

METAL CASTING PROCESS

PREVEIW

- What is Metal casting ?
- It is the industry of pouring liquid metal into a mold to achieve a desired shape.

INTRODUCTION (Contd)

- Almost all metals can be cast.
- The challenge in casting is to produce products (casts) that are of
- the desired composition, free from defects, and meet
- requirements for strength, dimensional accuracy and surface finish.

Metal Casting

- Create liquid metal - Melting
 - Combustion used to melt material
 - Electricity used to melt material

- Create solid shape - Casting
 - Permanent mold casting
 - Semi Permanent mold casting
 - Consumable mold casting

DIE CASTING VS FOUNDRY

- Die casting is a variation of metal casting
- Liquid metal injected into reusable steel mold, or die, very quickly with high pressures
- Reusable steel tooling and injection of liquid metal with high pressures differentiates die casting from other metal casting processes

• PROCESS CHART



CURRENT USE OF CASTINGS

- Cars
- Appliances
- Office equipment
- Sporting goods
- Machinery
- Toys
- Many other applications

CASTING PROCESS

- A liquid conforms to the shape of the vessel that holds it: this is the fundamental principle underlying all metal casting processes.
- The casting process basically involves:
 - (a) Pouring molten metal into a mold patterned after the part to be manufactured which extract heat.
 - (b) Allowing it to cool.
 - (c) Removing the metal from the mold.
- Important considerations in casting operations are as follows:
 - The flow of the molten metal into the mold cavity
 - The solidification and cooling of the metal in the mold
 - The influence of the type of mold material

Sand Casting Explained

The five basic steps in Foundry work / Sand Casting:

1. Patternmaking
2. Coremaking
3. Molding or mould making
4. Melting and Pouring
5. Cleaning and fettling
6. INSPECTION

Foundry work involves all or some of the processes illustrated in the following flowchart

PATTERN MAKING

- It is the first step to prepare a model-
Pattern.
- Pattern is the replica of feminine model of
final casting.
- It Differs in number of respects from
resulting castings.
- Mostly patterns are made of wood , as it is
very cheap and good workability.
- For higher durability and strength, patterns
are made from brass , Al, Mg alloy.

Pattern making - TYPES

- **1. SOLID PIECE PATTERN**
- 2. SPLIT PIECE PATTERN**
- **3. LOOSE PIECE PATTERN**
- **4. GATED PATTERN**

Pattern Materials

- Wood : *White Pine is favourite wood, Straight grained , light weight, Easy to work*
- *Eg : Cherry, Beech, Bass wood etc*
- *Metal : used for production work. Ability to withstand. Do not change their shape when subjected to moist conditions.*
- *Polystyrene: Consumable pattern. Molten metal vaporises the pattern. Best suited for cases where it is difficult or impossible to draw the pattern.*

PATTERN ALLOWANCES

- To produce a casting of proper size and shape and depend partly on product design, Mould design, Shrinkage, contraction etc of the metal being cast.
- Shrinkage allowance: *Positive allowance*
- Finishing allowance: *Positive allowance*
- Draft Allowance: *Positive allowance*
- Distortion allowance: *Positive allowance*
- Shake allowance: *Negative allowance*

MOULDING SAND

- Principal Raw material used in Moulding is Moulding Sand
- Main constituents are Silica, Alumina, Iron Oxide and small amount of oxides Ti, Mn, Ca and some alkaline compounds.

TYPES OF MOULDING SAND

- Natural Sand : It is also called Green sand collected from Natural Resources
- Tempered sand
- It contains water as only binder
- Sand is found on the banks of river and ponds.
- SYNTHETIC SAND:
- Artificial sand obtained by mixing relatively sand, binder(water+ bentonite) and other material required.

MOULDING SAND

- The chief constituent are
- Silica and clay
- Silica is 80-90%, Silicon dioxide (refractoriness, resistivity , Permeability)
- Clay – 8-10% It imparts bonding strength to moulding sand .Too much of clay causes cracking of materials.
- Additives: Coal Dust – used in sand
- Saw dust reduces expansion defect increase surface finish

- Sand Terminology
- Green Sand: Tempered well prepared foundry sand
- Dry Sand: Original having excess moisture.
- Facing sand: Facing sand forms the face of the mould.
- Parting Sand: Sand is sprinkled on the pattern and on the mould surface., so that one mould flask doesn't stick with one another.

Properties of Moulding Sand

- PERMEABILITY: depends upon size, shape, compactness, moisture content, bonding
- COHESIVENESS.
ADHESIVENESS
REFRACTORINESS
COLLAPSIBILITY.
-

Types of moulds

- Green sand mould
- Skin Dried Mould
- Dry sand mould
- Air Dried Mould

Type of moulds

- **Green Sand Mould** : It is the condition of sand when molten metal is poured. Molten metal is poured immediately after it is ready.
- Permeability is high and good.
- **Skin Dried mould**: The surface is dried to a depth of 12.5 to 25mm depth by means of hot air, infra red lamp.
- Suitable binder like resin , linseed oil molasses is added to provide hard surface.
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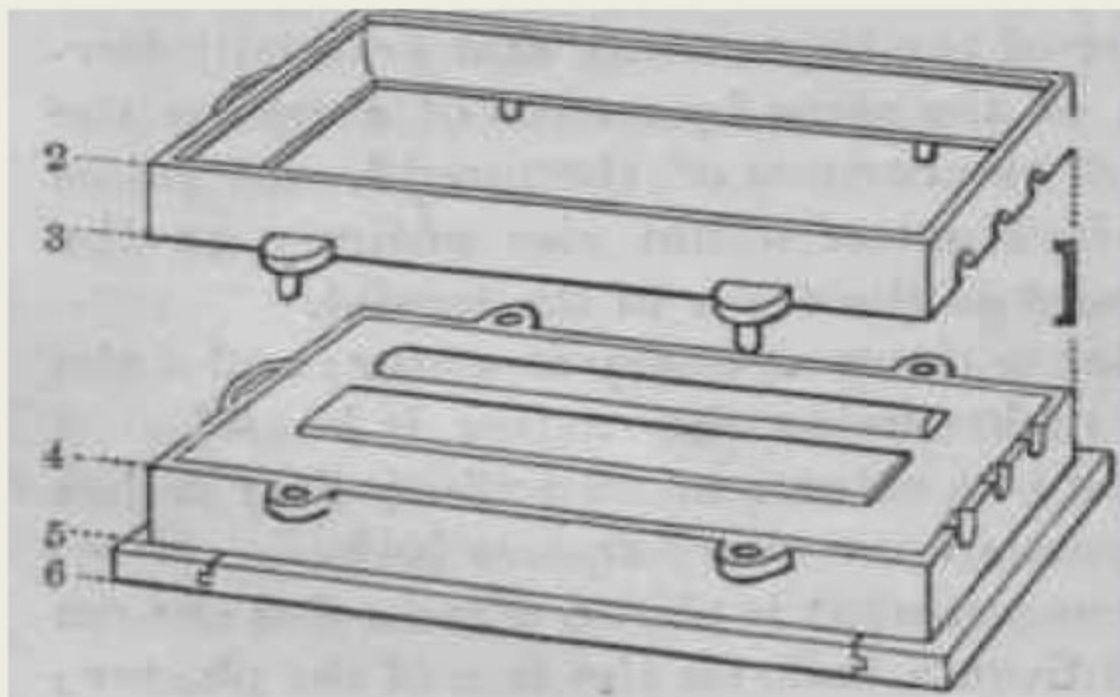
- Dry Sand Moulds: Moulds are made from fine grained and mixed binders and additives.
Baked in the oven
- Stronger Harder but less permeability.
- Air Dried mould:
- It is exposed to air for considerable time.

Foundry tools

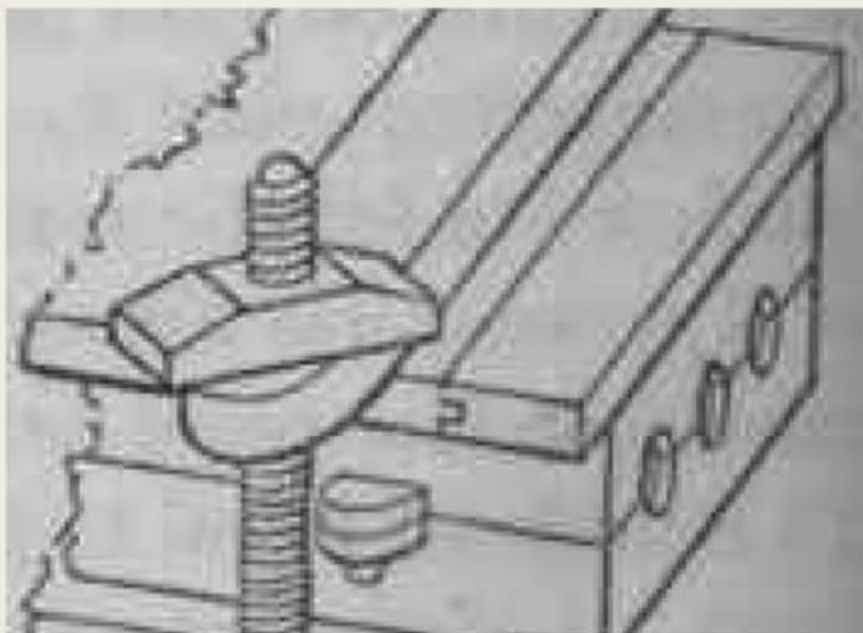
- Shovel
- Riddle
- Rammers
- Strike off bar
- Vent wire
- Trowel
- Slick
- Lifters
- Draw spike

Sand Casting

- Uses sand to hold the desired shape to be cast
- Bonded with chemicals or clay with water or oil
- Many different types of sand casting

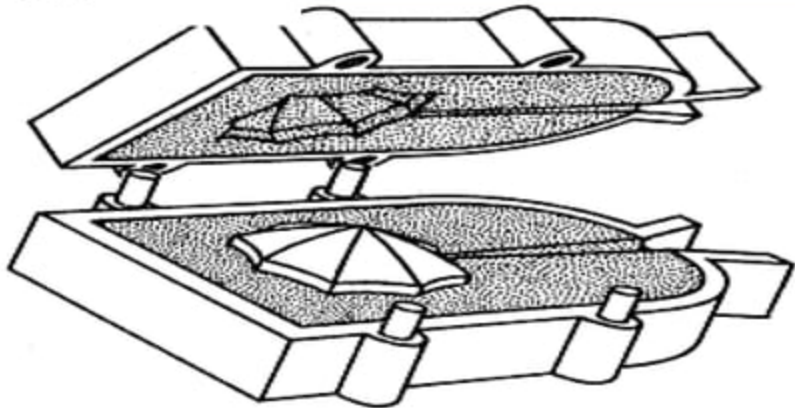
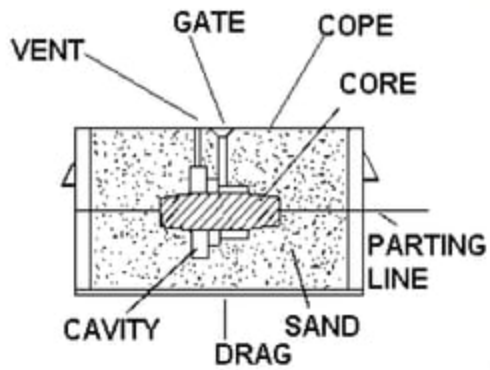


MOULDING BOXES



MOULDING BOXES

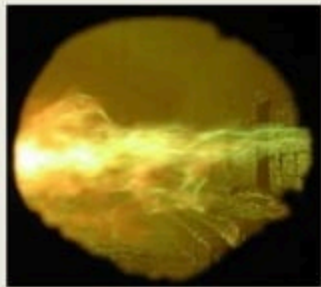
Sand Casting



Oxy-fuel Furnace

- Uses a fuel gas such as propane, natural gas or acetylene
- Oxygen or atmosphere is blown in and combined with fuel
- Heat from combustion melts the charge

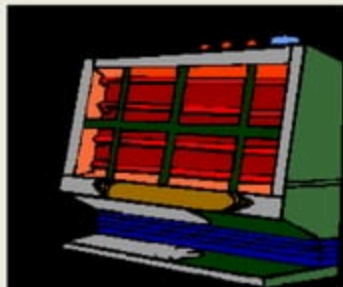
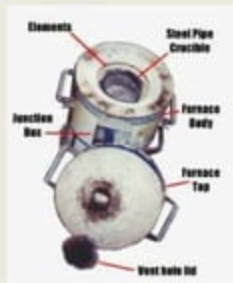
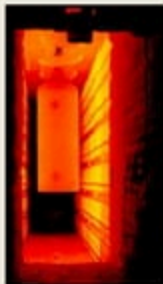
Oxy-fuel Furnace



Resistance Furnace

- A current passed through a material resulting in ohmic heating
- Radiation heats charge material
- Some convection and conduction occurs

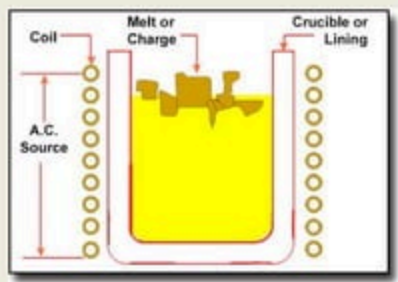
Resistance Furnace



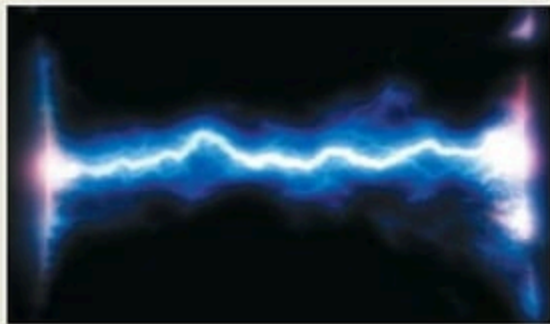
Induction Furnace

- A current is passed through a water cooled coil near or around the charge
- Eddy currents are produced in the charge material in response to the coil current
- Heat is generated through ohmic heating in the material

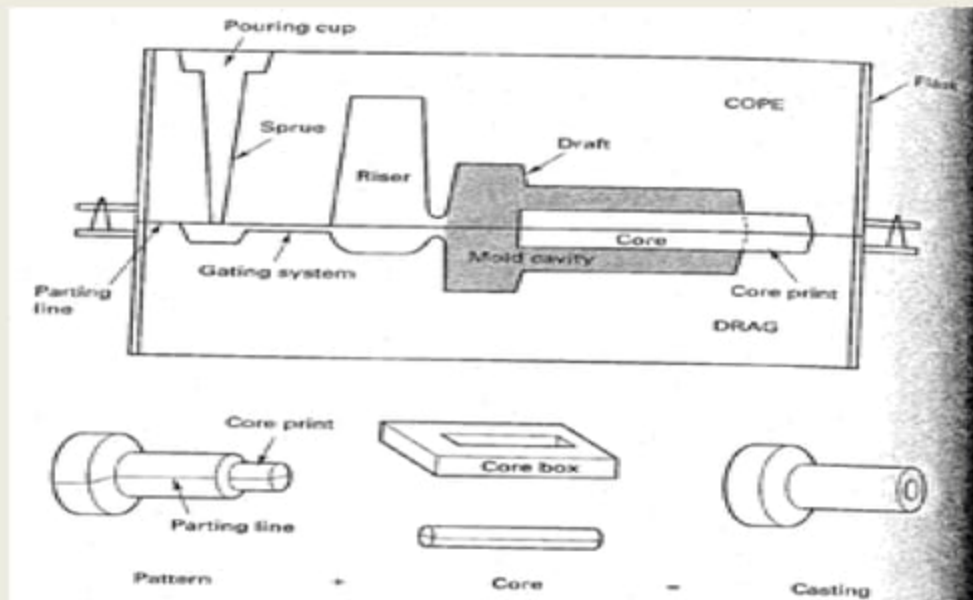
Induction Furnace



Electric Arc Furnace



CASTING PROCESS



HEAT EXTRACTION AND SOLIDIFICATION

- Directional solidification is important for the quality of the casting (solidification proceeds from the most remote section to the points of feeding).
1. Feeder heads (risers)
 - They serve as wells of liquid metal to compensate for shrinkage during solidification.
 2. Chills
 - They are heat-absorbing devices for fast freezing.
 - They are used to change progressive solidification to directional solidification.
 - Naturally, solidification is progressive from the wall of the mold towards the inner sections .

Casting Terminology

- **Pattern** this is an approximate duplicate of the final casting and the mould material is packed around the pattern and followed by removal of the pattern to produce a mouldcavity.
- **Flask** this is the box that contains the mould aggregate.
- **Cope** is the name given to the top half of the pattern, flask, mould or core.
- **Drag** is the name given to the bottom half of the pattern, flask, mould or core.

The **parting line** separates the cope and the drag.

- **A core** is a sand shape that is inserted into the mould to produce internal features of a casting such as holes.

Casting Terminology

- The **gating system is the network of channels used to deliver the molten metal to the**
- mould cavity. The metal is introduced through a mouth called the pouring cup, it travels
- vertically down through the sprue and then along horizontal channels called runners
- through a gate into the mould cavity.
- **Casting is the term used to describe both the process and the method.**

INTRODUCTION (CORES)

- ✓ It is defined as sand bodies used to form hollow portion or cavities of desired shape and cavities.
- ✓ Core is made of green sand and is placed in the mould after the pattern is withdrawn
- ✓ Core are subjected to high heat of molten metal when it a poured and it has a good strength, good permeability, high refractoriness and sufficient

- Types of cores

3.Horizontal Cores

4.Vertical cores

5.Balanced cores

6.Drop cores.

Defects in Casting

- Defects may be due to pattern, Moulding box, sand, cores, gating system, runner
- 1. **Mould shift:** Misalignment of pattern, or moulding box.
- 2. **Core shift:** Mis alignment, UNDERSIZE OR OVER SIZE, incorrect size of chaplet
- 3. **Swell:** In sufficient ramming , Molten metal pouring too rapidly or too hard.
- 4. **Shrinkage:** Crank, ,lack of directional solidification

CASTING INSPECTION

- To check the quality of casting for acceptance /Rejection.
- Two ways :
- Destructive Inspection Method
- Non destructive Inspection Method.

Destructive Inspection Method

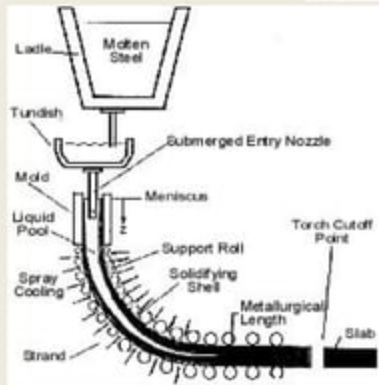
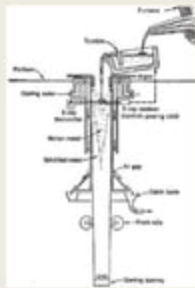
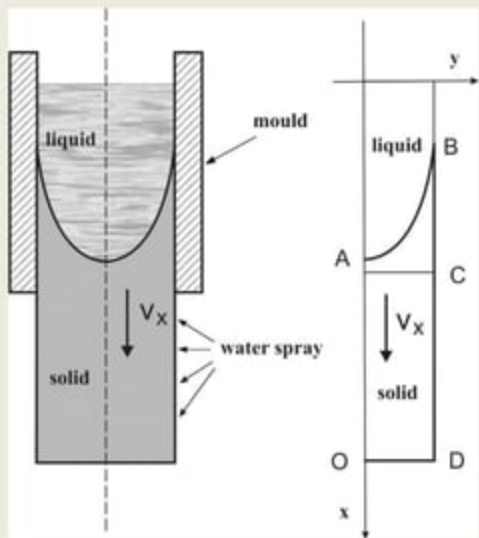
- Sample of casting is destroyed during inspection.
- Performed on test bars or on pieces cut from sample casting.
- Inspection is carried out to test and measure mechanical properties like tensile strength, percentage elongation, hardness etc.

Non destructive Inspection Method

- Inspection is done by not destroying the casting.
- A) Visual Inspection: Crack, Tears dirt , blow holes etc.
- B) Dimensional Inspection: Different gauges and Inspection .Techniques are used for dimensional verification.
- C) Pressure testing: To locate leaks in casting or check overall strength under hyfraulic presssure

- Radiographic Inspection: X-rays are passed through for internal inspection and recorded on photographic film.
- Ultrasonic Inspection
- Fluorescent Penetration: Dipping, Spraying, white powder, applied.

Continuous Casting



Semi-permanent Casting

- A mold is made with both permanent and single use parts
- Consumable parts are usually cores made of chemically bonded sand
- After each pour the mold is cleaned and new consumables are added

Semi-permanent Casting



Investment Casting

- A refractory material (investment) is poured around or built up on a pattern
- The investment is hardened by drying or heating
- The pattern is removed by melting or burning
- Metal is poured into the resulting cavity

Investment Casting

