



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L -1

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES

Date of Lecture:

Topic of Lecture: Introduction- patterns - Requirements of a good pattern, Pattern materials, types of patterns, Pattern allowances.

Introduction : (Maximum 5 sentences)

- Casting is one of the oldest manufacturing process. It is the first step in making most of the products
- Pattern materials are chosen from the amount of castings needed, accuracy and surface finish needed.
- The types of pattern is selected based on the complexity of the casting and the place of application.
- A pattern is always made larger than the final part to be made. The excess dimension is known as Pattern allowance.

Prerequisite knowledge for Complete understanding and learning of Topic:

- Basic Physics and Chemistry

Detailed content of the Lecture:

- Pattern: Replica of the part to be cast and is used to prepare the mould cavity.
- It is the physical model of the casting used to make the mould. Made of either wood or metal.

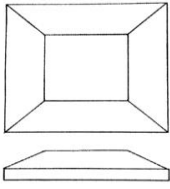
Requirements of a good pattern

- Easily worked, shaped and joined
- Light in weight
- Strong, hard and durable
- Resistant to wear and abrasion
- Resistant to corrosion
- Dimensionally stable and unaffected by variations in temperature and humidity
- Available at low cost

Pattern materials

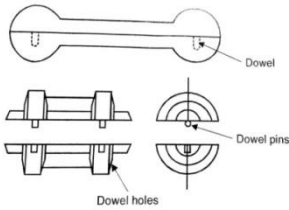
- Patterns for sand castings are subjected to considerable wear and tear due to ramming action that is required and the abrasive action of the sand
- Should be impervious to moisture because of changing surroundings
- Made of: wood, metal, plastics, plaster and synthetic materials
- Woods => white pine, sugar pine; The wood should be straight grain, light, easy to work, little tendency to develop crack and warp.
- More durable: Mahogany
- For large castings: metal such as cast iron or aluminium
- When metal pattern are cast from the wooden master pattern, double shrinkage must be provided on the wooden master pattern

Types Of Patterns



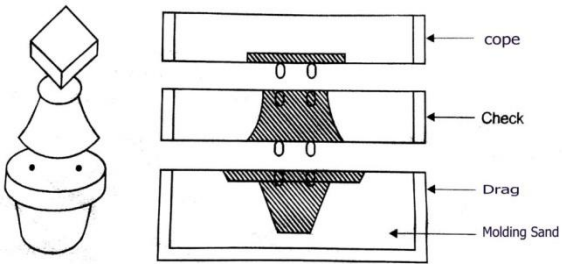
Solid Pattern Diagram

split pattern (or) two piece pattern:



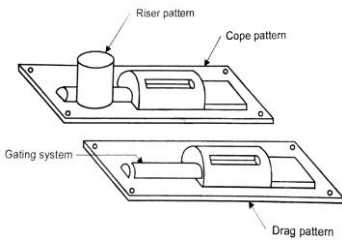
Split Pattern Diagram

Multi piece pattern:



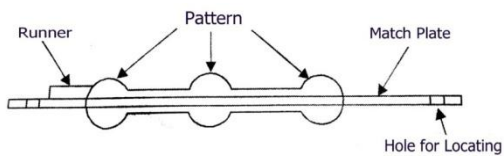
multi piece pattern Diagram

Cope and drag type of pattern:



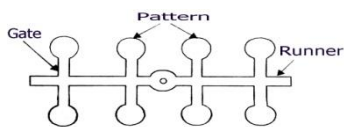
Cope and Drag Pattern Types Diagram

Match plate type pattern:



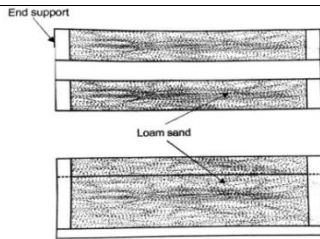
Match Plate Pattern Diagram

Gated pattern:



Gated pattern Diagram

Skeleton pattern:



Skeleton pattern Diagram

Pattern Allowances: ...

- 1: shrinkage or contraction allowance: ...
- 2: Draft allowance. ...
- 3: Finish or machining allowance. ...
- 4: Distortion or camber allowance. ...
- 5: Rapping or shaking allowance.

Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec11.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-2

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES Date of Lecture:

Topic of Lecture: Mould making, Types of moulds, moulding processes, types of sand moulding,

Introduction : (Maximum 5 sentences)

- There are different types of moulds such as sand mould, permanent mould etc.
- Moulding is nothing but the mould preparation activities for receiving molten metal.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Basic Physics and Chemistry

Detailed content of the Lecture:

Mould making

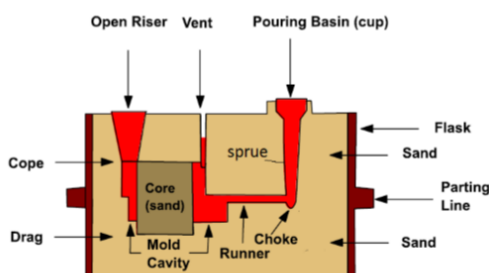
- Moulding usually involves: (i) preparing the consolidated sand mould around a pattern held within a supporting metal frame, (ii) removing the pattern to leave the mould cavity with cores. Mould cavity is the primary cavity.
- The mould cavity contains the liquid metal and it acts as a negative of the desired product.
- The mould also contains secondary cavities for pouring and channeling the liquid material in to the primary cavity and will act a reservoir, if required.
- Melting and Pouring The preparation of molten metal for casting is referred to simply as melting. The molten metal is transferred to the pouring area where the moulds are filled.
- Cleaning Cleaning involves removal of sand, scale, and excess metal from the casting. Burned-on sand and scale are removed to improved the surface appearance of the casting. Excess metal, in the form of fins, wires, parting line fins, and gates, is removed. Inspection of the casting for defects and general quality is performed

Moulding Processes

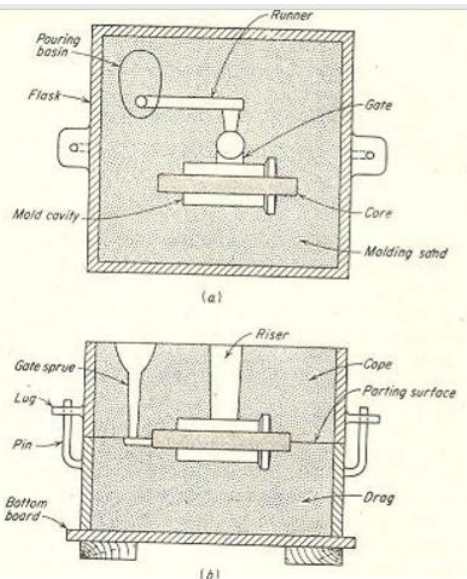
- 1) The drag flask is placed on the board
- 2) Dry facing sand is sprinkled over the board
- 3) Drag half of the pattern is located on the mould board. Dry facing sand will provide a non-sticky layer.
- 4) Molding sand is then poured in to cover the pattern with the fingers and then the drag is filled completely
- 5) Sand is then tightly packed in the drag by means of hand rammers. Peen hammers (used first close to drag pattern) and butt hammers (used for surface ramming) are used.
- 6) The ramming must be proper i.e. it must neither be too hard or soft. Too soft ramming will generate weak mould and imprint of the pattern will not be good. Too hard ramming will not allow gases/air to escape and hence bubbles are created in casting resulting in defects called 'blows'. Moreover, the making of runners and gates will be difficult.

- 7) After the ramming is finished, the excess sand is leveled/removed with a straight bar known as strike rod.
- 8) Vent holes are made in the drag to the full depth of the flask as well as to the pattern to facilitate the removal of gases during pouring and solidification. Done by vent rod.
- 9) The finished drag flask is now made upside down exposing the pattern.
- 10) Cope half of the pattern is then placed on the drag pattern using locating pins. The cope flask is also located with the help of pins. The dry parting sand is sprinkled all over the drag surface and on the pattern.
- 11) A sprue pin for making the sprue passage is located at some distance from the pattern edge. Riser pin is placed at an appropriate place.
- 12) Filling, ramming and venting of the cope is done in the same manner.
- 13) The sprue and riser are removed and a pouring basin is made at the top to pour the liquid metal.
- 14) Pattern from the cope and drag is removed.
- 15) Runners and gates are made by cutting the parting surface with a gate cutter. A gate cutter is a piece of sheet metal bent to the desired radius.
- 16) The core for making a central hole is now placed into the mould cavity in the drag. Rests in core prints.
- 17) Mould is now assembled and ready for pouring.

Typical sand mould



Mould Section and casting nomenclature



Mould Section and casting nomenclature, (a) top view, (b) front view

Video Content / Details of website for further learning (if any):

<https://nptel.ac.in/content/storage2/courses/112106175/downloads/Module%201/FAQ/FAQ-Lecture%203.pdf>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec29.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:, 322-341

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 348-352



LECTURE HANDOUTS

L-3

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES

Date of Lecture:

Topic of Lecture: Core making, types of cores, Core Prints, core box

Introduction : (Maximum 5 sentences)

Core making

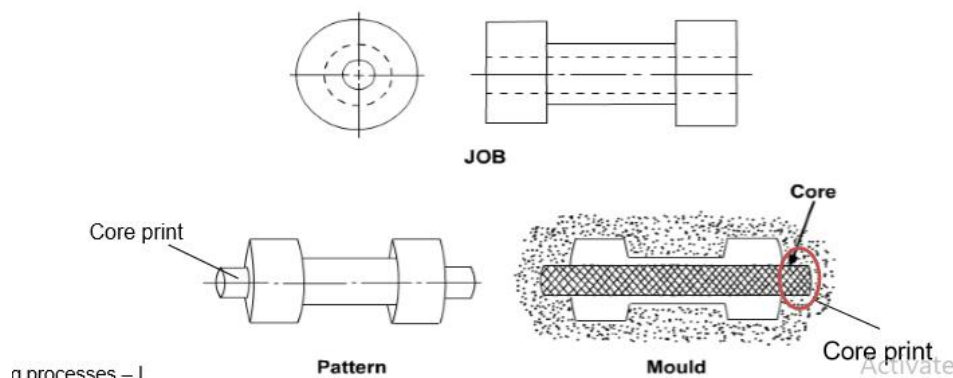
- Cores are placed into a mould cavity to form the interior surfaces of castings.
- Thus the void space is filled with molten metal and eventually becomes the casting.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:

- Core and core print: - Cores are used to make holes, recesses etc. in castings
- So where coring is required, provision should be made to support the core inside the mould cavity.
- Core prints are used to serve this purpose.
- The core print is an added projection on the pattern and it forms a seat in the mould on which the sand core rests during pouring of the mould.
- The core print must be of adequate size and shape so that it can support the weight of the core during the casting operation.



n processes - I

Activate

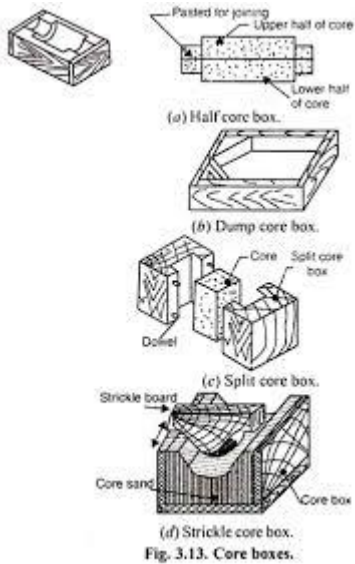
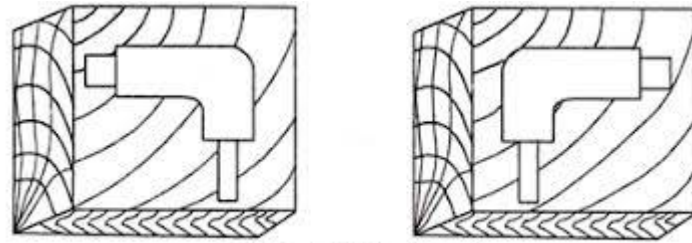


Fig. 3.13. Core boxes.



(e) Left and Right hand core box.

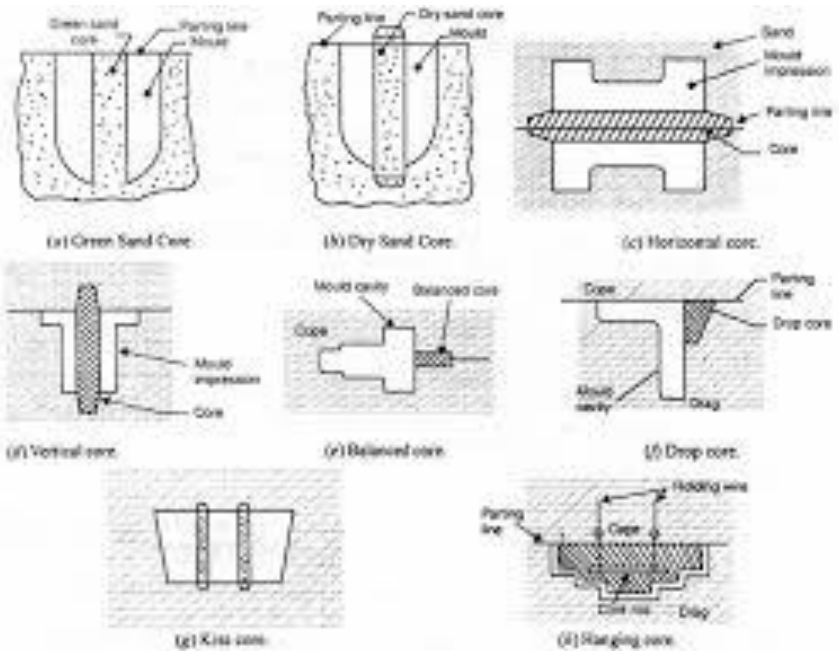


Fig. 3.11. Type of cores.

Video Content / Details of website for further learning (if any):

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec10.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:364-367



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-4

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES Date of Lecture:

Topic of Lecture: -Moulding Sand : Properties of moulding sand, types of moulding sand.

Introduction : (Maximum 5 sentences)

- Moulding sand has to have certain properties to produce sound castings.
- There are various types of moulding sands for different purposes

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:

PROPERTIES OF MOULDING SAND

1. Strength:

- The sand should have adequate strength in its green, dry and hot states Green strength is the strength of sand in the wet state and is required for making possible to Prepare and handle the mould.
- If the metal is poured into a green mould the sand adjacent to the metal dries and in the dry state it should have strength to resist erosion and the pressure of metal.

The strength of the sand that has been dried or basked is called dry strength at the time of Pouring the molten metal the mould must be able to withstand flow and pressure of the Metal at high temperature otherwise the mould may enlarge, crack, get washed or break

Strength of the moulding sand depends on:

1. Grain size and shape
2. Moisture content
3. Density of sand after ramming

The strength of the mould increases with a decrease of grain size and an increase of clay content and density after ramming. The strength also goes down if moisture content is higher than an optimum value.

2. Permeability:

The moulding sand must be sufficiently porous to allow the dissolved gases, which are evolved when the metal freezes or moisture present or generated within the moulds to be removed freely when the moulds are poured. This property of sand is called porosity or permeability.

3. Grain size and shape:

The size and shape of the grains in the sand determine the application in various types of foundry. These are three different sizes of sand grains.

Fine

Medium

Coarse

- Fine sand is used for small and intricate castings. Medium sand is used for benchmark and light floor works. If the size of casting is larger coarse sand is used
- Sand having fine, rounded grains can be closely packed and forms a smooth surface. Although fine-grained sand enhances mould strength.

4. Thermal stability:

The sand adjacent to the metal is suddenly heated and undergoes expansion. If the mould wall is not dimensionally stable under rapid heating, cracks, buckling and flacking off sand may occur.

5. Refractoriness:

- Refractoriness is the property of withstanding the high temperature condition moulding sand with low refractoriness may burn on to the casting
- It is the ability of the moulding material to resist the temperature of the liquid metal to be poured so that it does not get fused with the metal. The refractoriness of the Silica sand is highest.

6. Collapsibility:

The moulding sand should collapse during the contraction of the solidified casting it does not provide any resistance, which may result in cracks in the castings. Besides these specific properties the moulding material should be cheap, reusable and should have good thermal conductivity

7. Adhesiveness:

It is the important property of the moulding sand and it is defined as the sand particles must be capable of adhering to another body, then only the sand should be easily attach itself with the sides of the moulding box and give easy of lifting and turning the box when filled with the stand.

8. Reusability:

Since large quantities of sand are used in a foundry it is very important that the sand be reusable otherwise apart from cost it will create disposal problems

11. Easy of preparation and control:

Sand should lend itself to easy preparation and control by mechanical equipment.

12. Conductivity:

Sand should have enough conductivity to permit removal of heat from the castings.

Types of Moulding Sand:

Green Sand:

Dry Sand: When the moisture is removed from green sand, it is known as dry sand. ...

Loam Sand: Loam sand is a mixture of 50 percent sand and 50 percent clay. ...

Facing Sand: ...

Parting Sand: ...

Backing or Floor Sand: ...

System Sand: ...

Core Sand:

Video Content / Details of website for further learning (if any):

<http://www.yourarticlelibrary.com/metallurgy/moulding-sand-types-and-properties-metallurgy/95779>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:364-367



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-5

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES Date of Lecture:

Topic of Lecture: Melting equipment, Cupola Furnace, crucible furnace

Introduction : (Maximum 5 sentences)

- Different types of furnaces are available for the melting of metals.
- Based on the requirements and type of metal, the type of furnace is chosen.

Prerequisite knowledge for Complete understanding and learning of Topic:

- Basic Physics and Chemistry

Detailed content of the Lecture:

Equipments for Melting And Pouring

Hot Blast Cupola. Cupola Charger. Geared Tilting Ladles. According to Material: C.I., Steel, S.G. Iron and Aluminium. Pouring type: Lip type, T-spout, Bottom pouring, Drum type.

Cupola Furnace

Cupola furnaces are tall, cylindrical furnaces used to melt iron and ferrous alloys in foundry operations. Alternating layers of metal and ferrous alloys, coke, and limestone are fed into the furnace from the top. Furnace's cylindrical shaft lined with refractory and the alternating layers of coke and metal scrap. The molten metal flows out of a spout at the bottom of the cupola.

Description of Cupola

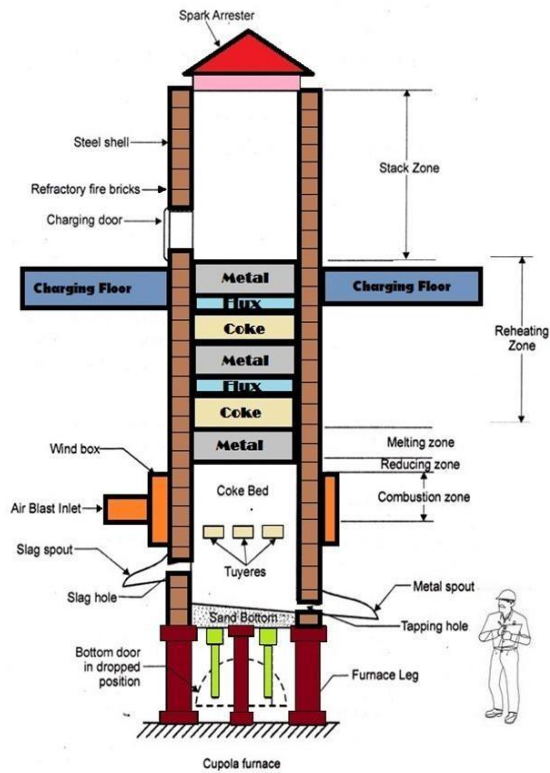
The cupola consists of a vertical cylindrical steel sheet and lined inside with acid refractory bricks. The lining is generally thicker in the lower portion of the cupola as the temperature is higher. There is a charging door through which coke, pig iron, steel scrap and flux is charged. The blast is blown through the tuyeres.

Operation of Cupola

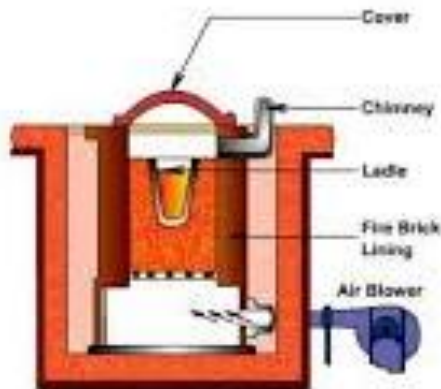
The cupola is charged with wood at the bottom. On the top of the wood a bed of coke is built. Alternating layers of metal and ferrous alloys, coke, and limestone are fed into the furnace from the top. The purpose of adding flux is to eliminate the impurities and to protect the metal from oxidation. Air 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.

Coke-FiredCrucibleFurnace:

Primarily used for non-ferrous metalsFurnace is of a cylindrical shapeAlso known as pit furnacePreparation involves: first to make a deep bed of coke in the furnaceBurn the coke till it attains the state of maximum combustionInsert the crucible in the coke bedRemove the crucible when the melt reaches to desired temperature.



COKE-FIRED FURNACE



Video Content / Details of website for further learning (if any):
<https://www.youtube.com/watch?v=GUctNyh1FR0>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:413-414

LECTURE HANDOUTS

L-6

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES

Date of Lecture:

Topic of Lecture: Electric furnace, gating system.

Introduction : (Maximum 5 sentences)

- Electric arc furnace is used to melt ferrous alloys, especially steel.

Prerequisite knowledge for Complete understanding and learning of Topic:

- Basic Physics and Chemistry

Detailed content of the Lecture:

Electric arc furnace:

An arc furnace is used to melt ferrous alloys, especially steel. The popularity of arc furnaces is because of their (i) High melting rates, (ii) High pouring temperature, (iii) Ability to produce high quality of metal of almost any desired composition, and (iv) Ability to hold the molten metal at constant temperature for longer periods of time.

The height of electrodes in the furnace can be adjusted, depending upon the amount of metal present. The metal melts in about two hours. The power supply is then switched-off, the electrodes are raised, and the furnace is tilted to get the molten metal in a ladle. A direct arc furnace has a thermal efficiency as high as 70%. Temperatures as high as 1900°C can be generated; Sizes up to 100 tonnes.

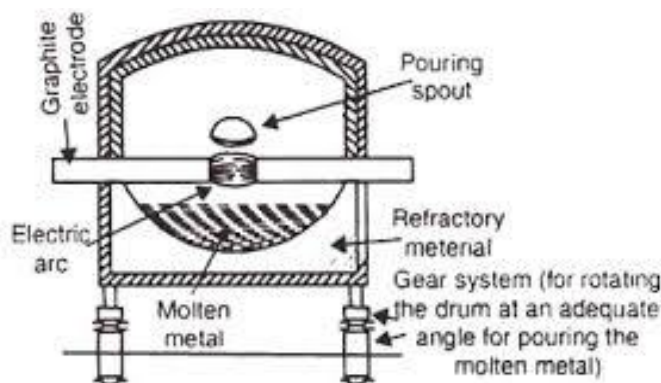
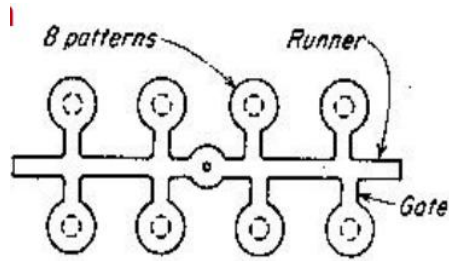


Fig. 4.4. An electric-arc furnace.

Gating System:

The assembly of channels which facilitates the molten metal to enter into the mold cavity is called the gating system. Alternatively, the gating system refers to all passage ways through which molten metal passes to enter into the mold cavity.



Gated pattern for making eight small patterns

Goals of Gating System:

To minimize turbulence to avoid trapping gasses into the mold

To get enough metal into the mold cavity before the metal starts to solidify

To avoid shrinkage

Establish the best possible temperature gradient in the solidifying casting so that the shrinkage if occurs must be in the gating system not in the required cast part.

Incorporates a system for trapping the non-metallic inclusions.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=GUctNyh1FR0>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:413-414

LECTURE HANDOUTS

L-7

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES

Date of Lecture:

Topic of Lecture: Sand casting, Shell-mould casting.

Introduction : (Maximum 5 sentences)

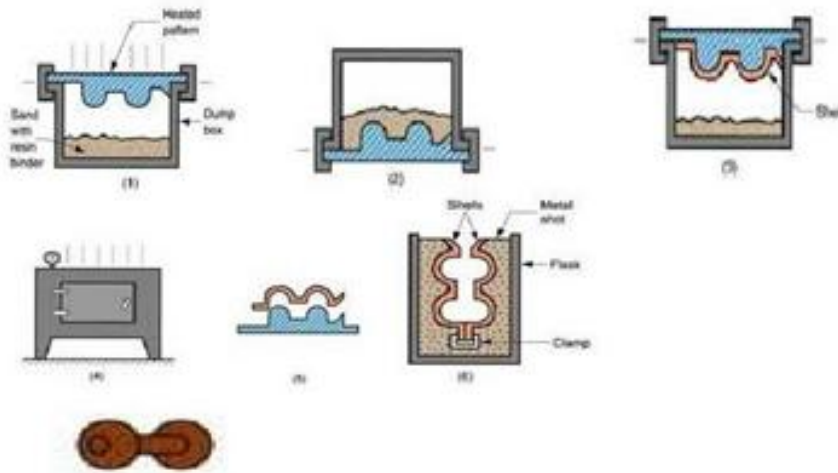
- There are many special casting processes.
- Among them very important processes are shell moulding and investment casting.
- Shell moulding is used for manufacturing symmetrical objects and investment casting is used when accuracy and good surface finish is required

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

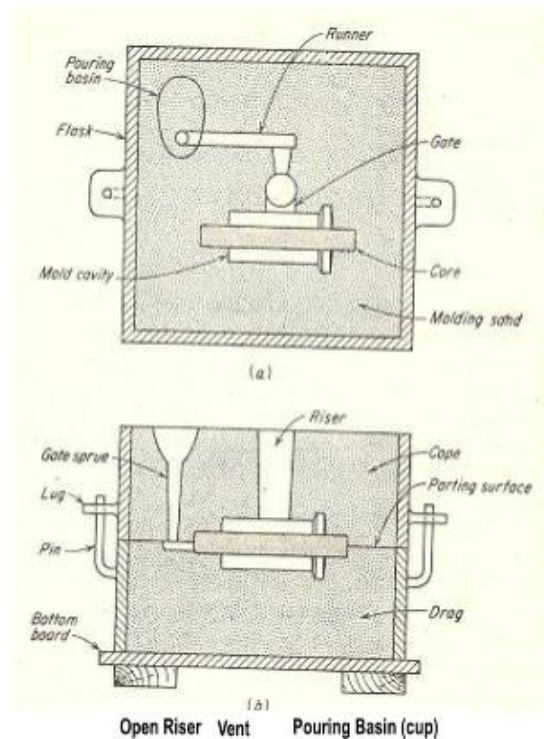
- Basic Physics and Chemistry

Detailed content of the Lecture:
Shell moulding



A metal pattern, attached to a pattern plate, usually made of cast iron is uniformly heated in an oven to nearly 200 °C-300 °C. The pattern-pattern plate assembly is taken out from the oven and sprayed with a lubricant.(For easy removal of shell, patterns are sprayed with silicone dissolved in acetone, and also provided with some ejector pins). It is then clamped onto the top of a container (called dump box). The dump box contains resin-coated sand. (Drysilica sand & thermosetting resins).The dump box is rotated through 180° so that the coated sand falls on the hot pattern.

Sand casting



SAND CASTING DEFECTS

Several types of defects may occur in castings, considerably reducing the total output of castings besides increasing the cost of their production. Defective castings offer problems to the foundry industry. A defect may be the result of a single clearly defined cause or of a combination of factors.

1. Blowholes and Pinholes: Blowholes generally appear as smooth walled, round voids or cavities opened to the casting surface. Blowholes are caused due to the entrapped bubbles of gas with smooth walls, excessive moisture in the moulding sand, low permeability of sand, hard ramming of sand or gas producing ingredients in the mould. They may occur in clusters or there may be one large smooth depression.

2. Shrinkage defects: When the metals solidify, there is a volumetric shrinkage, and if adequate feeding does not compensate for the shrinkage, voids will occur inside the casting. This defect can be prevented by adequate feeding of the molten metal and designing a gating system to enable directional solidification.

3. Hot tears: Hot tears are internal or external cracks or discontinuities on the casting surface. These are caused by hindered contraction occurring immediately after the metal has solidified. Immediately after the solidification, metal will have low strength, and if the solid shrinkage after casting causes sufficiently high stresses, the metal will fail with the resulting hot tear. They may be produced when the casting is poorly designed and abrupt sectional changes take place or no proper corner radii are provided. Hot tears can also be due to hard ramming and too much shrinkage of metal during solidification.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=Qkp2tnJFz1s>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:415-416



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-8

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES Date of Lecture:

Topic of Lecture: Investment casting, centrifugal casting.

Introduction : (Maximum 5 sentences)

- Centrifugal castings method is used to produce tube like structures.
- Gravity die casting is of two types-hot and Cold.
- Care should be taken in producing castings without defects.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

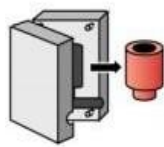
- Basic Physics and Chemistry

Detailed content of the Lecture:

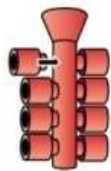
Investment Casting:

1. **Pattern making:** A metal die, usually of aluminium, having the cavity shape corresponding to the shape of the pattern is taken and molten wax is injected into it. When the wax solidifies, the die is opened and the pattern is removed. For economic considerations, it is a usual practice to make a gated pattern by assembling several wax patterns in a tree-like structure on to a central runner or sprue. Heated tool called spatula is used for assembling wax gates and sprue to the wax patterns.
2. **Pattern investment:** The multi-pattern assembly is covered in a permeable container. Fine ceramic based slurry known as investment is poured into the container. While the whole assembly is given low frequency vibrations. (The name of the casting process is derived from this process). Fineness of slurry is important as it determines the surface finish of the final castings. One way is to a How drying of the investment around the gated pattern in the container itself. Alternatively, the gated pattern with a thin coating of investment on it is take Fell out and after drying of this initial coating, with a refractory powder until a coating thickness of 5-10 mm has been built up over the entire wax pattern assembly.
3. **Pattern melting and removal:** After the investment has set around the pattern tree and dried, it is heated; for a temperature of 100°C-150°C by the wax pattern-tree to melt and run out (de-waxing).
4. **Investment hardening:** The mould of investment material is fully hardened by placing it for about 2 hours in an oven at a temperature of 700°C-1000°C, depending on the metal to be cast. This also burns off any residual wax in the mould cavities.
5. **Metal pouring and fettling of castings:** As soon as the mould is removed from the oven, the molten metal is poured into it. When solidified, the cast tree of the components is retrieved by breaking the mould made of the brittle investment material.

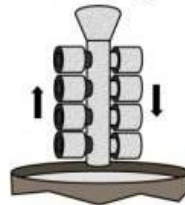
The Basic Steps in the Investment Casting Process



Wax Injection



Assembly



Shell Building



Dewax/Burnout



Gravity Pouring



Knock Out



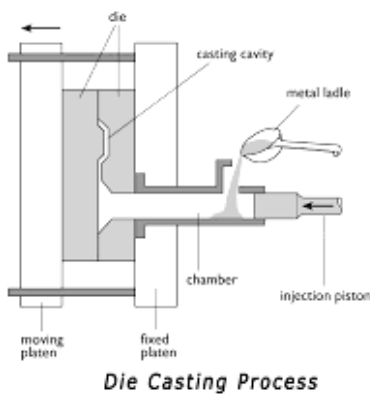
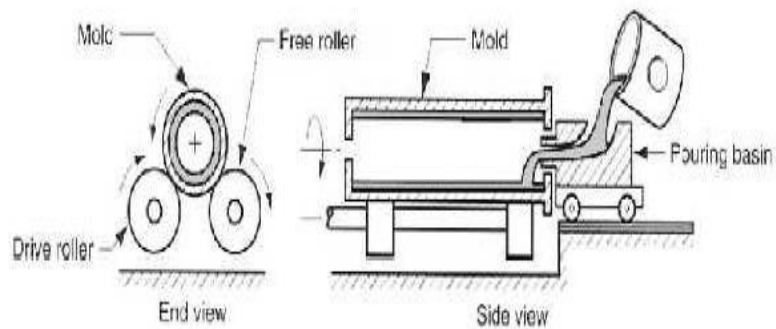
Cut-off



Finished Castings

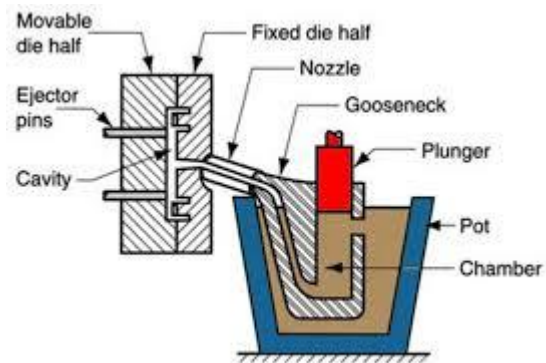
centrifugal casting

Centrifugal Casting: The centrifugal force acts to throw the molten metal against the mould wall, where it is allowed to remain until it cools and solidifies.



Die Casting Process

COLD



HOT

Video Content / Details of website for further learning (if any):

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec20.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promotors Pvt Ltd., Mumbai, 2015, pp:417



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-9

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.MURALIDHARAN

Unit : I - CASTING PROCESSES

Date of Lecture:

Topic of Lecture: Defects, Cleaning and Inspection of casting.

Introduction : (Maximum 5 sentences)

- Care should be taken in producing castings without defects.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:

Si no	Defects	Possible causes	Effective remedies
1	Blow holes	<ul style="list-style-type: none">❖ Excess moisture in the moulding sand❖ Rust and moisture in chills chaplets used.❖ Cores are not sufficiently baked❖ Moulds are not adequately vented	<ul style="list-style-type: none">❖ control moisture content❖ use clean and rust free chills, chaplet❖ bake the cores properly❖ Provide adequate venting in moulds and cores
2	Porosity	<ul style="list-style-type: none">❖ High temperature of pouring.❖ Gas disolved in metal charge❖ less amount of flux❖ slow solidification	<ul style="list-style-type: none">❖ Regulating pouring temperature❖ Control metal composition.❖ Increase flux proportion❖ Modify gating and risering
3	Shrinkage	<ul style="list-style-type: none">❖ faulty gating and risering and improper chilling	<ul style="list-style-type: none">❖ ensure proper directional solidification by modifying gating risering and chilling

4	Inclusions	<ul style="list-style-type: none"> ❖ faulty gating system ❖ Faulty pouring ❖ soft ramming of mould ❖ Rough handling of core and mould 	<ul style="list-style-type: none"> ❖ Modify gating system ❖ Improve pouring to minimize turbulence ❖ Provide harder ramming ❖ take care in handling
5	Hot tears or hot cracks	<ul style="list-style-type: none"> ❖ Lack of core collapsibility ❖ Lack of mould collapsibility ❖ Faulty design ❖ Hard ramming of mould 	<ul style="list-style-type: none"> ❖ Improve core collapsibility ❖ Improve mould collapsibility ❖ Modify the design ❖ Provide softer ramming
6	Misrun and cold shuts	<ul style="list-style-type: none"> ❖ Lack of fluidity in molten metal ❖ Faulty design and gating 	<ul style="list-style-type: none"> ❖ adjust proper pouring temperature ❖ Modify the design and gating system
7	Cuts and washes (Scabs)	<ul style="list-style-type: none"> ❖ Low strength of mould and core ❖ faulty gating ❖ Lack of binders in facing and core sand 	<ul style="list-style-type: none"> ❖ Improve mould and core strength ❖ Modify the gating system ❖ Add more binds
8	Mismatch	<ul style="list-style-type: none"> ❖ Worn out or bent clamping pins ❖ Misalignments of two halves of pattern ❖ Improper location and support of core ❖ faulty core boxes 	<ul style="list-style-type: none"> ❖ repair or replace the pins ❖ Replace dowel causing misalignment ❖ Provide adequate core support and locate it properly ❖ Replace the core boxes

Video Content / Details of website for further learning (if any):

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec20.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp:417



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-10

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Classifications of Welding

Introduction : There are many types of welding techniques used to join metals. The welding processes differ in the manner in which temperature and pressure are combined and achieved. The welding process is divided into two major categories: Plastic Welding or Pressure Welding and Fusion Welding or Non-Pressure Welding.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

Joining Processes, Plastic Welding or Pressure Welding, Fusion Welding or Non-Pressure Welding

Detailed content of the Lecture:

DEFINITION OF WELDING

“Welding is the process of joining together two pieces of metal so that bonding takes place at their original boundary surfaces”. When two parts to be joined are melted together, heat or pressure or both is applied and with or without added metal for formation of metallic bond.

CLASSIFICATION OF WELDING PROCESSES

There are many types of welding techniques used to join metals. The welding processes differ in the manner in which temperature and pressure are combined and achieved. The welding process is divided into two major categories: Plastic Welding or Pressure Welding and Fusion Welding or Non-Pressure Welding. Plastic Welding or Pressure Welding: When the metal piece acquires plastic state on heating, external pressure is applied. In this process, externally applied forces play an important role in the bonding operation. “A group of welding processes which produces coalescence at temperatures essentially below the melting point of the base materials being joined without the addition of a filler metal” is Pressure Welding Process. Without melting the base metal, due to temperature, time and pressure coalescence is produced. Some of the very oldest processes are included in solid state welding process. The advantage of this process is the base metal does not melt and hence the original properties are retained with the metals being joined.

Plastic Welding or Pressure Welding: When the metal piece acquires plastic state on heating, external pressure is applied. In this process, externally applied forces play an important role in the bonding operation. “A group of welding processes which produces coalescence at temperatures essentially below the melting point of the base materials being joined without the addition of a filler metal” is Pressure Welding Process. Without melting the base metal, due to temperature, time and pressure coalescence is produced. Some of the very oldest processes are included in solid state welding

process. The advantage of this process is the base metal does not melt and hence the original properties are retained with the metals being joined.

Fusion Welding or Non-Pressure Welding: The material at the joint is heated to a molten state and allowed to solidify. In this process the joining operation involves melting and solidification and any external forces applied to the system do not play an active role in producing coalescence. Usually fusion welding uses a filler material to ensure that the joint is filled. All fusion welding processes have three requirements: Heat, Shielding and Filler material.

TYPES OF WELDING

Welding process can also be classified as follows:

1. Gas Welding
 - Oxy Acetylene Welding • Oxy Hydrogen Welding • Pressure Gas Welding
2. Arc Welding
 - Carbon Arc Welding • Shield Metal Arc Welding • Submerged Arc Welding • Metal Inert Gas Welding • Tungsten Inert Gas Welding • Electro Slag Welding • Plasma Arc Welding
3. Resistance Welding
 - Spot Welding • Flash Welding • Resistance Butt Welding • Seam Welding
4. Solid State Welding
 - Forge Welding • Cold Welding • Friction Welding • Explosive Welding • Diffusion Welding • Ultrasonic Welding
5. Thermo-Chemical Welding
 - Thermit Welding • Atomic H₂ Welding
6. Radiant Energy Welding
 - Electron Beam Welding • Laser Welding

Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec10.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-11

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Resistance Welding – Spot, Seam, Projection welding

Introduction : Resistance welding (RW) is a group of fusion-welding processes that uses a combination of heat and pressure to accomplish coalescence.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Spot welding, Seam welding, Projection welding

Detailed content of the Lecture:

RESISTANCE WELDING

Resistance welding (RW) is a group of fusion-welding processes that uses a combination of heat and pressure to accomplish coalescence.

The heat being generated by electrical resistance to current flow at the junction to be welded.

The principal components include work parts to be welded (usually sheet metal parts), two opposing electrodes, a means of applying pressure to squeeze the parts between the electrodes, and an AC power supply from which a controlled current can be applied.

The operation results in a fused zone between the two parts, called a weld nugget in spot welding.

By comparison to arc welding, resistance welding uses no shielding gases, flux, or filler metal; and the electrodes that conduct electrical power to the process are non consumable.

RW is classified as fusion welding because the applied heat almost always causes melting of the faying surfaces (With exceptions).

Some welding operations based on resistance heating use temperatures below the melting points of the base metals, so fusion does not occur.

Spot Welding

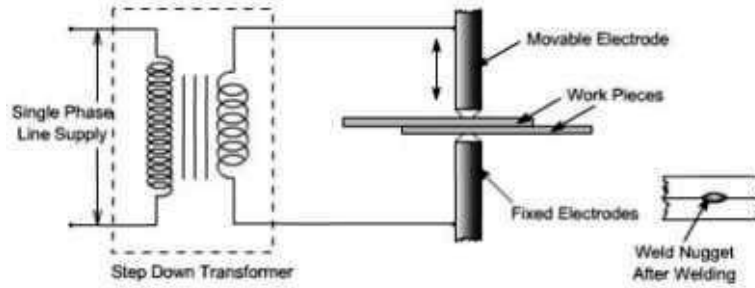
Resistance spot welding is by far the predominant process in this group.

It is widely used in mass production of automobiles, appliances, metal furniture, and other products made of sheet metal.

A typical car body has approximately 10,000 individual spot welds, and that the annual production of automobiles throughout the world is measured in tens of millions of units; the economic importance of resistance spot welding is very high.

The total resistance in the welding circuit is the sum of:

- i. Resistance of the electrodes.
- ii. Contact resistance between electrodes and the work pieces.
- iii. Resistance of the work pieces.
- iv. Resistance between the surfaces to be joined. These surfaces are called the faying surfaces.



Resistance Seam Welding

It is a continuous type of spot welding wherein spot welds overlap each other to the desired extent. In this process coalescence at the faying surfaces is produced by the heat obtained from the resistance to electric current (flow) through the work pieces held together under pressure by circular electrodes.

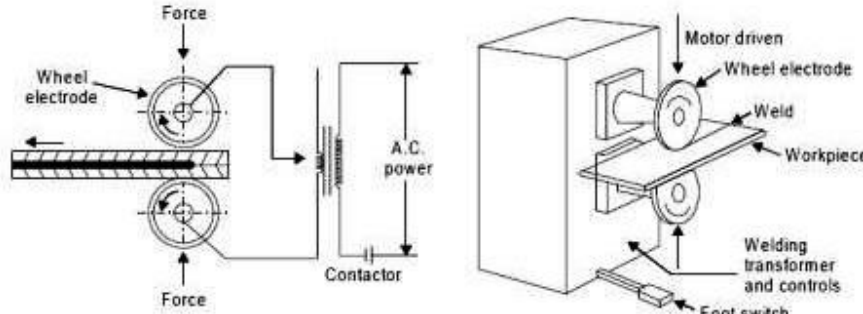


Fig. (a) Principle of seam welding process Fig. (b) Resistance seam welding process setup

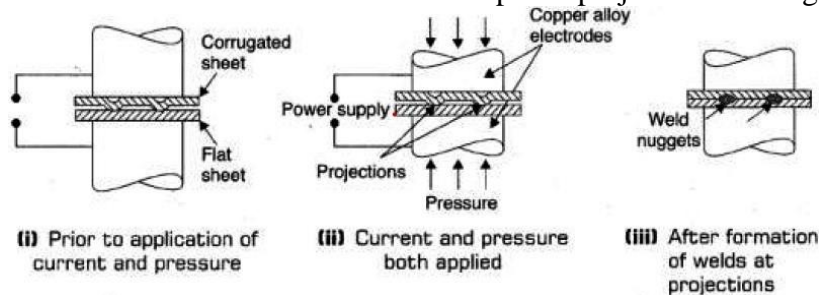
Resistance Projection Welding

This process is a resistance welding process in which two or more than two spot welds are made simultaneously by making raised portions or projections on predetermined locations on one of the workpiece.

These projections act to localize the heat of the welding circuit. The pieces to be welded are held in position under pressure being maintained by electrodes.

The projected contact spot for welding should be approximately equal to the weld metal thickness.

The welding of a nut on the automotive chassis is an example of projection welding.



Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



LECTURE HANDOUTS

L-12

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Resistance Butt Welding, Gas welding – Oxy Acetylene welding

Introduction : This welding is also used for joining metal pieces end to end but it has largely replaced the butt-welding method for weld articles small cross sections.

A fusion welding process which joins metals, using the heat of combustion of an oxygen /air and fuel gas (i.e. acetylene, hydrogen propane or butane) mixture is usually referred as 'gas welding'.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Butt welding, Gas welding, Oxy Acetylene welding

Detailed content of the Lecture:

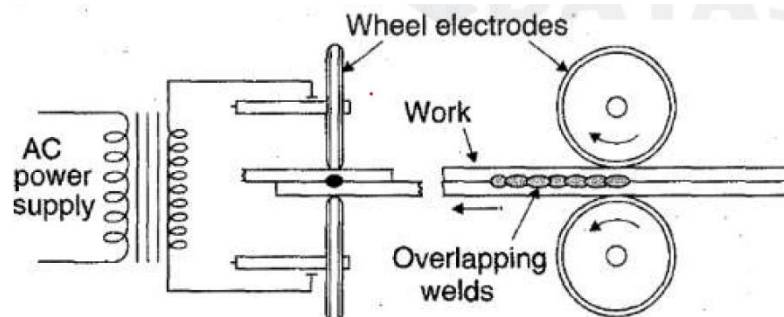
Resistance Butt Welding

This welding is also used for joining metal pieces end to end but it has largely replaced the butt-welding method for weld articles small cross sections.

It can be used for thick sections also. Initially the current is switched on and then one end the moveable part to be welded is brought gently closer to the fixed end of the other part to localize heat at the ends and thus raises the temperature of the ends quickly to the welding heat.

On acquiring contact of fixed end and moveable end with each other, the moveable end is then pressed against one another by applying mechanical pressure.

Thus the molten metal and slag to be squeezed out in the form of sparks enabling the pure metal to form the joint and disallowing the heat to spread back.



GAS WELDING PROCESSES

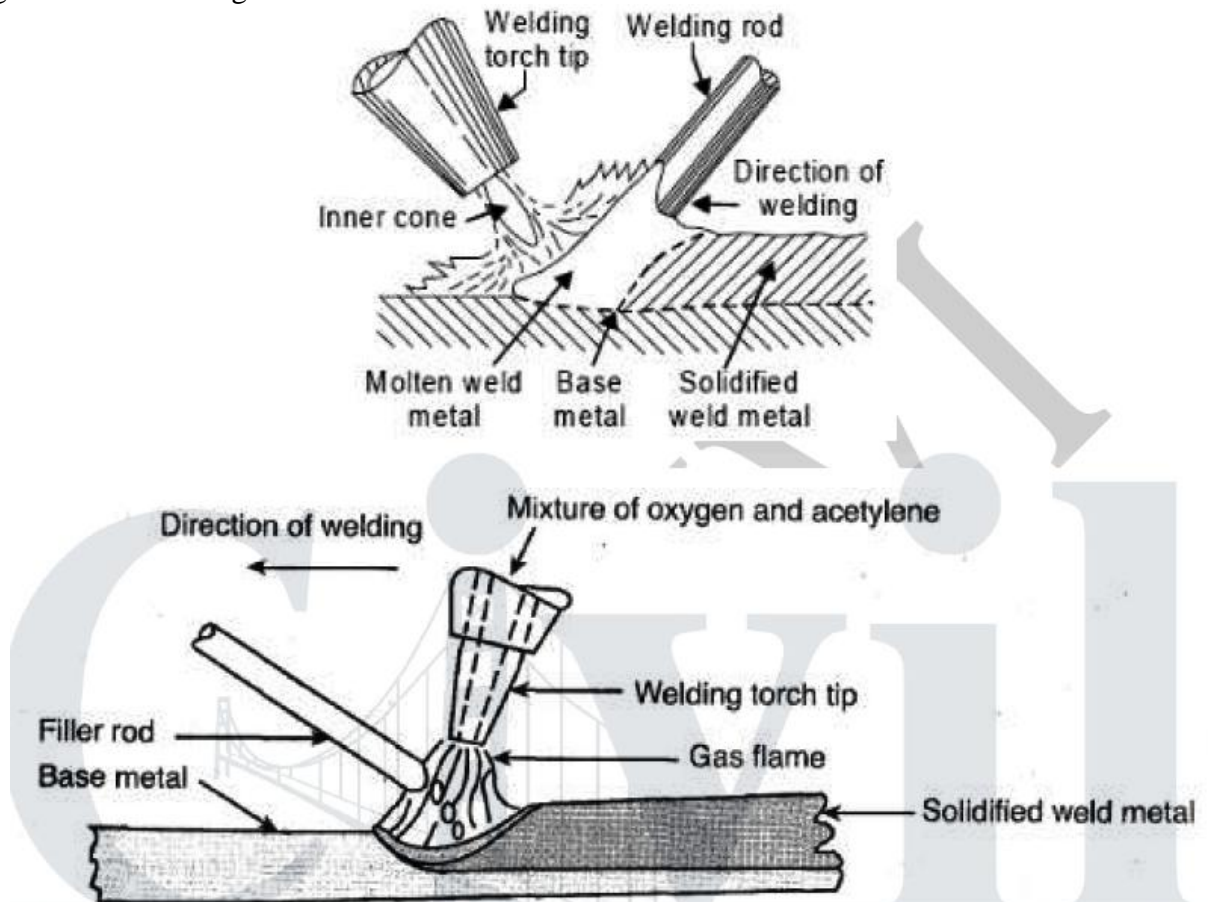
A fusion welding process which joins metals, using the heat of combustion of an oxygen /air and fuel gas (i.e. acetylene, hydrogen propane or butane) mixture is usually referred as 'gas welding'.

The intense heat (flame) thus produced melts and fuses together the edges of the parts to be welded, generally with the addition of a filler metal. Operation of gas welding is shown in Fig.

The fuel gas generally employed is acetylene; however gases other than acetylene can also be used

though with lower flame temperature.

Oxy-acetylene flame is the most versatile and hottest of all the flames produced by the combination of oxygen and other fuel gases.



Oxy-Acetylene Welding

In this process, acetylene is mixed with oxygen in correct proportions in the welding torch and ignited. The flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal.

The oxy-acetylene flame reaches a temperature of about 3300°C and thus can melt most of the ferrous and non-ferrous metals in common use.

A filler metal rod or welding rod is generally added to the molten metal pool to build up the seam slightly for greater strength.

Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec11.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



LECTURE HANDOUTS

L-13

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES

Date of Lecture:

Topic of Lecture: Arc welding, Shield Arc Welding, TIG, MIG

Introduction :

The process, in which an electric arc between an electrode and a workpiece or between two electrodes is utilized to weld base metals, is called an arc welding process.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Arc welding, Shield Arc Welding, TIG, MIG

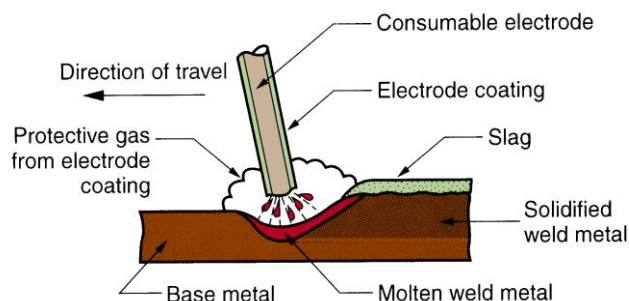
Detailed content of the Lecture:

ARC WELDING PROCESSES

The process, in which an electric arc between an electrode and a workpiece or between two electrodes is utilized to weld base metals, is called an arc welding process.

Most of these processes use some shielding gas while others employ coatings or fluxes to prevent the weld pool from the surrounding atmosphere.

SHEILDED ARC WELDING



Shielded metal arc welding (SMAW) is a commonly used arc welding process manually carried by welder.

It is an arc welding process in which heat for welding is produced through an electric arc set up between a flux coated electrode and the workpiece.

The process uses a consumable electrode which is primarily a filler metal rod having a coating of chemicals that provide flux and shielding.

The flux coating of electrode decomposes due to arc heat and serves many functions, like weld metal protection, arc stability etc.

Inner core of the electrode supply the filler material for making a weld.

Polarity is important and its selection depends on the metal to be welded, its thickness, required depth of heated zone, and the type of electrode used.

Straight polarity (workpiece positive; electrode negative) is preferred for thin workpieces and sheet metal because it produces shallow heat penetration.

On the other hand, reverse polarity (workpiece negative; electrode positive) produces deeper weld penetration and is preferred for thick workpieces.

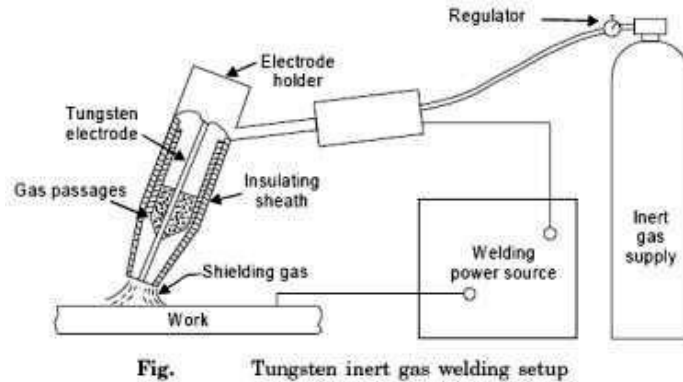
An electric arc is established by striking the tip of coated metal electrode with the metal workpiece and quickly raising it through a short distance sufficient to maintain the arc.

TUNGSTEN INERT GAS WELDING

In this process a non-consumable tungsten electrode is used with an envelope of inert shielding gas around it.

The shielding gas protects the tungsten electrode and the molten metal weld pool from the atmospheric contamination.

The shielding gases generally used are argon, helium or their mixtures.



METAL INERT GAS WELDING

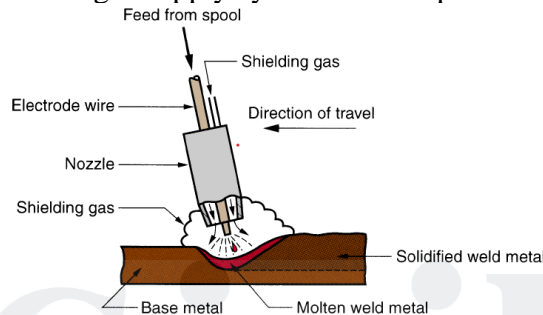
GMAW is also known by other names such as metal inert gas (MIG) welding and CO₂ welding. Utilizes a consumable bare wire electrode

There are other gas shielded arc welding processes utilizing the consumable electrodes, such as flux cored arc welding (FCAW) all of which can be termed under MIG.

Though gas tungsten arc welding (GTAW) can be used to weld all types of metals, it is more suitable for thin sheets. When thicker sheets are to be welded, the filler metal requirement makes GTAW difficult to use. In this situation, the GMAW comes handy.

The consumable electrode is in the form of a wire reel which is fed at a constant rate.

The welding torch is connected to the gas supply cylinder which provides the necessary inert gas.



Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec09.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341

LECTURE HANDOUTS

L-14

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Submerged Arc Welding, Electro Slag Welding

Introduction :

In submerged Arc welding process, a consumable bare electrode is used in combination with a flux feeder tube.

Electro-slag welding is mostly used for welding very thick components or plates (up to 40 to 500 mm thickness) where the joint to be welded is in a vertical position.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

Submerged Arc Welding, Electro Slag Welding

Detailed content of the Lecture:

Submerged Arc Welding

In this welding process, a consumable bare electrode is used in combination with a flux feeder tube. The arc, end of the bare electrode and molten pool remain completely submerged under blanket of granular flux (lime, silica, calcium fluoride and magnesium oxide).

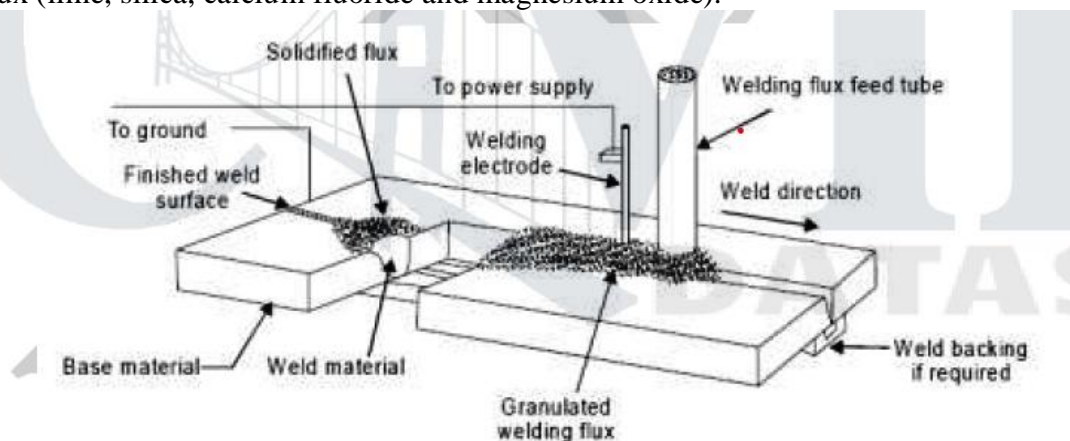


Fig. Schematic submerged arc welding process

The molten weld metal pool is thus entirely covered under a thick layer of flux and oxidation of weld metal is prevented.

In addition, spatter and sparks are prevented while fumes and u-v radiations are suppressed. The flux also acts as a thermal barrier, enabling faster weld pool formation.

Electro-slag Welding (ESW)

Electro-slag welding is mostly used for welding very thick components or plates (up to 40 to 500 mm thickness) where the joint to be welded is in a vertical position.

The components to be welded are set in the required vertical position with the necessary gap between

the butted edges and a backing plate is tacked at the bottom.

Water-cooled copper shoes which can travel along the joint are initially located at the lowermost position.

These shoes close off the space between the parts to be welded so that a V-shaped starting block is formed that prevents the slag and molten metal from spilling out of the pool.

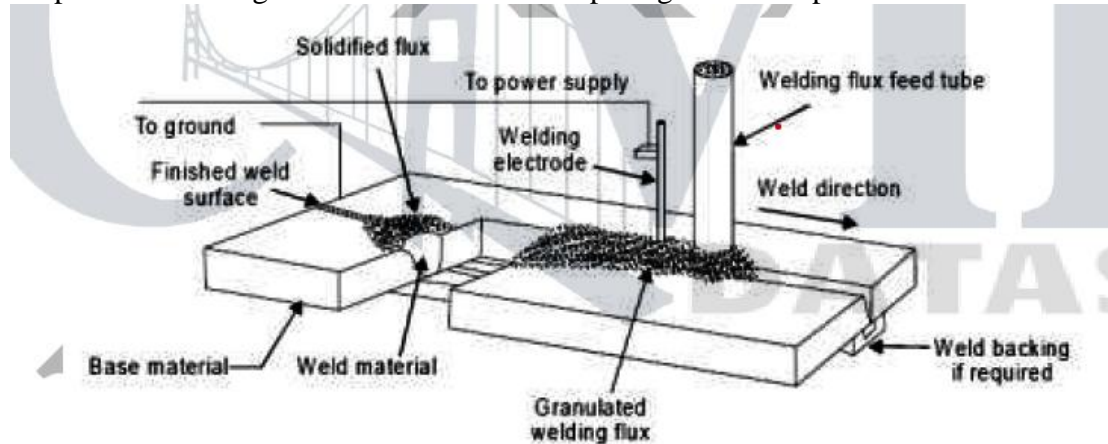


Fig. Schematic submerged arc welding process

To start the welding operation, an arc is created between the tip of the consumable electrodes and the bottom plate and upon the introduction of granular flux into the joint, a 3-4 mm thick layer of molten slag starts floating at the top of weld metal pool.

As the molten slag reaches the tip of the electrode the arc is extinguished and current is conducted directly from the electrode wire to the base metal through the conductive slag.

Thereafter, the high electrical resistance of the slag causes most of the heating required for welding, i.e., for melting the wire electrode and the workpiece metal.

Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec11.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



LECTURE HANDOUTS

L-15

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES

Date of Lecture:

Topic of Lecture: Plasma Arc Welding

Introduction :

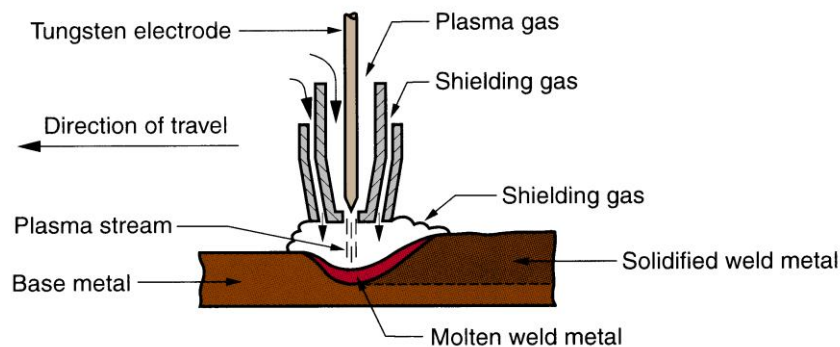
In PAW, a tungsten electrode is contained in a specially designed nozzle that focuses a high-velocity stream of inert gas (e.g., argon or argon–hydrogen mixtures) into the region of the arc to form a high velocity, intensely hot plasma arc stream.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

Plasma Arc Welding

Detailed content of the Lecture:

Plasma Arc Welding



Plasma, considered as the fourth state of matter.

Plasma is a partially ionized gas produced by the, passage of gas through an electrical field which separates into free electrons, neutrons and ions.

The energy required for this dissociation of gas is very high but as the atoms recombine, the process releases extremely high latent heat and temperatures as high as 17,000°C are generated.

Plasma, which is electrically conducting, is always present in between the electrodes whenever an arc is formed.

PAW and GTAW resemble in the sense that both use non-consumable tungsten electrodes and shielding gas.

However, the construction of the welding torch is different in the two cases.

In PAW, a tungsten electrode is contained in a specially designed nozzle that focuses a high-velocity stream of inert gas (e.g., argon or argon–hydrogen mixtures) into the region of the arc to form a high velocity, intensely hot plasma arc stream.

There are two types of plasma torches - transferred arc type and non transferred arc type.

In case of non-transferred type, both electrodes are inside the torch, while in the case of transferred arc

type, the arc is struck between the negatively charged electrode (which is in the torch) and the positively charged workpiece.

The transferred arc is better since it transfers more energy at the workpiece and is less susceptible to magnetic deflection but it can be used only with conductive work materials.

A high-velocity stream of plasma gas (argon or argon-hydrogen mixture) is introduced into the region of the arc to form a high-velocity, intensely hot plasma. For the purpose of arc shielding the gases used are argon, helium, and argon-helium mixture.

The reason for higher temperatures in PAW compared to those in GTAW lies in the constriction of the arc which produces a plasma jet of small diameter and a very high energy density.

Advantages

Good arc stability,

Better penetration control than most other AW processes, high travel speeds, and excellent weld quality.

The process can be used to weld almost any metal, including tungsten.

Difficult-to-weld metals with PAW include bronze, cast irons, lead, and magnesium

Limitations

Include high equipment cost and larger torch size, which tends to restrict access in some joint configurations.

Web link :

<https://slideplayer.com/slide/13257449/>

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec05.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



LECTURE HANDOUTS

L-16

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Friction Welding, Soldering and Brazing

Introduction :

In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure.

Soldering is a method of joining similar or dissimilar metals by heating them to a suitable temperature.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Friction Welding, Soldering

Detailed content of the Lecture:

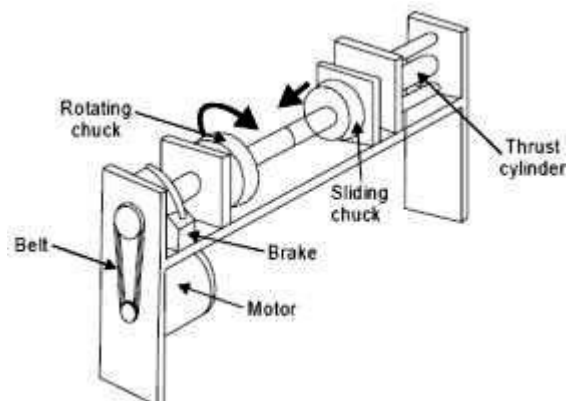
Friction Welding

In this process, the heat for welding is obtained from mechanically induced sliding motion between rubbing surfaces of work-pieces.

In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure.

As these parts are brought to rub against each other under pressure, they get heated due to friction.

When the desired forging temperature is attained, the rotation is stopped and the axial pressure is increased (upto 10 MN) to obtain forging action and hence welded joint.



SOLDERING

Soldering is a method of joining similar or dissimilar metals by heating them to a suitable temperature and by means of a filler metal, called solder, having liquidus temperature **not exceeding 450°C** and below the solidus of the base material. (solders used have a melting point between 180 to 270 °C)

Though soldering obtains a good joint between the two plates, the strength of the joint is limited by the strength of the filler metal used.

Solders are essentially alloys of lead and tin.

To improve the mechanical properties and temperature resistance, solders are added to other alloying elements such as zinc, cadmium and silver in various proportions.

Soldering is normally used for obtaining a neat leak proof joint or a low resistance electrical joint.

The soldered joints are not suitable for high temperature service because of the low melting temperatures of the filler metals used.

The soldering joints also need to be cleaned meticulously to provide chemically clean surfaces to obtain a proper bond.

Solvent cleaning, acid pickling and even mechanical cleaning are applied before soldering.

To remove the oxides from the joint surfaces and to prevent the filler metal from oxidizing, fluxes are generally used in soldering.

The most commonly used soldering methods include Hard soldering (Filler material – silver), soft soldering (copper rod) (flame or electrically heated), dip soldering, and wave soldering.

A soldering iron is a copper rod with a thin tip which can be used for flattening the soldering material.

The soldering iron can be heated by keeping in a furnace or by means of an internal electrical resistance whose power rating may range from 15 W for the electronic applications to 200 W for sheet metal joining.

Web link :

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec13.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-17

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Testing and Inspection of Welding

Introduction :

Inspection of welding, is a method of check the joining similar or dissimilar metals by heating them to a suitable temperature.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Inspection

Detailed content of the Lecture:

Testing and Inspection of Welding

In this process, the heat for welding is obtained from mechanically induced sliding motion between rubbing surfaces of work-pieces.

In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure.

As these parts are brought to rub against each other under pressure, they get heated due to friction.

When the desired forging temperature is attained, the rotation is stopped and the axial pressure is increased (upto 10 MN) to obtain forging action and hence welded joint.

Soldering is a method of joining similar or dissimilar metals by heating them to a suitable temperature and by means of a filler metal, called solder, having liquidus temperature **not exceeding 450°C** and below the solidus of the base material. (solders used have a melting point between 180 to 270 °C)

Though soldering obtains a good joint between the two plates, the strength of the joint is limited by the strength of the filler metal used.

Solders are essentially alloys of lead and tin.

To improve the mechanical properties and temperature resistance, solders are added to other alloying elements such as zinc, cadmium and silver in various proportions.

Soldering is normally used for obtaining a neat leak proof joint or a low resistance electrical joint.

The soldered joints are not suitable for high temperature service because of the low melting temperatures of the filler metals used.

The soldering joints also need to be cleaned meticulously to provide chemically clean surfaces to obtain a proper bond.

Solvent cleaning, acid pickling and even mechanical cleaning are applied before soldering.

To remove the oxides from the joint surfaces and to prevent the filler metal from oxidizing, fluxes are generally used in soldering.

The most commonly used soldering methods include Hard soldering (Filler material – silver), soft soldering(copper rod) (flame or electrically heated), dip soldering, and wave soldering.

A soldering iron is a copper rod with a thin tip which can be used for flattening the soldering material.

The soldering iron can be heated by keeping in a furnace or by means of an internal electrical resistance whose power rating may range from 15 W for the electronic applications to 200 W for sheet metal joining.

Web link :

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec13.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-18

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : FABRICATION PROCESSES Date of Lecture:

Topic of Lecture: Defects in Welds

Introduction :

Defects In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Defects

Detailed content of the Lecture:

Defects in Welding

In this process, the heat for welding is obtained from mechanically induced sliding motion between rubbing surfaces of work-pieces.

In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure.

As these parts are brought to rub against each other under pressure, they get heated due to friction.

When the desired forging temperature is attained, the rotation is stopped and the axial pressure is increased (upto 10 MN) to obtain forging action and hence welded joint.

Soldering is a method of joining similar or dissimilar metals by heating them to a suitable temperature and by means of a filler metal, called solder, having liquidus temperature **not exceeding 450°C** and below the solidus of the base material. (solders used have a melting point between 180 to 270 °C)

Though soldering obtains a good joint between the two plates, the strength of the joint is limited by the strength of the filler metal used.

Solders are essentially alloys of lead and tin.

To improve the mechanical properties and temperature resistance, solders are added to other alloying elements such as zinc, cadmium and silver in various proportions.

Soldering is normally used for obtaining a neat leak proof joint or a low resistance electrical joint.

The soldered joints are not suitable for high temperature service because of the low melting temperatures of the filler metals used.

The soldering joints also need to be cleaned meticulously to provide chemically clean surfaces to obtain a proper bond.

Solvent cleaning, acid pickling and even mechanical cleaning are applied before soldering.

To remove the oxides from the joint surfaces and to prevent the filler metal from oxidizing, fluxes are generally used in soldering.

The most commonly used soldering methods include Hard soldering (Filler material – silver), soft soldering(copper rod) (flame or electrically heated), dip soldering, and wave soldering.

A soldering iron is a copper rod with a thin tip which can be used for flattening the soldering material. The soldering iron can be heated by keeping in a furnace or by means of an internal electrical resistance whose power rating may range from 15 W for the electronic applications to 200 W for sheet metal joining.

Web link :

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107083/lec13.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 320-341



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-19

MECH

I/II

Course Name with Code: 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : III - BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Cold and Hot Working Processes, Rolling Classification

Introduction : Plastic deformation of metal carried out at a temperature above the recrystallization temperature is called hot working.

Plastic deformation of metals performed generally at room temperature (i.e., below the recrystallization temperature) is known as cold working

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Hot Working, Cold Working and Rolling

Detailed content of the Lecture:

Hot Working

Plastic deformation of metal carried out at a temperature above the recrystallization temperature is called hot working.

Under the action of heat and force, when the atoms of metal reach a certain higher energy level, the new crystals start forming. This is called recrystallization.

When this happens, the old grain structure formed by previously carried out mechanical working no longer exists; instead, new crystals which are strain-free are formed.

In hot working, the temperature at which the working is completed is critical since any extra heat left in the material after working will promote grain growth, leading to poor mechanical properties of the material.

Cold Working

Plastic deformation of metals performed generally at room temperature (i.e., below the recrystallization temperature) is known as cold working.

In some cases, slightly elevated temperatures may be used to provide increased ductility and reduced strength.

Cold working offers a number of distinct advantages, and for this reason various cold-working processes have become extremely important.

Significant advances in recent years have led to their greater use, and the trend appears likely to continue.

ROLLING

Rolling is a compressive deformation process in which the thickness of a slab or plate is reduced by two opposing cylindrical tools called rolls. The rolls rotate so as to draw the work into the gap between them and squeeze it.

Rolling is generally the first process that is used to convert material into a finished wrought product.

Large size starting stock (called ingot) is rolled into blooms, billets, or slabs.

Slabs can be further rolled to produce plate, sheet, and strip. These hot-rolled products are mostly the

starting material for subsequent processing.

Thread Rolling

Thread rolling is used to form threads on cylindrical parts by rolling them between two dies.

Ring Rolling

Ring rolling is a deformation process in which a thick-walled ring of smaller diameter is rolled into a thin-walled ring of larger diameter.

Gear Rolling

Gear rolling is a cold working process to produce certain gears.

Roll Piercing

Ring rolling is a specialized hot working process for making seamless thick walled tubes.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: International Journal of Science and Technology 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-20

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Rolling stand arrangements and defects in rolling

Introduction : Various rolling mill configurations are available to deal with the variety of applications and technical problems in the rolling process.

The defects in this category are wavy edges, zipper cracks, edge cracks, alligating, folds, and laminations

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Two-High Rolling Mill, Three-High Rolling Mill, Four-High Rolling Mill, Tandem Rolling Mill.

Detailed content of the Lecture:

Rolling stand arrangements

Two-High Rolling Mill

The basic rolling mill consists of two opposing rolls and is referred to as a two high rolling mill.

The rolls in these mills have diameters in the range of 0.6 to 1.4 m.

The two-high configuration can be either reversing or non-reversing.

In the non-reversing mill, the rolls always rotate in the same direction, and the work always passes through from the same side.

The reversing mill allows the direction of roll rotation to be reversed, so that the work can be passed through in either direction.

Three-High Rolling Mill

In the three-high configuration, there are three rolls in a vertical column, and the direction of rotation of each roll remains unchanged.

To achieve a series of reductions, the work can be passed through from either side by raising or lowering the strip after each pass.

The equipment in a three-high rolling mill becomes more complicated, because an elevator mechanism is needed to raise and lower the work.

As several of the previous equations indicate, advantages are gained in reducing roll diameter..

Four-High Rolling Mill

The four-high rolling mill uses two smaller-diameter rolls to contact the work and two backing rolls behind them.

Owing to the high roll forces, these smaller rolls would deflect elastically between their end bearings as the work passes through unless the larger backing rolls were used to support them.

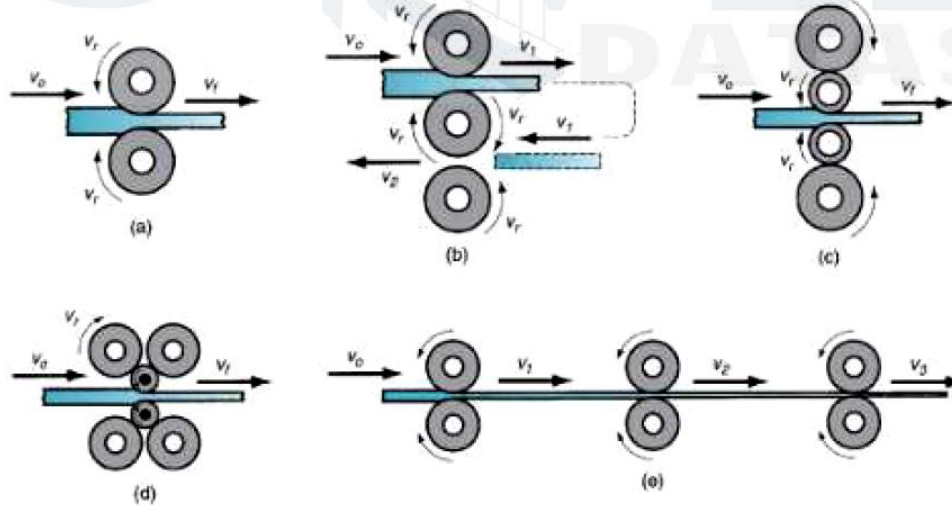
Cluster Rolling Mill

Another roll configuration that allows smaller working rolls against the work is the cluster rolling mill.

Tandem Rolling Mill

To achieve higher throughput rates in standard products, a tandem rolling mill is often used. This configuration consists of a series of rolling stands, as represented.

Although only three stands are shown in sketch, a typical tandem rolling mill may have *eight or ten stands*, each making a reduction in thickness or a refinement in shape of the work passing through.



Various configurations of rolling mills: (a) 2-high, (b) 3-high, (c) 4-high, (d) cluster mill, and (e) tandem rolling mill.

Defects in Rolled Plates and Sheets

Surface Defects:

The surface of rolled sheets may show defects such as scale, rust, scratches, cracks, pits, and gouges occurring due to the presence of impurities and inclusions of foreign material in the original cast material.

Other possible causes responsible for such defects are improper conditions during material preparation or during rolling operation.

Structural defects:

The defects in this category are wavy edges, zipper cracks, edge cracks, alligating, folds, and laminations. These defects can be further classified into:

i. Defects due to bending of rolls:

Rolls act as straight beams loaded transversely (with rolling loads) and undergo deflection. As a result, the edges of the strip get compressed more than the central portion, i.e., edges become thinner than the central portion.

Since the reduction in thickness is converted into increase in length of the strip, the strip elongates more at the edges than at the centre.

ii. Defects due to inhomogeneous deformation:

Edge cracks are formed mainly due to this cause. As the material is compressed under the rolls, there is a proportionate decrease in thickness with simultaneous increase in its length and width (lateral spread).

The decrease in thickness for the elements near the centre will be mainly converted into increase in length while for the elements at the edges, a part of the decrease in thickness is converted into increase in length and the remaining decrease in thickness is converted into lateral spread.

Consequently, the increase in length at the centre will be greater than that at the edges making the ends of sheet rounded.

Due to continuity of material elements, the material near the edges will be under tension while that around the centre will be under compression.

Video Content / Details of website for further learning (if any):

<http://www.soundsofchanges.eu/sound/rolling-stand-arrangement/>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: International Journal of Science and Technology 1(1):83-95 · May 2017



Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Forging classifications - Methods

Introduction :

Forging is a deformation process in which the work is compressed between two dies, using either impact or gradual pressure to form the part.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Open-Die Forging, Close Die Forging, Upsetting

Detailed content of the Lecture:

Forging

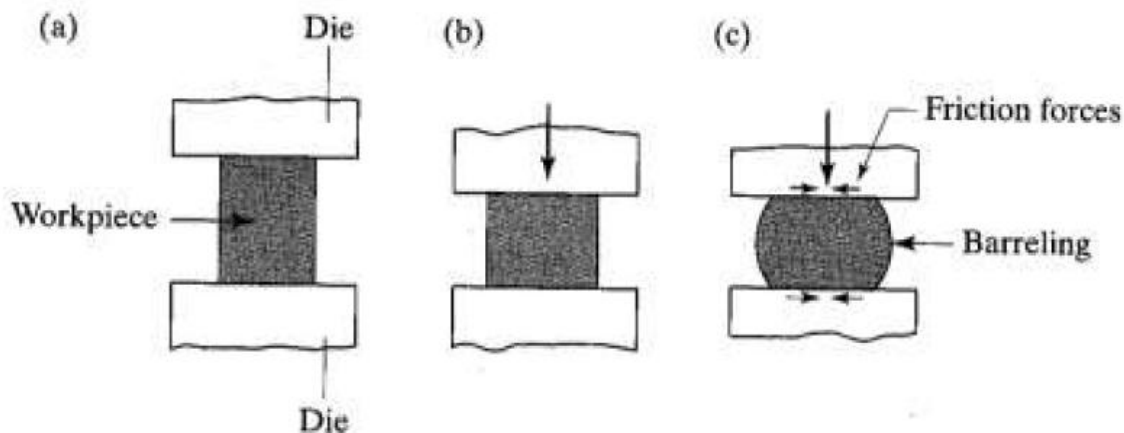
Forging is a deformation process in which the work is compressed between two dies, using either impact or gradual pressure to form the part.

Forging is carried out in many different ways.

One way to classify forging is by working temperature.

Most forging operations are performed hot or warm, owing to the significant deformation demanded by the process and the need to reduce strength and increase ductility of the work metal. However, cold forging is also very common for certain products.

Open-Die Forging



Most forging processes begin with open die forging.

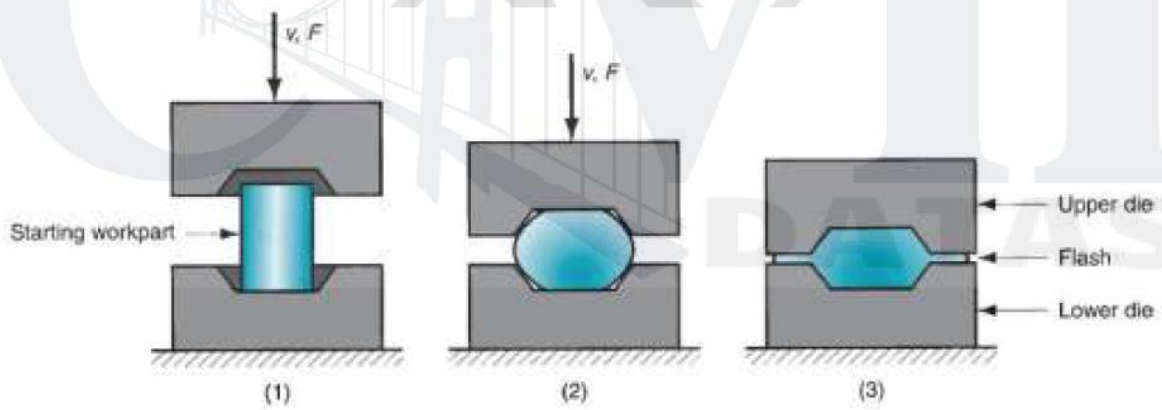
Open die forging is hot mechanical forming between flat or shaped dies in which the metal flow is not completely restricted.

The stock is laid on a flat anvil while the flat face of the forging hammer is struck against the stock.

The equipment may range from the anvil and hammer to giant hydraulic presses.

Open-die hot forging is an important industrial process.

Impression or Close Die Forging



Impression-die forging, sometimes called closed-die forging, is performed with dies that contain the inverse of the desired shape of the part.

The raw workpiece is shown as a cylindrical part similar to that used in the previous open-die operation.

As the die closes to its final position, flash is formed by metal that flows beyond the die cavity and into the small gap between the die plates.

Upsetting and Heading

Upsetting (also called upset forging) is a deformation operation in which a cylindrical work part is increased in diameter and reduced in length.

Upsetting is widely used in the fastener industry to form heads on nails, bolts, and similar hardware products.

In these applications, the term heading is often used to denote the operation.

More parts are produced by upsetting than by any other forging operation.

It is performed as a mass-production operation—cold, warm, or hot—on special upset forging machines, called headers or formers.

These machines are usually equipped with horizontal slides, rather than vertical slides as in conventional forging hammers and presses.

Trimming

Trimming is an operation used to remove flash on the work part in impression die forging.

In most cases, trimming is accomplished by shearing, in which a punch forces the work through a cutting die, the blades for which have the profile of the desired part.

Swaging and Radial Forging

Swaging and radial forging are forging processes used to reduce the diameter of a tube or solid rod.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: International Journal of Science and Technology 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-22

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Classification of the Extrusion Process

Introduction :

Extrusion is a compression process in which the work metal is forced to flow through a die opening to produce a desired cross-sectional shape.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Direct Extrusion, Indirect Extrusion

Detailed content of the Lecture:

Extrusion Process

Extrusion is a compression process in which the work metal is forced to flow through a die opening to produce a desired cross-sectional shape.

Materials that can be extruded are aluminum, copper, steel, magnesium, and plastics. Aluminum, copper and plastics are most suitable for extrusion.

The process is similar to squeezing toothpaste from its plastic tube.

Classification of the Extrusion Process

Depending on the ductility of the material used extrusions can be carried out various ways.

By working temperature

- Cold extrusion
- Warm extrusion
- Hot extrusion

By performance technique

- Continuous extrusion
- Discrete extrusion

By physical configuration

- Forward or Direct extrusion
- Backward or Indirect extrusion

Direct Extrusion (Forward Extrusion):

The heated metal billet is loaded into a container.

A ram compresses the material, forcing it to flow through the openings in a die at the opposite end of the container.

The metal is subjected to plastic deformation, slides along the walls of the container and is forced to flow through the die opening.

As the ram approaches the die, a small portion of the billet remains that cannot be forced through the die opening.

This extra portion, called the butt, is separated from the product by cutting it just beyond the exit of the

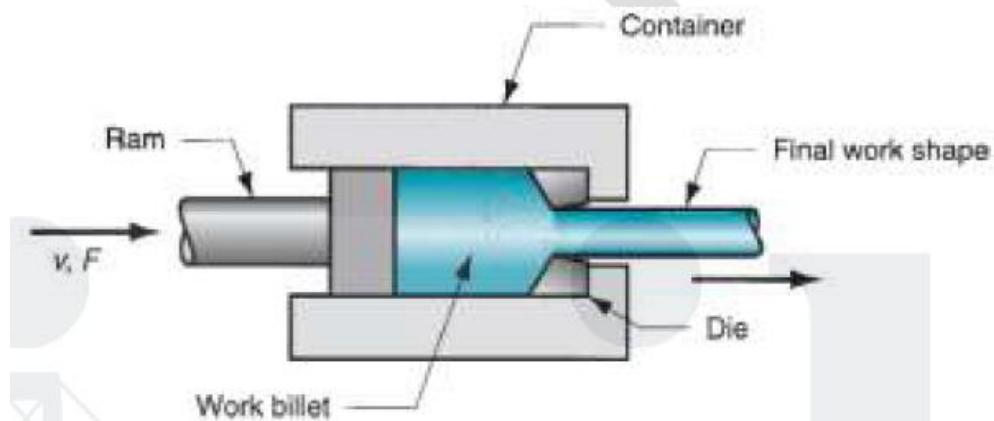
die.

One of the problems in direct extrusion is the significant friction that exists between the work surface and the walls of the container as the billet is forced to slide toward the die opening.

This friction causes a substantial increase in the ram force required in direct extrusion.

In hot extrusion, the friction problem is aggravated by the presence of an oxide layer on the surface of the billet.

This oxide layer can cause defects in the extruded product.

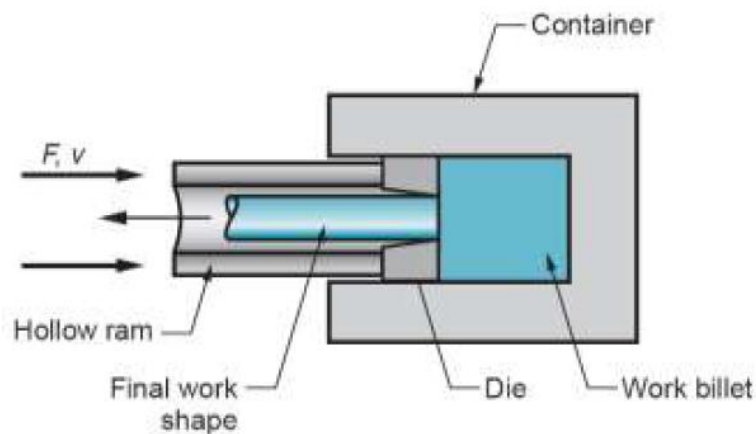


Indirect Extrusion (Backward Extrusion /Reverse Extrusion)

Metal is forced to flow through the die in an opposite direction to the ram's motion.

Lower extrusion force as the work billet metal is not moving relative to the container wall.

The die is mounted to the ram rather than at the opposite end of the container.



As the ram penetrates into the work, the metal is forced to flow through the clearance in a direction opposite to the motion of the ram.

Since the billet is not forced to move relative to the container, there is no friction at the container walls, and the ram force is therefore lower than in direct extrusion.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-23

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Hot Extrusion and Cold Extrusion Process

Introduction :

Hot extrusion involves prior heating of the billet to a temperature above its recrystallization temperature.

Cold extrusion at room temperature also eliminates the need for heating the starting billet.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Hot Extrusion and Cold Extrusion

Detailed content of the Lecture:

Hot Extrusion

Hot extrusion involves prior heating of the billet to a temperature above its recrystallization temperature.

This reduces strength and increases ductility of the metal, permitting more extreme size reductions and more complex shapes to be achieved in the process.

Applicable for metals and alloys that do not have sufficient ductility at room temperature.

Additional advantages include reduction of ram force, increased ram speed, and reduction of grain flow characteristics in the final product.

In this extrusion, die wear can be excessive and cooling of the hot billet in the chamber can be a problem, which results in highly non-uniform deformation.

To reduce cooling of the billet and to prolong die life, extrusion dies may be preheated, as is done in hot forging operations.

Cooling of the billet as it contacts the container walls is a problem, and isothermal extrusion is sometimes used to overcome this problem.

Lubrication is critical in hot extrusion for certain metals (e.g., steels), and special lubricants have been developed that are effective under the harsh conditions in hot extrusion.

Hot billet causes the following problems:

Because the billet is hot, it develops an oxide film unless heated in an inert atmosphere furnace. This film can be abrasive and it can affect the flow pattern of the material.

It also results in an extruded product that may be unacceptable in cases in which good surface finish is important.

Cold Extrusion

Extrusion carried out at ambient temperature. Often combined with forging operations.

Cold extrusion at room temperature also eliminates the need for heating the starting billet.

Cold extrusion and warm extrusion are generally used to produce discrete parts, often in finished (or near finished) form.

The term impact extrusion is used to indicate high-speed cold extrusion.

Some **important advantages** of cold extrusion include increased strength due to strain hardening, close tolerances, improved surface finish, absence of oxide layers, and high production rates.

OTHER EXTRUSION PROCESSES

Impact Extrusion

Impact extrusion is performed at higher speeds and shorter strokes than conventional extrusion. It is used to make individual components.

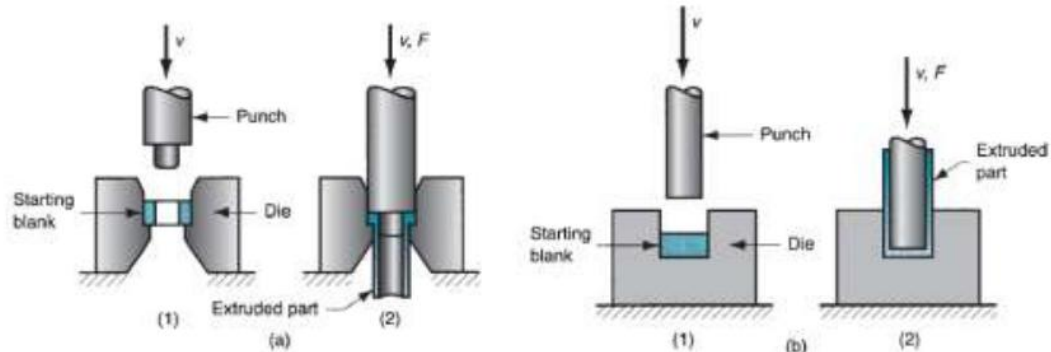
As the name suggests, the punch impacts the workpart rather than simply applying pressure to it.

Impacting can be carried out as forward extrusion, backward extrusion, or combinations of these. Impact extrusion is usually done cold on a variety of metals.

Backward impact extrusion is most common.

Products made by this process include toothpaste tubes and battery cases.

As indicated by these examples, very thin walls are possible on impact extruded parts.

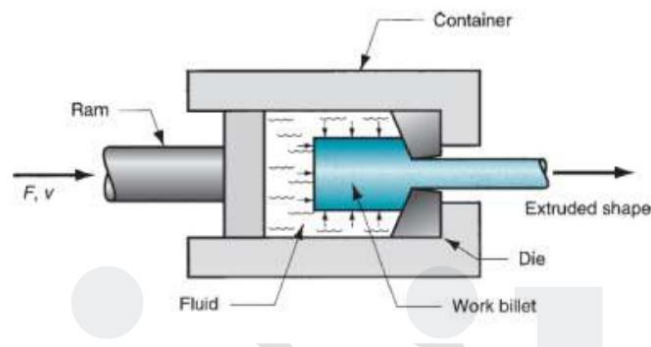


Hydrostatic Extrusion

One of the problems in direct extrusion is friction along the billet– container interface.

Using hydrostatic system to reduce the friction and lower the power requirement.

The problem can be addressed by surrounding the billet with fluid inside the container and pressurizing the fluid by the forward motion of the ram.



Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



LECTURE HANDOUTS

L-24

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Defects in extruded products

Introduction :

Internal crack due to excessive tensile stress at the centre possible, piping is a defect associated with direct extrusion and high part temperature that causes cracks.

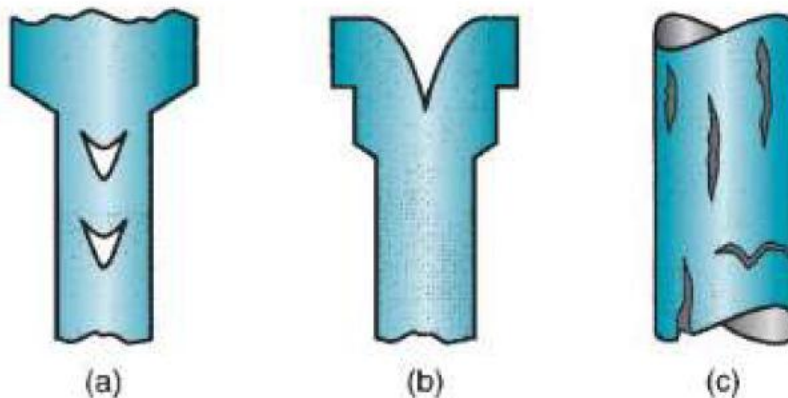
Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Centre-burst, Surface cracking

Detailed content of the Lecture:

DEFECTS IN EXTRUDED PRODUCTS



a) Centre-burst:

Internal crack due to excessive tensile stress at the centre possibly because of high die angle, low extrusion ratio and impurities in the work metal that serve as starting points for crack defects.

Other names sometimes used for this defect include arrowhead fracture, center cracking, and chevron cracking.

b) Piping:

The formation of a Sink hole at the end of billet under direct extrusion.

Piping is a defect associated with direct extrusion.

The use of a dummy block whose diameter is slightly less than that of the billet helps to avoid piping.

Other names given to this defect include tailpipe and fishtailing.

c) Surface cracking:

This defect results from high part temperature that causes cracks to develop at the surface.

They often occur when extrusion speed is too high, leading to high strain rates and associated heat generation.

Other factors contributing to surface cracking are high friction and surface chilling of high temperature billets in hot extrusion.

Process Variables in Direct Extrusion

The die angle

Reduction in cross-section

Extrusion speed

Extrusion pressure

Billet temperature

Lubrication

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-25

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Drawing

Introduction :

Drawing is usually performed as a cold working operation

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Drawing

Detailed content of the Lecture:

DRAWING PRACTICE

Drawing is usually performed as a cold working operation.

It is most frequently used to produce round cross sections, but squares and other shapes are also drawn.

Wire drawing is an important industrial process, providing commercial products such as electrical wire and cable; wire stock for fences, coat hangers, and shopping carts; and rod stock to produce nails, screws, rivets, springs, and other hardware items.

Bar drawing is used to produce metal bars for machining, forging, and other processes.

Drawing is an operation in which the cross section of a bar, rod, or wire is reduced by pulling it through a die opening.

The general features of the process are similar to those of extrusion.

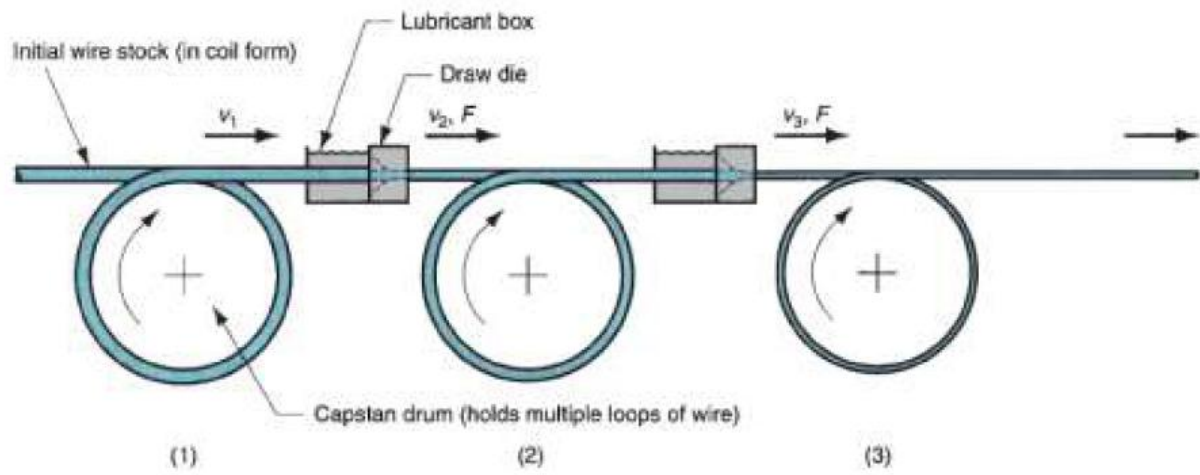
The difference is that the work is pulled through the die in drawing, whereas it is pushed through the die in extrusion.

Although the presence of tensile stresses is obvious in drawing, compression also plays a significant role because the metal is squeezed down as it passes through the die opening.

For this reason, the deformation that occurs in drawing is sometimes referred to as indirect compression.

The basic difference between bar drawing and wire drawing is the stock size that is processed.

Bar drawing is the term used for large diameter bar and rod stock, while wire drawing applies to small diameter stock. Wire sizes down to 0.03 mm (0.001 in) are possible in wire drawing.



Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Wire Drawing

Introduction :

Drawing is an operation in which the cross section of a bar, rod, or wire is reduced by pulling it through a die opening. Wire sizes down to 0.03 mm (0.001 in) are possible in wire drawing.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

Wire Drawing

Detailed content of the Lecture:

WIRE AND BAR DRAWING

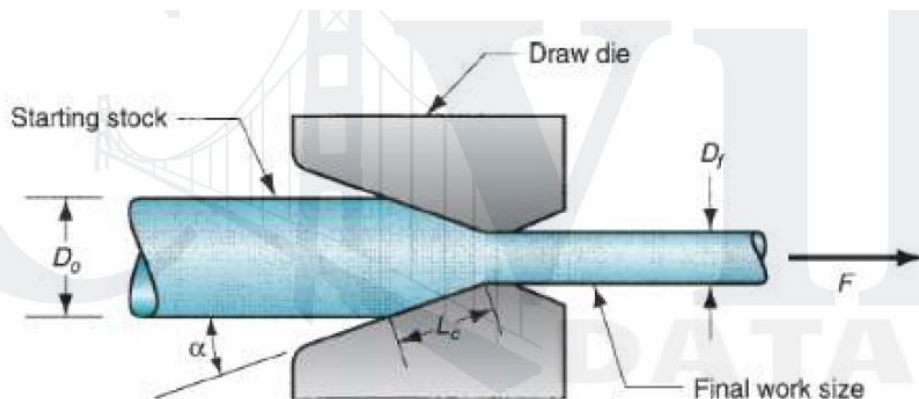
Drawing is an operation in which the cross section of a bar, rod, or wire is reduced by pulling it through a die opening.

The general features of the process are similar to those of extrusion.

The difference is that the work is pulled through the die in drawing, whereas it is pushed through the die in extrusion.

Although the presence of tensile stresses is obvious in drawing, compression also plays a significant role because the metal is squeezed down as it passes through the die opening.

For this reason, the deformation that occurs in drawing is sometimes referred to as indirect compression.



The basic difference between bar drawing and wire drawing is the stock size that is processed.

Bar drawing is the term used for large diameter bar and rod stock, while wire drawing applies to small diameter stock. Wire sizes down to 0.03 mm (0.001 in) are possible in wire drawing.

Although the mechanics of the process are the same for the two cases, the methods, equipment, and even the terminology are somewhat different.

Drawing is usually performed as a cold working operation.

It is most frequently used to produce round cross sections, but squares and other shapes are also drawn. Wire drawing is an important industrial process, providing commercial products such as electrical wire and cable; wire stock for fences, coat hangers, and shopping carts; and rod stock to produce nails, screws, rivets, springs, and other hardware items.

Bar drawing is used to produce metal bars for machining, forging, and other processes.

Video Content / Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-27

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : BULK DEFORMATION PROCESSES Date of Lecture:

Topic of Lecture: Tube Drawing

Introduction :

Tube drawing can be carried out either with or without a mandrel. The simplest method uses no mandrel and is used for diameter reduction.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

Tube Drawing

Detailed content of the Lecture:

TUBE DRAWING

Drawing can be used to reduce the diameter or wall thickness of seamless tubes and pipes, after the initial tubing has been produced by some other process such as extrusion.

Bar drawing is used to produce metal bars for machining, forging, and other processes.

Drawing is an operation in which the cross section of a bar, rod, or wire is reduced by pulling it through a die opening.

The general features of the process are similar to those of extrusion.

The difference is that the work is pulled through the die in drawing, whereas it is pushed through the die in extrusion.

Although the presence of tensile stresses is obvious in drawing, compression also plays a significant role because the metal is squeezed down as it passes through the die opening.

For this reason, the deformation that occurs in drawing is sometimes referred to as indirect compression.

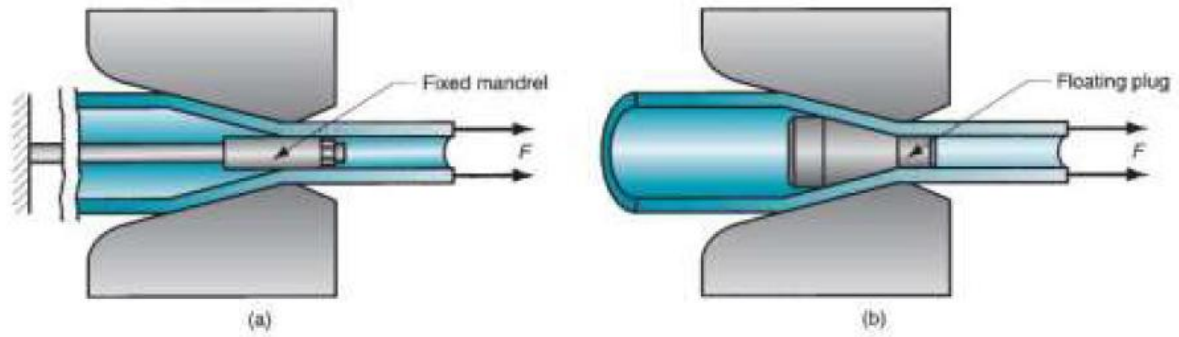
Tube drawing can be carried out either with or without a mandrel. The simplest method uses no mandrel and is used for diameter reduction.

The term tube sinking is sometimes applied to this operation.

The problem with tube drawing in which no mandrel is used, is that it lacks control over the inside diameter and wall thickness of the tube.

This is why mandrels of various types are used.

The first, (a), uses a fixed mandrel attached to a long support bar to establish inside diameter and wall thickness during the operation.



Tube drawing with mandrels: (a) fixed mandrel, (b) floating plug.

Video Content/Details of website for further learning (if any):

<https://www.youtube.com/watch?v=jk0Kap7afMc>

Important Books/Journals for further learning including the page nos.:

Review on Cold Rolling Mill Roll Deformation: [International Journal of Science and Technology](#) 1(1):83-95 · May 2017



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-28

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Metal Stamping and Forming

Introduction :

Stamping(also known as pressing) is the process of placing flat sheet metal in either blank or coil form into a stamping press where a tool and die surface forms the metal into a net shape
Sheet metalworking processes are forming and cutting operations performed on metal sheets, strips, and coils.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

Metal Stamping, Forming

Detailed content of the Lecture:

METAL STAMPING:

Stamping(also known as pressing) is the process of placing flat sheet metal in either blank or coil form into a stamping press where a tool and die surface forms the metal into a net shape. Stamping includes a variety of sheet-metal forming manufacturing processes, such as punching using a machine press or stamping press, blanking, embossing, bending, flanging, and coining. This could be a single stage operation where every stroke of the press produces the desired form on the sheet metal part, or could occur through a series of stages.

The process is usually carried out on sheet metal, but can also be used on other materials, such as polystyrene.

Stamping is usually done on cold metal sheet. See Forging for hot metal forming operations.

SHEET METAL FORMING:

Processes which bend, stretch, cut, or fracture relatively thin metal sheets or pieces into a wide variety of different forms.

Sheet metal is characterized by high ratio of surface area to thickness.

- Forming is generally carried out in tensile forces
- Decreasing thickness should be avoided as far as possible as they can lead to necking and failure.
- The major factors that contribute significantly include elongation, anisotropy, grain size, residual stresses, spring back, and wrinkling.

Sheet metalworking processes are forming and cutting operations performed on metal sheets, strips, and coils.

The surface area-to-volume ratio of the starting metal is high.

Thus, this ratio is a useful means to distinguish bulk deformation from sheet metal processes. Bending operations Deep or cup drawing Shearing processes Miscellaneous.

Sheet metal processes can be broken down into two major classifications and one minor classification

- Shearing processes: processes which apply shearing forces to cut, fracture, or separate the material.
- Forming processes: processes which cause the metal to undergo desired shape changes without

failure, excessive thinning, or cracking. This includes bending and stretching.

- Finishing processes: processes which are used to improve the final surface characteristics.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:

LECTURE HANDOUTS

L-29

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Bending, Deep Drawing

Introduction :

Bending in sheet-metalwork is defined as the straining of the metal around a straight axis.

Drawing is a sheet-metal-forming operation used to make cup-shaped, box-shaped, or other complex-curved and concave parts.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

Bending, Deep Drawing

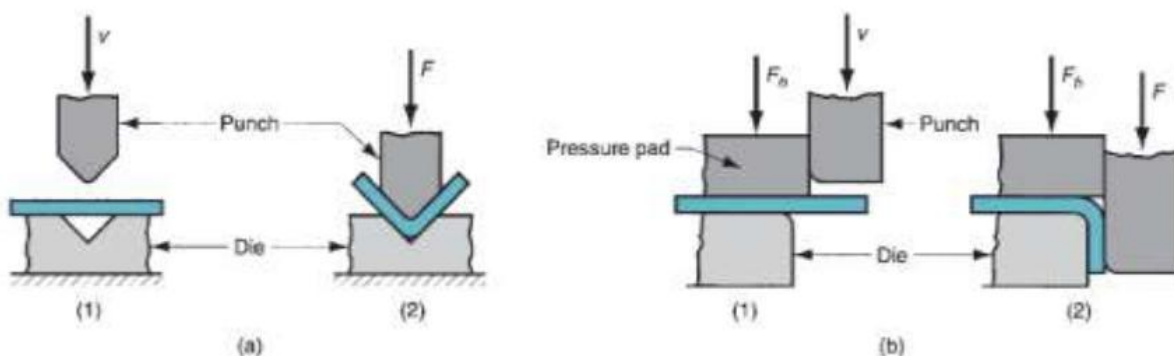
Detailed content of the Lecture:

BENDING OPERATIONS

Bending in sheet-metalwork is defined as the straining of the metal around a straight axis. During the bending operation, the metal on the inside of the neutral plane is compressed, while the metal on the outside of the neutral plane is stretched. The metal is plastically deformed so that the bend takes a permanent set upon removal of the stresses that caused it. Bending produces little or no change in the thickness of the sheet metal.

V-BENDING AND EDGE BENDING

Bending operations are performed using punch and die tooling. The two common bending methods and associated tooling are V-bending, performed with a V-die; and edge bending, performed with a wiping die.



Two common bending methods: (a) V-bending and (b) edge bending; (1) before and (2) after bending. Symbols: v = motion, F = applied bending force, F_b = blank.

In V-bending, the sheet metal is bent between a V-shaped punch and die.

Included angles ranging from very obtuse to very acute can be made with V-dies.

V-bending is generally used for low-production operations.

It is often performed on a press brake, and the associated V-dies are relatively simple and inexpensive. Edge bending involves cantilever loading of the sheet metal.

A pressure pad is used to apply a force to hold the base of the part against the die, while the punch forces the part to yield and bend over the edge of the die.

Edge bending is limited to bends of 90 or less.

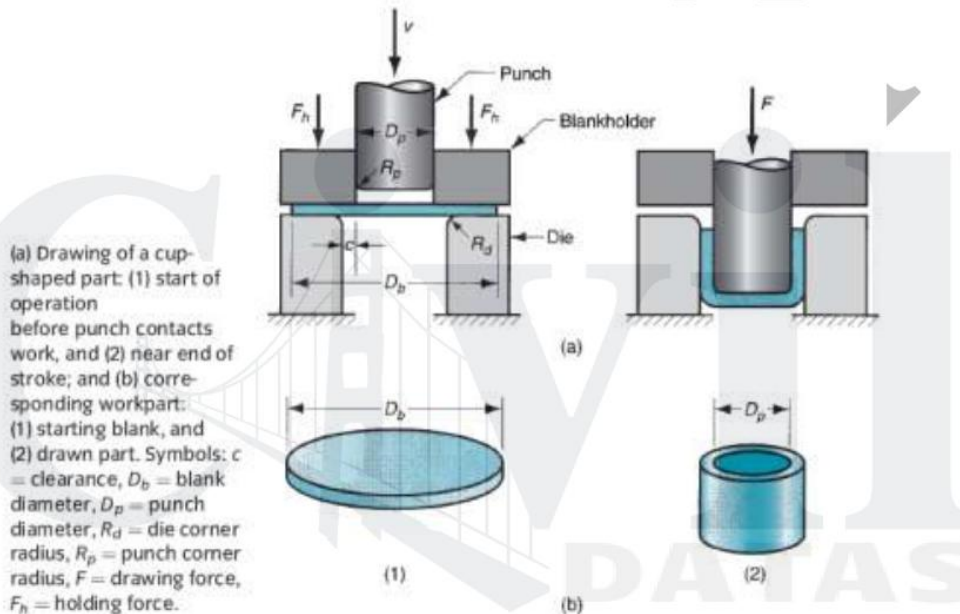
More complicated wiping dies can be designed for bend angles greater than 90.

Because of the pressure pad, wiping dies are more complicated and costly than V-dies and are generally used for high-production work.

DEEP DRAWING

Drawing is a sheet-metal-forming operation used to make cup-shaped, box-shaped, or other complex-curved and concave parts. It is performed by placing a piece of sheet metal over a die cavity and then pushing the metal into the opening with a punch. Parts made by drawing include beverage cans, ammunition shells, sinks, cooking pots, and automobile body panels.

As the punch proceeds downward toward its final bottom position, the work experiences a complex sequence of stresses and strains as it is gradually formed into the shape defined by the punch and die cavity. As the punch first begins to push into the work, the metal is subjected to a bending operation. The sheet is simply bent over the corner of the punch and the corner of the die. The outside perimeter of the blank moves in toward the center in this first stage, but only slightly.



Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Stretch Forming, Metal Spinning, Blanking, Piercing

Introduction :

Stretch forming is a sheet-metal deformation process in which the sheet metal is intentionally stretched and simultaneously bent in order to achieve shape change.

Spinning is a metal-forming process in which an axially symmetric part is gradually shaped over a mandrel or form by means of a rounded tool or roller.

Blanking involves cutting of the sheet metal along a closed outline in a single step to separate the piece from the surrounding stock.

Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Stretch Forming, Metal Spinning, Blanking, Piercing

Detailed content of the Lecture:

STRETCH FORMING

Stretch forming is a sheet-metal deformation process in which the sheet metal is intentionally stretched and simultaneously bent in order to achieve shape change.

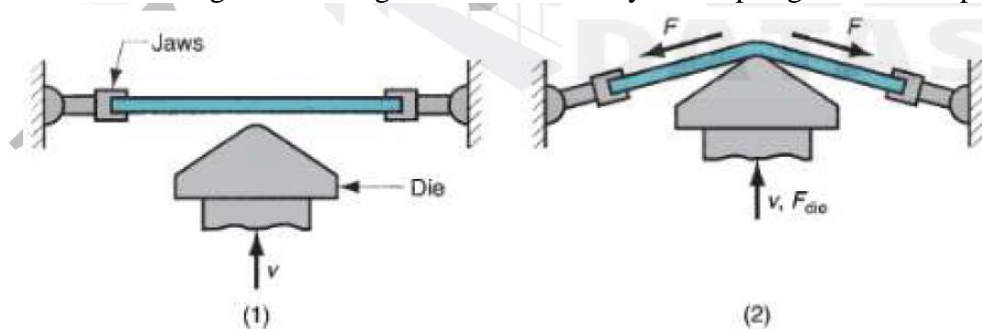
The process is relatively simple and gradual bend.

The work part is gripped by one or more jaws on each end and then stretched and bent over a positive die containing the desired form.

The metal is stressed in tension to a level above its yield point.

When the tension loading is released, the metal has been plastically deformed.

The combination of stretching and bending results in relatively little Spring back in the part.



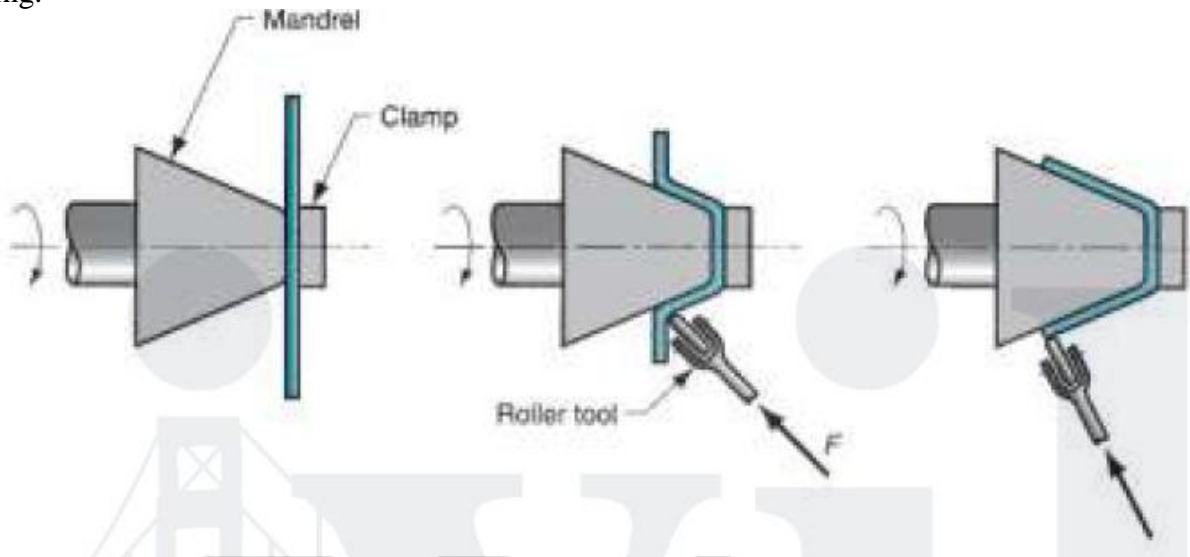
SPINNING / METAL SPINNING

Spinning is a metal-forming process in which an axially symmetric part is gradually shaped over a mandrel or form by means of a rounded tool or roller.

The tool or roller applies a very localized pressure (almost a point contact) to deform the work by axial and radial motions over the surface of the part.

Basic geometric shapes typically produced by spinning include cups, cones, hemispheres, and tubes.

There are three types of spinning operations: (1) conventional spinning, (2) shear spinning, and (3) tube spinning.

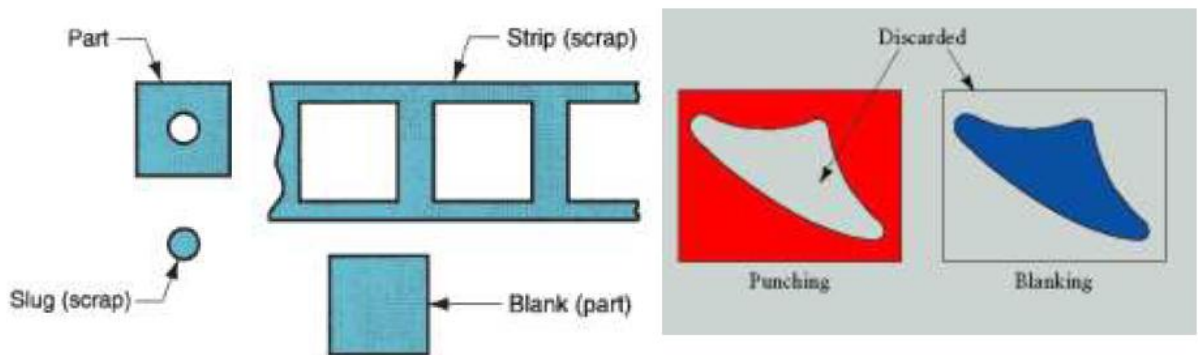


Blanking:

Blanking involves cutting of the sheet metal along a closed outline in a single step to separate the piece from the surrounding stock.

The part that is cut out is the desired product in the operation and is called the blank.

The hole and metal left behind is discarded as waste.



Piercing:

It is a cutting operation by which various shaped holes are made in sheet metal.

In piercing, the hole is the desired product, the material pierced out to form the hole being waste.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



LECTURE HANDOUTS

L-31

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Embossing, Coining, Notching, Punching

Introduction :

An operation consisting of shallow or moderate draws, made with male and female dies, usually used for stiffening flats panels or for decoration.

Coining is a special application of flash less forging in which fine details in the die are impressed into the top and bottom surfaces of the work part.

Notching is cutting operation by which metal pieces are cut from the edge of a sheet, strip or blank.

Prerequisite knowledge for Complete understanding and learning of Topic:

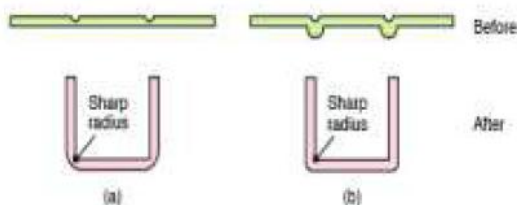
(Max. Four important topics)

Embossing, Coining, Notching, Punching

Detailed content of the Lecture:

Embossing:

An operation consisting of shallow or moderate draws, made with male and female dies, usually used for stiffening flats panels or for decoration.

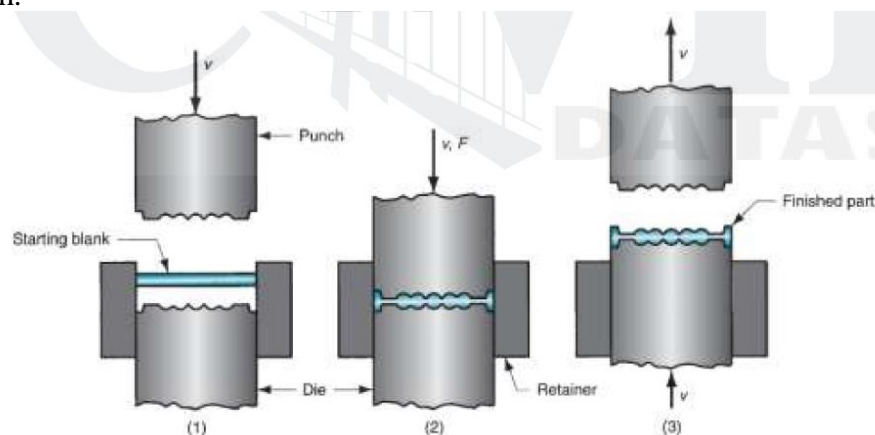


Application of (a) scoring, or (b) embossing to obtain a sharp inner radius in bending. However, unless properly designed, these features can lead to fracture. Source: Society of Manufacturing Engineers.

Coining

Coining is a special application of flash less forging in which fine details in the die are impressed into the top and bottom surfaces of the work part.

There is little flow of metal in coining, yet the pressures required to reproduce the surface details in the die cavity are high.

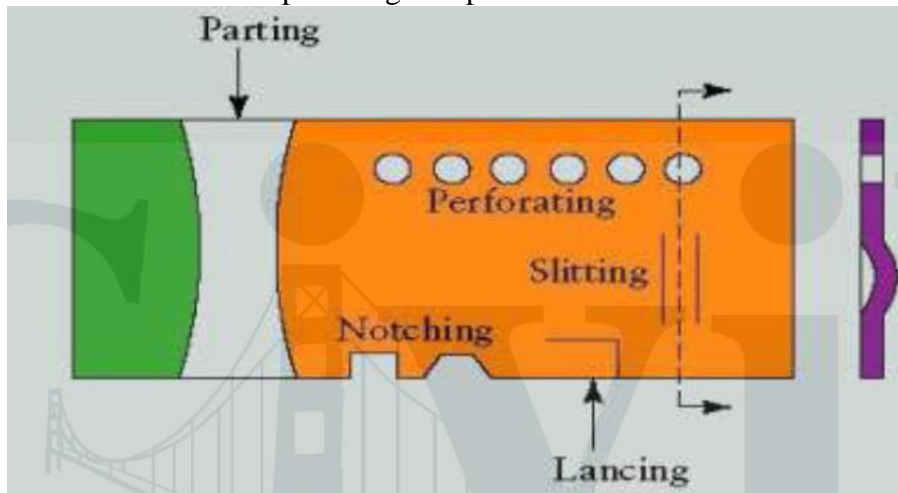


Notching: This is cutting operation by which metal pieces are cut from the edge of a sheet, strip or blank.

Notching involves cutting out a portion of metal from the side of the sheet or strip. *Seminotching* removes a portion of metal from the interior of the sheet.

Perforating: This is a process by which multiple holes which are very small and close together are cut in flat work material.

Perforating involves the simultaneous punching of a pattern of holes in sheet metal.



Punching :

It is a cutting operation by which various shaped holes are made in sheet metal.

In punching, the hole is the desired product, the material punched out to form the hole being waste.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-32,33

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Roll Forming, Rubber Press Forming

Introduction :

For bending continuous lengths of sheet metal and for large production runs, roll forming is used.

The two operations are performed on conventional presses, but the tooling is unusual in that it uses a flexible element (made of rubber or similar material) to effect the forming operation.

Prerequisite knowledge for Complete understanding and learning of Topic:

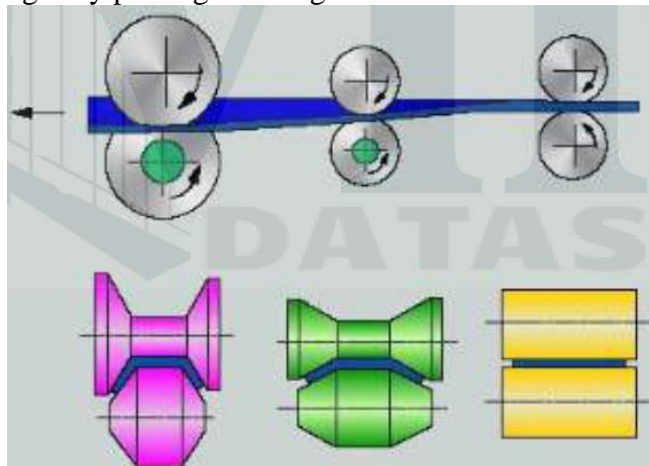
(Max. Four important topics)

Roll Forming, Rubber Press Forming

Detailed content of the Lecture:

Roll forming:

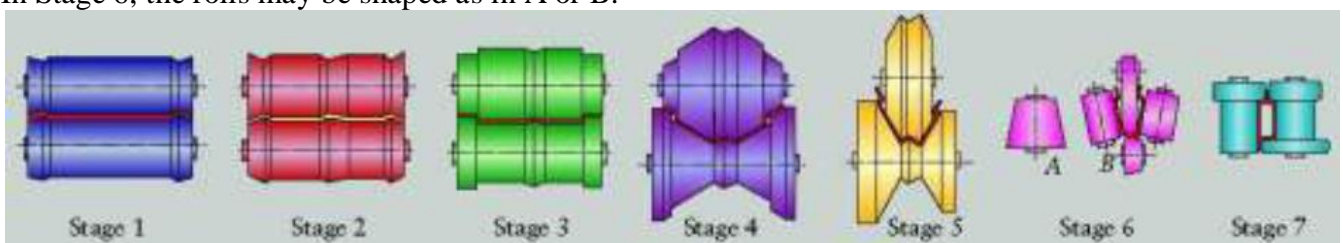
For bending continuous lengths of sheet metal and for large production runs, roll forming is used. The metal strip is bent in stages by passing it through a series of rolls.



Roll-forming process

Stages in roll forming of a sheet-metal door frame.

In Stage 6, the rolls may be shaped as in A or B.



RUBBER FORMING PROCESSES

The two operations are performed on conventional presses, but the tooling is unusual in that it uses a flexible element (made of rubber or similar material) to effect the forming operation.

The operations are

(1) Rubber Pad Forming /The Guerin process, and (2) Hydroforming.

Rubber Pad Forming /The Guerin process

Guerin process uses a thick rubber pad (or other flexible material) to form sheet metal over a positive form block.

The rubber pad is confined in a steel container.

As the ram descends, the rubber gradually surrounds the sheet, applying pressure to deform it to the shape of the formblock.

It is limited to relatively shallow forms, because the pressures developed by the rubber (up to about 10 MPa) are not sufficient to prevent wrinkling in deeper formed parts.

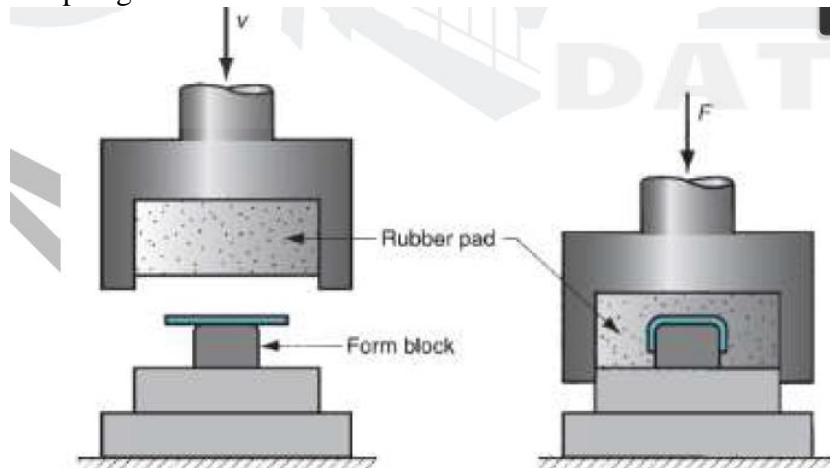
The *advantage* of the Guerin process is the relatively low cost of the tooling.

The form block can be made of wood, plastic, or other materials that are easy to shape, and the rubber pad can be used with different form blocks.

These factors make rubber forming attractive in small-quantity production, such as the aircraft industry, where the process was developed.

In rubber pad forming, one of the dies in a set is made of flexible material, such as a rubber or polyurethane membrane.

Polyurethanes are used widely because of their resistance to abrasion, long fatigue life and resistance to damage by burrs or sharp edges of the sheet blank.



Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:

LECTURE HANDOUTS

L-34

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Hydro Mechanical Forming

Introduction :

In hydro mechanical forming or fluid forming process, the pressure over the rubber membrane is controlled throughout the forming cycle, with maximum pressure reaching 100 MPa.

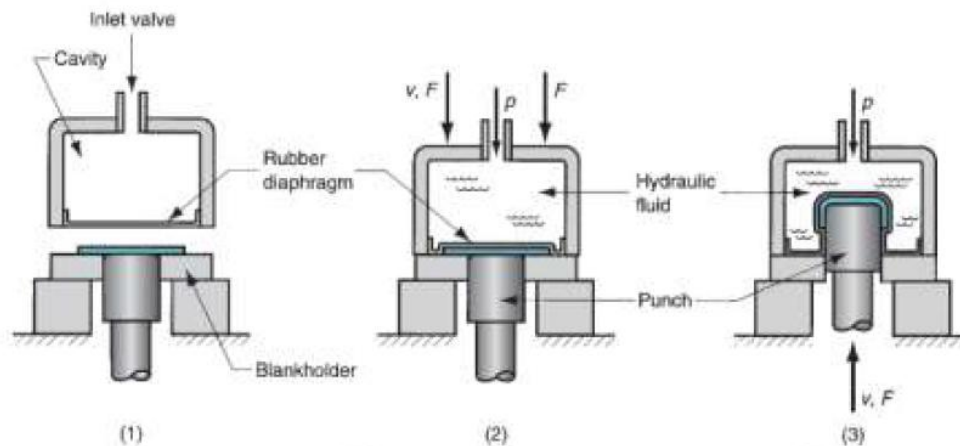
Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

Hydro Mechanical Forming

Detailed content of the Lecture:

Hydro mechanical form (or) Fluid Forming Process



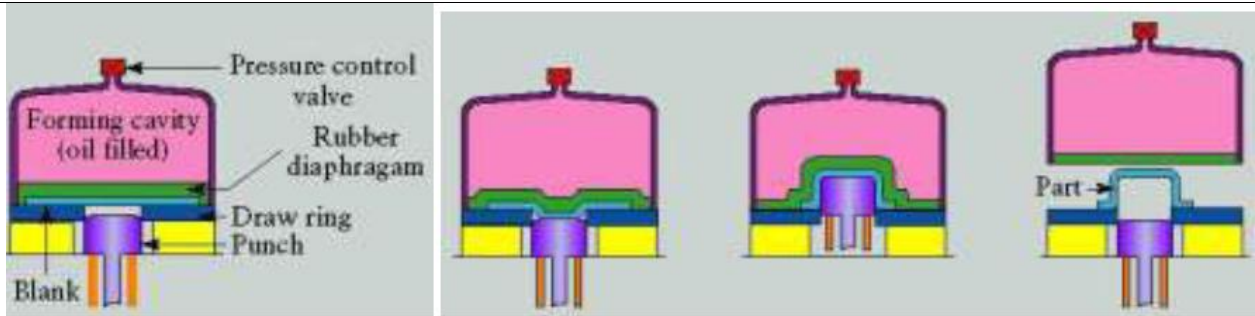
Hydroform process: (1) start-up, no fluid in cavity; (2) press closed, cavity pressurized with hydraulic fluid; (3) punch pressed into work to form part. Symbols: v = velocity, F = applied force, p = hydraulic pressure.

In hydro mechanical forming or fluid forming process, the pressure over the rubber membrane is controlled throughout the forming cycle, with maximum pressure reaching 100 MPa.

This procedure allows close control of the part during forming to prevent wrinkling or tearing.

When selected properly, rubber forming and hydro forming processes have the following *advantages*:

- Low tooling cost
- Flexibility and ease of operation
- Low die wear
- No damage to the surface of the sheet and
- Capability to form complex shapes.



Note that, in contrast to the ordinary deep-drawing process, the pressure in the dome forces the cup walls against the punch.

The cup travels with the punch; in this way, deep drawability is improved.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-35

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Comparison of Forming

Introduction :
Compare the different types of forming.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)
Roll, Stretch, Peen, Explosive

Detailed content of the Lecture:

Process	Characteristics
Roll forming	Long parts with constant complex cross-sections; good surface finish; high production rates; high tooling costs.
Stretch forming	Large parts with shallow contours; suitable for low-quantity production; high labor costs; tooling and equipment costs depend on part size.
Drawing	Shallow or deep parts with relatively simple shapes; high production rates; high tooling and equipment costs.
Stamping	Includes a variety of operations, such as punching, blanking, embossing, bending, flanging, and coining; simple or complex shapes formed at high production rates; tooling and equipment costs can be high, but labor costs are low.
Rubber-pad forming	Drawing and embossing of simple or complex shapes; sheet surface protected by rubber membranes; flexibility of operation; low tooling costs.
Spinning	Small or large axisymmetric parts; good surface finish; low tooling costs, but labor costs can be high unless operations are automated.
Superplastic forming	Complex shapes, fine detail, and close tolerances; forming times are long, and hence production rates are low; parts not suitable for high-temperature use.
Peen forming	Shallow contours on large sheets; flexibility of operation; equipment costs can be high; process is also used for straightening parts.
Explosive forming	Very large sheets with relatively complex shapes, although usually axisymmetric; low tooling costs, but high labor costs; suitable for low-quantity production; long cycle times.
Magnetic-pulse forming	Shallow forming, bulging, and embossing operations on relatively low-strength sheets; most suitable for tubular shapes; high production rates; requires special tooling.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



LECTURE HANDOUTS

L-36

MECH

I/II

Course Name with Code : 19GES15/MANUFACTURING PROCESSES

Course Faculty : Mr.S.MURALIDHARAN

Unit : METAL FORMING PROCESSES Date of Lecture:

Topic of Lecture: Defects in Forming

Introduction :

In forming, wrinkle, tear, ear, scratch defects will occur.

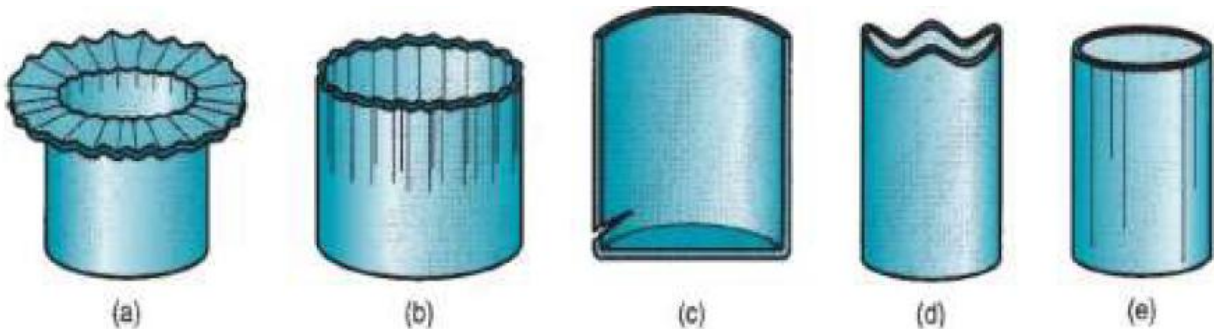
Prerequisite knowledge for Complete understanding and learning of Topic:

(Max. Four important topics)

wrinkle, tear, scratch.

Detailed content of the Lecture:

DEFECTS IN FORMING



Common defects in drawn parts: (a) wrinkling can occur either in the flange or (b) in the wall, (c) tearing, (d) earing, and (e) surface scratches.

(a) Wrinkling in the flange

Wrinkling in a drawn part consists of a series of ridges that form radially in the undrawn flange of the work part due to *compressive buckling*.

(b) Wrinkling in the wall

If and when the wrinkled flange is drawn into the cup, these ridges appear in the *vertical wall*.

(c) Tearing

Tearing is an open crack in the vertical wall, usually near the base of the drawn cup, due to *high tensile stresses* that cause thinning and failure of the metal at this location. This type of failure can also occur as the metal is pulled over a sharp die corner.

(d) Earing

This is the formation of irregularities (called ears) in the upper edge of a deep drawn cup, *caused by anisotropy* in the sheet metal.

If the material is perfectly isotropic, ears do not form.

(e) Surface scratches

Surface scratches can occur on the drawn part if the punch and die are not smooth or if lubrication is insufficient.

Video Content / Details of website for further learning (if any):

Can be added as link

Important Books/Journals for further learning including the page nos.:



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-37

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Processing of plastics

Introduction : (Maximum 5 sentences)

Plastics can be machined, cast, formed, and joined with relative ease requiring little post-processing or surface finish operations

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

- Basic Physics and Chemistry

Detailed content of the Lecture:

- Plastics melt or cure at relative low temperatures
- Plastics require less energy to process than metals
- Raw materials most commonly are pellets, powders
- Also available as sheet, plate, rod, and tubing (produced by extrusion, etc.)
- Liquid plastics used to make reinforced plastic parts
- (composite materials)

Process	Characteristics
Extrusion	Long, uniform, solid or hollow complex cross-sections; high production rates; low tooling costs; wide tolerances.
Injection molding	Complex shapes of various sizes, eliminating assembly; high production rates; costly tooling; good dimensional accuracy.
Structural foam molding	Large parts with high stiffness-to-weight ratio; less expensive tooling than in injection molding; low production rates.
Blow molding	Hollow thin-walled parts of various sizes; high production rates and low cost for making containers.
Rotational molding	Large hollow shapes of relatively simple shape; low tooling cost; low production rates.
Thermoforming	Shallow or relatively deep cavities; low tooling costs; medium production rates.
Compression molding	Parts similar to impression-die forging; relatively inexpensive tooling; medium production rates.
Transfer molding	More complex parts than compression molding and higher production rates; some scrap loss; medium tooling cost.
Casting	Simple or intricate shapes made with flexible molds; low production rates.
Processing of composite materials	Long cycle times; tolerances and tooling cost depend on process.

Video Content / Details of website for further learning (if any):

https://personal.egr.uri.edu/vms/ISE%20240/Polymer_processing_VMS08.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 441-447



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-38

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Compression moulding

Introduction : (Maximum 5 sentences)

- Compression molding is an old and widely used molding process for thermosetting plastics.
- Its applications also include thermoplastic phonograph records, rubber tires, and various polymer matrix composite parts.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

- Basic Physics and Chemistry

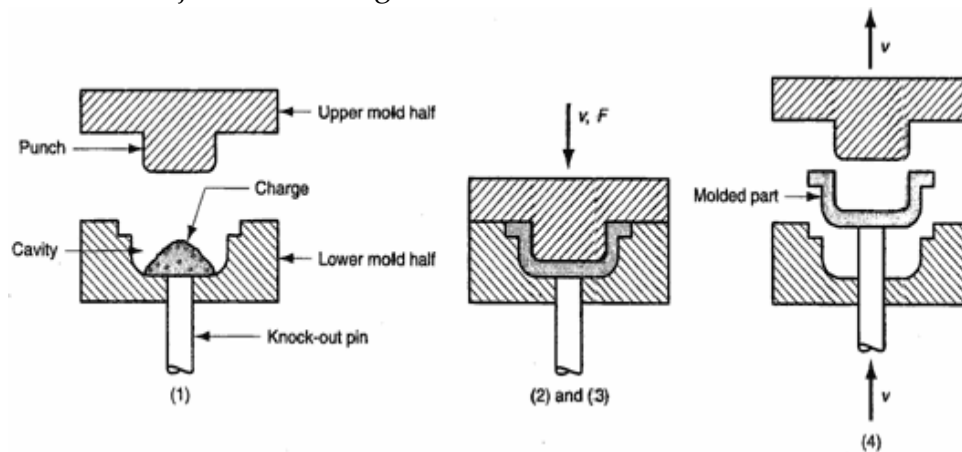
Detailed content of the Lecture:

The process consists of (1) loading a precise amount of molding compound, called the charge, into the bottom half of a heated mold; (2) bringing the mold halves together to compress the charge, forcing it to flow and conform to the shape of The process consists of (1) loading a precise amount of molding compound, called the charge, into the bottom half of a heated mold; (2) bringing the mold halves together to compress the charge, forcing it to flow and conform to the shape of The initial charge of molding compound can be in any of several forms, including powders or pellets, liquid, or preform. The amount of polymer must be precisely controlled to obtain repeatable consistency in the molded product. It has become common practice to preheat the charge prior to its placement into the mold; this softens the polymer and shortens the production cycle time. Preheating methods include infrared heaters, convection heating in an oven, and use of a heated rotating screw in a barrel. The latter technique (borrowed from injection molding) is also used to meter the amount of the charge.

Compression molding presses are oriented vertically and contain two platens to which the mold halves are fastened. The presses involve either of two types of actuation: (1) upstroke of the bottom platen or (2) downstroke of the top platen, the former being the more common machine configuration. They are generally powered by a hydraulic cylinder that can be designed to provide clamping capacities up to several hundred tons.

Molds for compression molding are generally simpler than their injection mold counterparts. There is no sprue and runner system in a compression mold, and the process itself is generally limited to simpler part geometries due to the lower flow capabilities of the starting thermosetting materials. However, provision must be made for heating the mold, usually accomplished by electric resistance heating, steam, or hot oil circulation. Compression molds can be classified as hand molds, used for trial runs; semiautomatic, in which the press follows a programmed cycle but the operator manually loads and unloads the press; and automatic, which operate under a fully automatic press cycle (including automatic loading and unloading).

Materials for compression molding include phenolics, melamine, epoxies, urethanes, and elastomers. Typical TS plastic moldings include electric plugs, sockets, housings, pot handles, and dinnerware plates. Advantages noted for compression molding in these applications include: molds that are simpler, less expensive, and require low maintenance; less scrap; and low residual stresses in the molded parts . A typical disadvantage is longer cycle times and therefore lower production rates than injection molding.



Video Content / Details of website for further learning (if any):

<https://www.plasticsintl.com/blog/what-is-compression-molding>.

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 445-447

LECTURE HANDOUTS

L-39

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Transfer moulding, injection moulding

Introduction : (Maximum 5 sentences)

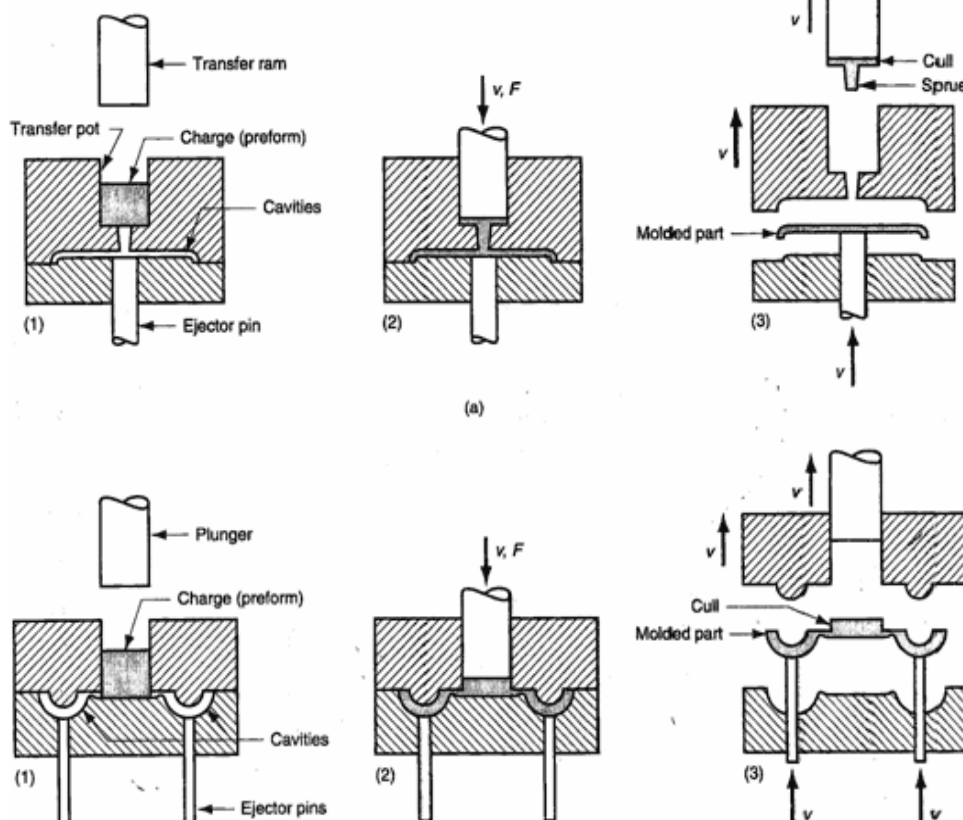
- In this process, a thermosetting charge (preform) is loaded into a chamber immediately ahead of the mold cavity, where it is heated; pressure is then applied to force the softened polymer to flow into the heated mold where curing occurs.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

- Basic Physics and Chemistry

Detailed Lecture:

content of the



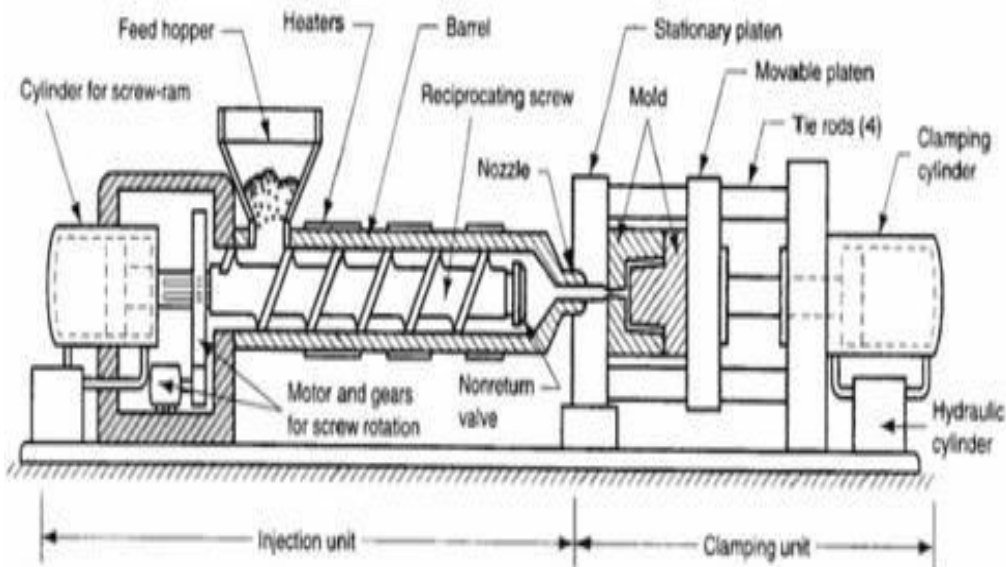
There are two variants of the process: (a) **pot transfer molding**, in which the charge is injected from a "pot" through a vertical sprue channel into the cavity; and (b) **plunger transfer molding**, in which the charge is injected by means of a plunger from a heated well through lateral channels into the mold

cavity. In both cases, scrap is produced each cycle in the form of the leftover material in the base of the well and lateral channels, called the **cull**. In addition, the sprue in pot transfer is scrap material. Because the polymers are thermosetting, the scrap cannot be recovered.

Transfer molding is closely related to compression molding, because it is utilized on the same polymer types (thermosets and elastomers). One can also see similarities to injection molding, in the way the charge is preheated in a separate chamber and then injected into the mold. Transfer molding is capable of molding part shapes that are more intricate than compression molding but not as intricate as injection molding. Transfer molding also lends itself to molding with inserts, in which a metal or ceramic insert is placed into the cavity prior to injection, and the heated plastic bonds to the insert during molding

Injection moulding

Injection molding is a process in which a polymer is heated to a highly plastic state and forced to flow under high pressure into a mold cavity, where it solidifies. The molded part, called a molding, is then removed from the cavity. The process produces discrete components that are almost always net shape. The production cycle time is typically in the range 10 to 30 seconds, although cycles of one minute or longer are not uncommon. Also, the mold may contain more than one cavity; so that multiple moldings are produced each cycle.



Video Content / Details of website for further learning (if any):

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107086/lec29.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 449



LECTURE HANDOUTS

L-40

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Blow moulding, thermo forming

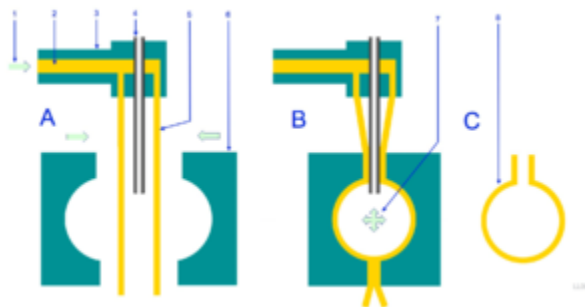
Introduction : (Maximum 5 sentences)

- Blown film extrusion is a technology that is the most common method to make plastic films, especially for the packaging industry.
- The process involves extruding a tube of molten polymer through a die and inflating to several times its initial diameter to form a thin film bubble.

Prerequisite knowledge for Complete understanding and learning of Topic: (Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:



Blow molding moulding) is a specific manufacturing process by which hollow plastic parts are formed and can be joined together. It is also used for forming glass bottles or other hollow shapes.

In general, there are three main types of blow molding: extrusion blow molding, injection blow molding, and injection stretch blow molding.

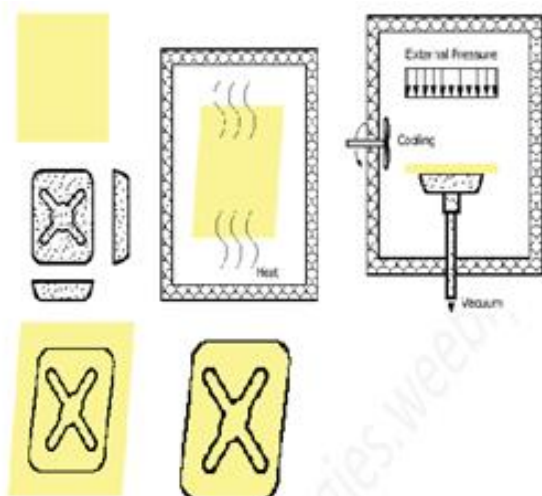
The blow molding process begins with melting down the plastic and forming it into a parison or, in the case of injection and injection stretch blow molding (ISB), a preform. The parison is a tube-like piece of plastic with a hole in one end through which compressed air can pass.

The parison is then clamped into a mold and air is blown into it. The air pressure then pushes the plastic out to match the mold. Once the plastic has cooled and hardened the mold opens up and the part is ejected. The cost of blow molded parts is higher than that of injection-molded parts but lower than rotational molded parts.

Process in Thermoforming

- 1.The plastic sheets used in thermoforming is usually made by extrusion. The one-sided mold is usually made by aluminum.
- 2.This sheet of plastic material is first heated to become a flexible membrane. It is soft but still not liquid or gooey.
- 3.The soft, rubber-like membrane is placed on the mold and stretched to fit. Vacuum, external air pressure, and mechanical forces are used to rid the air bubbles.
- 4.The plastic part is removed from the mold after it cools and hardens.
- 5.Trimming, drilling, and other finishing processes may be needed to obtain the final product

Aluminum is the most common thermoforming mold material due to its very high coefficient of thermal conductivity that allows speedy and consistent cooling cycle.



Video Content / Details of website for further learning (if any):

<https://www.custompartnet.com/wu/thermoforming>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 450



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-41

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Calendaring

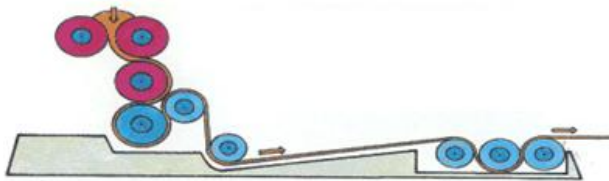
Introduction : (Maximum 5 sentences)

- A PVC blend is pre-gelatinised and then kneaded to form a viscous material. It is laminated through a series of cylinders and transformed into a continuous sheet, which is cooled and then rolled up. The sheets may be mono-oriented during the process.
- As with extrusion, calendaring is a continuous process

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

- Basic Physics and Chemistry

Detailed content of the Lecture:



- Calendaring is a finishing process used on cloth where fabric is folded in half and passed under rollers at high temperatures and pressures.
- Calendaring is used on fabrics such as moiré to produce its watered effect and also on cambric and some types of sateens.
- In preparation for calendaring, the fabric is folded lengthwise with the front side, or face, inside, and stitched together along the edges. The fabric can be folded together at full width, however this isn't done as often as it is more difficult. The fabric is then run through rollers that polish the surface and make the fabric smoother and more lustrous. High temperatures and pressure are used as well. Fabrics that go through the calendaring process feel thin, glossy and papery.

Video Content / Details of website for further learning (if any):

http://eacharya.inflibnet.ac.in/data-server/eacharya-documents/55daa452e41301c73a2cb5ac_INFIEP_208/806/ET/lec%20-3.pdf

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 448-44



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-42

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Advantages of plastic materials

Introduction : (Maximum 5 sentences)

- Plastics have lot of advantages over other materials

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

- Basic Physics and Chemistry

Detailed content of the Lecture:

Advantages of plastic:

Light in weight.

Possess very good strength and toughness.

Plastics are corrosion resistant and chemically inert.

Strong, good and cheap to produce.

Used for building, construction, electronics and transportation industries.

It can be reused and restored over again and again.

Main Advantages of Plastic

Here are some of the reasons plastic is so widely used:

Lightweight

Probably one of the biggest benefits of plastic is how lightweight it is, while still being able to carry (no pun intended) so many other benefits. It can be as simple as plastic grocery bags making your trips back and forth up the driveway that much easier. Or as major as making cars more fuel efficient without sacrificing any of their vital safety features.

Cheap

Sure, there are other materials that are just as good, just as strong, and just as versatile as plastic. But they all cost a fortune to produce. Plastic is so cheap to make that many people even think we have too much of it.

Now, it's penchant for creating inexpensive products can also be seen as a negative at times. People often assume – and sometimes rightfully so – that certain plastic products are poorly made. Think plastic silverware or furniture. But we'd argue that's more a product of how it was manufactured, not the material it's made from.

Durable

Plastic can take an absolute beating. It's tough, resilient, and excellent at absorbing shock. It's one of the main reasons cars are able to get safer and safer everyday. Plastic bumpers absorb shock, plastic dashboards and door panels are a little kinder on your head during a wreck, and plastic fuel tanks minimize explosion risks.

It's even been used to create bullet proof vests that are stronger and lighter than some of the other materials they've been commonly made of in the past.

Recyclable

If you're like most of us, you've probably reused an empty soda bottle at least once in your life. You've got plastic tupperware and maybe even some plastic plates, cups, and bowls. A combination of a few of the material's finer traits makes it incredibly reusable.

It can also be recycled and reshaped into new products. Even more amazingly, it can be melted down into oil or fuel and scientists are working to make this process more and more efficient by the day. Read about how recycling can benefit the economy this excellent blog post.

Video Content / Details of website for further learning (if any):

<https://www.udemy.com/blog/advantages-of-plastic/>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2015, pp: 453-454



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-43

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Introduction to composite material

Introduction : (Maximum 5 sentences)

- A composite material (also called a composite material or shortened to composite material, which is the common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:

A composite material is a combination of two materials with different physical and chemical properties. When they are combined they create a material which is specialised to do a certain job, for instance to become stronger, lighter or resistant to electricity. The reason for their use is because they improve the properties of their base materials and are applicable in many situations

Some common composite materials include:

- **Ceramic matrix composite:** Ceramic spread out in a ceramic matrix. These are better than normal ceramics as they are thermal shock and fracture resistant
- **Metal matrix composite:** A metal spread throughout a matrix
- **Reinforced concrete:** Concrete strengthened by a material with high tensile strength such as steel reinforcing bars
- **Glass fibre reinforced concrete:** Concrete which is poured into a glass fibre structure with high zirconia content
- **Translucent concrete:** Concrete which encases optic fibres
- **Engineered wood:** Manufactured wood combined with other cheap materials. One example would be particle board. A speciality material like veneer can also be found in this composite
- **Plywood:** Engineered wood by gluing many thin layers of wood together at different angles
- **Engineered bamboo:** Strips of bamboo fibre glued together to make a board. This is a useful composite due to the fact it has higher compressive, tensile and flexural strength than wood
- **Parquetry:** A square of many wood pieces put together often out of hardwood. It is sold as a decorative piece

- **Wood-plastic composite:** Either wood fibre or flour cast in plastic

Video Content / Details of website for further learning (if any):

<https://www.twi-global.com/technical-knowledge/faqs/what-is-a-composite-material>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 453-454



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-44

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Classification of composite materials

Introduction : (Maximum 5 sentences)

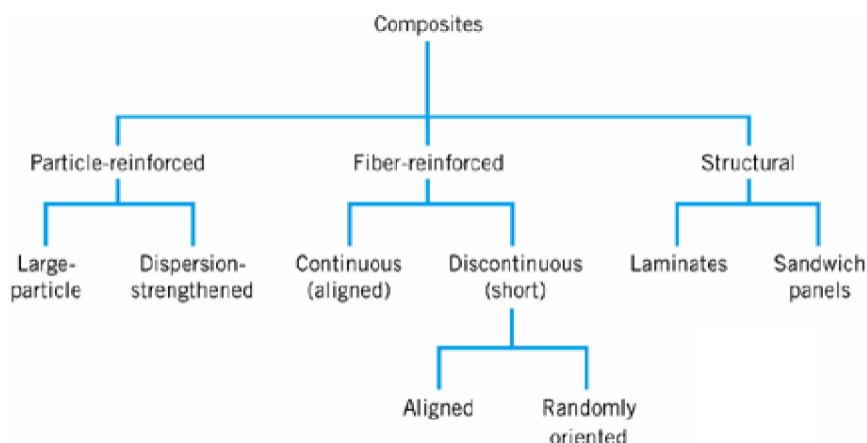
- Based on type of matrix material as metal-matrix composites, polymer-matrix composites and ceramic-matrix composites.
- Based on size-and-shape dispersed phase as particlereinforced composites, fiber-reinforced composites and structural composites.

Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)

- Basic Physics and Chemistry

Detailed content of the Lecture:

Classification of composites (contd...)



Particulate composites These composites contain large number of coarse particles. These composites are designed to produce combination of properties rather than increase the strength. Mechanical properties are characterized by rule-of-mixtures. Elastic modulus of these composites is given by the following bounds, derived from rule-of-mixtures

Fiber-reinforced composites These composite constituents are, usually, soft matrix embedded with harder fibers. Matrix serves as medium to transfer applied load to fibers, which carry most of the applied load. It also protects fibers from external environment. Fibers are either continuous and

discontinuous. Continuous→ fibers provide best efficiency, however discontinuous fibers are used when manufacturing economics dictate the use of a process where the fibers must be in this form. Properties of these composites depend on many parameters:→ properties of matrix and fibers, fiber length and volume fraction, their orientation, and interface bond strength

Structural composites Two classes of structural composites are – laminar→ composites and sandwich structures. Laminar composites – consists of layers of materials. Many→ laminar composites are designed to increase corrosion resistance while retaining low cost, high strength or light weight. E.g.: thin coatings, thicker protective coatings, claddings, bimetallies, laminates. Sandwich structures – consists of thin layers joined to core→ in between. Neither the filler material nor the facing material is strong or rigid, but the composite possesses both properties

Video Content / Details of website for further learning (if any):

<https://nptel.ac.in/content/storage2/courses/112104168/L02.pdf>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 454-455



MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu



LECTURE HANDOUTS

L-45

MECH

I/II

Course Name with Code : Manufacturing Processes-19GES15

Course Faculty : S.Muralidharan

Unit : V

Date of Lecture:

Topic of Lecture: Advantages of composite materials.

Introduction : (Maximum 5 sentences)

- Composites offer many benefits.
- Key among them are strength, light weight, corrosion resistance, design flexibility and durability.

**Prerequisite knowledge for Complete understanding and learning of Topic:
(Max. Four important topics)**

- Basic Physics and Chemistry

Detailed content of the Lecture:

Advantages of Composite Materials

- As molded dimensional accuracy. Tight tolerance, repeatable moldings. ...
- Chemical Resistance.
- Consolidated Parts and Function.
- Corrosion Resistance.
- Design Flexibility.
- Durable.
- High Flexural Modulus to Carry Demanding Loads. High Impact Strength.
- High Performance at Elevated Temperatures.

Design Flexibility – Thermoset Composites give designers nearly unlimited flexibility in designing shapes and forms. They be molded into the most intricate components and can be made a wide range of densities and chemical formulations to have precise performance properties.

Low cost per cubic inch – When comparing costs based on volume, thermoset composites have lower material costs than traditional materials such as wood, engineered thermoplastics and metals. In addition, because thermoset composites have a low petroleum-based content, they are not subjected to the price fluctuations experienced in petroleum-based products.

Lower material costs – Because thermoset composites can be precisely molded, there is little waste and therefore significantly lower overall material costs than metals products.

Improved productivity – Industrial Designers and Engineers are able to reduce assembly costs by combining several previously assembled parts into a single component. Also, inserts can be molded directly into the part during the molding process thereby eliminating the need for a post-process. In addition, composites do not usually require additional machining, thereby reducing work-in-process and time to market.

Video Content / Details of website for further learning (if any):

<https://www.mar-bal.com/applications/advantages-of-composites/>

Important Books/Journals for further learning including the page nos.:

Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt Ltd., Mumbai, 2015, pp: 454-455