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ASSIGNMENT

Q1) Explain conventional and non-conventional manufacturing process. Explain various manufacturing process.

Ans) Conventional manufacturing process:-

Conventional manufacturing processes refer to traditional methods of producing goods using tools, machine, and manual labour. These processes are typically used for shaping, cutting, joining and finishing materials into final products. Some key conventional manufacturing processes include:-

1. Casting:- Pouring liquid material (usually metal) into a mold to solidify and take the shape of the mold.

e.g:- Sand casting, die casting.

2. Machining:- Removing material from a workpiece using tool like lathes, mills, and drills to achieve the desired shape and size.

e.g:- Turning, milling, drilling.

3. Forming:- Shaping materials, typically metals, by applying force to bend, stretch, or compress them.

e.g:- Rolling, forging, extrusion.

4. Joining:- Combining multiple parts or materials together through mechanical, thermal, or adhesive methods.

e.g:- Welding, brazing, soldering, riveting.

5. Shearing: Cutting materials into specific shapes and sizes using a shearing force.

e.g.: Punching, blanking, stamping

6. Casting: A process in which a material is heated to a liquid state and then poured into a mold, where it solidifies into the desired shape.

e.g.: Sand casting, investment casting.

These processes are often used in mass production and are effective and reliable, though they may not be the most efficient compared to modern manufacturing methods like additive manufacturing or automated technologies.

Advantages: Low cost, easy to set up, suitable for large quantities.

Disadvantages: Limited design flexibility, high material waste, slower production rates.

Applications: Prototyping, low-volume production, large-scale manufacturing.

Conclusion: Casting and shearing are traditional manufacturing processes that remain relevant for many applications.

Unconventional Manufacturing Processes

It is also known as non-traditional or advanced manufacturing methods, the techniques that differ from conventional processes in how they remove or shape materials. These methods are often used to produce complex geometric, work with hard-to-machine materials, or achieve high precision that traditional methods cannot. They typically involve energy or other physical processes like electrical, thermal, or chemical energy.

Examples of unconventional manufacturing processes:

1. Electrical Discharge Machining (EDM): A method that removes material from a workpiece using controlled electrical sparks between a tool electrode and the workpiece. It is especially useful for machining hard metals and creating intricate details. e.g., wire EDM, hole EDM.
2. Laser Beam Machining: Uses a high-power laser beam to cut, drill, or grind materials. It is used for precision cutting and drilling.
3. Water Jet Cutting: Uses a high-pressure stream of water, often mixed with abrasive particles, to cut through various materials.
4. Ultrasonic Machining: Uses high-frequency ultrasonic vibrations to remove material from a workpiece.
5. Electron Beam Machining: Uses a focused beam of electrons to remove material. It is used for precision cutting and drilling.
6. Chemical Machining: Uses chemical etching to remove material from a workpiece.
7. Abrasive Jet Machining: Uses a high-speed stream of abrasive particles to erode material from a workpiece.
8. Plasma Arc Cutting: Uses a plasma arc to cut through metal.
9. Additive Manufacturing: Builds parts layer by layer using materials like powder or liquid.

Q2. Explain various factors which influence selection of manufacturing process.

The selection of manufacturing process is influenced by a variety of factors, each impacting the parts quality, lead time and overall efficiency of production. These factors include:

1) Material Properties - The type of material affects the choice of process.

For e.g.: metal may require forging or casting, whereas plastic might be suited for injection molding.

2) Part Design - Complexity of the part design plays a key role. Parts with complex geometries might be better suited for additive manufacturing or precision machining, whereas simpler designs may be produced using casting, stamping or molding.

3) Production Volume - The quantity of parts to be produced influences the choice. Low high-volume production processes like injection molding or casting, or stamping, for low-volume or prototype production.

4) Tolerance and Surface Finish - The required precision, flatness, and surface quality influence process choice.

5) Cost Considerations - The overall cost includes both initial setup costs and per-unit cost.

6) Lead Time - The required time for producing a part involves the time to source materials, process them, and assemble the part. Availability of materials, process selection, and the time to set up the process are also factors.

8. Energy Consumption - Some processes require more energy than others. For e.g., casting involves pouring molten material, which is intensive compared to processes like 3D printing, which might use less energy. Depending on the material and method.

9. Environment and Safety Concerns - Some manufacturing processes involve hazardous materials, conditions, or equipment.

10. Flexibility - The need for flexibility in design changes or production volume requirements may make certain processes more appealing than others.

Q3. Explain the principles of chip removal process.

Chipless Process

Chipless manufacturing processes involve no removal of material in the form of chips. These methods typically involve deforming or reshaping the material without cutting it away, leading to little or no waste generation.

Types of Chipless Processes

- 1) Forging: In forging, shaping metal using compressive forces. The material is plastically deformed by either application of heat and pressure, forming the desired shape without removing material.
- 2) Extrusion: Material is forced through a die to create a long shape with a consistent cross-section. It is often used for like pipes, rods, or profiles.
- 3) Rolling: The material is passed through a pair of rollers to reduce thickness or change the shape.

Rolling is commonly used for producing sheets, plates or strip metal.

4. Stamping / Die casting: Material is pressed into a die to create a specific shape. The process can be used for creating flat or complex parts.

5. Swaging: A form of cold working that reduces the diameter of a tube or wire by a series of blows with a die.

Advantages of Chipless Processes

- (i) Minimal waste: Since no material is removed, the amount of scrap or amount of waste generated is much lower or less compared to chip removal processes.
- (ii) High material utilization: The entire material is used in the forming process, reducing scrap.
- (iii) Cost effective: Often less expensive in high-volume production due to lower material loss.

2) Chip Removal Process

Chip removal processes involve removal of material in the form of chips or swarf to shape or finish a workpiece. These are typically associated with processes like turning, milling, and grinding. These processes remove material to achieve the desired shape or dimension.

Types of chip Removal Processes

1) Turning: A rotating tool is used to remove material from a rotating workpiece. This is primarily used for cylindrical shapes & is widely used in the production of shafts.

2) Milling: A rotating cutting tool removes material from the workpiece as it is fed into the tool.

This process can create flat, curved or complex surfaces.

3) Drilling: A cutting tool is used to create holes in a workpiece. This process is often used to make cylindrical holes.

4) Grinding: Abrasive particles remove material from a workpiece to improve surface finish and achieve precise dimensions.

5) Sawing: A serrated tool cuts material into desired shape or size by removing material in the form of chips.

6) Electrical Discharge Machining (EDM): A process that uses electrical discharge to remove material from the workpiece. It is used for hard materials or when precise intricate cuts are needed.

Advantages of chip Removal Processes

i) Precision and accuracy: These processes allow for very tight tolerances and high quality finishes, ideal for applications requiring exact dimensions and surface smoothness.

ii) Material flexibility: Can be applied to a wide range of materials, including metals, plastics and composites.

iii) Versatility: A wide variety of shapes, sizes & features can be produced through chip removal.

Disadvantages

(i) Material waste: Significant amount of material are removed as chips, leading to material waste.

(ii) Energy consumption: These processes often require more energy, especially with hard materials or for high-precision applications.

(iii) Tool wear: The cutting tools involved in these processes can wear down over time, leading to additional maintenance or tool replacement.

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Q14) Explain Primary, Secondary and Tertiary Manufacturing Process.

Manufacturing processes are generally classified into primary, secondary and tertiary based on how raw materials are transformed into finished products.

Primary Manufacturing Process

The primary manufacturing process involves converting raw materials into a basic form that can be used for further processing. It is the first stage of production, often involving extraction, refining, and shaping of natural resources into materials that industries can use.

Key features:-

- Involves raw material extraction and initial processing.
- Transforms natural resources into usable materials.

Example:-

1. Metal Processing:- Iron ore is mined and then processed into pig iron, which is further refined into steel.

2. Aluminum Processing:- Bauxite ore is mined and then processed into aluminum metal.

3. Refining:- Crude oil is refined into various petroleum products.

4. Smelting:- Limestone is smelted to produce lime.

5. Chemical Processing:- Natural gas is processed into various chemical products.

6. Food Processing:- Grains are processed into flour, and fruits are processed into juice.

2) Secondary Manufacturing Process:-

The secondary manufacturing process involves taking raw materials (or semi-processed materials from the primary manufacturing stage) and converting them into finished or semi-finished products. This stage focuses on shaping, assembling, and refining materials to create usable goods.

Key features:-

- Uses materials from the primary process.
- Involves machining, molding, casting, assembling, and finishing.
- Produces semi-finished or finished products for consumers and industries.

Example:-

1. Metalworking & Fabrication

- Casting metals into machine parts.
- Welding, cutting, and assembling metal structures.
- Forging iron to make tools.

This stage adds value to raw material, making them useful for consumers and industries, before moving to tertiary processes like branding, marketing, and distribution.

3) Tertiary Manufacturing Process

The tertiary manufacturing process focuses on customizing, packaging, distributing, and servicing finished products. It enhances the value of goods produced in the secondary manufacturing stage and ensure they reach consumers effectively.

Key Features

- Involves final product customization, branding, packaging and distribution.
- Provides services related to product maintenance, repair and sale.
- Ensure products are market-ready and delivered to consumers.

Examples

- 1) Product customization & finishing
 - Painting and branding vehicles before sale.
 - Engraving company logos on finished products.
- 2) Packaging & labeling
 - Packaging food items for retail.
 - Sealing & labeling pharmaceutical products.

This process ensure that products are accessible, marketable and functional for end users, completing the manufacturing cycle. From raw materials to consumer-ready goods.

Q5b. Explain factors for selection of manufacturing process.

Choosing the right manufacturing process is crucial for ensuring efficiency, cost-effectiveness, and quality. The selection depends on several key factors:

1) Material Type

- The properties of the material determine suitable processes. Casting is preferred for metals, while injection molding is best for plastics.

2) Product Design Complexity

- Simple designs can use basic processes like machining, while complex designs may require 3D printing or precision casting.

3) Production Volume

- Low-volume flexible (N/C) machining or 3D printing for small batches.
- High-volume injection molding or mass production techniques for economies of scale.

4) Cost & Budget

- Includes material cost, labor, machine setup, & operation expenses.
- For large production runs, cost-effective material selection is crucial.

5) Required Precision & Tolerances

- Some products need high accuracy, requiring CNC machining or laser cutting.
- Ex: Medical implants require extreme precision.

6) Manufacturing Speed & Lead Time

- Some processes are fast, while others take longer.
- Ex: 3D printing is quick for prototyping but slow for mass production.

7) Energy & Environmental Impact

- Processes with high energy consumption or pollution may need alternatives.
- Ex: Sustainable manufacturing focuses on recycling or eco-friendly methods.

8) Availability of Equipment & Skilled Labor

- Some processes require specialized machines & expertise.
- Ex: Laser cutting needs skilled operators with high-end machine.

9) Strength & Durability Requirements

- Structural components may need forging or casting instead of machining.
- Ex: Automotive chassis are often made through welding and stamping.

10) Surface Finish & Aesthetic Requirements

- High-quality finishes may need additional processes like polishing or coating.

Ex: Smartphones require anodized aluminum housing for a premium look.

Conclusion

Selecting the right manufacturing process depends on balancing cost, quality, speed, and material properties to meet the desired product specification efficiently.

Each process has its own set of advantages and disadvantages.

Choosing between different processes or more than one method depends on the specific requirements of the product.

Manufacturers often use a combination of different processes to create a final product.

Understanding the capabilities and limitations of each process is crucial for making the right choice.

Continuous innovation in manufacturing technology is constantly pushing the boundaries of what is possible.

Collaboration between designers, engineers, and manufacturers is essential for successful product development.

Assignment 402

Explosive properties of molding sand - April

Molding sand is a crucial material in casting process, used to create molds for metal castings. Its properties determine the quality and accuracy of the final cast product.

1. Strength

- The ability to hold its shape under mechanical stress.
- Ensure the mold does not break or collapse during casting.

2. Permeability

- Allows gases and steam to escape during metal pouring.
- Prevents gas defects like porosity in the final casting.

3. Cohesiveness (Bonding Ability)

- Enables sand grains to stick together, maintaining mold integrity.
- Essential for sharp & precise casting details.

4. Refractoriness

- The ability to withstand high temperatures without melting or degrading.
- Crucial for casting metal with high melting points like steel.

5. Variability

- The easy ease with which sand flows and fills the mold cavity.

6. Collapsibility

- The ability of sand mold to break apart easily after casting.
- Reduces defects in the final product and simplifies mold removal.

7. Grain Size

- Affects surface finish & permeability.
- Finer grains provide a smooth surface but may reduce permeability.

8. Moisture Content

- Essential for sand cohesion, but should be controlled to avoid steam-related defects.
- Too much moisture can cause porosity while too little reduces strength.

Conclusion

The right balance of these properties ensures high-quality casting, minimizing defects and improving the efficiency of the metal casting process.

9. Turbidity

- Turbidity affects the clarity of the casting.
- Turbidity can cause defects in the casting.
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Explain any 8 casting defect.

Casting defects are imperfections that occur during the metal casting process. These defects can affect the quality, strength, and functionality of the final product. They can be caused by improper mold design, poor metal pouring, gas entrapment, or inadequate cooling.

In other words, it refers to the imperfections that occur during the casting process. It is of following types:-

1) Blow holes - Defects in casting that appear as rounded and spherical shape in the casting product.

- Gas bubbles trapped in the metal during solidification.
- Appear as internal or surface cavities.

2) Blisters - Defects in casting that appear as gas pockets in the casting product.

- Caused by trapped gases within the casting during solidification.
- Can appear as small holes or voids in the casting.

3) Misruns - Defect in casting that appears as the missing portion in the casting product.

- Incomplete filling of the mold due to low pouring temperature or slow flow.
- Results in missing section of the casting.

4) Cold shut - Metal solidifies before reaching or filling the mold completely. It causes the type of defect is called as cold shut.

- Happens when two metal streams fail to fuse properly.
- Appears as a weak or incomplete joint.

5) Scrab - Roughness in casting surface due to the loose sand when binding of sand is called as scrub.

- Sand particles from the mold get embedded in the casting.
- Leads to weak spots and rough surfaces.

6) Mold shift - When the upper scope of mold and lower drag is not aligned properly, then such type of defect is called mold shift.

- Misalignment of mold halves leading to a displaced casting.
- Causes an unwanted step or mismatch in the final part.

7) Gate riser - During the casting process the displacement of gate riser causes casting defects.

- Gate is not fixed aligned properly.

8) Shrinkage - When the molten metal is solidifying the it undergoes shrinkage. If any compensation is not done then that type of defect is called as shrinkage.

- Occur when the metal shrinks during cooling.
- Can lead to casting cracks, voids.

Prevention of Casting Defects

- Proper mold design and gating system.
- Controlling pouring temperature and metal composition.
- Using degassing techniques to remove gases.
- Ensuring proper cooling and solidification rates.

Q3. Explain Centrifugal casting with details.

Centrifugal casting is a process used to produce cylindrical components by pouring molten metal into a rotating mold. The high-speed rotation forces the metal against the mold wall due to centrifugal force, creating a dense and high-quality casting. This method is widely used for producing pipes, rings, bushings, and other hollow components.

Types of Centrifugal Casting

There are three main types of centrifugal casting:-

1. True Centrifugal casting (Hogabauer)

- Used for cylindrical or tubular components.
- The mold rotates about a horizontal axis.
- Molten metal is poured into the rotating mold, and

centrifugal force pushes it outward. The inner surface remains free of impurities, and the outer surface takes the shape of the mold.

2. Vertical Centrifugal Casting

- The mold rotates around a vertical axis.
- Suitable for smaller cylindrical parts like gun barrels and shafts.
- Molten metal spreads evenly, but gravity plays a more significant role in the solidification process.

3. Semi-Centrifugal Casting

- Used for symmetrical parts like wheels and pulleys.
- A stationary central core is used to create a central hole.
- The centrifugal force creates a dense outer surface while allowing a controlled solidification of the central region.

Advantages Principle of Centrifugal Casting

- Mold Preparation: A metallic or sand-lined mold is coated with a preparatory material to prevent adhesion.

2. Rotation of the mold:- The mold begins rotating at high speeds.

3) Pouring of Molten Metal - The molten metal is introduced into the mold while it is rotating so that uniform casting is obtained.

4) Metal Distribution - Centrifugal force pushes the metal towards the mold wall, ensuring uniform thickness.

5) Cooling and Solidification - The outer layers cool and solidify first, followed by the inner layers, resulting in a dense structure.

6. Removal of casting - Once cooled, the casting is removed from the mold and undergoes further machining or finishing.

7) Advantages of Centrifugal Casting

- Produces high-density casting with minimal defects.
- Eliminates the need for cores in hollow components.
- Improved mechanical properties due to uniform solidification.

• Can produce large and complex shapes with high dimensional accuracy.

• Reduces porosity and inclusion by pushing impurities to the inner surface, which can be machined away.

8) Advantages of Centrifugal Casting

- High initial cost due to specialized equipment.
- Limited to circular or symmetrical components.
- Requires precise control of speed, temperature, and pouring conditions.

• Inner surface may require machining to remove defects or inclusion.

9) Application of centrifugal casting

1) Pipeline and Tubes

2) Rotors and Rings

3) Pumping and Bearings

4) Roller and Cylinders

5) High-strength components

Centrifugal casting is a critical process in modern manufacturing, offering high-quality and defect-free metal components.

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Explain different types of patterns.
Pattern is a replica of the object to be cast, used to create the mold cavity in the casting process. Patterns are designed to account for shrinkage, machining allowance, and draft angle to ensure proper casting. There are several types of patterns used in foundry work, each suited for different casting requirements.

Types of pattern are:
1) Single Piece Pattern - It is a pattern which is made in a single piece of a complete final product.

A solid, one-piece pattern that replicates the entire shape of the object to be cast.

Application - Simple, small and straightforward castings.

Advantage - Simple and easy to manufacture.

Disadvantage - Limited in terms of complexity for more intricate designs.

Use - Commonly used in sand casting for smaller, simple parts.

2) Split Pattern - This is a pattern which is made up of different or more than one piece to form a complete final product.

The pattern is divided into two or more parts that can be assembled to form the mold.

Application - Used for casting with intricate shapes or internal features (like, holes & cavities).

Advantage - Easier to remove from the mold and useful for parts with undercuts or complicated geometries.

Disadvantage - More complex to design and manufacture.

Use - Common in sand casting for parts requiring a mold with more complexity.

3) Match Plate Pattern - A type of pattern mounted on a metal plate, with the pattern on both sides. The plate ensures proper alignment of the two halves of the mold.

Application - High-production casting with multiple similar parts.

Advantage - Can produce multiple identical castings quickly, suitable for mass production.

Disadvantage - Higher initial cost due to the metal plate and design.

4) Sweep Pattern - A pattern is formed by moving a tool along a fixed axis to create a shape, especially used for parts with rotational symmetry.
Application - Castings that are rotationally symmetric such as pipe or tanks.
Advantage - Efficient for producing symmetrical parts.
Disadvantage - Restricted to simple shapes.

5) Gated Pattern - A gated pattern is a type of pattern used in sand casting that incorporates an integrated gating system to control the flow of molten metal into the mold cavity.

Advantages of Gated Pattern:
1. It allows for the creation of complex gating systems.
2. It helps in controlling the flow of molten metal, reducing turbulence.
3. It is suitable for producing large, complex castings.
4. It can be used for both sand and investment casting.
5. It provides a more uniform flow of molten metal into the mold cavity.
6. It is easy to modify and adjust.
7. It is a cost-effective method for producing large quantities of parts.

Q5) Explain the Diagram of Cupola furnace.

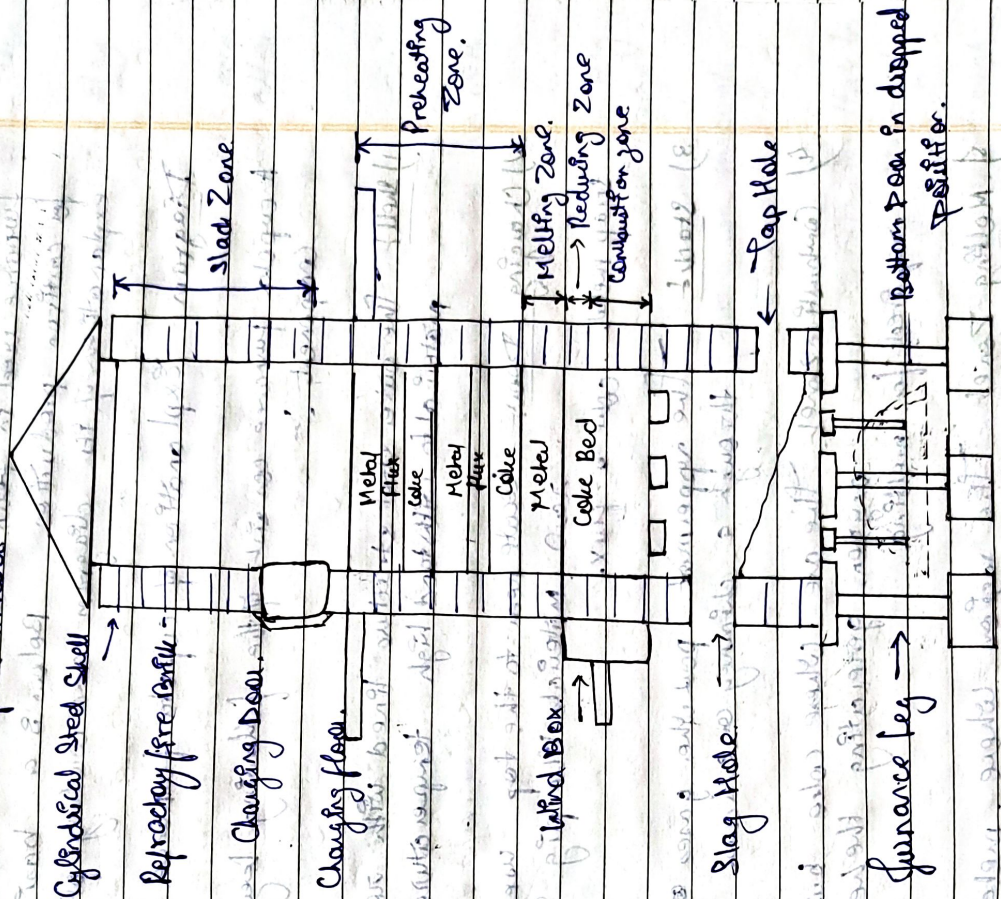


Fig. Cupola Melting Furnace.

The diagram illustrates the internal structure of a cupola furnace, showing the various zones and components involved in the melting process.

The cupola furnace is a vertical cylindrical furnace used for iron to melt metal, primarily for cast iron production. Below is a brief explanation of its diagram and working principle.

Diagram Explanation of cupola furnace.

A cupola furnace consists of the following key components:-

1) Shell - The outer steel structure lined with refractory material to withstand high temperatures.

2) Charging Door - Located near the top used to load scrap metal, coke & flux.

3) Stack - The uppermost part where gases escape through a chimney or exhaust system.

4) Combustion Zone - The area where coke burns with oxygen, generating the heat required for melting.

5) Melting Zone - The region where metal absorbs heat and turns into molten iron.

6) Slag Formation Zone - Here, impurities react with the flux to form slag, which floats on top of the molten metal.

7) Top Hole - An outlet at the bottom from where molten metal is removed.

8) Slag Hole - A separate outlet for removing slag.

9) Bottom Door - The base of the furnace which can be opened to remove residue after operation.

Working Principle - The furnace is loaded from the top with layers of coke, metal, and flux.

1) Combustion - Air & blow is through the tuyeres, igniting the coke and creating intense heat.

2) Melting - The metal melts as it moves down through the furnace.

3) Slag separation - Impurities combine with the flux to form slag, which is periodically removed.

4) Tapping - The molten metal is drawn off through the top hole and poured into molds.

Q66 - Explain Investment casting & die casting in detail.

Investment casting & die casting are both metal casting processes used to create complex parts with high precision. Below is a detailed explanation of both processes, including their working principles.

1) Investment Casting (Lost - Wax Casting):

Investment casting, also known as lost wax casting, is a process where a wax pattern is coated with a ceramic shell, then melted away to create a mold for pouring molten metal.

Process Steps

1. Pattern Making A wax model of desired part is created. This can be done by hand or using injection molding.

2) Assembly Multiple wax patterns are attached to wax sprues to allow multiple castings to be made.

3) Ceramic Coating (Shell Building) The wax assembly is repeatedly dipped into a ceramic slurry and sand to form a strong shell.

4) Wax Removal The ceramic coated assembly is heated in an autoclave or furnace to melt and drain out the wax, leaving a hollow ceramic mold.

5) Mold Spruing The ceramic mold is further heated to remove any remaining wax and strengthen the mold.

6) Metal Pouring Molten metal is poured into the ceramic mold.

7) Cooling & Solidification The metal solidifies into the desired shape.

8) Shell Removal & Finishing The ceramic shell is broken away, and the metal casting is cleaned and finished.

Advantages:

- High precision & fine surface finish.
- Can produce intricate & complex shapes.
- Can use a variety of metals including aluminum, stainless steel, & titanium.
- Minimal material wastage.

Disadvantages:

- Expensive & time-consuming process.
- Not suitable for large or high-volume production.
- Applications: Aerospace & automotive components, Jewelry and artwork, Industrial turbine blades.

Die Casting is a metal casting process in which molten metal is injected into a steel mold (die) under high pressure. It is ideal for making producing precise and complex metal parts.

Types of Die Casting:-

- 1) Hot Chamber Die Casting:- Used for metal with low melting points. The injection system is immersed in molten metal.

2) Cold Chamber Die Casting:- Used for metal with high melting points. Molten metal is poured manually into a separate injection system.

Process Steps:-

- 1) Die Preparation:- The steel die is coated with a lubricant to prevent sticking and regulate temperature.

2) Metal Injection:- Molten metal is injected into the die cavity under high pressure.

3) Cooling & Solidification:- The metal solidifies quickly (cools and solidifies) inside the mold.

4) Ejection:- The solidified part is ejected using ejector pin. Trimming & finishing. Excess material is removed, and surface finishing processes are applied if needed.

Advantage:-

- High production speed & efficiency.
- Excellent dimensional accuracy & surface finish.
- Suitable for complex & thin-walled components.
- Minimal machining required after casting.

Disadvantage:-

- High initial cost for molds (die).
- Not suitable for very large parts.
- Limited to metals with high fluidity (e.g., aluminum, zinc).

Applications:-

- Automotive engine and transmission parts.
- Consumer electronics (smartphone frame, laptop housing).
- Industrial equipment (pump tools).
- Household appliances & cookware.

Q3) Explain the penetration test, magnetic particle inspection & Radiographic inspection.

1) Dye Penetrant Test - (Liquid penetration Test) :-

DPT is a surface inspection technique used to detect cracks, porosity, and other defects in non-porous materials like metals, ceramics, and plastics.

Procedure :-

1) Surface Preparation :- The test surface is cleaned to remove dirt, grease, and contaminant.

2) Application of penetrant :- A liquid dye is applied to the surface and allowed to seep into surface defects.

3) Dwell Time :- The penetrant is left for a specific time (5-30 minutes) to allow penetration.

4) Excess Penetrant Removal :- The surface is carefully cleaned without removing penetrant trapped in defect.

5) Developer Application :- A white powder or liquid developer is applied which draws the trapped penetrant out of the defects.

1) Inspection :- Under visible light or UV light, defects appear as visible marks.

2) Post-Cleaning :- The surface is cleaned after inspection.

Advantages :-

- Simple, low-cost method
- Effective for detecting fine surface cracks.
- Can be used on non-magnetic materials.

Disadvantages :-

- Can only detect surface defects.
- Cannot be used on porous material.
- Requires proper cleaning and handling.

Applications :-

- Aerospace and automotive components.
- Pressure vessels & pipes.

Magnetic Particle Inspection (MPI)

MPI is used to detect surface & near-surface defects in ferromagnetic materials like iron, steel, & nickel.

Procedure

- 1) Surface Preparation - The surface is cleaned of any dirt, grease, or coating.
- 2) Magnetization - The part is magnetized using a permanent magnet, an electro magnet, or passing an electric current through it.
- 3) Application of Magnetic Particles - Fine ferromagnetic particles of fluorescent or visible color are applied to the surface.
- 4) Defect Detection - If there is a crack or defect, magnetic flux leakage occurs, attracting particles to form a visible indication.
- 5) Inspection - The part is inspected under normal or UV light for fluorescent particles.
- 6) Demagnetization & cleaning - After inspection, the part is demagnetized and cleaned.

Advantages

- Can detect both surface and near-surface defects.
- Provides immediate results.
- Can be used on large or complex shapes.

Disadvantages

- Only works on ferromagnetic materials.
- Requires proper surface cleaning.
- Magnetic fields must be correctly aligned to detect defects.

Applications

- Automotive and aerospace components.
- Welded joints and pipelines.
- Railroad tracks or heavy machinery.

3) Radiographic Inspection (RT)

Radiographic Testing uses X-rays or gamma rays to inspect internal defects in materials and components. It is commonly used in welding, casting, and structural components.

Procedure

1) Radiation - Source - X-rays or gamma rays are directed at the test object.

2) Penetration - Radiation passes through the material and different thicknesses or defects cause variation in absorption.

3) Detection on Film / Digital sensor - A radiographic film or digital detector captures the transmitted radiation.

4) Image interpretation - Variations in the image indicate porosity, voids or incomplete weld fusion.

Advantage

- Can detect internal defects
- Provides a permanent record for future reference

Disadvantage

- Expensive to negative specialized equipment
- Radiation safety precautions are necessary
- Time-consuming compared to other NDT methods

RS/1

ASSIGNMENT : 03.

Q1) Explain hot rolling & cold rolling process with difference.

Cold Rolling - It is the method of metal forming process.

Cold rolling is also known as cold forming, involve deformation the metal at room temperature or slightly above this process is performed without any external heating.

Process

Rolling - Reducing thickness by passing metal between rollers.

Straining - Rolling metal through a die to reduce its diameter.

Bending - Changing the shape of metal by applying force.

Drawing - Using a die to cut or shape metal sheets.

Characteristics

1) Increase strength - Due to work hardening & dislocation in the metal crystal structure increases.

2) Surface finish - Produce is smooth, shiny surface.

3) Precision - High dimensional accuracy.

Adv. to hot rolling - Cold rolling is stronger.

Advantages

- High surface quality & precise dimension.
- Low energy consumption.
- Used for making small detailed parts.

Disadvantages

- Metal becomes brittle with repeated deformation.
- Requires more force as material hardens.

HOT WORKING

It is the method of metal forming process. Hot working is known as hot forming process. Hot working involves deforming the metal at a temperature above its recrystallization temperature, making the metal more ductile & easier to shape.

Process

Forging :- Shaping metal using compressive force.

Extrusion :- Forging metal through a die to create long shape.

Drawing :- Pulling metal into shape while hot.

Rolling :- Similar to cold rolling but performed at high temperature.

Characteristics

Hot Work Holding :- The metal can recrystallize during deformation preventing hardening.

Recrystallization :- Maintain high ductility, allowing for complex shapes.

Surface Finish :- Generally rougher compared to cold working.

Advantages

- Suitable for large component & complex shape.
- Can produce stronger parts due to improved grain.

Disadvantages

- High energy consumption.
- Poor surface finish.
- Environmental fragility due to thermal expansion.

Ques Explain Hot Working Process?

Hot Working :- Hot working is known as shaping in machine is used to shape an out metal sheets into desired forms. The automotive, electronics & appliance ducts efficiency & precision.

Hot working is a process of metal forming at a temperature above the recrystallization temperature of the metal. This process is used to shape metal into various forms like rods, sheets, and forgings.

"KEY POINT"

1) Material Preparation:- Metal sheet are fed into the press machine.

2) Die & Punch Setup:- This machine have two tools 'Die' & 'Punch'. A tool that punches into the die to cut or form the material.

3) Feeding the material:- The metal sheet is fed into the press using manual feeding, automatic feeder or coil feed system.

4) Pressing operation:- The press machine applies high force to the piece like hydraulic or mechanical which moves down into the die.

5) Types of press working operation:-

- Deep Drawing
- Blanking
- Bending
- Punching
- Drawing

6) Part ejection & collection:- After the operation on the formed part is ejection from the die & collected for further processing or assembly.

7) Inspection & finishing:- The part and inspected for defects like burr, incorrect dimension etc. Final finishing process like heat treatment may be applied & coating.

Advantage

- High productivity & speed for large production run.
- consistent quality & precision.
- Cost effective for mass production.

Q3) Explain Forging Process?

Ans:- Forging:- Forging is a manufacturing process that involve shaping metal using compressive force. Typically after applying high pressure through tools like pressure & die for hammer to deform the metal into the desired shape.

"Key Point"

1) Heating:- The metal is often heated to make it more malleable. This is called hot forging.

2) Forming the metal:- The metal is placed between the forging dies or under a hammer.

3) Applying force:- The metal is subjected to compressive force using.

- 1) Hammering
- 2) Pressing

4) Shaping:- The metal flows & fills the shape of the die. The process can be multiple times to achieve the desired geometry.

5) cleaning & finishing - The forged parts are cleaned & many under go additional process like finishing, machining or heat treatment.

It's types :-

- 1) Open Die Forging.
- 2) Closed Die Forging.
- 3) Ring Forging.
- 4) Roll Forging.

Advantage :-

- High strength
- Durability.
- Versatility.

Disadvantage :-

- High initial cost.
- High strength deformation.
- Complex shape without machining (cast).

Application :-

- Aerospace Parts.
- Auto motive Component.
- Industrial machine.
- Hand tools.

Explain Extrusion Process :-

Extrusion Process :-

The Extrusion process is a manufacturing process used to create object with a pre-determined cross-sectional profile. It involves forcing material through a shaped die to produce long continuous shapes. The process is widely used in manufacturing of pipes, rods, sheets, & example a profile.

It's Types :-

- 1) Direct Extrusion :- The material is pushed in the same direction as the movement of the die. Simple & more common in metal extrusion.
- 2) Indirect Extrusion :- The die moves towards the material & the material is pushed in the opposite direction. This allows for better control of the process.

Advantages :-

- Produce complex cross-section easily.
- High production rate.
- Good surface finish.
- Minimum material waste.

Disadvantages :-

- Higher initial cost.
- Limited to product with consistent cross-section.

Application:

→ Metals

→ Plastics

→ Food Industry.

→ Paper Industry.

→ Textile Industry.

→ Automobile Industry.

→ Aerospace Industry.

→ Medical Industry.

→ Packaging Industry.

→ Construction Industry.

→ Agriculture Industry.

→ Mining Industry.

→ Chemical Industry.

→ Pharmaceutical Industry.

→ Electronics Industry.

→ Defense Industry.

→ Marine Industry.

→ Space Industry.

→ Energy Industry.

→ Environmental Industry.

→ Transportation Industry.

→ Telecommunications Industry.

→ Media Industry.

→ Entertainment Industry.

→ Hospitality Industry.

→ Retail Industry.

→ Food and Beverage Industry.

Explain:

1) Punching

2) Blanking

3) Notching

4) Lancing

5) Shearing

6) Piercing

7) Drawing

8) Extrusion

9) Rolling

10) Forging

11) Casting

12) Welding

13) Machining

14) Grinding

15) Polishing

16) Coating

17) Heat Treating

18) Surface Finishing

19) Assembly

20) Packaging

21) Distribution

22) Sales

23) Marketing

24) Customer Service

25) Logistics

26) Procurement

27) Finance

28) Human Resources

29) Information Technology

30) Legal

31) Compliance

32) Quality Management

33) Environmental Management

2) Blanking

Blanking is a cutting process where a largest sheet of metal is fed into a process & a punch cuts out a specific shape from the sheet. The remaining metal is waste & the blank is the desired part.

It often used to produce simple shape like discs, washers, or flat components.

- # Components:
- 1) Metal sheet
 - 2) Blanking Press
 - 3) A Punch
 - 4) A Die

How it worksBlanking Process:

1) Material: Blanking starts with a sheet or strip of metal, which is fed into the blanking press.

2) Punch and Die: The metal is positioned above a punch, which has a cavity matching the desired shape. A punch, also shaped like the desired part, is placed above the metal.

3) Shearing: The press exerts force, causing the punch to move downwards and shear the metal sheet along the edge of the cavity.

4) Blank: The sheared out piece, called the "blank", is the final product.

5) Scrap: The remaining portion of the sheet metal becomes scrap.

3) NOTCHING

Notching involves cutting a small portion from the edge of a metal sheet to create a notch. This process is used to make V-shaped, U-shaped or other customized notches, which are often needed for assembly or structural purposes.

Components :-

- 1) A Punch Press
- 2) A Notching Machine

Notching Process:

1) A punch press or other specialized machine uses a die and punch to cut away the desired material from the workpiece.

2) The die is designed to create the specific shape & size of the notch.

3) The punch forces the die against the workpiece, shearing away the notch.

4) The resulting chip has the unwanted material removed.

Use of Notching :-

- 1) Creating specific shapes
- 2) Joining components.
- 3) Preparing for bending
- 4) Battery manufacturing.

Types of Notching :-

- 1) Tube Notching :- Used for cutting notches in tubes or pipes.
- 2) End Notching :- Used to create notches on ends of a pipe.
- 3) Side Notching :- Used to create notches on the side of a pipe.

Advantages of Notching :-

- 1) Versatility :- It can be used on various materials including aluminum, stainless steel & titanium.
- 2) Accuracy :- Notching can be done with high precision, creating clean and accurate notches.
- 3) Efficiency :- It can be a fast and efficient process, especially when using automated machines.

4) LANCING

1) Lancing is a cutting process where a sharp tool called a punch makes a straight cut into the metal without completely separating it. This method is used to create slots or grooves, often for ventilation, alignment or further processing.

Components :-

- 1) Metal sheet
- 2) Lancing Tool.

5) BLITTING

1) Blitting is the process of cutting a metal sheet into narrow strips or coils. It involves feeding the sheet through a set of rotary knife or blades that can cut along the length of the material.

Components :- 1) An uncoated die
2) A cutter
3) A Recaller.

Method :-

- 1) Log Slitting :- Slitting allows for efficient use of raw materials and reduces waste.
- 2) Round Slitting :- The material is unwound, cut into strips, and then rewound into smaller coils.

Advantages :-

- 1) It allows for efficient use of raw materials and reduce waste.
- 2) Slitting machines can produce highly accurate and consistent widths.
- 3) Slitting can be applied to a wide range of materials, including steel, aluminium, plastic, films, and more.

Process :- A large roll of material (e.g. steel, aluminium, plastic film) is fed through a slitting machine.

6. NIBBLING :- Slitting is a cutting process where a machine makes a series of small, overlapping cuts to remove material from a sheet metal. Also, Part of small screws, & for cutting irregular shapes or perforations. In other words, nibbling is a sheet metal process that uses a series of small overlapping punches to cut complex shapes or contours. This process is a form of punching where the punches are positioned closely together, creating a series of small cuts that, when combined, form the desired shape.

Slitting Process :-

- 1) Preparation :- The material is placed on a coil, with a rear step to ensure accurate positioning.

2) Punching :- The punch descends, forming a small hole or notch in the material.

- 3) Repositioning :- The punch is raised, and the workpiece is moved slightly, so the next punch stroke will cut near the previous one.

4) Iteration :- This punching and repositioning process is repeated along the desired cut line, progressively removing material and forming the desired shape.

Advantages :-

- 1) Flexibility in Design
- 2) Lower cost for some applications.
- 3) No Heat or Thermal Influence.
- 4) Easier to obtain precise holes.

Disadvantages :-

- 1) Surface Imperfection on cut edges.
- 2) Slower Production.
- 3) Potential for Tool Wear, causing burrs or changes in thickness.
- 4) Limitation in Material Thickness.
- 5) Design Limitation.

Qb Explain Rolling and Drawing Process.

ROLLING PROCESS

It is a metal forging process the raw material is passed the two or above rotating rollers to move to them and change shape. These process of compression process. This class of sheets, metal bars, Rod and slab. The high dimension accuracy and high surface finishing.

Types of Rolling

1) Hot Rolling :- Performed at high temperature it makes the metal easier to shape & reduces internal stress.

2) Cold Rolling :- Done at room temperature or slightly above, providing better surface finish and higher dimensional tolerance.

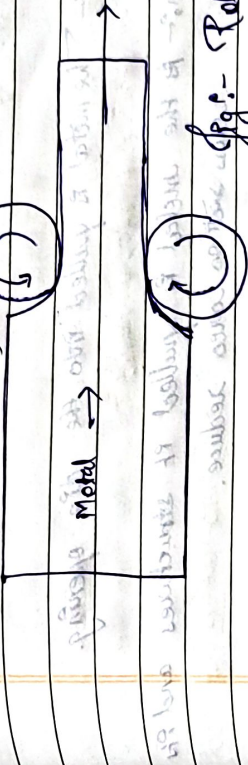
Uses :-

1) Feeding :- The metal is fed between rollers.

2) Compression :- The roller apply pressure, reducing the metal thickness.

3) Exit :- The metal comes out with a desired shape and thickness.

Roller (Smooth) Water cooling



Advantages :-

- Fast Process
- High Time Efficiency
- Mass Production
- Surface Finish.

Applications :-

- 1) Production of sheet
- 2) Plates
- 3) Bars structural beam, & more.

DRAWING

It's metal forming process it uses applied tensile force to change metal shape. Diameter is decrease & length is increase, improve its surface finishing.

Types :-

- 1) ROD Drawing :- Using for making rod or bar.
- 2) Wire Drawing :- Used for thin wire often with multiple passes through progressively small dies.
- 3) Tube Drawing :- Used for producing tubes with high precision.

Steps:-

- 1) Feeding:- The metal is pulled into the die opening.
- 2) Elongation:- As the metal is pulled its structures and grain pattern area reduce.
- 3) Exit:- The metal exits the die with a smaller dia and smoother finish.

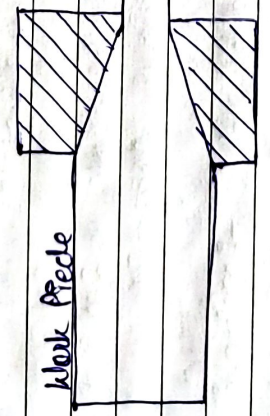


Fig:- Drawing Process..

Advantage:-

- Mass Production, High, most low cost.
- Precise the accurate.
- Strong ability.
- Mechanical Properties improved.

Disadvantage:-

- Initially cost high
- Don't make complicated shape
- Application of electrical wires
- Cables
- Metal Rod

ASSIGNMENT - 04 UNIT-5

Q1) Explain Injection molding with Diagram?

Ans:- Injection Molding is a manufacturing process where molten material is forced into a mold cavity, where it cools and solidifies, resulting in a part that conforms to the mold's shape. It's a common method for producing plastic and rubber parts, particularly in high-volume production.

Components:-

- i) Mold Base.
- ii) Injection Cavity.
- iii) Molding System.
- iv) Feed System.
- v) Ejection System
- vi) Cooling System
- vii) Venting System
- viii) guiding structure.

Diagram:-

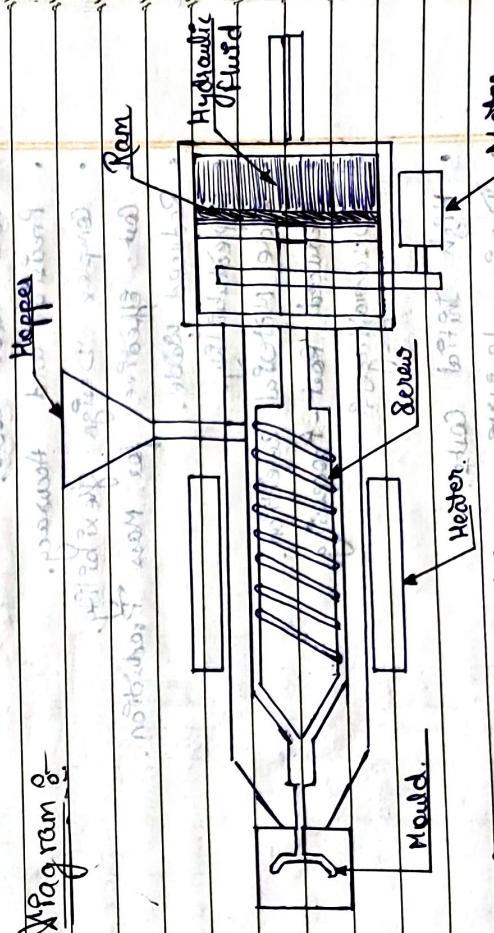


Fig:- Injection Molding.

Molding Process :-

1) Clamping :- The mold, consisting of two halves, is closed and clamped together.

2) Injection :- Molten material is injected into the mold cavity under high pressure.

3) Cooling :- The molten material cools and solidifies, taking the shape of the mold.

4) Ejection :- The mold is opened, and the solidified part is ejected.

5) Inspection :- The molded part is inspected for quality.

Advantages :-

- High Production speed
- Low Labour Costs.
- Precision and Accuracy.
- Complex Design flexibility.
- Cost-Effective for Mass Production.
- Reduced Waste.
- Repeatable Rty.
- Wide Material selection.
- Reduced Post-Processing

Disadvantages :-

- High Initial Costs.
- Design Limitation.

- Longer Lead Times.
- Not Cost-Effective for Low Volume.

Ques Explain Blow Molding with Diagram?

Ans Blow Molding :- Blow molding is a manufacturing process that shapes hollow plastic products by inflating a softened plastic tube, called a parison, within a mold cavity.

The process is used to create various hollow items, including bottles, containers, and other shaped plastic products.

Components :-

- 1) Extruder
- 2) Parison head
- 3) Cooling system.
- 4) Blow mold.

Diagram :-

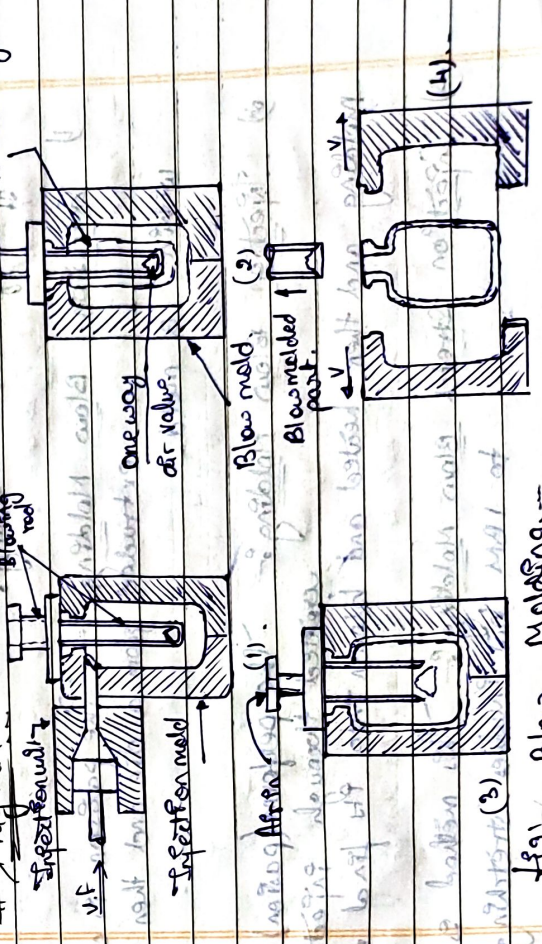


Fig. 1 Blow Molding

blowing process

1) Parison formation:- The process begins with heating plastic pellets and extruding them through a die to form a tube like preform or parison.

2) Parison placement:- The hot parison is then transferred to a hollow mold which is clamped or positioned below the mold halves to take a hollow molding.

3) Inflation:- Compressed air is introduced into the parison causing it to inflate and take the shape of the mold cavity.

4) Cooling and Ejection:- As the plastic cools, it solidifies and the mold opens to eject the finished hollow product.

Types of Blow Molding

1) Extrusion Blow Molding:- The parison is continuously extruded from a die and then inflated within a mold.

2) Injection Blow Molding:- The preform (parison) is first created through injection molding and then heated and blown into the final shape.

3) Injection Stretch Blow Molding:- This method is similar to 1BM but involves stretching the

preform before blowing it into the mold, often used to create stronger and more durable bottles.

Advantages

- Versatility: Blow molding can create a wide range of hollow shapes and sizes.
- Cost effective.
- Light Weight.
- Durable.

Q2) Explain the Difference operation in powder metallurgy.

Powder Metallurgy:- Powder metallurgy is a manufacturing process that uses metal powders to create parts through compaction and sintering. This process involves mixing metal powders, compressing them into desired shape, and then heating them in a controlled atmosphere to fuse the particles together.

- ## # Components:-
- Metal powders.
 - Bearing
 - Cutting tool.
 - Medical implants.

Key aspects of powder metallurgy

1) Raw Materials:- Metal powders, including elemental and alloy powders, are the starting point.

2) Compacting:- The powders are pressed into a die to form a green compact. The desired shape.

3) Densifying:- The green compact is heated in a controlled atmosphere to fuse the particles together, creating a dense solid part.

4) Advanced Applications:- Powder metallurgy enables the processing of materials with high melting points, the generation of superior properties, and the manufacture of products with controlled porosity.

5) Versatility:- It allows for complex geometries and pre-processed materials with enhanced properties.

Advantages

- Material Utilization: Minimizes material waste and costs.
- Shape complexity: Enables the production of intricate parts with high accuracy.
- Near-Net-shape: Reduces or eliminates the need for post-processing.
- Customization: Allows for the tailoring of material properties.

Limitations:-

- Cost:- Can be more expensive than some traditional manufacturing methods.
- Material Limitations: Some materials may be challenging to produce through powder metallurgy.



Fig:- Powder Metallurgy Process.

Working Process:-

- 1) Powder Production:- Metal powders are produced through various methods, including atomization (liquid or gas), electrolysis, or solid-state reduction, according to the metal powder industry federation.
- 2) Mixing and Blending:- The metal powders are mixed with other materials like binder, lubricants, or reinforcing agents to achieve the desired properties in the final part.

3) Compacting:- The powder mixture is pressed into the desired shape within a die under high pressure to form a "green compact".

4) Sintering:- The green compact is then heated to a point in a controlled temperature just below the metal's melting point, where particles together and create a solid part.

5) Optical Grinding:- Depending on the application, the sintered part may undergo additional processes like machining, heat treatment, or surface grinding to achieve the final desired characteristics.

Q4) Explain in brief methods used for preparing metal powders in powder metallurgy.

Answer: Metal powders in powder metallurgy can be prepared using various methods, such as:-

1) Atomization:- This method is widely used and involves spraying molten metal into a stream of gas or liquid, which rapidly cools and solidifies the droplets into powder. Gas atomization is particularly versatile and commonly used for producing fine, spherical powders.

2) Crushing and Milling:- This involves using mechanical force to break down solid metal into powder. These methods are suitable for producing powders with specific size and shape characteristics.

3) Electrolysis:- This method utilizes an electrolytic process to deposit metal in a spongy or powdered state, followed by further processing to achieve desired purity and density.

4) Chemical Methods: These include:-

a) Oxide reduction:- Metal oxides are reacted with reducing agents to produce metal powders.

b) Precipitation from solution:- Metals are precipitated from solutions, such as through

chemical reactions.

c) Thermal decomposition:- Metal carbonyls or hydrides are heated to produce metal powders.

5) Solid State Reduction:- This method involves reacting metallic ores with carbon in a furnace to produce sponge metal, which is then crushed and sieved into powder.

6) Centrifugal atomization:- This method uses centrifugal force to break down molten metal into droplets.

7) Vacuum evaporation:- Metal is evaporated in a vacuum and then condensed into a solid surface to form powder.

Assignment - 05

Q1) Explain process of Gas welding with neat sketch.

Definition:- Gas welding, also known as oxy-fuel welding, is a process that uses the heat from burning fuel gases (like acetylene or propane) with oxygen to melt and fuse metals together, creating a joint. This method can be used for joining, cutting and heating metals, and it is particularly effective for welding thin metal sections.

In other words, it is a metal joining process in which we use gases like oxygen and acetylene. By burning of the gases a high temperature flame is generated and this high temp. flame melts the metal and when the metal solidifies and the metal joins together. There are two separate cylinders green and for oxygen and red one for acetylene.

Working Principle:-

Gas welding works on the principle of joining metals by melting them with a high-temperature flame produced by burning fuel gases like acetylene and oxygen. The flame melts the edges of the metal, which are then fused together as they cool, creating a solid joint.

Components:-

- 1) Oxygen gas
- 2) Oxygen gas valve
- 3) Acetylene gas regulator
- 4) Acetylene gas valve
- 5) Furnible plug
- 6) Gas meter, etc.
- 7) Welding torch
- 8) Needle Valve
- 9) Pressure Regulator

Diagram:-

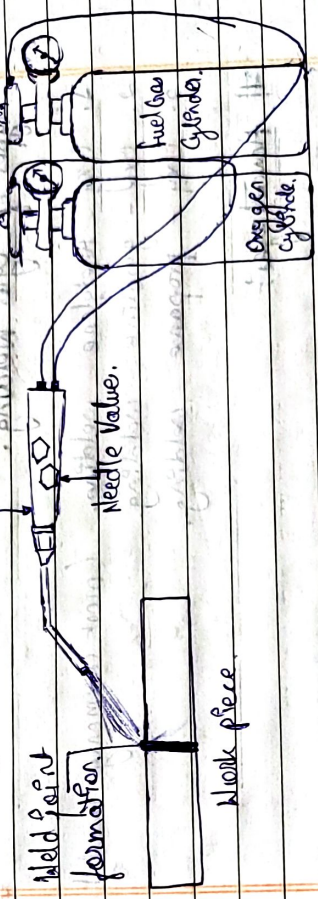


Fig:- Gas welding

Working process:-

1. Flame Generation:- A welding torch mixes fuel gas and oxygen, creating a high-temperature flame.
2. Metal Heating:- The flame is directed at the metal edges to be joined, heating them to a molten state.
3. Fusion:- The molten edges fuse together, forming a weld.

4. Filler Metal (optional) :- A filler metal rod can be manually fed into the weld pool to add additional material and strengthen the joint.

5. Flame Adjustment :- A ratio of oxygen to fuel gas can be adjusted to create different types of flame (neutral, oxidizing, reducing).

Types of Gas Welding :-

1. Oxy - Acetylene welding. (most commonly used)
2. Oxy - gasoline welding.
3. Oxy - propane welding.

Advantages :-

- 1) Easy to weld | Easy Process.
- 2) No. skilled worker required.
- 3) Can be used anywhere.
- 4) Low cost maintenance.
- 5) Gas welding is a flexible and forgiving process.
- 6) Gas welding equipment is relatively portable.

Disadvantages :-

1. Large Heat affected area.
2. Low strength welding.
3. Suitable for thin materials only.

Applications :-

1. Joining Metals.
2. Sheet metal fabrication.
3. Aircraft parts.
4. Automotive chassis and frames.
5. Repair work.

Ques Explain MIG welding and TIG welding with neat diagram.

1. MIG welding :-

Inert Gas Welding (IGW) is also known as Gas Metal Arc Welding (GMAW). It is a type of Arc welding. In the welding consumable electrode is used for welding purpose. It can be used for both thin and thick materials.

In other words, it is a semi-automatic and automatic arc welding process that uses a continuous electrode and a shield welding gas to join metal pieces. It creates a weld by melting the base metal and filler wire. Then fusing them together while protecting the weld pool from contamination with a shielding gas.

Components :-

- 1) Electrode feeder
- 2) Weld Gun
- 3) Gas cylinder $\rightarrow$ Inert gas $\rightarrow$ Argon, Ar , mixture
- 4) Power supply $\rightarrow$ constant voltage.

Diagram :-

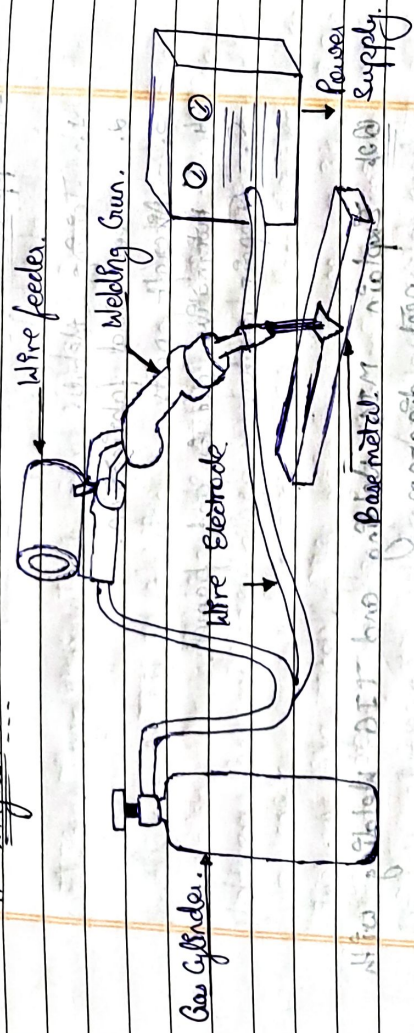


Fig. 5 - MIG Welding.

Working Process :-

1. In MIG welding consumable electrode continuously feed through weld gun.
2. Arc is created b/w base metal and the electrode.
3. Due to Arc base metal and electrode melts and create a weld pool.
4. To save the weld pool from contamination and oxidation Inert gas is supplied in welding zone.

Key features :-

1. Fast and effective process.
2. Produce clean weld.
3. Very low slag production.
4. Easy to operate.
5. Can be used for thin and thick material.
6. It can be used to weld Aluminium, stainless steel, steel, etc.

Advantages :-

1. MIG welding is relatively simple to learn.
2. It can produce high quality welds.
3. It is suitable for wide range of application.
4. It is also faster than some other welding process.

Disadvantages :-

1. MIG welding can be less precise than other methods like TIG welding.
2. It may not be as strong especially in certain applications.

Application :-

MIG welding is widely used in manufacturing construction, automotive and other industries.

TIG Welding

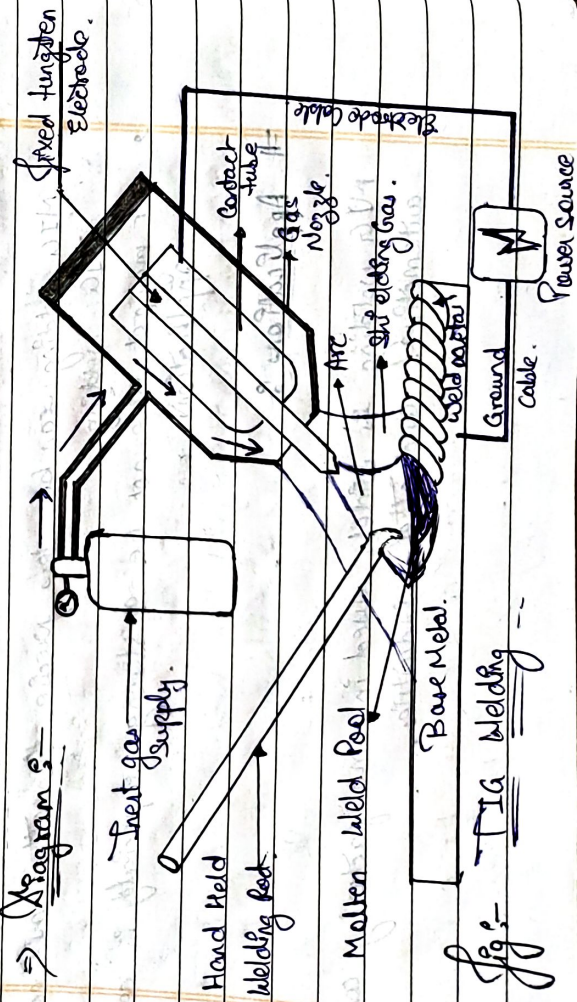
TIG (Tungsten Inert Gas Welding)

TIG welding is also known as Gas Tungsten Arc Welding (GTAW), is a welding process that utilizes a non-consumable tungsten electrode to create an electric arc, which is then shielded by an inert gas like argon. This method is known for its precision and versatility, allowing for the fusion of various metals with high-quality, clean welds and control over heat input. It is a type of Arc Welding.

⇒ Components

- i) Tungsten Electrode
- ii) Weld Gun
- iii) Gas Inert Gas (Argon gas)
- iv) Power Supply (constant Voltage)
- v) Filler Material

⇒ Diagram



⇒ Working Process

1. In TIG welding non-consumable electrode is continuously feed through the weld gun.
2. Arc is created b/w base metal and the electrode by filling the filler material.
3. Due to Arc, base metal and filler material melt and create a weld pool.
4. To save the weld pool from contamination and oxidation the shielding gas is used to cover the weld pool by supplying the inert gas in the welding zone.

⇒ Key features

1. Fast and effective process
2. Produce clean weld.
3. Very less slag production.
4. Easy to operate
5. Can be used for thin and thick material.
6. It can be used to weld aluminium, stainless steel, steel etc.

⇒ Advantages

1. High-Quality Welds: TIG welding produces clean and aesthetically pleasing welds.
2. Versatility: Suitable for various materials and applications.
3. Precise Control: Allows for fine-tuning of heat input.

Fig: TIG Welding

4. Minimal fusing required:- Welds often require less post-weld fusing.

→ Its advantages :-

1) Higher skill level required:- TIG welding requires more skill and practice compared to other processes like MIG.

2) Slower welding speed:- TIG welding is generally slower than MIG or laser welding.

3) More expensive equipment:- TIG welding equipment can be more expensive than MIG or oxyfuel welding equipment.

→ Applications :-

1. Aerospace.
2. Automotive.
3. Manufacturing.
4. Art and sculpture.

Q2: Explain Thermit welding with neat diagram.

Ans:- Thermit welding :- Thermit welding is a process that uses the heat generated from an exothermic chemical reaction to fuse metal parts together.

This reaction involves a mixture of powdered aluminum and iron oxide (thermite), which, when ignited, produces intense heat, melting the iron oxide and forming a molten iron pool that fuses the metal pieces in a mold. Thermit welding uses a mixture of iron oxide and aluminum powder, typically in a 1:3 weight ratio.

→ Components :-

- 1) Mold.
- 2) Thermit mixture
- 3) Igniter
- 4) Crucible (Heat resisting container).
- 5) Grinder.
- 6) Demolding.

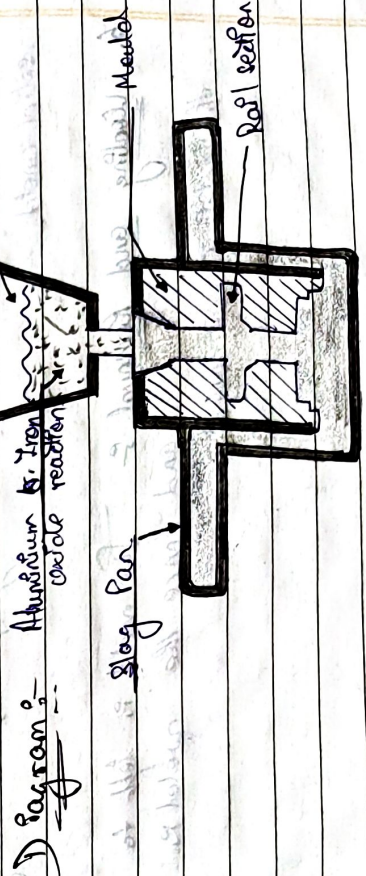


Fig:- Thermit welding.

Molding Process:-

1. Preparing the part:- The parts to be welded are cleaned and placed within a sand or graphite mold ensuring a gap for the molten metal to flow in.

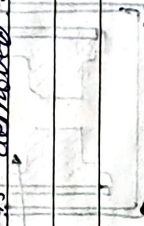
2. Mixing Thermit:- A mixture of powdered aluminium and iron oxide (thermit) is placed in a crucible, according to volume.

3. Ignition:- The thermit is ignited, usually with a barium peroxide igniter, causing the reaction to begin.

4. Reaction:- The aluminium reacts with the iron oxide producing superheated molten iron (and aluminium oxide slag), according to reaction.

5. Fusing:- The molten iron flows into the mold and fuses with the parts being joined, creating a solid weld.

6. Cooling and Removal:- The mold is left to cool, and once the weld is solid, the mold is removed.



Advantages:-

- 1) No external power source:- It doesn't require electricity or other external power source.
- 2) High strength welds:- The molten metal creates a strong, solid joint.
- 3) On-site welding:- It can be used for welding in the field, especially for large structures like railway tracks.

Disadvantages:-

1. Limited to ferrous metals:- It's primarily used for joining steel and other ferrous metals.
2. Potential for porosity:- The welds can sometimes be porous if not done correctly.
3. Requires specialized equipment:- It needs specific molds, crucibles, and igniter.

Explain in detail Resistance Welding with its principle.

⇒ Resistance Welding :- Resistance welding is a process that joins metals by applying pressure and passing an electric current through the contact area, creating heat and melting the materials. This fusion welding process doesn't require filler metal, fluxes or shielding gases.

In other words, Resistance welding is a welding process in which electric resistance is used to generate heat and join the metals by applying pressure from both the sides. The electric wire is joined in the two ends of the metal and electric current is supplied to and due to the resistance the current can't flow and convert into heat and melts the metal and applying pressure the metal are joined together.

⇒ Working Principle :-

Resistance welding works on the principle of resistivity.

When the current flows through the metal due to the resistivity the electric energy converts into heat energy and melts the metal and by applying pressure metals join together.

⇒ Components :- Resistance welding machines consists of three main components :-

- 1) An electrical circuit.
- 2) A Mechanical System.
- 3) A Control System.

⇒ Diagram :-

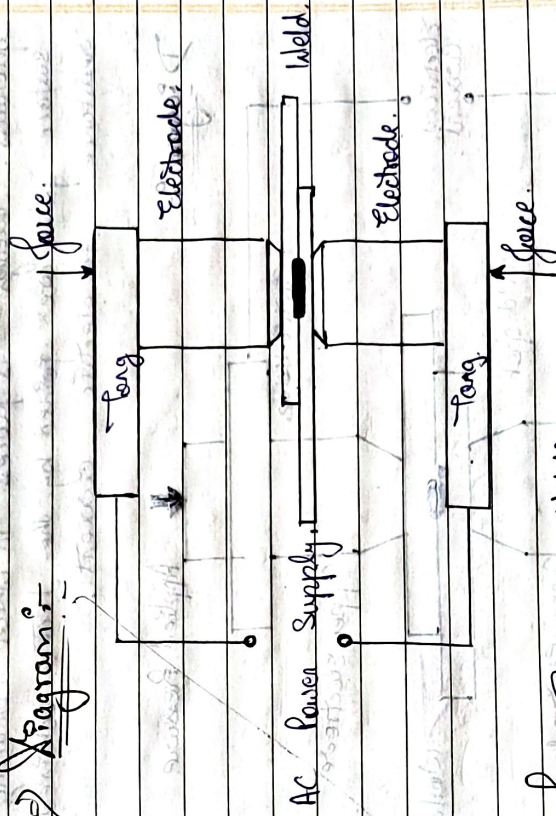


Fig:- Resistance Welding :-

⇒ Types of Resistive Welding :-

1. Spot Welding.
2. Seam Welding.
3. Projection Welding.
4. Percussion Welding.

1) Spot Welding :-

Spot welding is a type of resistance welding. In which the two metal pieces are joined.

In other words, spot welding is a type of electric resistance welding used to weld various sheet metal products, through a process in which contacting metal surface points are joined by the heat obtained from resistance to electric current.

Diagram :-

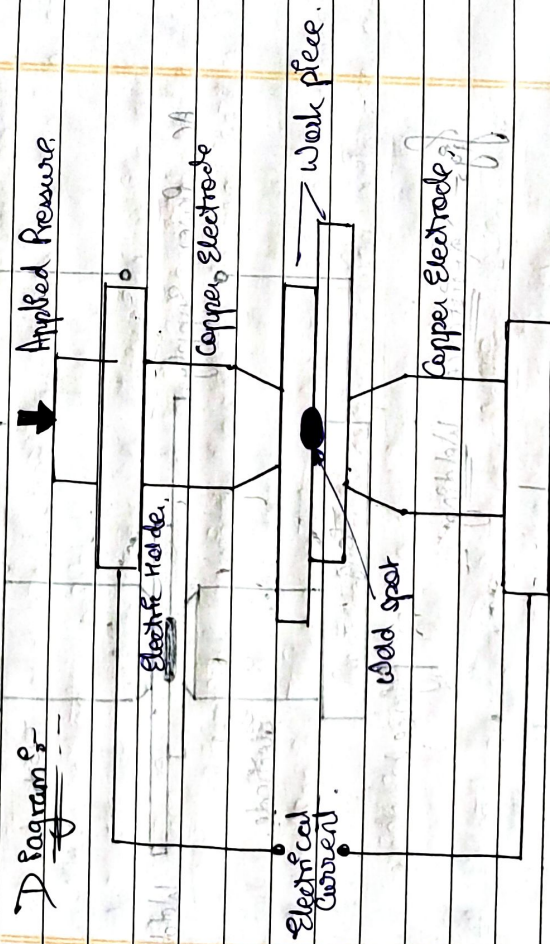


Fig Spot Welding

→ Working Principle :-

2) Seam Welding :- (Continuous Spot Welding)

Seam welding is a resistance welding process that creates a continuous weld by using rotating, wheel-shaped electrodes to make a series of overlapping spot welds.

It is a type of resistance welding in which the two electrode rollers are used to heat the metal and by applying pressure to joint them together.

Diagram :-

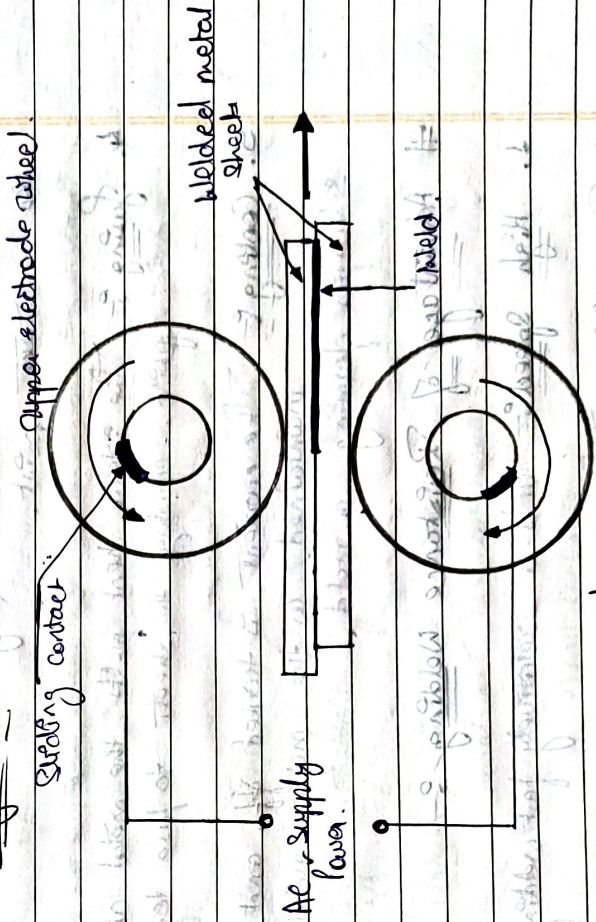


Fig Seam Welding

Welding Process:-

1. Preparation:- The metal sheets are cleaned to remove contaminants like grease oil and paint, and the electrode surfaces are prepared.
2. Clamping:- The metal sheets are clamped together by two copper alloy electrodes.
3. Heating:- A high electrical current is passed through the sheets, creating resistance and heat at the contact point.
4. Fusing:- The intense heat melts the metal at the contact point, causing the sheets to fuse together.
5. Cooling:- The current is turned off, and pressure is maintained as the molten metal cools and solidifies forming a weld.

Advantages of Resistance Welding:-

1. High Speed:- It's a relatively fast welding process.
2. Repeatability:- The process can be highly controlled and repeatable, leading to consistent welds.
3. Cost-Effective:- It can be an economical option for certain applications.
4. Strong and efficient welding joint.

5. Can be used for thin materials.
6. Automated:- Many resistance welding processes can be automated.
7. Mass production.

Disadvantages:-

- 1) High Equipment Cost.
2. Precise Voltage and current control.
3. Only used for metal have resistance.

Weld Defects:-

Weld defects are imperfections in a weld that can compromise its strength, integrity, and overall performance. Common weld defects include porosity, cracks, lack of fusion, slag inclusions, and undercut. These defects can be caused by various factors, including incorrect welding parameters, poor technique, or unsuitable materials.

Types of Weld Defects:-

- 1) Cracks:- These are fractures or separation within the weld or the surrounding heat-affected zone.

Causes:- 1) Material Properties.

2) Fast cooling.

3) High current.

Remedies:- 1) Optimum material property.

2) Optimum cooling.

3) Optimum use of current.

2) Porosity :- Tiny gas bubbles or voids within the weld metal, reducing its strength.

- Causes 1) Material properties
2) Gas shielding not done.
3) Metal and Electrode are not clean.
4) Metal and Electrode are wet.

Remedies 1) No proper gas shielding.

- 2) Clean both metal & Electrode properly
3) Dry the metal & Electrode well

3) Under Cut :- A groove or depression at the weld toe, reducing the effective cross-section of area of the joint.

- Causes 1) High Current.
2) Fast Cooling.
3) Poor technique.

Remedies 1) Optimum current
2) Optimum cooling.
3) Perfect technique.

4) Incomplete Fusion / Penetration :- Lack of proper bonding b/w weld metal and base metal.
Failure of the weld to fully fuse or penetrate through the base metal, creating weak points.

Causes 1) Metal properties
2) Incomplete heat
3) Poor technique.
4) Fast cooling.

Remedies 1) Optimum metal properties
2) Optimum Heat
3) Perfect proper technique.
4) Optimum cooling.

5) Slag Inclusion :- Trapped slag (a by-product of the welding process / small particles of powder metal goes) within the weld, affecting its strength.

- Causes 1) Poor technique
2) Base metal not clean.
3) Base metal wet.

Remedies 1) Proper technique.
2) Clean the base metal.
3) Dry the base metal.

6) Overlap :- Excess weld metal extending beyond the weld toe or root, creating a weak point.

7) Burn-through :- Melting of base metal through the welding process, creating holes or weak points.

Q4 Explain Effects of weld heat in welding

There are several types of heat effect in the weld zone of them are:-

1) Micro-structure of metal changes

Due to weld heat the micro structure of the material changes like

- i) Grain Size: High heat input leads to coarse grain formation in the heat affected zone (HAZ) which can negatively impact toughness.

- ii) Phase Transformation: Welding heat can induce phase transformation in the HAZ altering its mechanical properties.

2) Mechanical Properties changes

Due to the weld heat the mechanical properties of the metal & also get affected.

- i) Tensile strength decreases due to heat.

- ii) In HAZ the Hardness increases.

- iii) It improves toughness.

- iv) Increases ductility.

- v) Effect fatigue Resistance.

3) Residual stress increment

Due to the weld heat the residual stress increases in following ways:-

- i) Residual stress: As the weld cools, the shrinkage of the weld metal and the HAZ generate stresses that can be significant. These residual stresses can lead to distortion, cracking, and reduced fatigue life.

- ii) Distortion: Uneven distribution of heat and shrinkage forces during welding can cause the welded component to distort, particularly in thick sections.

4) Corrosion Change Increases

i) Post-Weld Heat Treatment (PWHT):

PWHT involves

reheating the welded component to a specific temperature range and then cooling it slowly to relieve residual stresses and improve the mechanical properties of the HAZ.

ii) Reduces Corrosion Resistance

Due to excess

or HAZ high temperature in the HAZ the properties of that are decreased and increases the chance of corrosion simultaneously.

5) Pre-Existing Properties Changes

Welding heat significantly alters the pre-existing properties of metals, primarily within the heat-affected zone (HAZ). This zone experiences changes in microstructure and mechanical properties like Hardness, tensile strength, and

toughness, potentially leading to weakened areas and reduced overall structural integrity.

1) Exposure to moisture

Exposure to moisture can lead to the formation of water within the material, which can cause swelling and distortion. This can lead to the formation of cracks and other defects, which can reduce the structural integrity of the material.

2) Exposure to heat

Exposure to heat can lead to the formation of thermal stresses, which can cause cracking and other defects. This can lead to the formation of cracks and other defects, which can reduce the structural integrity of the material.

3) Exposure to chemicals

Exposure to chemicals can lead to the formation of chemical reactions, which can cause corrosion and other defects. This can lead to the formation of cracks and other defects, which can reduce the structural integrity of the material.

4) Exposure to radiation

Exposure to radiation can lead to the formation of radiation damage, which can cause cracking and other defects. This can lead to the formation of cracks and other defects, which can reduce the structural integrity of the material.

5) Exposure to mechanical stress

Exposure to mechanical stress can lead to the formation of mechanical stresses, which can cause cracking and other defects. This can lead to the formation of cracks and other defects, which can reduce the structural integrity of the material.