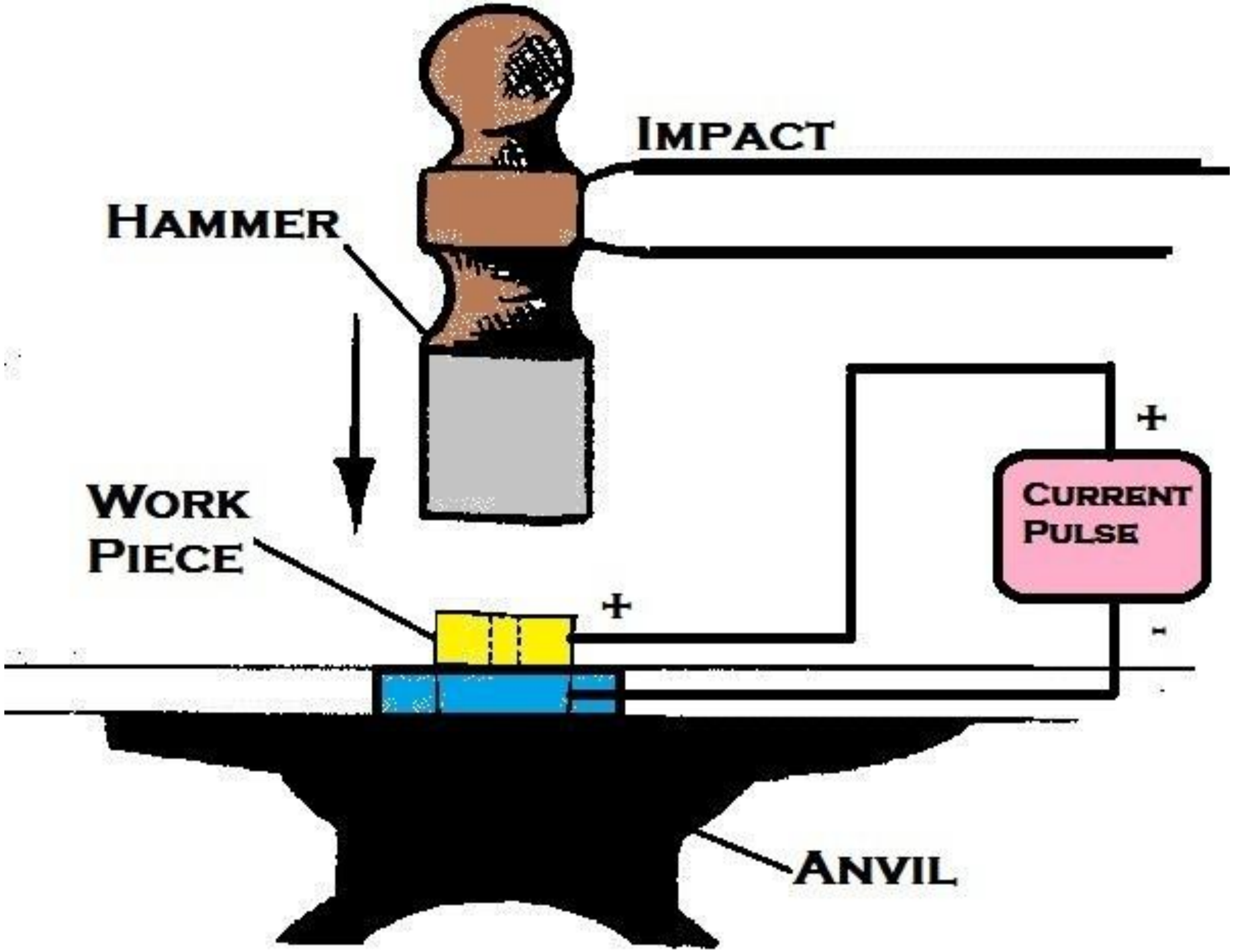
- The method of joining a projectioned component by using resistance spot welding operation is called the resistance projection welding.
- The shape of electrode will be same as the shape of the component to be joined.



Projection Welding

Precussion Welding Operation

- This is a non-fusion pressure welding.
- End-to-end joining is done so joints are produced.
- No separate electrodes are used- the components to be joined acts as electrode.
- In this the power supply will be given first so that the joint can be heated to a temperature nearly equal to the melting point temperature of the material so that the material of the joint will become very soft and atoms present in the surfaces will more active to share the energy.
- Now stop the power supply and apply the force percussively.
- It gives lower joint strength and are used for joining of shafts from end to end.

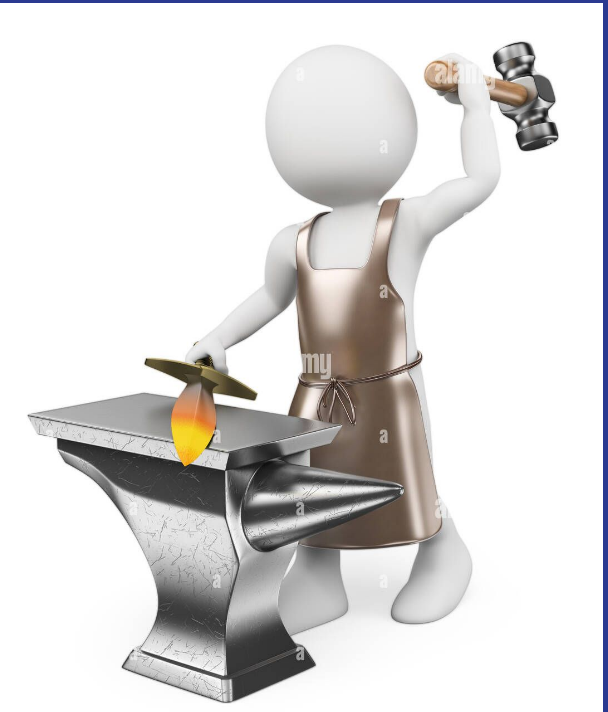

Impact
Hammer
+
Current Pulse
Work Piece
+
-
Anvil

Applications

- Resistance Seam Welding- Produce leak proof joint required in small tanks, boilers etc.
- Resistance Projection Welding- Production of nut and bolt.
- Precussion Welding Operation- Welding pipe and tubes.

MANUFACTURING PROCESS
UNIT - 3
DEFORMATION PROCESSES

GROUP 3 (ROLL NO. 31-45)



GROUP MEMBERS

Group Leaders:-

1. Roll No. 40 - Chetna Madaan
2. Roll No. 43 - Deepti Chincholi

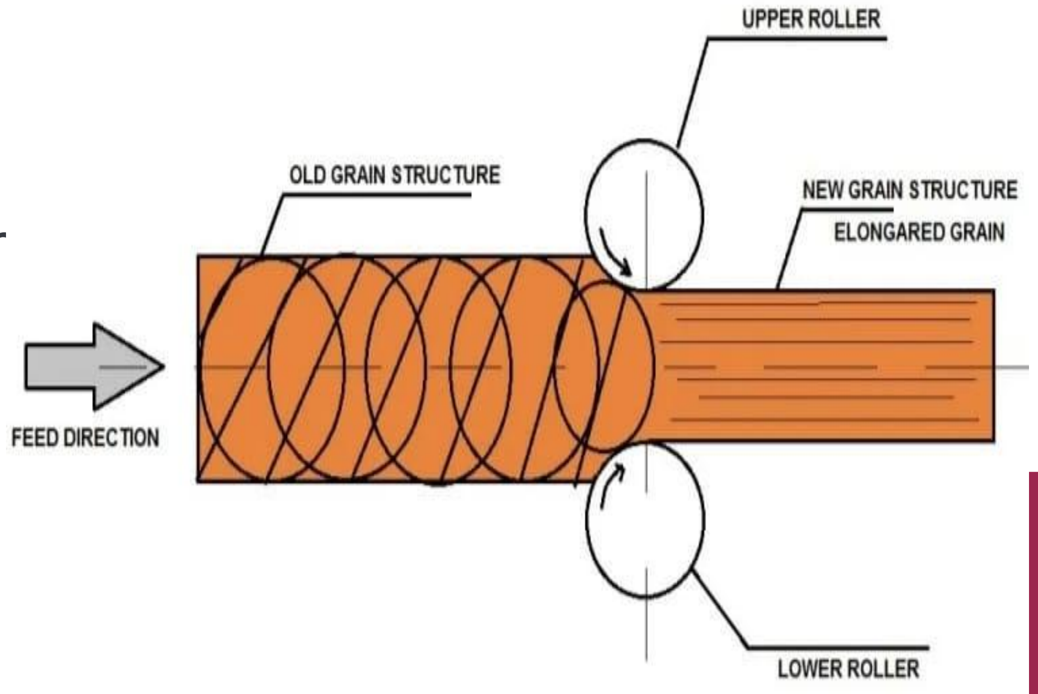
Other group members:-

1. Roll No. 31 - Anushka	Hot and Cold Working of metals
2. Roll No. 32 - Aradhy Umesh	Typical Forging operations
3. Roll No. 33 - Aran Pahwa	Rolling of metal
4. Roll No. 34 - Arman Singh	Principle of Rod drawing
5. Roll No. 35 - Ashish Sharma	Tube drawing
6. Roll No. 36 - Ashutosh Upadhyay	Shearing operation
7. Roll No. 38 - Ayush Pandey	Bending operation
8. Roll No. 39 - Bhaskar Saxena	Drawing operation
9. Roll No. 41 - Deepak Kumar Yadav	Forging
10. Roll No. 42 - Deepanshu	Extrusion
11. Roll No. 44 - Dheeraj Rathore	Stretch Forming operation
12. Roll No. 45 - Dipshita Malik	Metal Spinning

Hot and Cold working of Metals

The metal-working processes are traditionally divided into hot working and cold-working processes. The division is on the basis of the amount of heating applied to the metal before applying the mechanical force.

Hot-working Process is a type of metal forming process and this distinction is based on the particular temperature at which the deformation is carried out. The minimum temperature at which plastically deformed metals form new grains or crystals within a specified time is recrystallization temperature.



Advantages

Hot working is suitable for bulk production.

The shape and size of metal can be easily changed.

Porosity is considerably reduced.

Disadvantages

Due to oxidation, it leads poor surface finish.

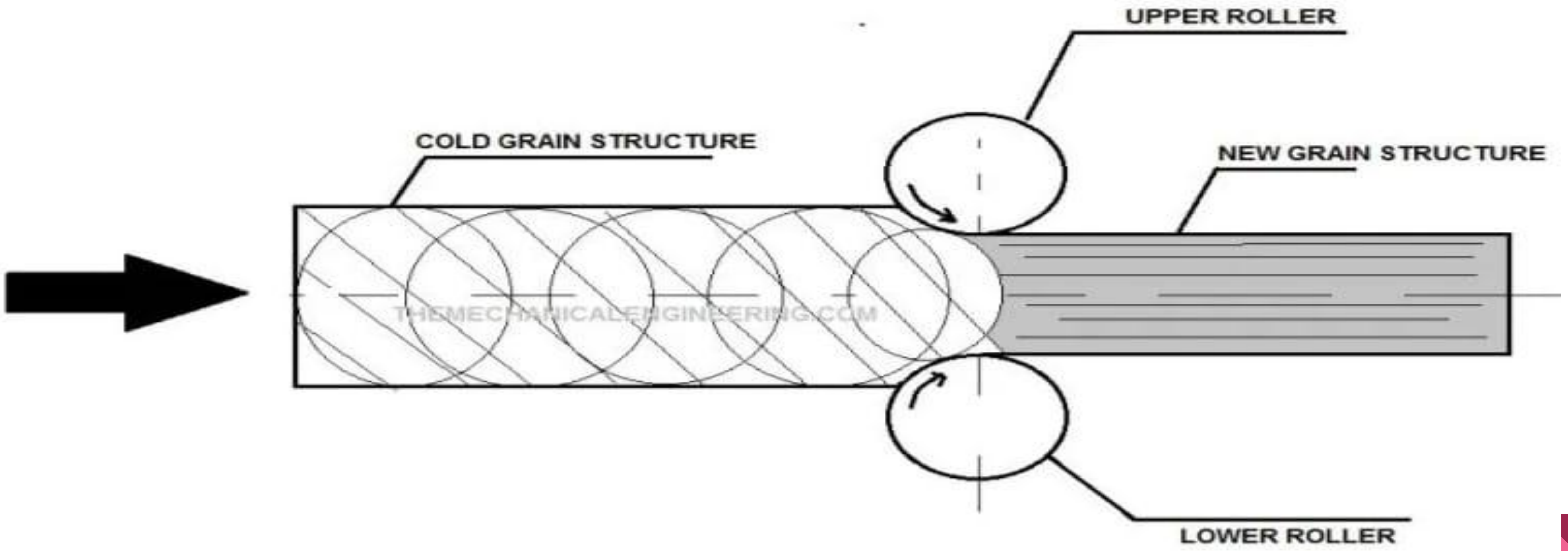
Maintaining and handling the hot work set up is not easy.

It is not suitable for all types of metals.

Applications

The **hot working process is used to manufacture different types of products like tubes, pipes, metal sheets,** etc. Different types of products we encounter daily are manufactured using this method like the many types of equipment of automobile, aerospace, architecture, home decor, etc.

Cold working is the process of metal forming in which the deformation of metal occurs below its recrystallization temperature.



Advantage

The cold working procedure produces a smooth surface finish.

This produces an accurate dimension of the parts

Heating of the metal is not required.

Disadvantage

It requires a clean and smooth surface.

Brittle metals cannot be cold-worked properly.

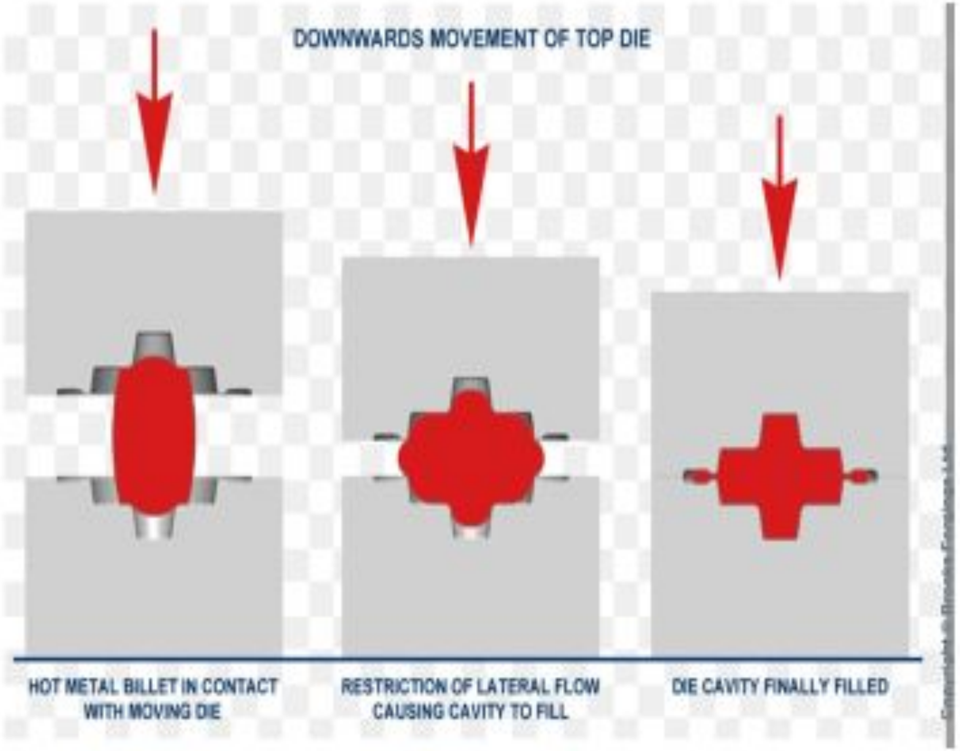
It requires more powerful equipments.

Applications The cold working process is used to manufacture different products in industries like large flat sheets, metal tubes, screw heads, riveted joints, and much more.

https://youtu.be/YkL4U7RwvIo

Forging operation

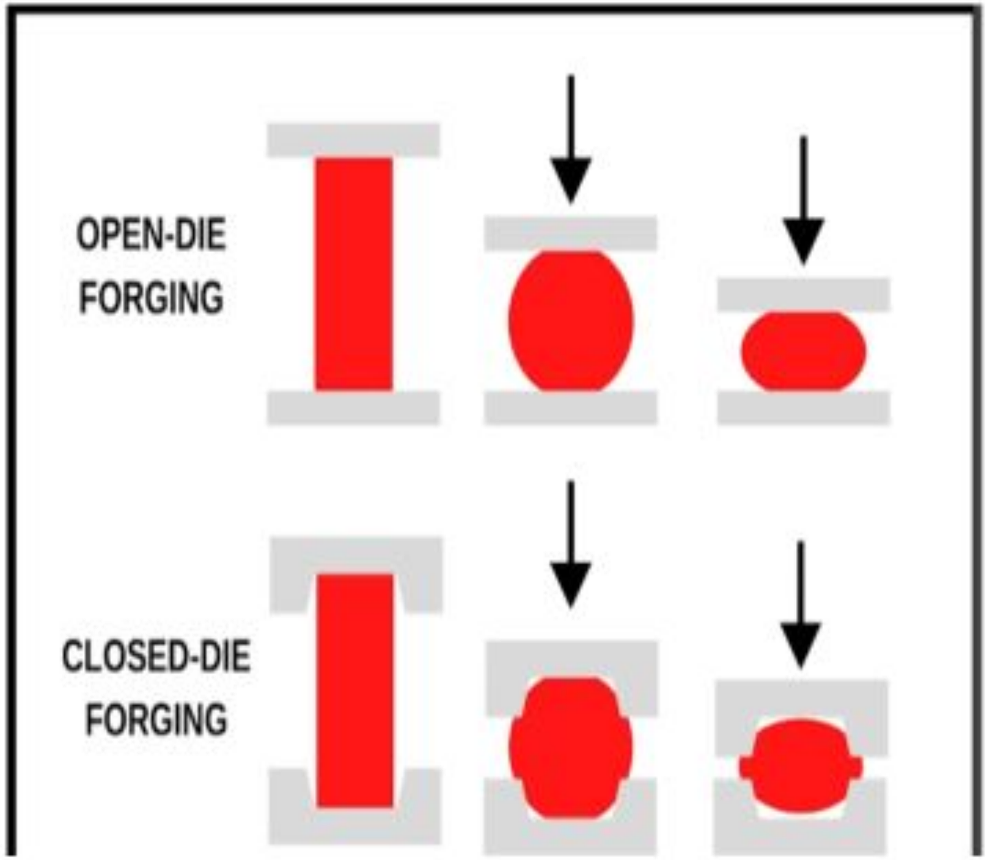
Forging is a manufacturing process involving the shaping of metal using localized compressive forces. The blows are delivered with a hammer or a die. Forging is often classified according to the temperature at which it is performed: cold forging, warm forging, or hot forging.



Open and closed die forging

Open-die forging, also known as free forging or smith forging, is the process of striking a hammer to deform a piece of metal, typically placed on a stationary anvil

Closed-die forging, or impression-die forging, involves metal being placed between one or more custom-shaped dies. The metal is hammered or pressed, causing it to flow and fill the shaped-die cavities.



Advantage and disadvantage

Advantages of forging

- Some common advantages of forging are given as under:

1. Forging refines the structure of the metal.
2. It results in considerable saving in time, labor and material as compared to the production of similar item by cutting from a solid stock and then shaping it.
3. Forging increases the strength by setting the direction of grains.
4. Because of intense working, flaws are rarely found, so it has good reliability.
5. The reasonable degree of accuracy may be obtained in forging operation.

Disadvantages of Forging

Few dis-advantages of forging are given as under.

1. Rapid oxidation in forging of metal surface at high temperature results in scaling which wears the dies.
2. The close tolerances in forging operations are difficult to maintain.
3. Forging is limited to simple shapes and has limitation for parts having undercuts etc.
4. Some materials are not readily worked by forging.
5. The initial cost of forging dies and the cost of their maintenance is high.

TYPICAL FORGING OPERATION

1)SMITH FORGING:A hammer strikes and deforms a metal on a stationary anvil. In this type of forging, the metal is never completely confined in the dies—allowing it to flow except for the areas where it is in contact with the dies.

1.1)FULLERING: Fullering," more generally, refers to **any forging process creating a sharp transition in cross-dimensional area**; with care, some types of fullering can be achieved using only hammer and the edge of the anvil (which acts as the fuller).

1.2)FLATTING: **For removing the hammer and corrugation marks and for obtaining a smooth surface on the job, a flatter or set of hammer is used**. This process is known as flatting or setting down

1.3)SWAGGING: Swaging, also pronounced “swedge”, is **a metal-forming technique in which the metal of one part is deformed to fit around another part by either pressing or hammering, or by forcing the material through a die**

2)DROP FORGING:**Drop forging** is a process that uses a pair of impression dies and a heavy hammer to form and compress metal bars or billets into complex shapes

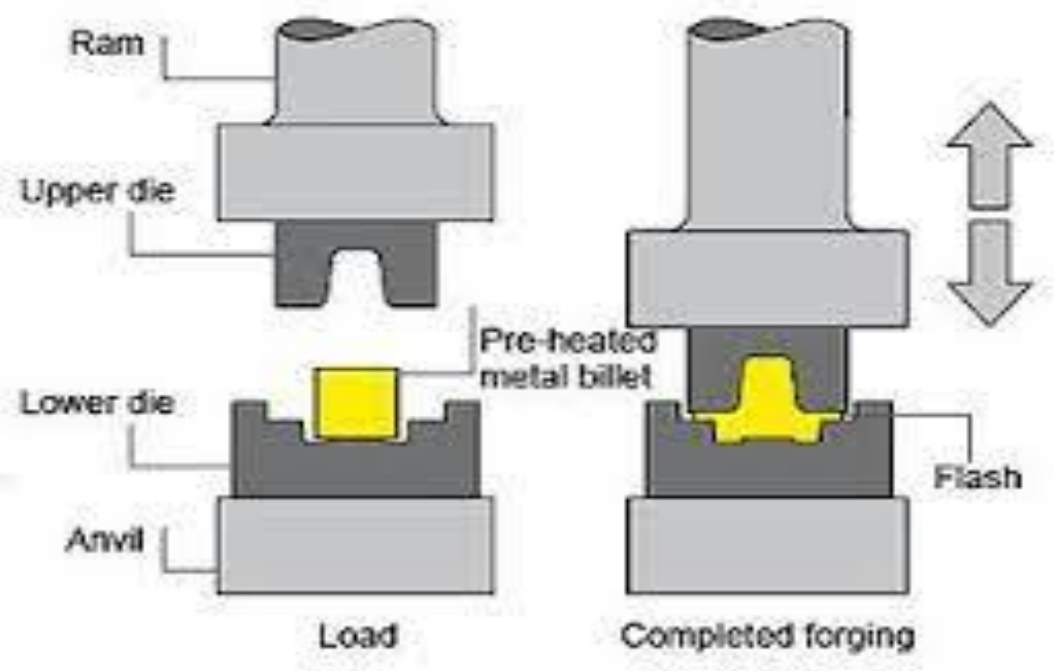
3)PRESS FORGING: Press forging is **a method of forming a piece of metal into a specific shape by applying gradual pressure on a shaped die holding the metal**

4)MACHINE OR UPSET FORGING: Upset forging **involves locally heating a metal bar and then, while holding it firmly with special tooling, applying pressure to the end of the bar in the direction of its axis to deform it**.

HERE ARE THE SOME LINKS:

https://www.slideshare.net/Bilalwahla/forging-34839660

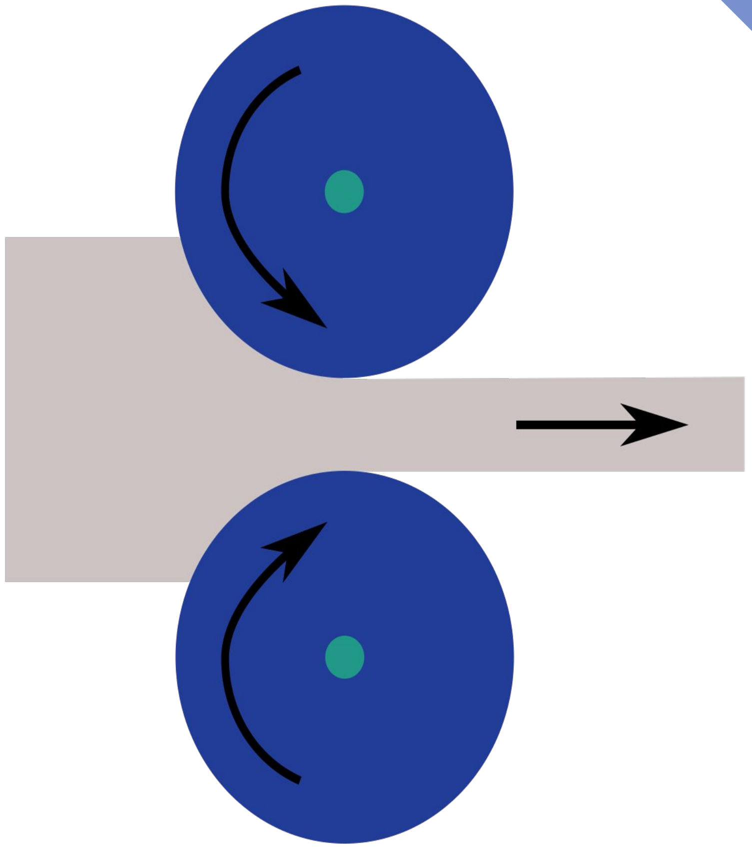
https://skill-lync.com/blogs/what-is-forging-different-types-of-forging-process



ROLLING:

It is a deformation process in which thickness of the metal is reduced by comprehensive forces exerted by 2 opposing rolls.

Rolling works on same as any other metal forming process. When a compressive force applied by a set of rolls on ingot or any other product like blooms or billets, plastic deformation takes place which decrease its cross section area and convert it into required shape. These rolls are designed according to the final product requirement. They are cylindrical in shape and fitted with the die of the required shape which to be rolled on blooms or billets. Rolling can be done in both hot and cold way.



https://youtu.be/iB6jArEIoYE

Disadvantages:

1. Poor surface finish
2. Suitable only for large sectional production
3. High cost of equipment

Applications:

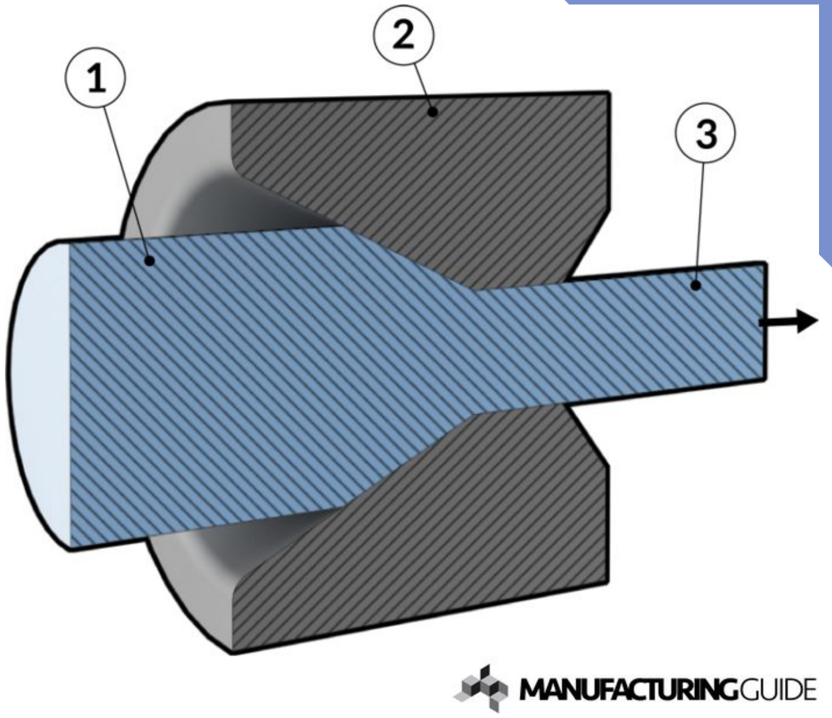
1. Automobile industry
2. Railway industry

Uses:

1. Used for making hollow seamless tubes
2. Used for mass production of threaded parts like screws.

ROD DRAWING

Forming process in which the workpiece is drawn through a tapered shape(die) that reduces and changes the cross-sectional area. The workpiece [1] in the form of a bar stock is cleaned and coated with a lubricant before processing. One end is inserted through the die [2] and by a pulling or tensile force, the entire rod is drawn through the drawing die which reduces and changes the rods cross sectional area [3]



Advantages

1. Good surface finishing
2. Adaptability to mass production
1. Close dimensional control
2. Improved dimensional properties
1. Economical benefits

Disadvantages

1. High energy demand to pull the workpiece through the die.
2. Lubricants are required to reduce friction and heat
3. Risk of wear and tear

Uses : Rod and wire products cover a very wide range of applications which include shafts for power transmission, machine and structural components, blanks for bolts and rivets, electrical wiring, cables, wire stock for fences, rod stock to produce nails, screws, rivets, springs and many others. Drawing of rods from steel rounds is used to produce rods for machining, forging, and other processes etc.

Youtube Link - https://www.youtube.com/watch?v=ANh6CzHjFTM

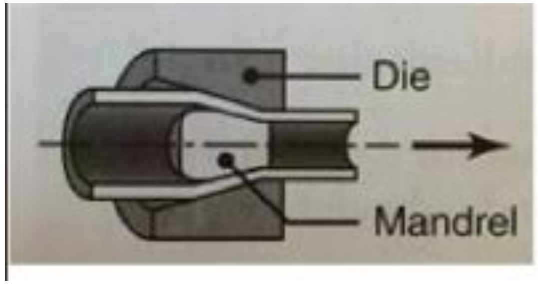
Tube Drawing

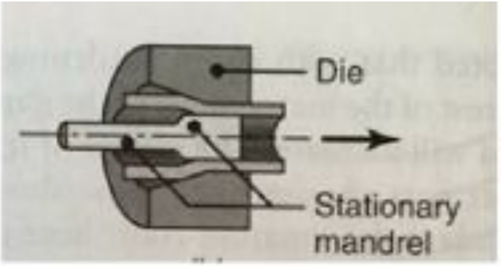
Tubes produced by extrusion or other process (such as shape rolling) Also tubes can be reduced in thickness or diameter by tube drawing. The shape of tubes can be changed by using dies and mandrels with various profiles

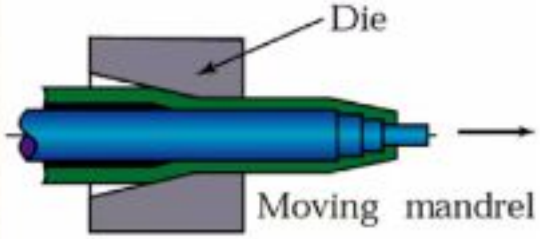
Tube drawing is also similar to wire drawing, except that a mandrel of appropriate diameter is required to form the internal hole.

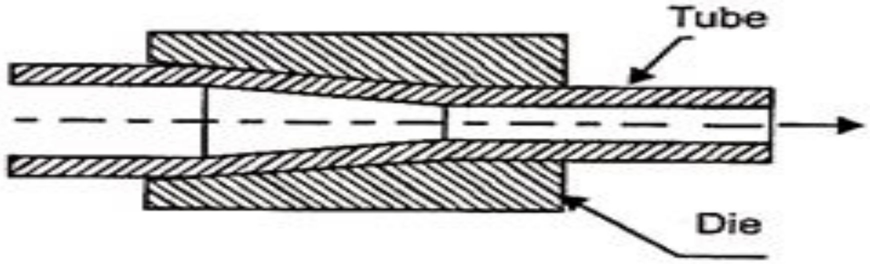
Here three arrangements are shown in figure
(a) with a floating plug and
(b) fixe plug drawing
(c) with a moving mandrel

Tube Drawing

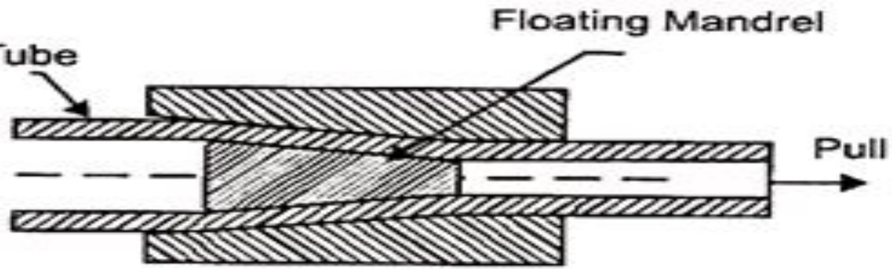




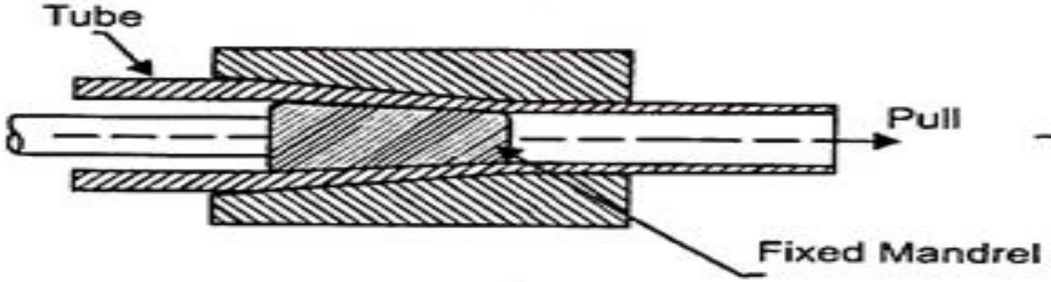




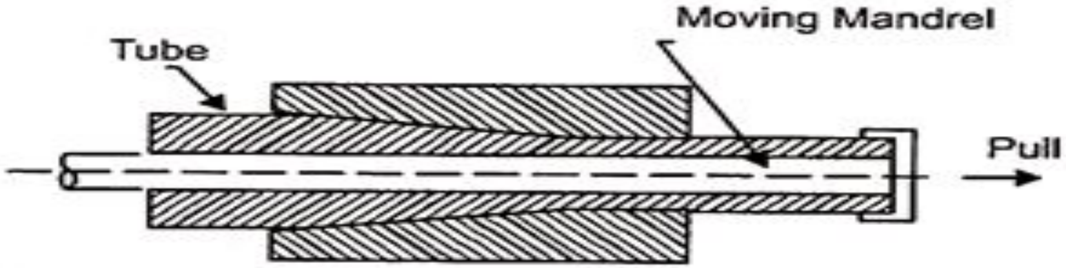
(a) Tube sinking



(b) Tube drawing with floating mandrel



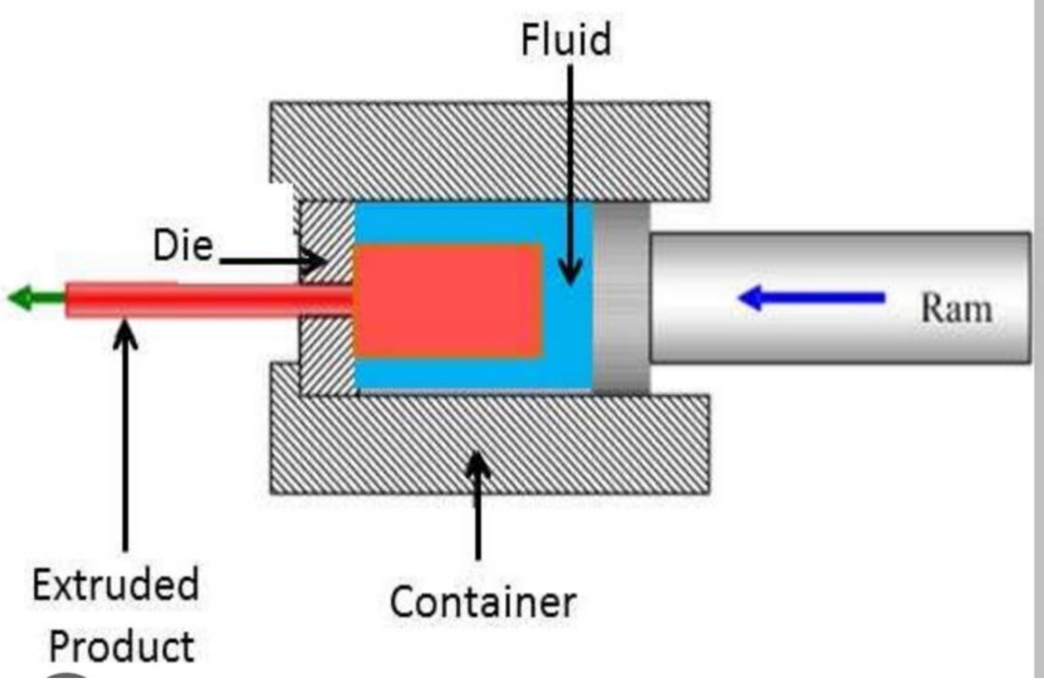
(c) Tube drawing with fixed mandrel



(d) Tube drawing with moving mandrel

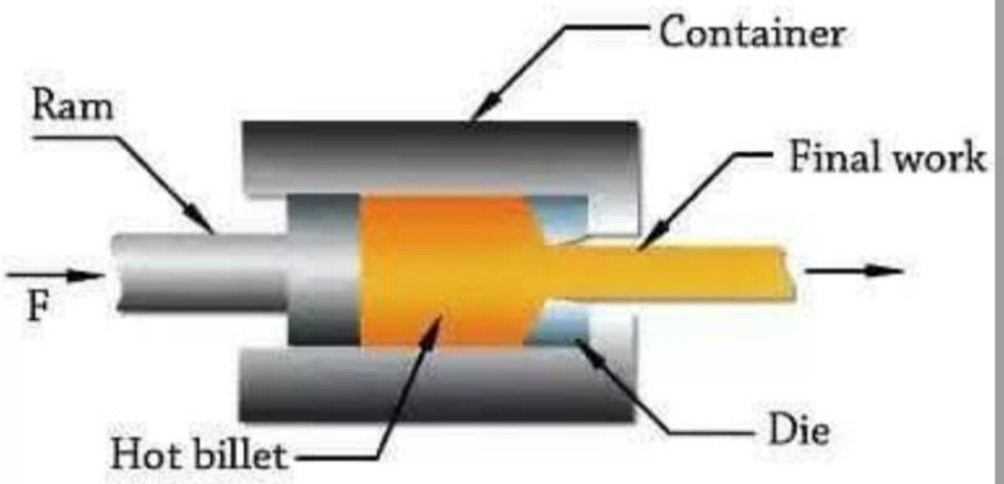
Extrusion

Extrusion is **a process where a material undergoes plastic deformation by the application of a force causing that material to flow through an orifice or die**. The material adopts the cross-sectional profile of the die and if the material has suitable properties, that shape is retained in the final extrudate.



Extrusion may be continuous (theoretically producing indefinitely long material) or semi-continuous (producing many pieces). It can be done with hot or cold material.

TYPES OF EXTRUSION

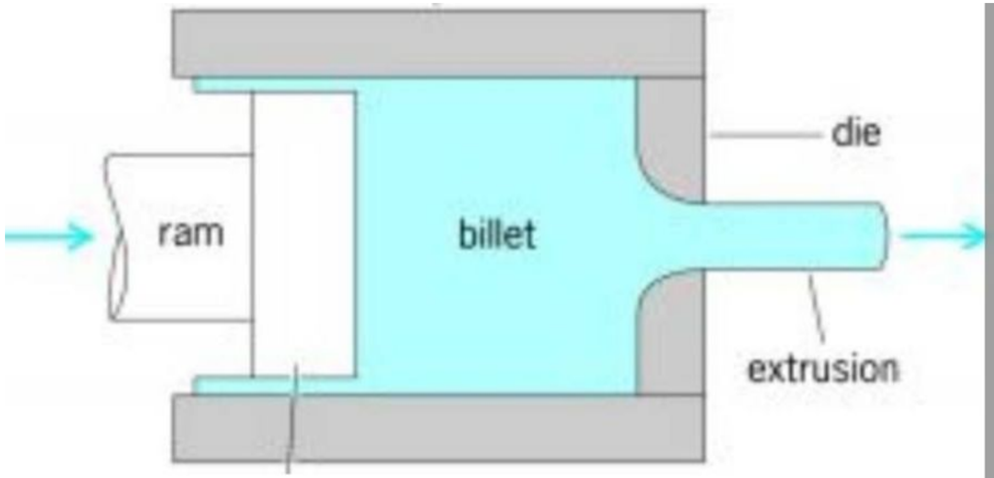


Hot extrusion

Hot and cold extrusion

Hot extrusion:- Hot extrusion is the production process used to form special steel profiles with a constant longitudinal cross-section. It acts through a force called “compression”.

Cold extrusion:- Cold extrusion can also be defined as the process of shaping of a cold metal by striking a slug.



YouTube link :-

https://youtu.be/Y75IQksBb0M

Advantages of Extrusion :-

- Continuous
- High production volumes
- Low cost per pound
- Efficient melting
- Many types of raw materials
- Good mixing (compounding)

- Disadvantages
  - Limited complexity of parts
  - Uniform cross-sectional shape only

Application:

- Extrusion is widely used in production of tubes and hollow pipes.
- Aluminum extrusion is used in structure work in many industries.
- This process is used to produce frames, doors, window etc. in automotive industries.
- Extrusion is widely used to produce plastic objects.

SHEARING OPERATION

Shearing is also known as die cutting . It is a process that cuts stock(or metal sheet) without the formation of chips .

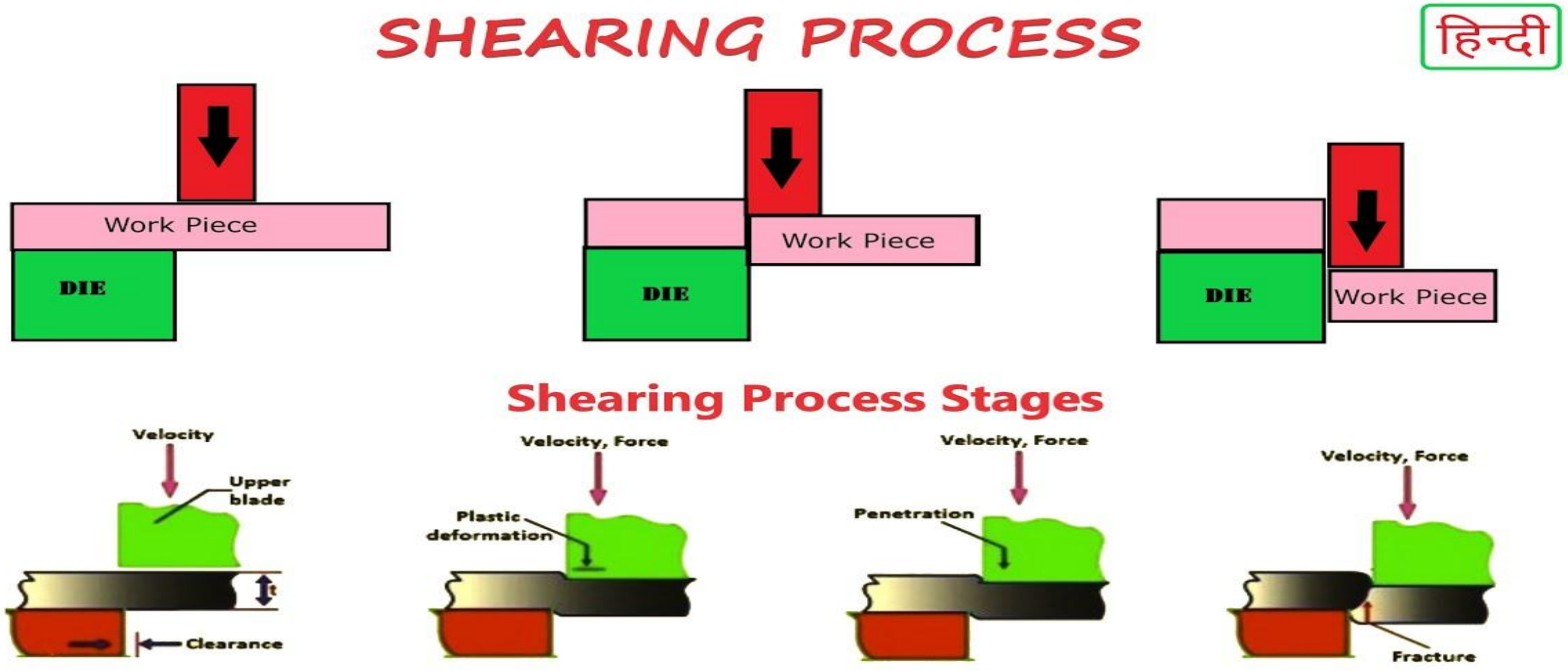
Shearing is performed by slicing through a piece of sheet metal with a blade that's most often affixed to a tool or machine.

Strictly speaking , if the cutting blades are straight then the process is called shearing ; if the cutting blades are curved then they are shear type operation.

Phases of shearing process :-

1)Contact engaging 2) Penetration stage 3) Fracturing stage 4)Full material separation

Shearing starts as the punch presses against the sheet metal. At first, cracks form in the sheet on both the top and bottom edges. As the punch descends further, these cracks grow and eventually meet each other and the slug separates from the sheet. A close look at the fractured surfaces will reveal that these are quite rough and shiny; rough because of the cracks formed earlier, and shiny because of the contact and rubbing of the sheared edge against the walls of the die.



Advantages

- Incredibly fast, with shearing cutting through sheet metal in just seconds.
- Creates clean cuts with smooth edges.
- Can be performed on sheet metal in a variety of diameter sizes.

Disadvantages

- Not ideal for low-volume manufacturing applications.
- Exceptionally hard metals like tungsten cannot be sheared.
- May cause deformity in sheet metal.

YOUTUBE LINK :- https://youtu.be/3iu2f4ax-_o

Bending opertaion

Bending is **a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metal**. Commonly used equipment include box and pan brakes, brake presses, and other specialized machine presses

Advantage of bending operation

Bending is a **cost-effective near net shape process when used for low to medium quantities**. Parts usually are lightweight with good mechanical properties.

Disadvantage of bending operation

A disadvantage is that some process variants are sensitive to variations in material properties.

Application of bending operation

- Agriculture industry: It is useful for Vineyard accessory, Agricultural Spring, Tractor part
- Furniture industry: It is useful for decoration lamps, bottle holder, chair frame
- Automotive industry: It has many applications in this industry for the production muffler hargers with end forming units, single head or head and collar, headrest frames, bonnet rods, tank floats, child seat hooks, etc.
- Railway industry: Applications in the railway industry include railway clips, etc.
- Construction Industry: There a large number of applications in the construction industry like scaffolding safety hooks, ceiling hook, frameworks concrete

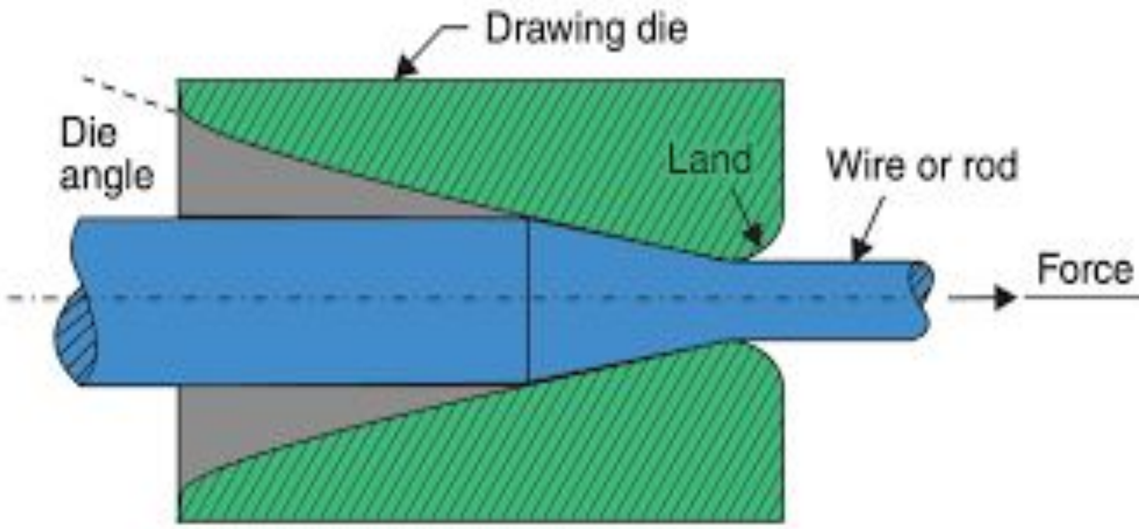
Wire Drawing

Definition :Wire drawing is a metalworking process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing die(s)

Applications :There are many applications for wire drawing, including electrical wiring, cables, tension-loaded structural components, springs, paper clips, spokes for wheels, and stringed musical instruments.

Advantages The advantages of wire and rod drawing of other applications are:

- Good surface finishing.
- Adaptability to mass production.
- Close dimensional control.
- Improved dimensional properties.
- Economical benefits.



Youtube Link For Animation :
https://www.youtube.com/watch?v=pd4Uk8vk09c&ab_channel=LEARNANDGROW

Types Of Wire Drawing

Hydrostatic Wire Drawing

Bundle Wire Drawing

Tandem Wire Drawing

Stretch Forming Operation

Stretch forming is a metal forming process in which a selected material is simultaneously stretches and bends over a die, to form One or several curve radii.

Type of stretch forming operation

1. Swing arm stretch wrap V- Press
2. Sheet Metal Stretch Forming

   (T-Press, L-Press, VTL-Press)

Advantages And Disadvantages of stretch forming

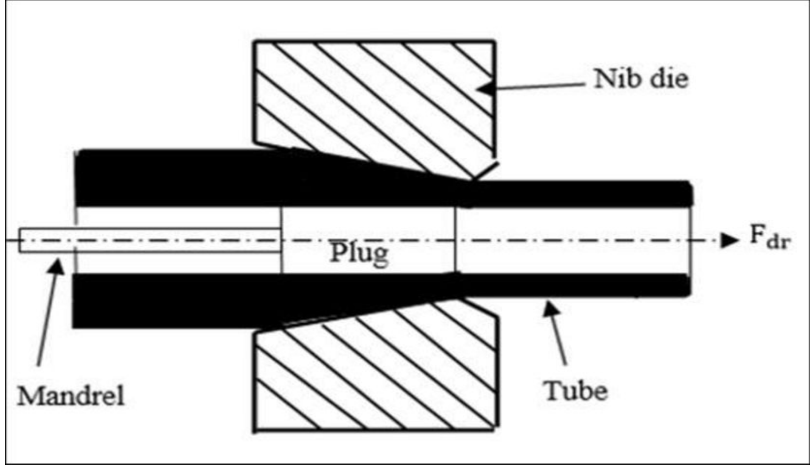
Advantages

1. Cost effective.
2. Minimize residual
3. Can create sharp contours and reentrant angle

Disadvantage

1. Not recommended for high volume production.

Fixed Plug Drawing



This is the oldest tube drawing method.

Fixed plug drawing, also known as stationary mandrel drawing, uses a mandrel at the end of the die to shape the ID of the tube.

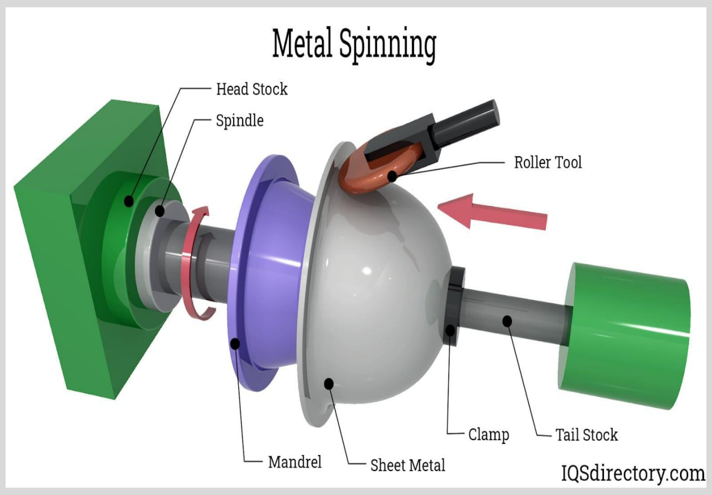
This process is slow and the area reductions are limited (lengths of tubes are limited), but it gives the best inner surface finish of any of the processes.

METAL SPINNING

Metal Spinning or Spin forming is a metalworking process by which a disc or tube of metal is rotated at high speed and formed into an axially symmetric part. It is usually done with hands of CNC technology.

Metal Spinning does not involve removal of material, as in conventional wood or metal turning, but forming of sheet metal over an existing shape.

It ranges from an artisan’s speciality to the most advantageous way to form round metal parts for commercial applications.



ADVANTAGES OF METAL SPINNING

1. Several operations can be performed in one set-up.
2. Changes in part design can often be made through changes in tooling, particularly if the change is a reduction in size.
3. Smaller amount of waste products produced.
4. Produces products without seams.
5. Assures a higher degree of reliability on parts that have a structural function.
6. Avoids warping
7. Lead times are usually shorter compared to other tooling methods.
8. Low-cost tooling

THANKS FOR WATCHING

UNIT-4 METALLURGY

MADE BY:

GROUP 4 (46 TO 61)

GROUP MEMBERS

Group leaders:

Roll No. 59- Anish Murali

Group members:

Roll No. 46 Dishank Arya - Introduction of powder metallurgy process

Roll No.47 Divya Nishu- blending

Roll No.48 Divyansh Thakur- sintering

Roll No.49 Gauav Garg- compaction

Roll No.50 Gaurika Thakur- Types of plastics

Roll No.51 Hemant Rawat- Characteristics of the forming and shaping processes

Roll No.52 Himanshu Mehra- Moulding of Thermoplastics

Roll No.53 Japinder Singh- , Injection moulding

Roll No.54 Jayesh Uriyal- Blow moulding

Roll No.55 Jayshree Patra- Rotational moulding

Roll No.56 Harsh Garg- Film blowing

Roll No.57 Garvit Kumar- Extrusion

GROUP MEMBERS

Group leaders:

Roll No. 59- Anish Murali

Group members:

Roll No. 58 Neal Malik - Thermoforming

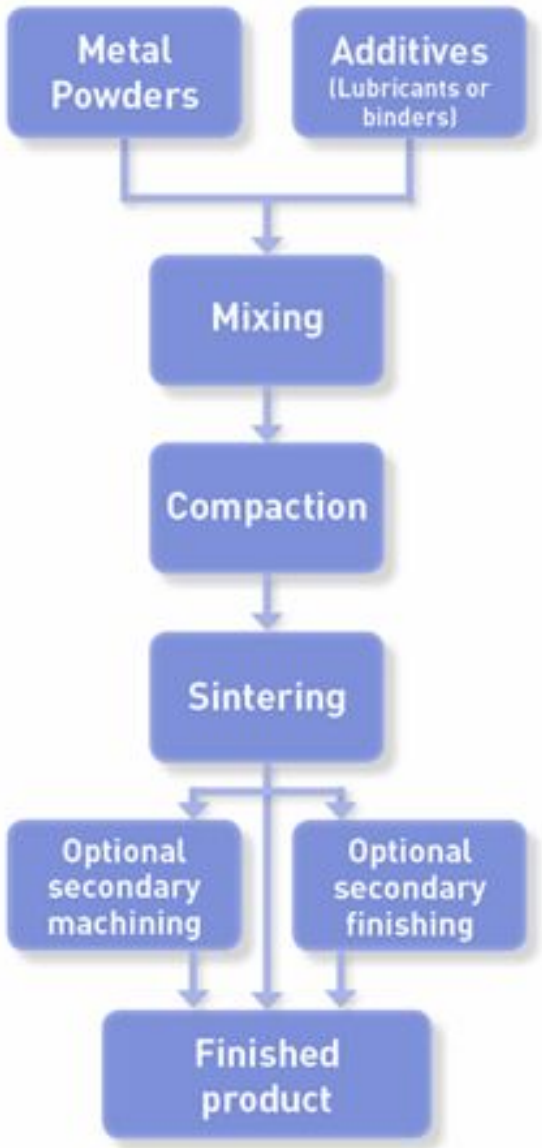
Roll No.59 Vanshaj Goel - Compression moulding

Roll No.60 Anish Murali - Transfer moulding

Roll No.61 Nipun Rustagi - compaction

INTRODUCTION TO METALLURGY PROCESS

- **<u>What is Powder Metallurgy</u> ?**
- Powder metallurgy is a manufacturing process that produces precision and highly accurate parts by pressing powdered metals and alloys into a rigid die under extreme pressure. With the development and implementation of technological advances, powder metallurgy has become the essential process for the production of bushings, bearings, gears, and an assortment of structural parts.
- The key to the accuracy and success of powder metallurgy is the sintering process that heats parts to bond the powder particles . The temperature in sintering is slightly below the melting point of the primary metal such that the bonds of the powdered particles are bound together.

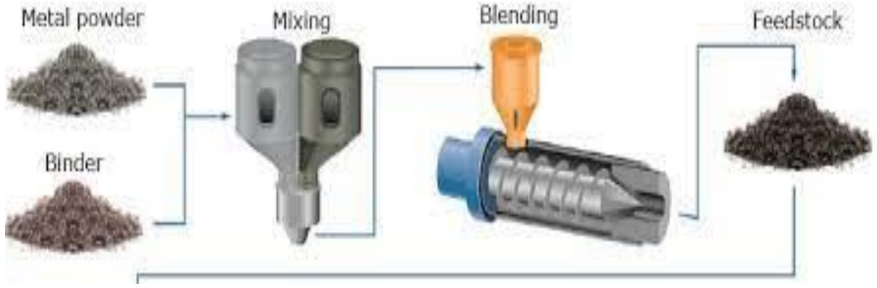


INTRODUCTION TO METALLURGY PROCESS

- **The Powder Metallurgy Process**
- The process of powder metallurgy is an ancient, unique method for forming shapes and designs from ferrous and non-ferrous metals. Powder metallurgy has been used for thousands of years as a way to produce household items and tools. It began as a method for mass producing products and parts in the middle of the first industrial revolution.
- Until the early part of the 20th Century, the process was used sporadically but was not considered to be a viable production method. With the development of electricity and technological advances, powder metallurgy has found a place as a highly efficient and productive method for producing parts with high tolerances and minimal waste.
- **The four basic steps to the powder metallurgy process are powder preparation , mixing and blending , compacting , and sintering** . These steps have been used over the centuries to produce a variety of products.
- As with any manufacturing process, powder metallurgy has variations to accommodate the requirements of individual parts. The different methods and techniques have grown from the development of technological advances and engineering specifications. Four of the variations are conventional, injection molding, isostatic pressing, and metal additive manufacturing, which is the newest advancement.

BLENDING

- The term blending refers to the combination of particles of the same chemistry and different sizes. It involves combining different chemicals to create a new chemical. The chemicals that are combined can be in various phases such as liquid or powder, organic or inorganic, etc. Moreover, we can blend these components to get the desired viscosity, pH level, and filtration level.
- Convective blending involves gross movement of particles through the mixer either by a force action from a paddle or by gentle tumbling under rotational effects.
- Diffusion is a slow blending mechanism and will pace a blending process in certain tumbling mixers if proper equipment fill order and method are not utilized.
- Shear mechanism of blending involves thorough incorporation of material passing along forced slip planes in a mixer.



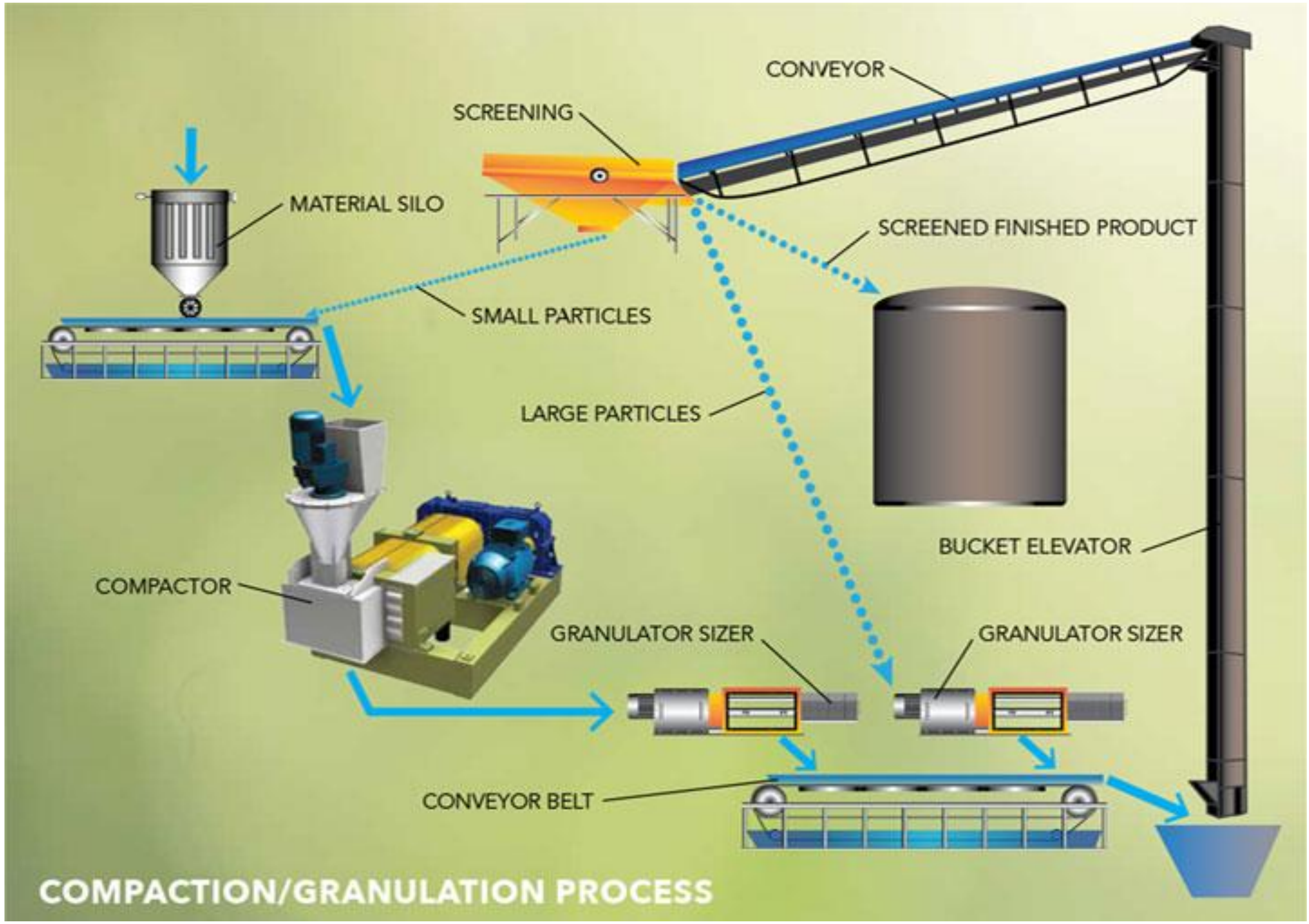
COMPACTION

- The compacting process is the compressing of fine-sized powders between a roll compactor. The compacted material is then typically reduced in size and screened to specification.

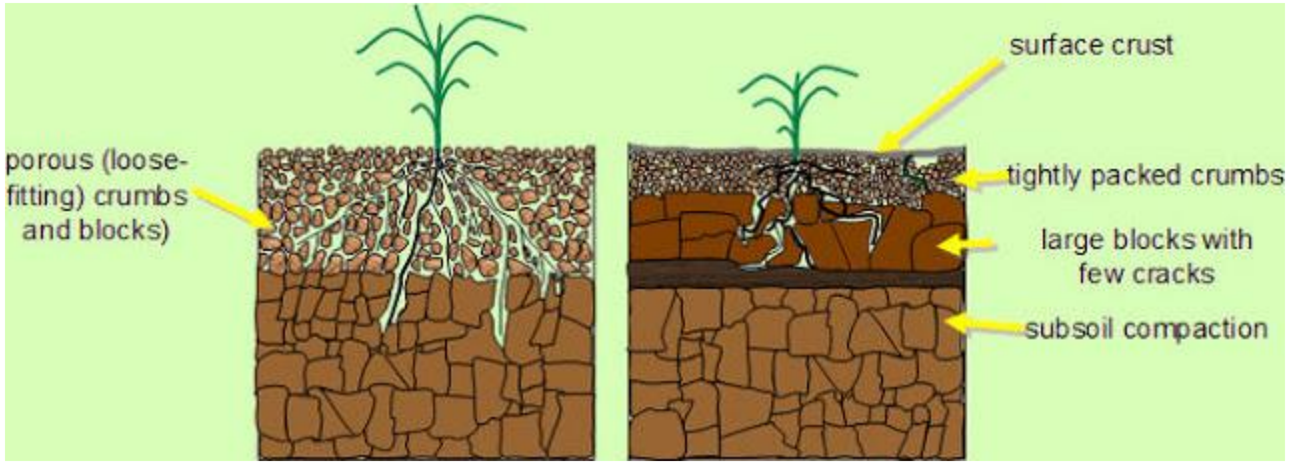
1) Materials are fed and mixed from the material silo into the compactor. Feed materials are then pressed together into compacts by roll compactors.

2) The produced compacts are broken into granules and classified into desired particle sizes. Undersized materials are fed back into the roll compactor while oversize materials are fed back for further size reduction.

3) Materials of the final desired size and shape are ready for any further finishing, such as drying or anti-caking agent application, and prepped for final packaging.



Typical compaction and granulation plants include special auxiliary equipment used for milling, screening, mixing, de-aeration and material handling. This equipment needs to be properly selected and designed to ensure proper operating conditions and quality products.



SOIL COMPACTION

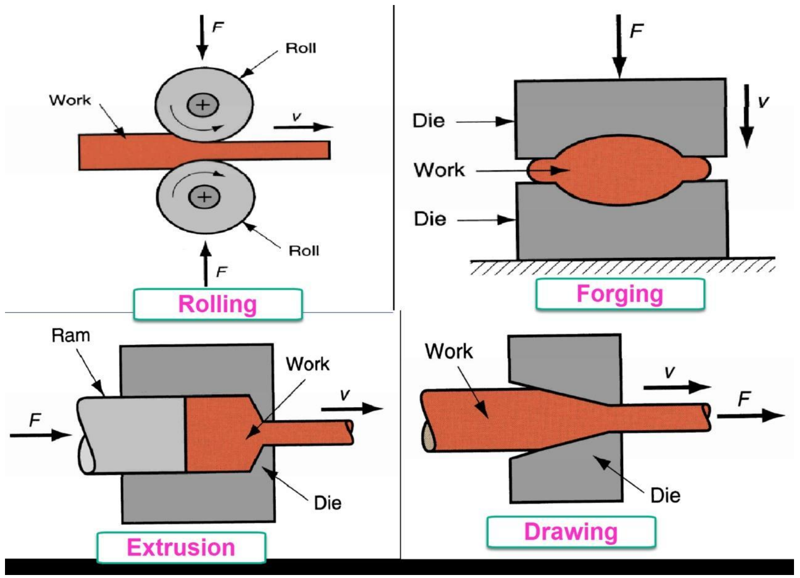
1) Soil compaction occurs when soil particles are pressed together, reducing pore space between them. Heavily compacted soils contain few large pores, less total pore volume and, consequently, a greater density.

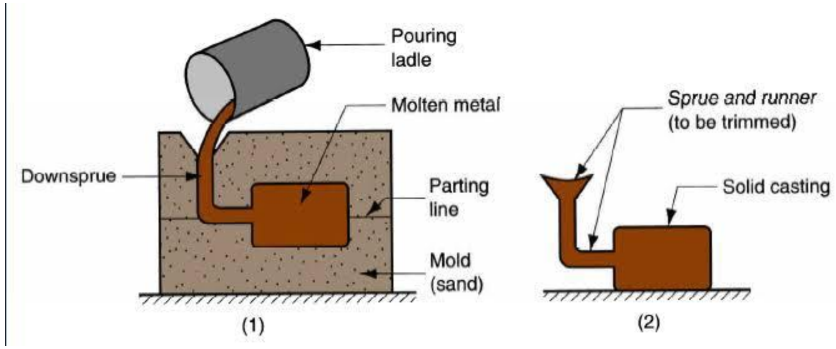
2) A compacted soil has a reduced rate of both water infiltration and drainage. This happens because large pores more effectively move water downward through the soil than smaller pores.

3) Soil compaction changes pore space size, distribution and soil strength

SINTERING

TYPES OF PLASTIC





CHARACTERISTICS OF FORMING AND SHAPING PROCESS

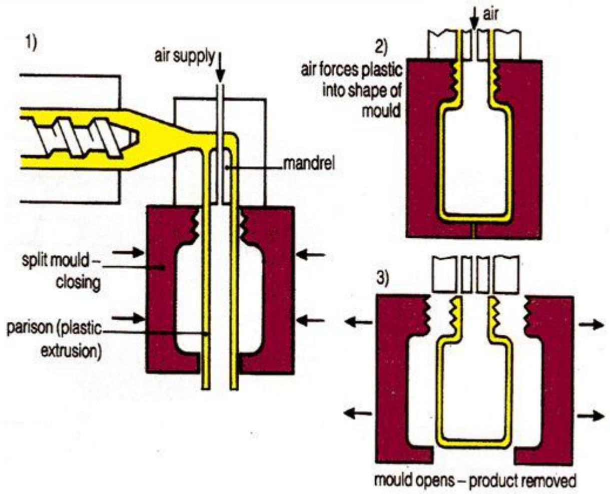
- Metal forming processes are characteristic in that the metal being processed is plastically deformed to shape it into a desired geometry. In order to plastically deform a metal, a force must be applied that will exceed the yield strength of the material.
- This is where material is poured or a liquid is forced into a mould and then left to harden to take a particular shape. This allows for complex shapes to form in a single operation. Shaping can be completed by casting, injection moulding or composite layup.
- Solidification processes – starting material is a heated liquid or semifluid
  Particulate processing – starting material consists of powders
  Deformation processes – starting material is a ductile solid (commonly metal)
- Material removal processes – starting material is a ductile or brittle solid

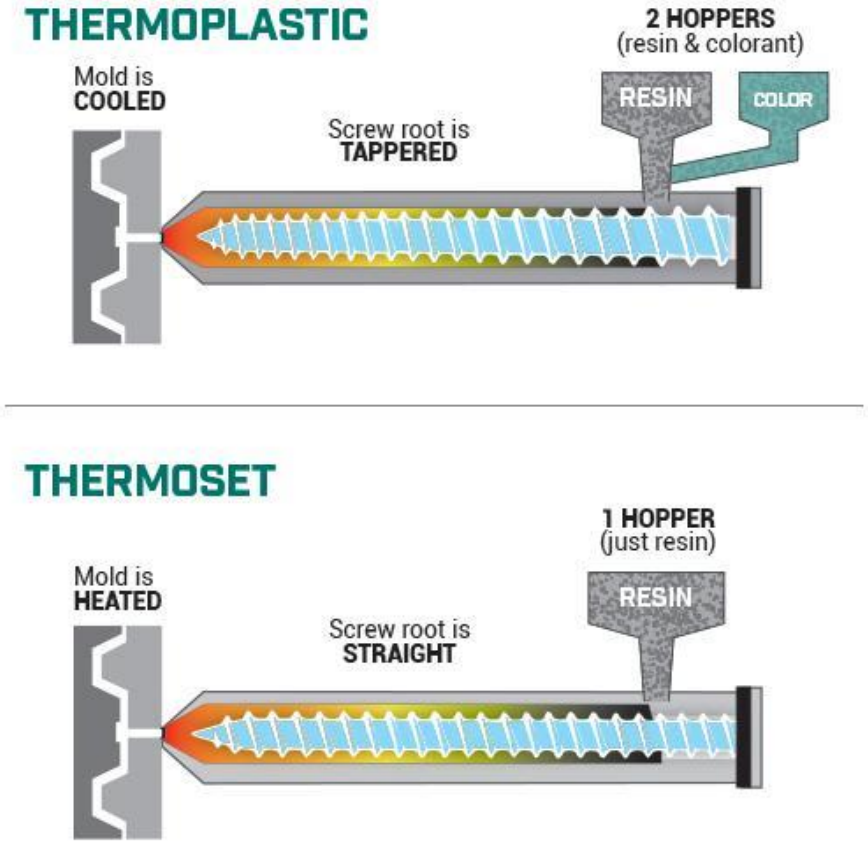
MOULDING OF THERMOPLASTIC

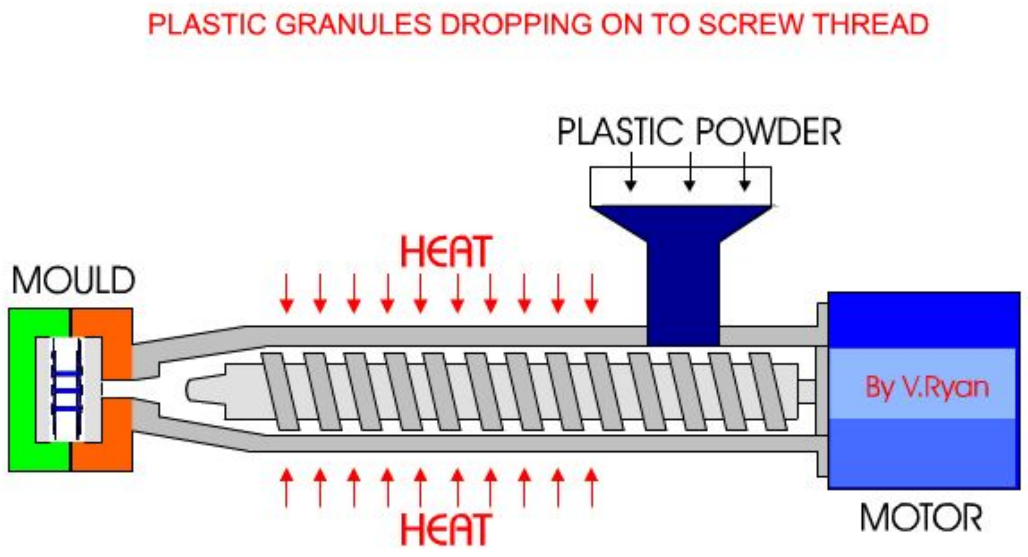
EXTRUSION BLOW- MOULDING

- The cycle

1. A tube of plastic called a parison is extruded into an open two-part mould
2. Mould closes to pinch the mould and air is blown into the tube forcing the plastic against the insides of the mould
3. The mould is opened to release the plastic shape and the cycle begins again.







INJECTION MOULDING

Injection molding is a forming process using molds. Materials such as synthetic resins (plastics) are heated and melted, and then sent to the mold where they are cooled to form the designed shape. Due to the resemblance to the process of injecting fluids using a syringe, this process is called **injection molding**.

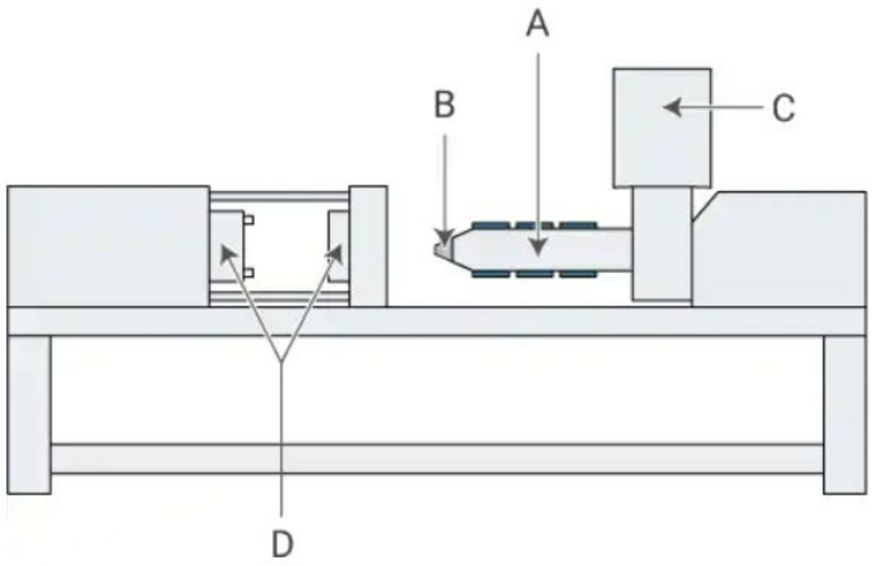
The flow of the process is as follows:

Materials are melted and poured into the mold, where they harden, and then the products are taken out and finished . With injection molding, diversely shaped parts, including those with complex shapes, can be continuously and quickly manufactured in large volumes.

Therefore, injection molding is used to manufacture commodities and products in a wide range of industries.

INJECTION MOULDING

Basic Structure of Injection Molding Machines



A : Cylinder (heats the material)

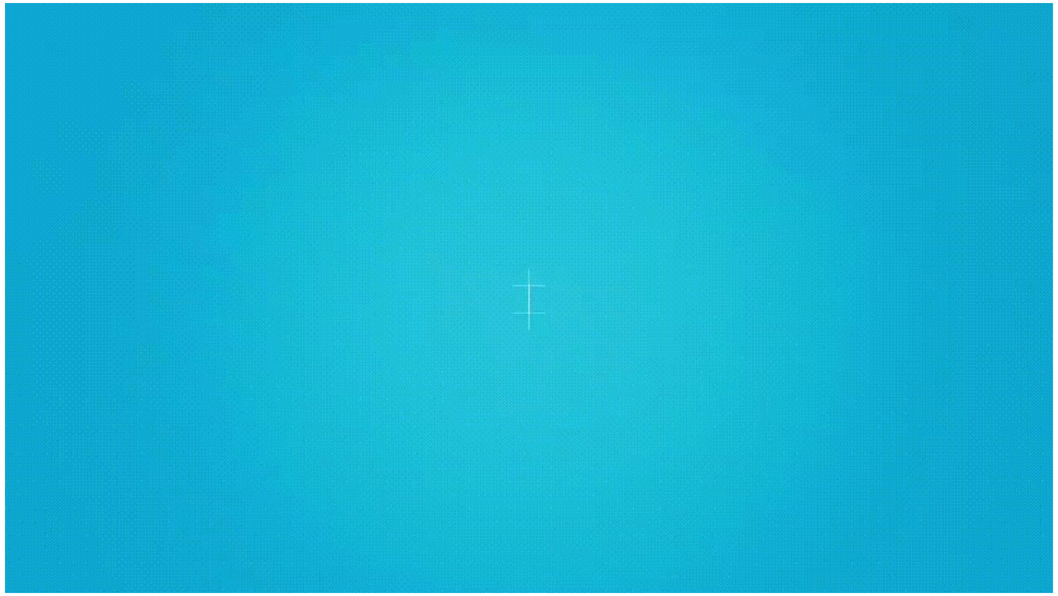
B : Nozzle (injects the melted material)

C : Hopper (material feeder)

D : Mold (material is poured into the mold cavity between two plates)

- **Injection Molding Machines**
- Injection molding machines come in different types, such as motorized machines driven by servo motors, hydraulic machines driven by hydraulic motors, and hybrid machines driven by a combination of a servo motor and a hydraulic motor. The structure of an injection molding machine can be briefly summarized as consisting of an injection unit that sends the melted materials into the mold, and a clamping unit that operates the mold.
- In recent years, the use of CNC has been increasingly adopted in injection molding machines, giving rise to the popularity of models that enable high-speed injection under programmed control. On the other hand, a number of specialized machines, such as models that form the light guide plates for LCD monitors, are also used.

BLOW MOULDING



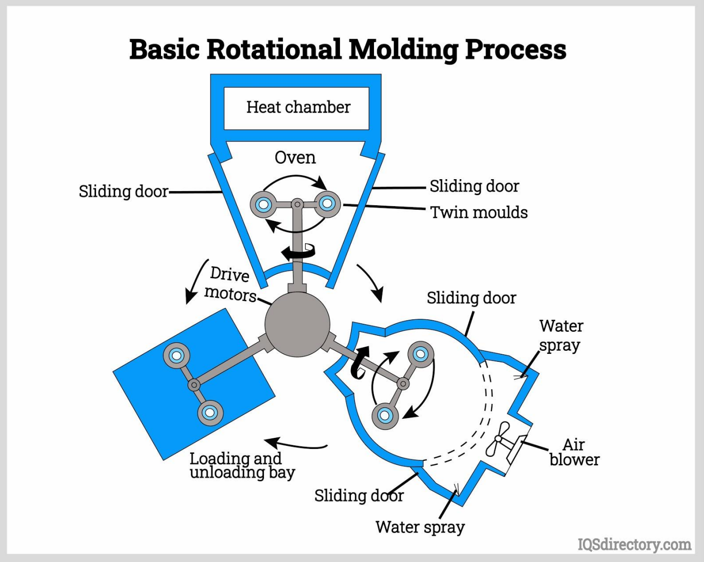
- Blow molding is a manufacturing process that is used to produce hollow plastic parts by inflating a heated plastic until it fills a mold and forms the desired shape.
- There are three types of blow molding :
  - Extrusion Blow Molding
  - Injection Blow Molding
  - Stretch Blow Molding
- The thermoplastic (in the form of small pellets or granules) are heated above the melting temperature and molded into a preform.
- This preform is heated above the glass transition temperature and converted into a hollow tube called parison.
- The parison is then clamped between two mold halves and inflated by high air pressure (60-140 psi) until it conforms to the inner shape of the mold.

BLOW MOULDING

- Advantages :
  - Low tooling cost
  - Ability to mold complex parts with uniform thickness
  - Fast production rate
- Disadvantages :
  - Limited to hollow parts
  - Thick parts can't be manufactured
  - Trimming is required
- Application :
  - Plastic Bottles
  - Automotive Ducts
  - Food Storage Container

ROTATIONAL MOULDING

- Rotational Molding
- Rotational molding, commonly referred to as "rotomolding", is a plastic casting technique used to produce large hollow, seamless, and double-walled parts. It is a three-stage process that involves a mold on a rotating frame, a heating chamber, and a cooling chamber. Molds for the rotomolding process are specially designed and are capable of producing single and double wall products.
- Process
  - A hollow mold is filled with powdered plastic resin.
  - The mold begins rotating bi-axially and is transferred into an oven.
  - The mold continues to rotate as the resin melts and coats the walls of the mold.
  - The mold is cooled until the resin hardens into the desired shape.
  - The rotation is stopped, and the mold is opened to remove the finished part.
- Applications of Rotational Moulding
  - Automotive industry.
  - Agricultural industry.



FILM BLOWING

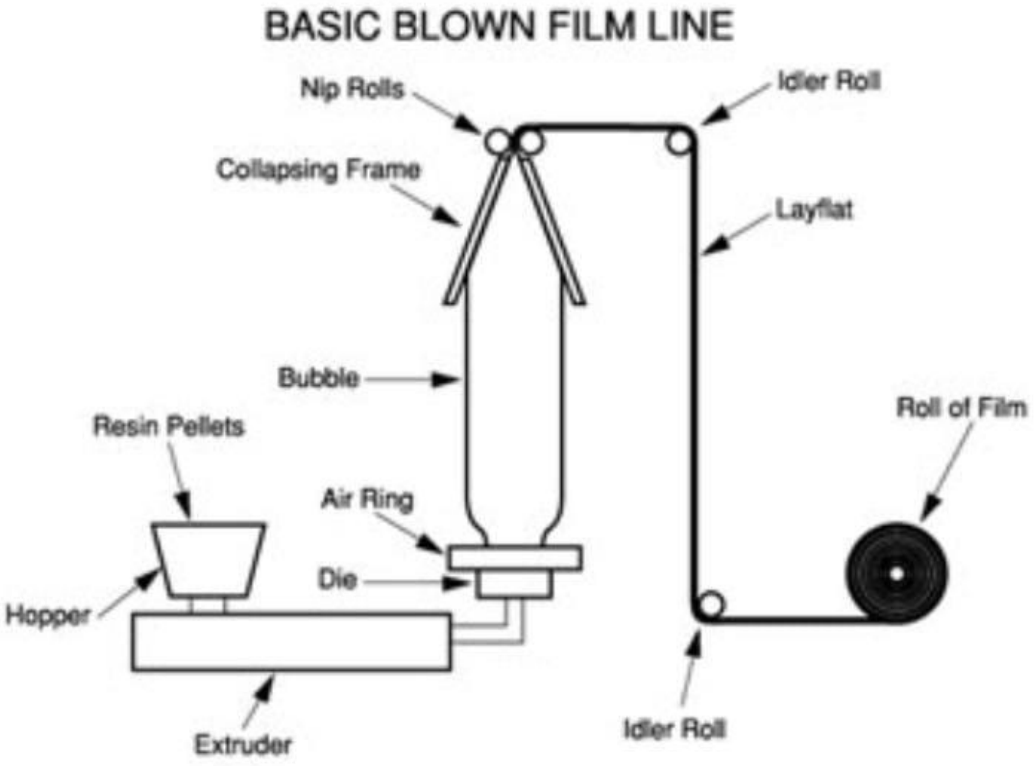
- Blown Film Extrusion is an established process which is sued to manufacture a wide range of commodity & specialized plastic films for the packaging industry. Also known as Film Blowing Process, this extrusion process generally comprises extrusion of molten thermoplastic tube and its constant inflation to severaltimes of its initial diameter. This forms a thin, tubular product which may be used directly, or indirectly by slitting it to create a flat film.
- Process of film blowing
  - The extrusion of plastic melt is done via an annular slit die, generally vertically, for the formation of a thin walled tube. The introduction of air takes place through a hole present in the die's center for blowing up the tube just like a balloon. The cooling of the hot film is done by the high-speed air ring that blows onto it. This air ring is mounted on the top of die. Then following procedures take place:The tube of the film continues its movement upwards (constantly colling) till is is passed via nip rolls.
  - Here, the tube is flattened for the creation of “lay-flat” tube of film. Also known as collapsed tube, this lay-flat tube goes back to the extrusion tower via rollers.On the higher output lines, exchange of air (which is available in the bubble) takes place. This is called IBS (Internal Bubble Cooling).Then the lay-flat film is kept as it is or its edges are slit off for producing 2 flat film sheets & wound up onto the reels. If kept as it is, the film's tube is created into bags by the process of sealing all across the film's width along with cutting or perforating. This process is carried out at a later stage or in line with the process of blown film

FILM BLOWING

Application of film blowing

Industry Packaging	Shrink Film , Stretch Film , Bag Film , Container Liners
Consumer Packaging	Packaging Film For Frozen Products Shrink Film For Transport Packaging Food Wrap Film
Laminating Film	Laminating of aluminum or paper used for packaging milk, coffee, and similar products
Barrier Film	Film Made of Raw Materials like Polyamides and EVOH acting as an aroma or oxygen barrier that are used to package food, e.g. cold meats and cheese
Agricultural Film	Greenhouse Film , Crop Forcing Film , Silage Film , Silage Stretch Film
Films For Packaging Medical Products	

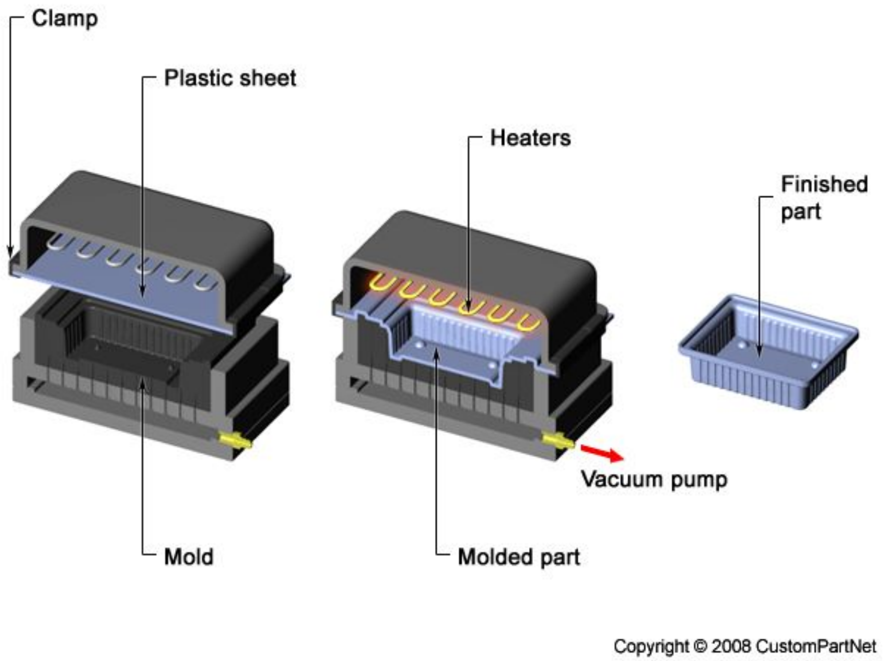
EXTRUSION



- Blown Film Extrusion is an established process which is sued to manufacture a wide range of commodity & specialized plastic films for the packaging industry. Also known as Film Blowing Process. In the process of Blown Film Extrusion, the common resins that are used are Polyethylene's (LDPE, HDPE and LLDPE). Some of these materials are PP, PP, and EVOH.
- Process Of Blown Film Extrusion
- The extrusion of plastic melt is done via an annular slit die, generally vertically, for the formation of a thin walled tube.
- The introduction of air takes place through a hole present in the die's center for blowing up the tube just like a balloon.
- The cooling of the hot film is done by the high-speed air ring that blows onto it.
- This air ring is mounted on the top of die.

THERMOFORMING

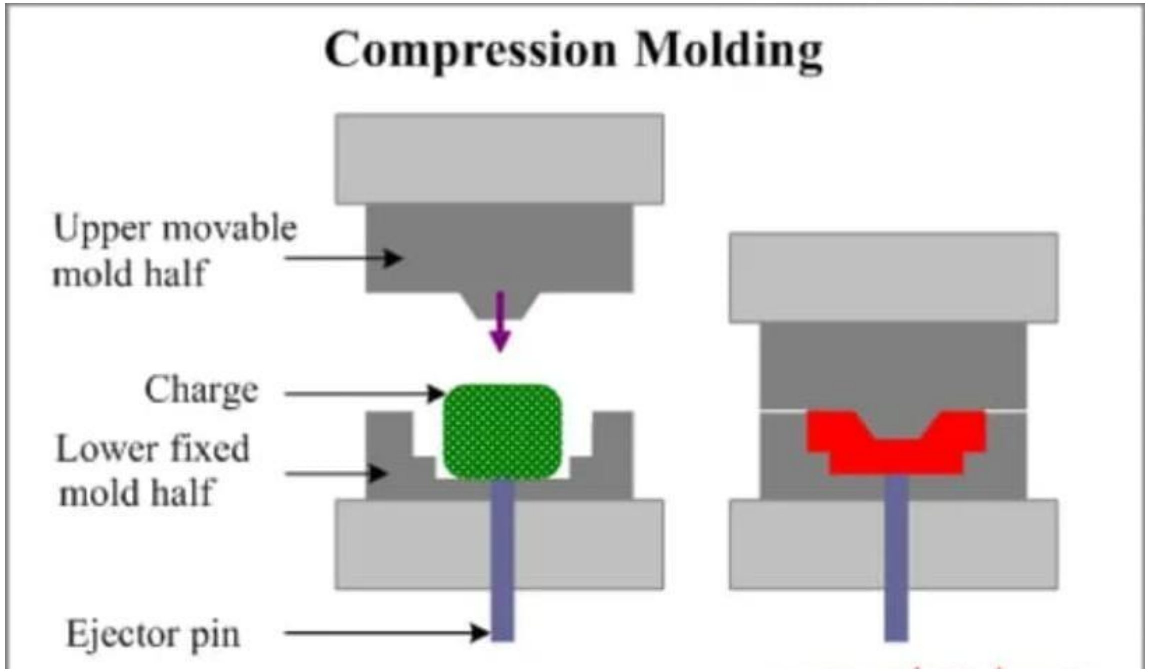
- Thermoforming is a manufacturing process where a plastic sheet is heated to a pliable forming temperature, formed to a specific shape in a mold, and trimmed to create a usable product. The sheet, or "film" when referring to thinner gauges and certain material types, is heated in an oven to a high-enough temperature that permits it to be stretched into or onto a mold and cooled to a finished shape. Its simplified version is vacuum forming.
- Process
  - Thermoforming is a common method for producing plastic packaging. Thermoplastics are the materials used for thermoforming. These materials include ABS, polystyrene, polycarbonate, PETG, etc. The choice of material depends on the manufacturing project and the required characteristics of the produced item.
  - Thermoforming polymers can be heated and formed repeatedly. They are pliable and recyclable .



COMPRESSION MOULDING

Process Description

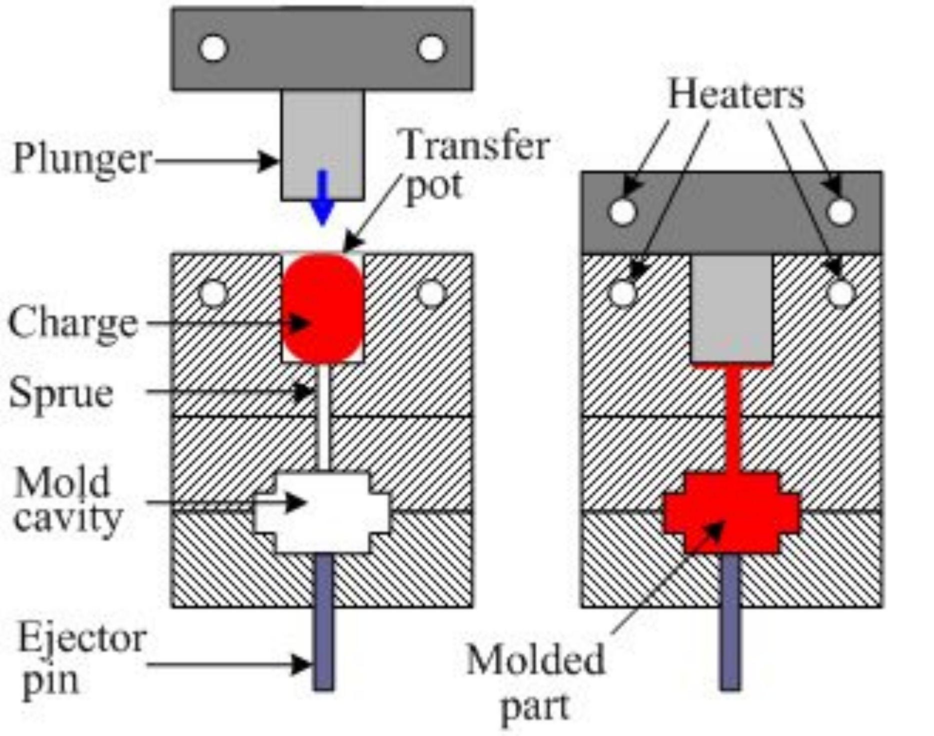
- Charge is placed in cavity of matched mold in the open position,
- Mold is closed by bring the two halves together,
- Pressure is exerted to squeeze the resin so that it fills the mold cavity,
- While under pressure the mold is heated which cures the resin.



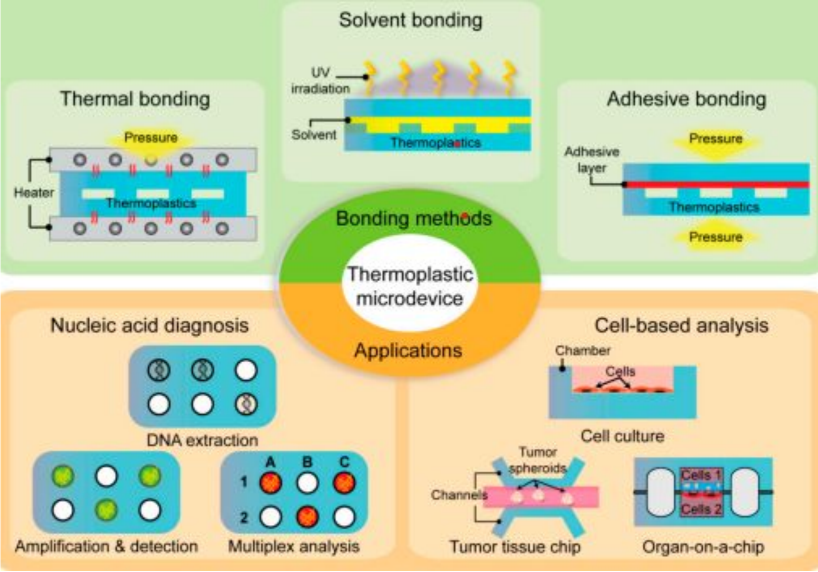
TRANSFER MOULDING

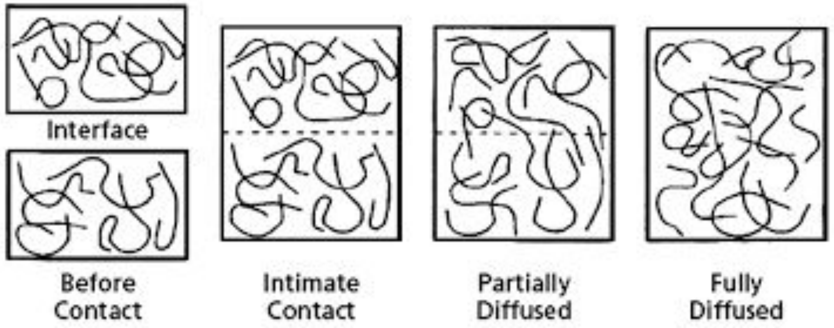
- What is Transfer Moulding?
- Transfer moulding is a manufacturing process where casting material is force into a mold and make the casting.
- This is similar to compression moulding but the main difference is that in compression the mold is enclosed whereas in transfer the mold is open to fill the plunger.
- Thermoset polymer, Epoxy resins are some materials which are used in transfer moulding.

TRANSFER MOULDING



- Process of Transfer Moulding:
- The pre-heated, uncured molding compound placed in the transfer pot.
- The mold is closed up and under hydraulic pressure, the molding compound is forced through a small hole into the cavity.
- The mold is held closed while the molding compound cured(thermosets) or cooled(thermoplastics).
- The mold is split to free the product, with the help of ejector pins.
- Any flash or sprue material is trimmed off.





BONDING OF THERMOPLASTIC

- Thermoplastics. Thermoplastics may take on amorphous or crystalline structures. In thermoplastics the long chain molecules exist in the form of linear bonding but are also bonded to each other by secondary Van Der Waals forces (secondary bonds).
- Joining of thermoplastic composites can be categorized into **mechanical fastening, adhesive bonding, solvent bonding, co-consolidation, and fusion bonding or welding**. Fusion bonding or welding has great potential for the joining, assembly, and repair of thermoplastic composite components.

THANK YOU