Foundry Technology
Unit 2

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Syllabus Unit 1

- **Moulding and Core-making Materials:**
  - Ingredients of common type of moulding and core-making sands,
  - their properties and behavior,
  - testing of sands and clay.
- **Moulding Processes:**
  - Classification,
  - Brief description of processes such as green sand, dry sand, loam, floor, Pit and machine molding. No-bake molding process. CO_2-Silicate process.

Molding Material and Properties:

A large variety of molding materials is used in foundries for manufacturing molds and cores. They include molding sand, system sand or backing sand, facing sand, parting sand, and core sand. The choice of molding materials is based on their processing properties. The properties that are generally required in molding materials are:

1. Refractoriness:

It is the ability of the molding material to with stand high temperatures (experienced during pouring) with out

1. Fusion,
2. Cracking, buckling or scabbing,
3. Experiencing any major physical change.

- Silica sand has a high refractoriness.

2. Permeability:

- During pouring and subsequent solidification of a casting, a large amount of gases and steam is generated.
- These gases are those that have been absorbed by the metal during melting, air absorbed from the atmosphere and the steam generated by the molding and core sand.
- If these gases are not allowed to escape from the mold, they would be entrapped inside the casting and cause casting defects.
- To overcome this problem the molding material must be porous.
- Proper venting of the mold also helps in escaping the gases that are generated inside the mold cavity.

3. Green Strength:

- The molding sand that contains moisture is termed as green sand.
- The green sand particles must have the ability to cling to each other to impart sufficient strength to the mold.
- The green sand must have enough strength so that the constructed mold retains its shape.
- Green strength helps in making and handling the moulds.

4. Dry Strength:

- A mould may either intentionally be dried, or a green sand mould may lose its moisture and get dried while waiting for getting poured or when it comes in contact with molten metal being poured.
- The sand thus dried must have dry strength to
  1. Withstand erosive forces due to molten metal,
  2. Withstand pressure of molten metal,
  3. Retain its exact shape, and
  4. Withstand the metallostatic pressure of the liquid material.

5. Hot Strength:

- As soon as the moisture is eliminated, the sand would reach at a high temperature when the metal in the mold is still in liquid state.
- The strength of the sand that is required to hold the shape of the cavity is called hot strength.
- In the absence of adequate hot strength, the mold may

1. enlarge
2. Break
3. get cracked.
4. erode

6. COLLAPSIBILITY:

- Collapsibility determines the readiness with which the molding sand,
  1. Automatically gets collapsed after the casting solidifies, and
  2. Breaks down in knock out and cleaning operations.
- If the mould or core does not collapse, it may restrict free contraction of solidifying metal and cause the same to tear or crack.

7. Flowability:

- It is the ability of the molding sand to get compacted to a uniform density.
- Flowability assists molding sand to flow and pack all-around the pattern and take up the required shape.
- Flowability increases as clay and water contents increase.

8. Adhesiveness:

It is the property of molding sand owing to which, it

1. Sticks with the walls of molding boxes,
2. Thus makes it possible to mold cope and drag.

9. Fineness:

- Finer sand mould resist metal penetration and produce smooth casting surfaces.
- Fineness and permeability are in conflict with each other and hence they must be balanced for optimum results.

10. Chemical inertness

- The sand must not react with the metal being cast. This is especially important with highly reactive metals, such as magnesium and titanium

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11. Cohesiveness

- This is the ability of the sand to retain a given shape after the pattern is removed.

12. Availability/cost

- The availability and cost of the sand is very important because the amount of sand required is three to six times the weight of the casting. Although sand can be screened and reused, the particles eventually become too fine and require periodic replacement with fresh sand.
- In large castings it is economical to use two different sands, because the majority of the sand will not be in contact with the casting, so it does not need any special properties. The sand that is in contact with the casting is called *facing sand*, and is designed for the casting on hand. This sand will be built up around the pattern to a thickness of 30 to 100 mm (1.2 to 3.9 in). The sand that fills in around the facing sand is called *backing sand*. This sand is simply silica sand with only a small amount of binder and no special additives.

MOULDING MATERIALS

- Material should be such that the mould cavity retains its shape till the molten metal has solidified. Moulding materials are:
- 1.Metal & alloys
- 2. Wax
- 3. Plaster
- 4. Sand (Silica, Zircon, Olivine,
- Chromite, magnesite, etc.)

Natural Moulding Sand Composition & Properties

Properties	Iron Base	Copper Base(Brass)
1. AFS Fineness no.	70-80	20-30
2. Clay %	15-18	17-19
3. Grain Shape	Sub-angular	Sub-angular
4. Moisture %	6	7
5. Permeability	75	250
6. G.C.S. p.s.i.	7.0	10
7. Sinter Point °C	1200	1250

Types of Moulding Methods

1) ***Green sand moulding:***

- Sand in moist condition
- 5% water, 15 to 30% clay
- Used for both mould making & core making
- Moisture & permeability are controlled to prevent casting defects
- Poured in green condition
- Used for producing simple, small & medium sized castings

2) Dry Sand Moulding:

- Green sand moulds when dried fully results in dry sand moulding.
- One can have semi-dried or skin dried mould depending on extent of drying.
- Green strength & rigidity are higher than green sand.
- Less defects
- Silica flour added for good strength, erosion resistance & good surface finish.

3) Loam Moulding:

- Clay is used up to 50% remaining silica sand
- Sand mixture is almost pasty
- Used for moulding large grey C.I. castings.

- Sweep or skeleton pattern may be used for moulding.
- Moulding is done in a pit under the ground level.

TYPES OF SANDS:

a) **System sand:**

- Used in mechanical sand preparation & handling system.
- No facing sand used
- Used sand is cleaned & reconditioned (Water, binder, special additives are added)

b) Parting Sand:

- Dry silica sand, burnt sand
- Sprinkled over pattern, parting surface
- Pattern & mould half box withdrawal becomes easier

c) Facing sand:

- Sand mixture just next to the pattern is known as facing sand.
- Thickness of this sand above pattern may be up to 2 to 2.5cms
- Freshly prepared synthetic sand or reconditioned sand
- It withstands the temperature & pressure of molten metal
- Retains the shape & size of mould cavity till the casting is solidified.

d) Back up sand or Backing sand:

- This supports the facing sand.

- It is the reused sand
- The bulk of the mould box is filled with backing sand & compacted.

Molding Sand Composition:

The main ingredients of any molding sand are:

- Base sand,
- Binder, and
- Moisture

1. Base Sand:

- Silica sand is most commonly used base sand.
- Other base sands that are also used for making mold are zircon sand, Chromite sand, and olivine sand.
- Silica sand is cheapest among all types of base sand and it is easily available.

2. Binder:

- Binders are of many types such as:
  1. Clay binders,
  2. Organic binders and
  3. Inorganic binders

- Clay binders are most commonly used binding agents mixed with the molding sands to provide the strength.

- The most popular clay types are:
  - Kaolinite or fire clay (Al_2O_3 2 SiO_2 2 H_2O) and Bentonite (Al_2O_3 4 SiO_2 nH_2O)
  - Of the two the Bentonite can absorb more water which increases its bonding power.

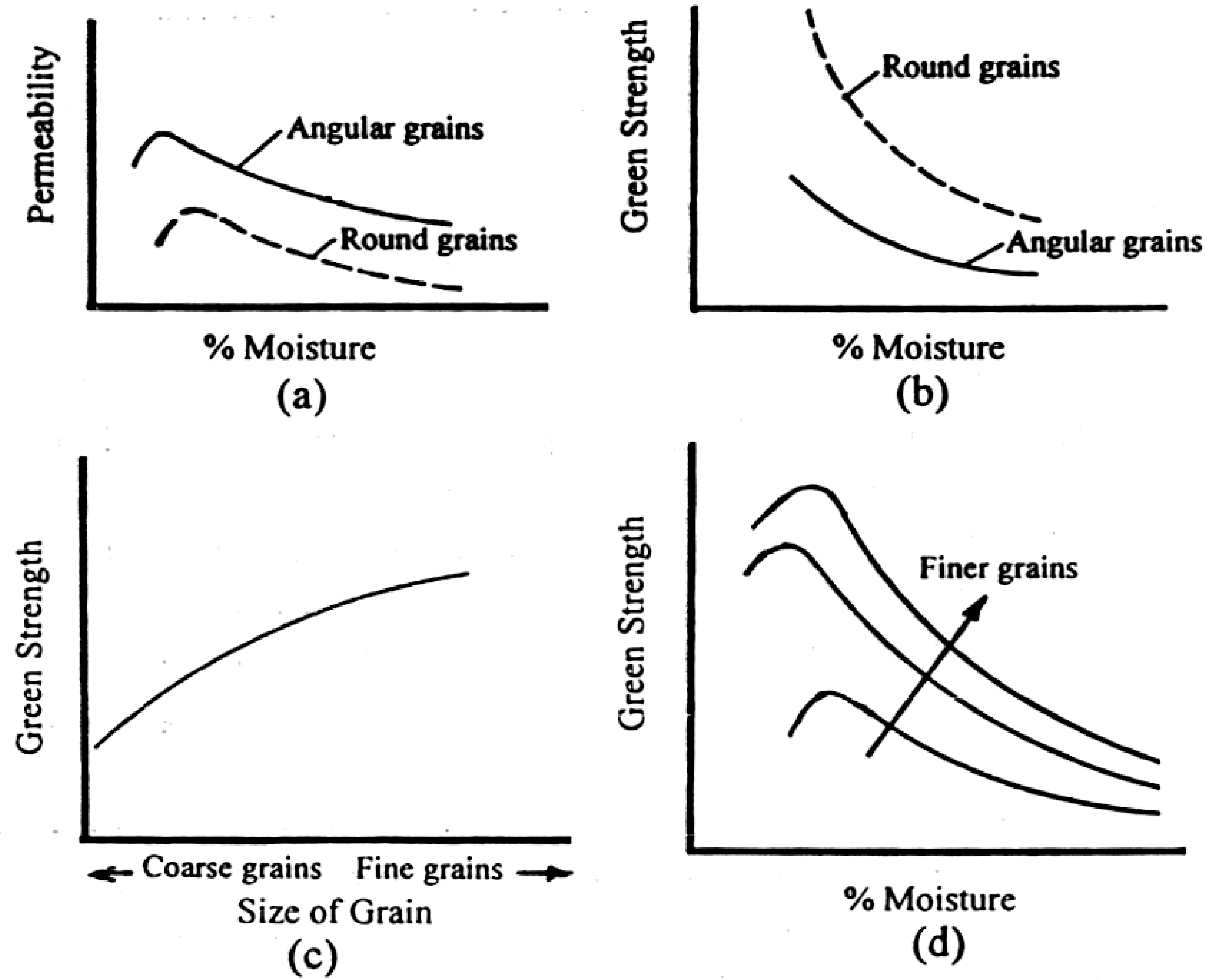
3. MOISTURE:

- Clay acquires its bonding action only in the presence of the required amount of moisture.
- When water is added to clay, it penetrates the mixture and forms a microfilm, which coats the surface of each flake of the clay.
- The amount of water used should be properly controlled.
- This is because a part of the water, which coats the surface of the clay flakes, helps in bonding, while the remainder helps in improving the plasticity.

A Typical Composition of Molding Sand:

Molding Sand Constituent	Weight Percent
Silica sand	92
Clay (Sodium Bentonite)	8
Water	4

EFFECT OF MOISTURE, GRAIN SIZE AND SHAPE ON MOULD QUALITY



- **Natural and Synthetic molding sand Natural molding sand:**
- The following average compositions are seen in natural molding sand: 65.5% silica grains, 21.7% clay content, 12.8% undesirable impurities.
- Too much clay content and other impurities fill up the gaps between the sand grains. This will hinder the necessary passage of steam and other gases during pouring of the mold.
- Synthetic molding sand is made by mixing together specially selected high quality clay free silica, with about 5% of clay. They are tailor made to give most desirable results.

- Some of the advantages of synthetic molding sand are:
  - Refractory grain sizes are more uniform,
  - Higher refractoriness (= 3000oF),
  - Less bonding agent is required (about 1/3rd of the clay percentage found in natural molding sand),
  - More suitable for use with mechanical equipment
- Advantages of natural molding sand:
  - 1. moisture content range is wide,
  - 2. molds can be repaired easily

• Core making:

- Generally Cores are used for making interior surfaces of hollow castings and now-a-days it is used for making exterior surfaces and for other purposes.
- Green sand cores contain ordinary molding sand and dry sand core contains hardened or baked sand.
- Core mix contains clay free silica sand. This is suitably mixed with binders, water and other ingredients to produce a core mix.
- Synthetic core binders have some unusual properties like shorter baking times and excellent collapsibilities which reduces the defect in castings.

- Urea formaldehyde binders burn out faster and collapse at lower temperature as compared to phenol formaldehyde binders. Thus urea formaldehyde binders are suitable for use at lower temperature metals like Al, Mg, thin sections of brass, bronze.

- Phenol formaldehyde binders are employed for thick sections of CI, steel castings .

- ***Binders Used in Sand Casting for Molds, Cores***

- **Clays:**
- Fire clay (kaolinite)
- Southern bentonite (calcium montmorillonite)
- Western bentonite (sodium montmorillonite)
- Secondary mica clays (illite)
- **Oils:**
- Vegetables (e.g. linseed oil)
- Marine animal (e.g., whale oil)
- Mineral (used for diluting oils given above)
- **Synthetic resins, thermosetting:**
- Urea formaldehyde
- Phenol Formaldehyde
- **Cereal binders made from corn:**
- Gelatinized starch (made by wet milling, contains starch and gluten)
- Gelatinized corn flour (made by dry-milling hominy)
- Dextrin (made from starch, a water-soluble sugar)

- **Wood –product binders:** Natural resin (e.g., rosin, thermoplastic), Sulfite binders (contain lignin, produced in the paper pulp process), Water-soluble gums, resins, and organic chemicals.
- **Protein binders (containing nitrogen):** Portland cement Pitch (a coal-tar product), Molasses (usually applied in water as a spray), Cements (e.g., rubber cement) Sodium silicate (water glass, CO_2 hardening binders).

- Core characteristics:
- Good dry sand cores should have the following characteristics:
- 1.Good dry strength and hardness after baking
- 2.Sufficient green strength to retain the shape before baking
- 3.Refractoriness
- 4.Surface smoothness
- 5.Permeability
- 6.Lowest possible amount of gas created during the pouring of casting

- **Core dryers:**

- cores must be supported properly in the green state, before they are baked, hardened.
- Curved surfaces of the cores will be flattened if placed on the flat core plates
- Few cores should be prevented from sagging and breaking
- Flat surfaces are required for supporting the cores. These are called 'Core dryers'. They are designed to support the cores.

- Core wires, rods, arbors:

- Small core have sufficient strength after baking to withstand the molten metal upward force. For iron castings the lifting force is four times the weight of a core.

- Certain cores and slender cores which do not have strength are supported by embedding wires, rods, arbors into the core sections.

- Wires are meant for small cores, where as arbors are C I or steel based skeleton structures. Removing arbors is an issue here, sometimes arbors are made in parts, bolted together to facilitate easy removal. Hooks are provided in the arbors for easy removal. They sometimes project outside the core prints.

• Core venting :

- Proper core venting is required especially if the cores are surrounded largely by molten metal. The cores containing binders will produce gases, steam because of the heat generated due to molten metal.

- These gases should be vented out through core prints so that defects like 'blows' can be avoided.

- Large cores are sometimes made hollow.

- Core baking :

- After cores are made and placed on the core dryer, they are taken to ovens for baking

- Baking removes moisture and hardens core binders

- generally core sands are poor conductors of heat and hence heat penetrates slowly into the interior sections of the cores

- In a core having thin and thick sections, the thin sections will be over baked, while thick sections will be optimally baked

- Over baking of cores will result in destroying the binders
and hence core will be just a heap of sand

- Core ovens Continuous ovens:

- -Are those through which the core moves slowly on the conveyor.
- Continuous loading and unloading is followed and hence the baking time is controlled by the rate of travel of the conveyor.
- Generally same sized cores are used in this.
- Batch type ovens:
- No movement of cores occur

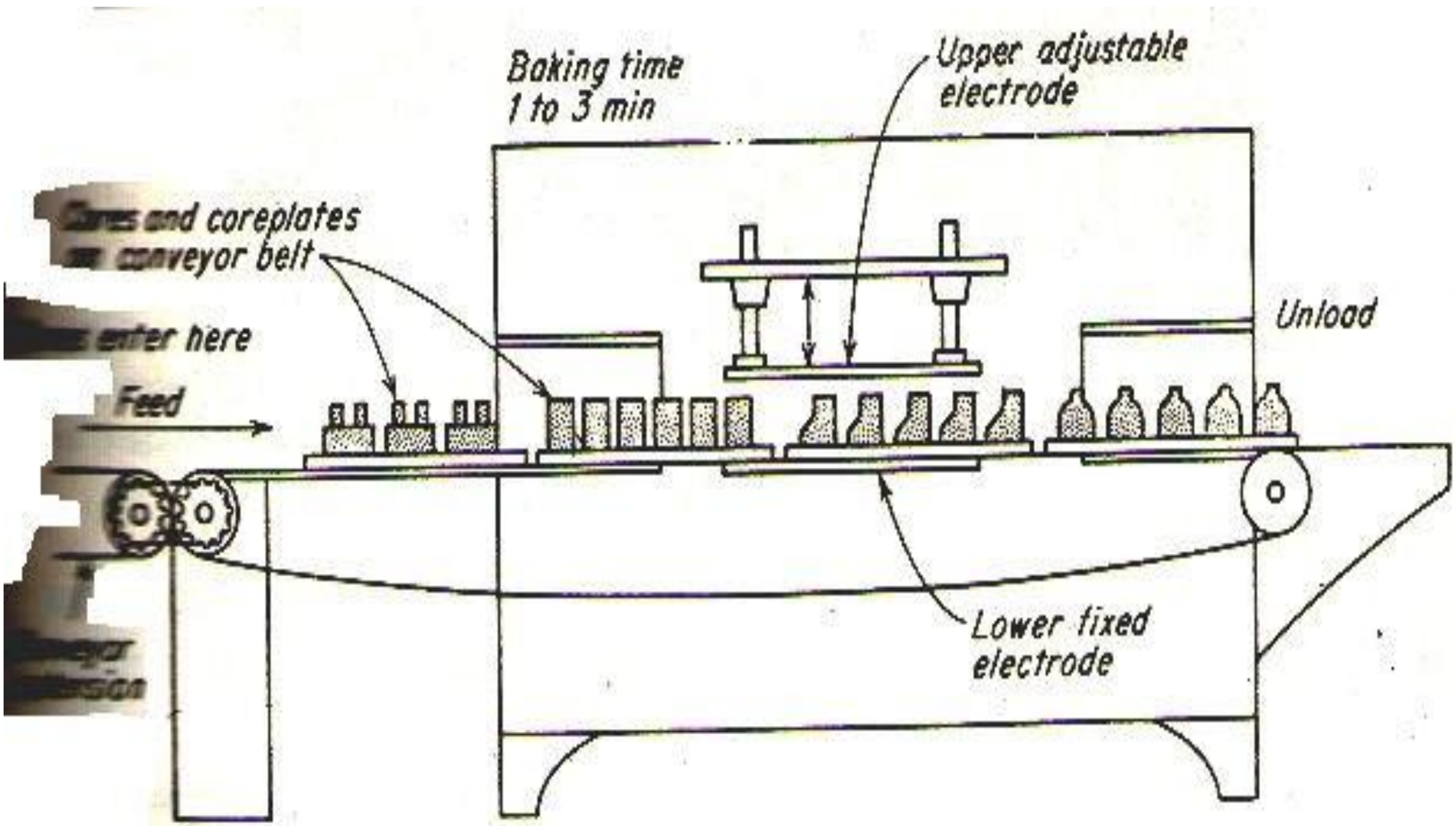
- Electricity, gas, oil are used for heating and temperature is maintained uniformly and closely controlled by suitable instruments.

- Temperature is of the order of 450oF and this depends upon the binder.

- Heating elements are properly spaced to have uniform/same temperature distribution throughout the container.

- Replacing new air from outside is done through blowers so that moisture can be controlled.

DIELECTRIC CORE BAKING



- Rapid baking is possible by dielectric heating.
- Induction heating: used for heating materials which are conductors of electricity, like metals, and is done in continuously varying magnetic field.
- Dielectric heating is done for non-conductors of electricity. In this alternating electric field is established between two parallel plates which act as an electric condenser.

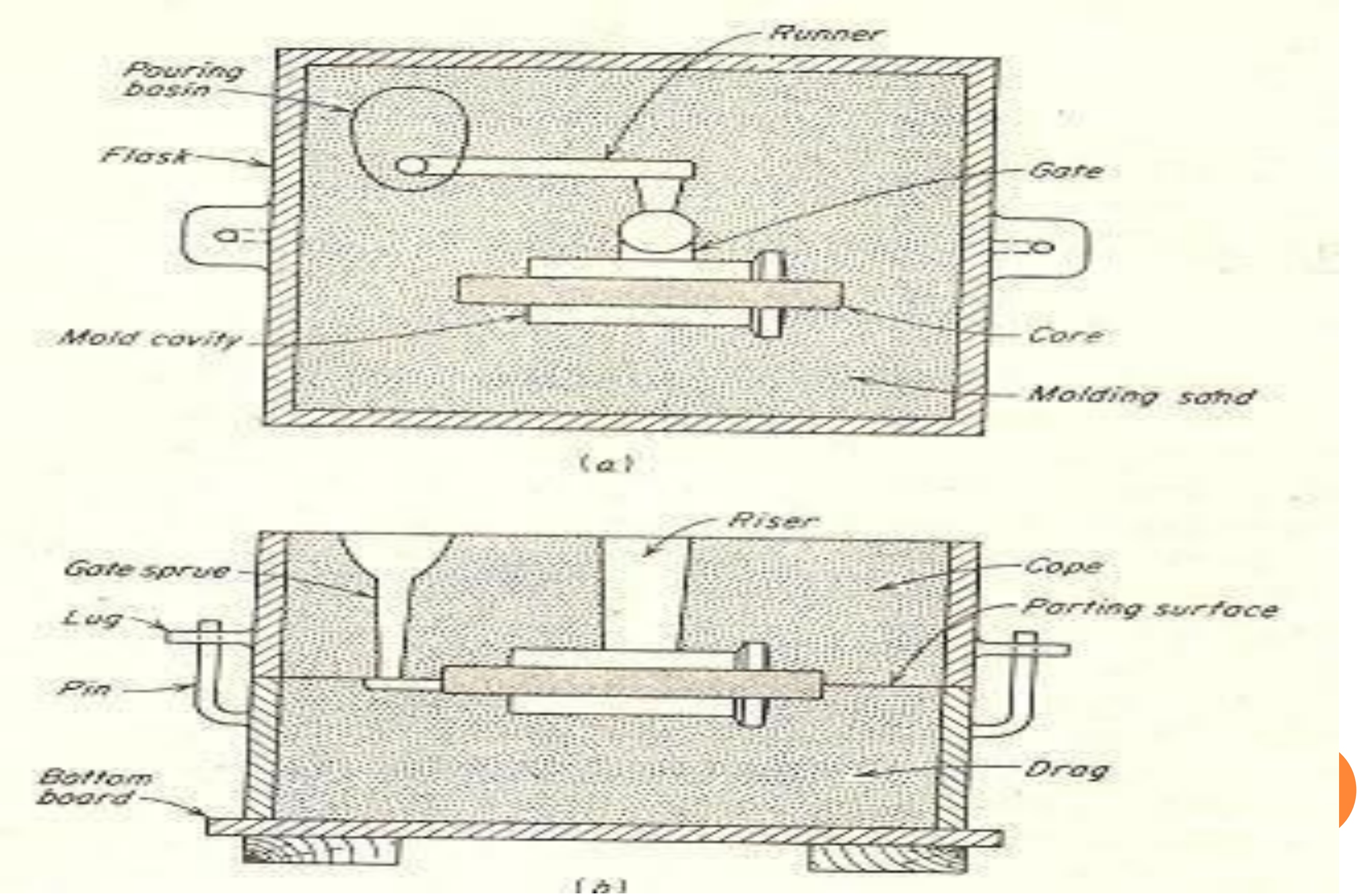
- The material to be heated is placed in between these parallel electrodes
- With a high frequency electric current (15 million times/sec) in ON condition, heat is generated into the molecules.
- IN this case, the interior of the cores are heated rapidly as outer surfaces.
- Thermosetting synthetic resin binders, which cure app. at 250°F and which do not require oxidation are well suited for dielectric heating.

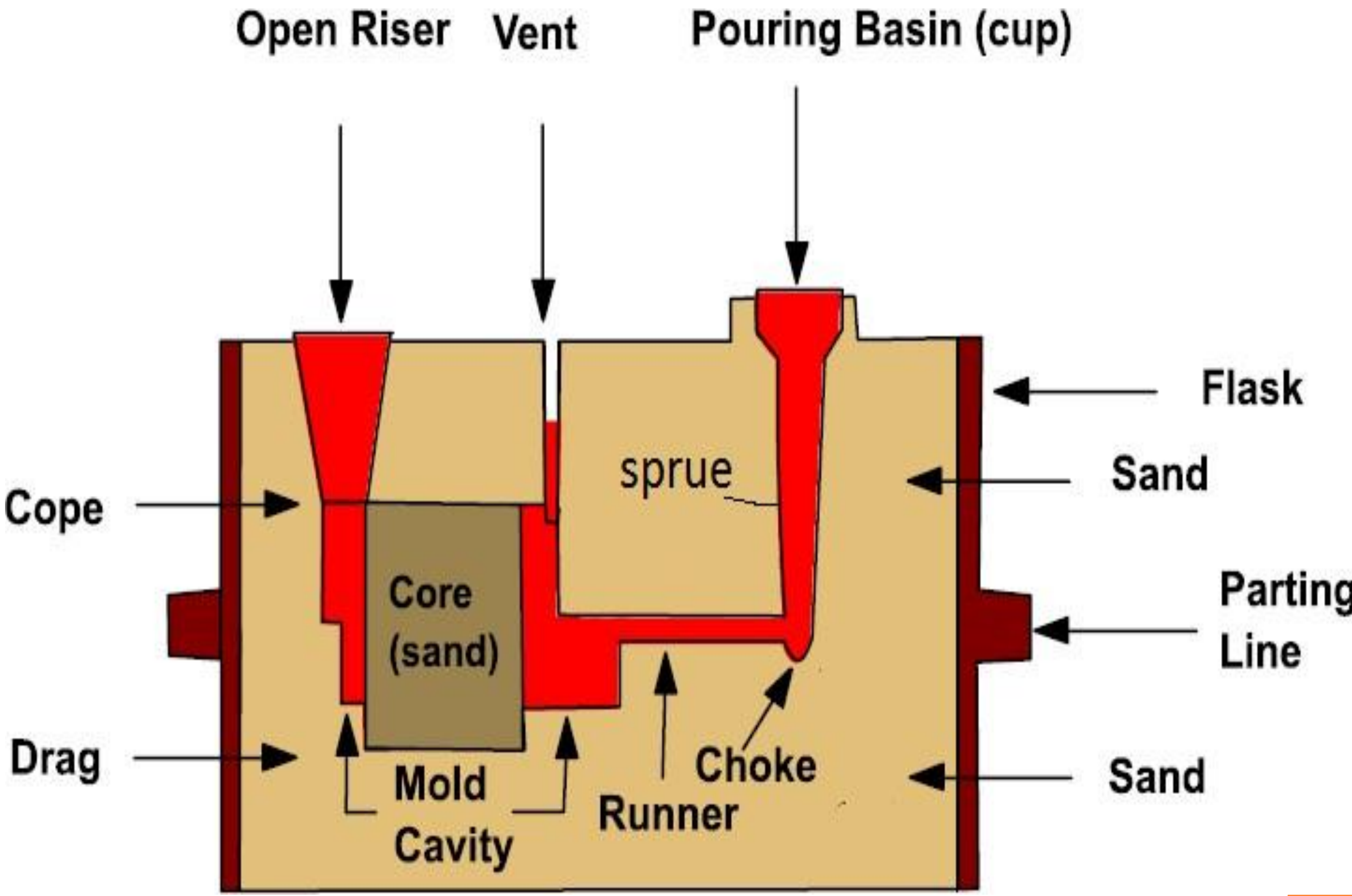
- Core coatings:

- A fine refractory coating or facing is generally applied on the core surface by spraying or by dipping the core into a tank containing facing liquid
- this is done to have a smoother cast surface by preventing the penetration of molten metal into spaces between sand grains.
- Facing materials: finely ground graphite, silica, zircon flour
- after coating, the layer is dried, usually by torches, burners
- Yield considerable cost savings.

- Handling them and keeping them in mold is tricky.
- Method 1: A green sand core can be rammed up on the dry sand core base.
- Method 2: Ram the green sand core around an arbor, by which it can be lifted.

IMPORTANT CASTING TERMS




Open Riser
Vent
Pouring Basin (cup)
Flask
sprue
Sand
Cope
Core
(sand)
Parting
Line
Drag
Mold
Cavity
Choke
Runner
Sand

- **Flask:** A metal or wood frame, without fixed top or bottom, in which the mould is formed. Depending upon the position of the flask in the moulding structure, it is referred to by various names such as drag – lower moulding flask, cope – upper moulding flask, cheek – intermediate moulding flask used in three piece moulding.
- **Pattern:** It is the replica of the final object to be made. The mould cavity is made with the help of pattern. Parting line: This is the dividing line between the two moulding flasks that makes up the mould.

- **Moulding sand**: Sand, which binds strongly without losing its permeability to air or gases. It is a mixture of silica sand, clay, and moisture in appropriate proportions.

- **Facing sand:** The small amount of carbonaceous material sprinkled on the inner surface of the mould cavity to give a better surface finish to the castings.

❖ *Making a simple sand mould :*

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.

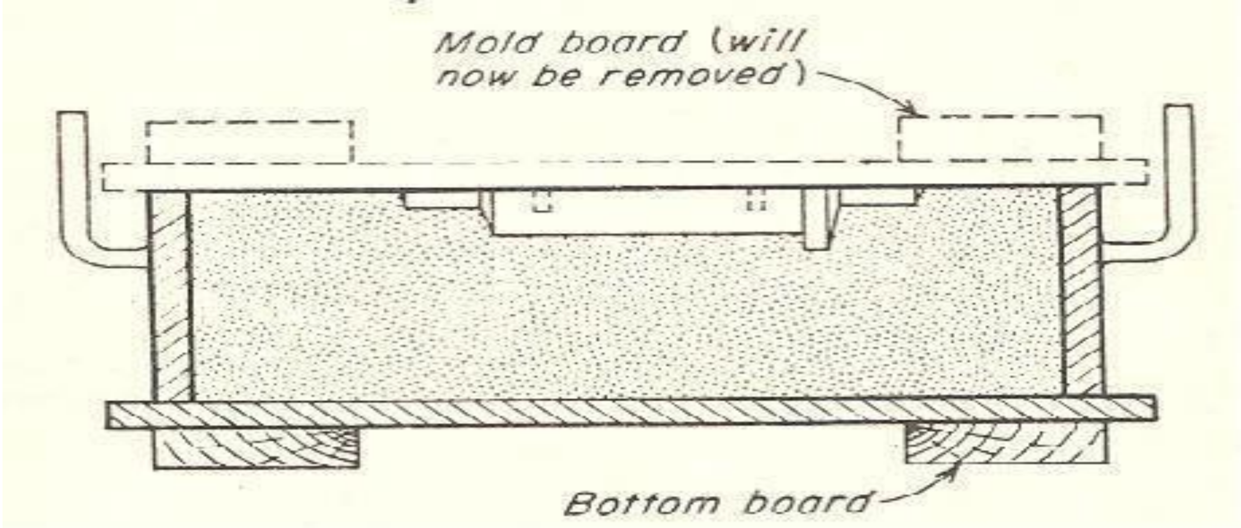
13) The sprue and riser are removed and a pouring basin is made at the top to pour the liquid metal.

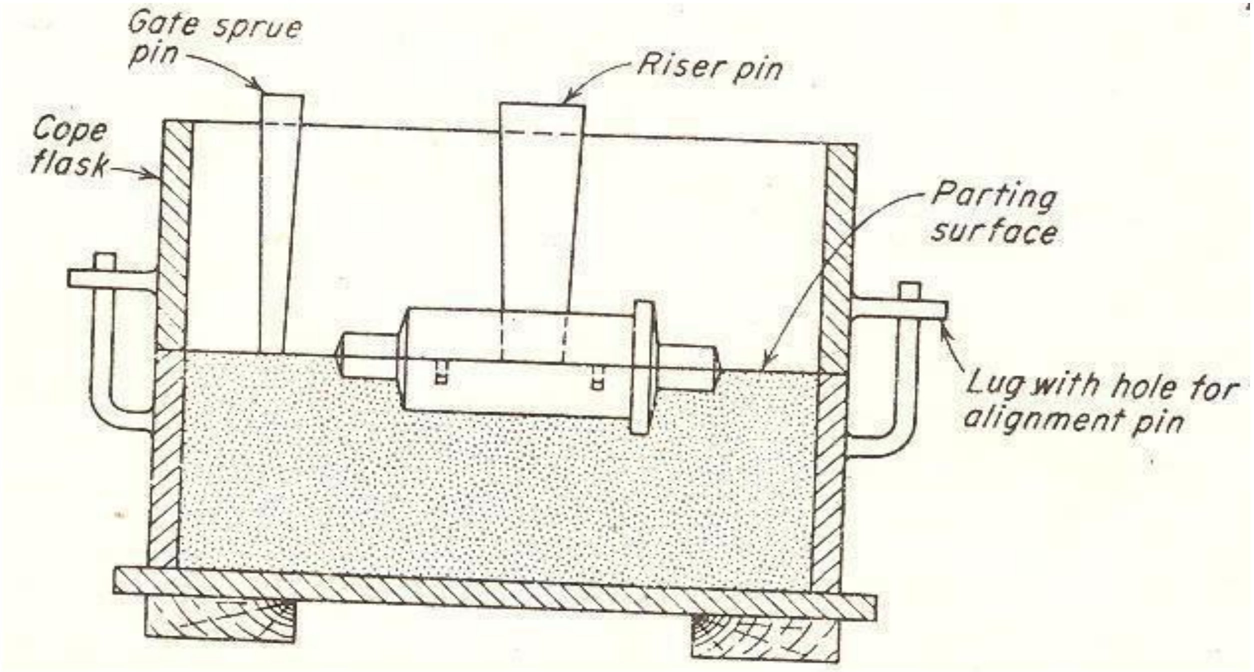
14) Pattern from the cope and drag is removed.

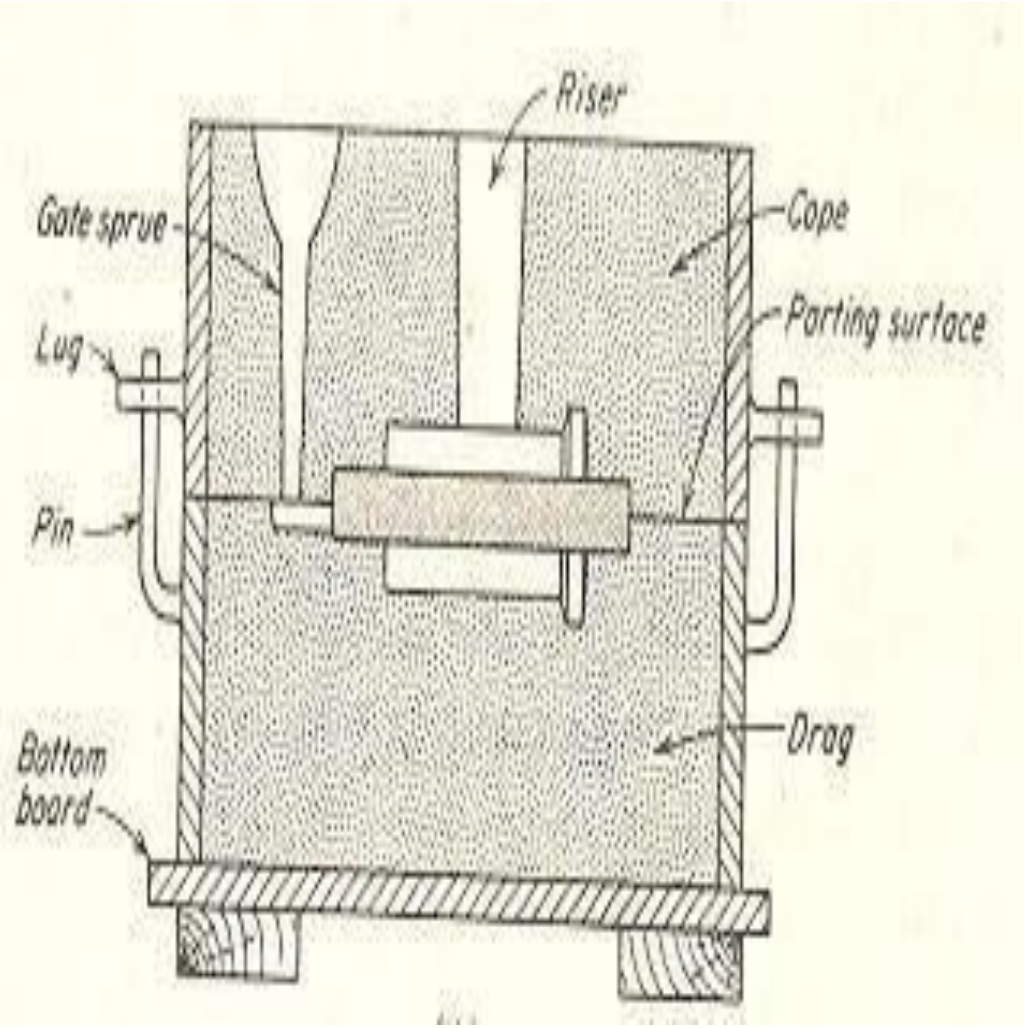
15) Runners and gates are made by cutting the parting surface with a gate cutter. A gate cutter is a piece of sheet metal bent to the desired radius.

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.


Mold board (will
now be removed)
Bottom board


Gate sprue
pin
Riser pin
Cope
flask
Parting
surface
Lug with hole for
alignment pin



Riser
Gate sprue
Cope
Parting surface
Lug
Pin
Drag
Bottom board

Moulding processes

(A) According to the method used :

1) Floor moulding
2) Bench moulding
3) Pit moulding
4) Machine moulding

1) Floor moulding :

- This method of moulding is commonly used for preparing the mould

  of heavy and large size of jobs.

- In floor moulding , the floor itself acts as a drag.
- It is preferred for such rough type of casting where

  the upper surface finish has no importance.

2) Bench moulding :

- Bench moulding is done on a work bench of a height convenient to the moulder.
- It is best suited to the mould of small and light items which are to be casted by non- ferrous metals.

3) Pit moulding :

- Large sizes of jobs which cannot be accommodated in moulding

  boxes are frequently moulded in pits.

- Here, the pit acts as a drag. Generally, one box, i.e.

  cope is sufficient to complete the mould.

- Runner and riser , gates and pouring basin are cut in it.

4) Machine moulding :

- Machine moulding method is preferred for mass production of identical casting as most of the moulding operations such as ramming of sand, rolling over the mould, and gate cutting etc. are performed by moulding machine.
- Therefore, this method of moulding is more efficient and economical in comparison to hand moulding.

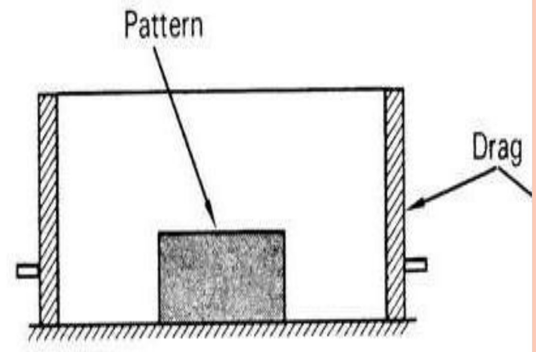
(B) According to the mould materials

1) Green sand moulding
2) Dry sand moulding
3) Loam sand moulding
4) Core sand moulding

1) Green sand moulding

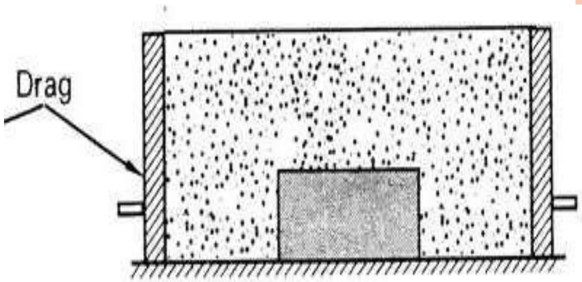
- Procedure involved in making green sand moulds

1. Suitable proportions of silica sand (85 - 92 %), bentonite binder (6-12 %), water (3-5 %) and additives are mixed together to prepare the green sand mixture.



(a) Pattern placed in drag box

2. The pattern is placed on a flat surface with the drag box enclosing it as shown in figure (a). Parting sand is sprinkled on the pattern surface to avoid green sand mixture sticking to the pattern.

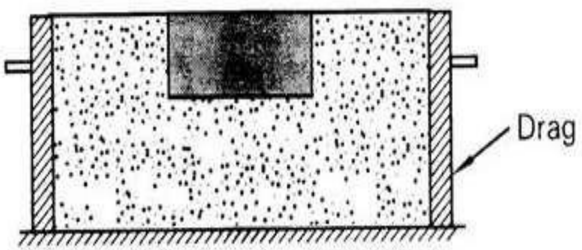


(b) Drag is filled with sand

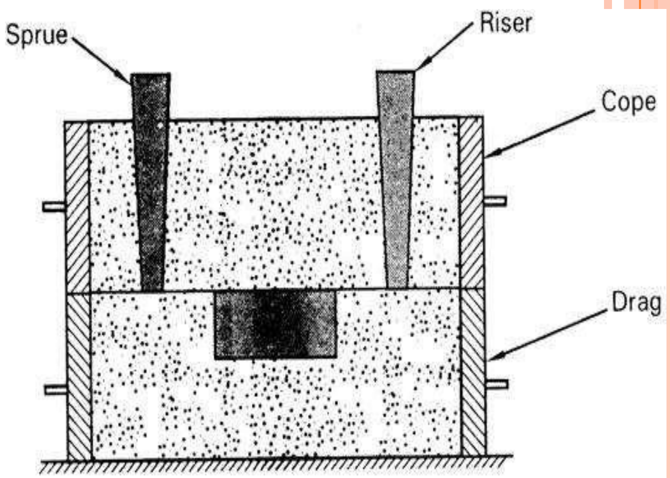
3. The drag box is filled with green sand mixture and rammed manually till its top surface. Refer figure (b).

4. The drag box is now inverted so that the pattern faces the top as shown in figure (c). Parting sand is sprinkled over the mould surface of the drag box.

5. The cope box is placed on top of the drag box and the sprue and riser pin are placed in suitable locations. The green sand mixture is rammed to the level of cope box as shown in figure (d).



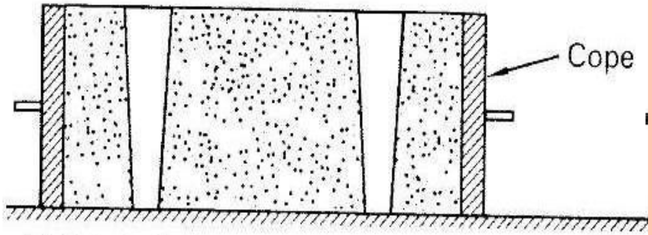
(c) Drag box inverted so that pattern faces the top



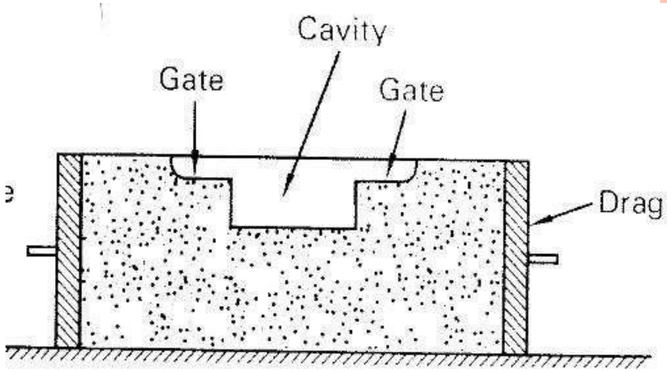
(d) Cope is placed on drag. Sprue & riser placed in position & sand rammed in cope box

6. The sprue and the riser are removed from the mould. The cope box is lifted and placed aside, and the pattern in the drag box is withdrawn by knocking it carefully so as to avoid damage to the mould.

7. Gates are cut using hand tools to provide passage for the flow of molten metal. Refer figure (e) and (f).



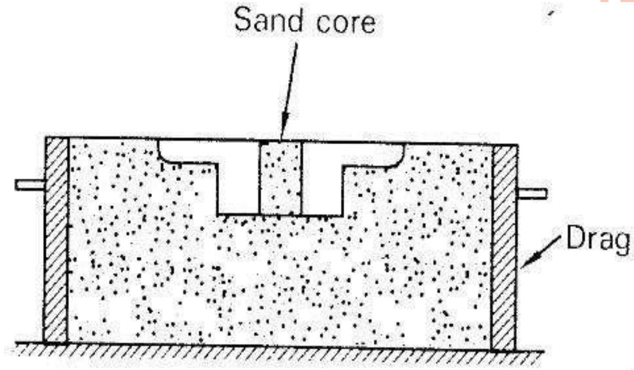
(e) Sprue & riser are removed. Cope box is placed aside of drag



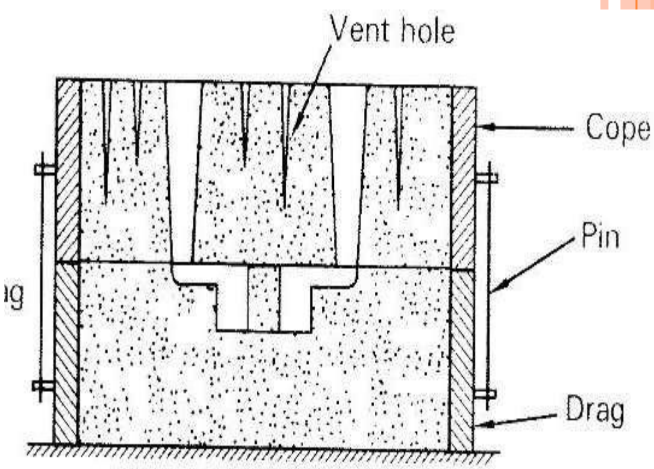
(f) Pattern is removed to leave a cavity in the mould. Gates are cut.

8. The mould cavity is cleaned and finished. Cores, if any, are placed in the mould to obtain a hollow cavity in the casting. Refer figure (g).

9. The cope is now placed on the drag box and both are aligned with the help of pins. Vent holes are made to allow the free escape of gases from the mould during pouring. The mould is made ready for pouring. Refer figure (h).



(g) Core is placed in mould cavity



h) Cope placed on drag & vent holes are made. Mould is ready for pouring

- **Advantages**
  - Green sand molding is adaptable to machine molding.
  - No mold baking or drying is required.
  - There is less mold distortion than in dry sand molding.
  - Time and cost associated with mold baking or drying is eliminated.
  - Green sand molding provides good dimensional accuracy across the parting line.
- **Disadvantages**
  - Green sand molds possess lower strengths.
  - They are less permeable.
  - There are more chances of defects (like blow holes etc.) occurring in castings made by green sand molding.
  - Surface finish deteriorates as the weight of the casting increases.
  - Dimensional accuracy of the castings decreases as their weight increases.

2) Dry sand moulding

- Here, in the preparation of the mixture for dry sand moulding, special binding material such as resin, molasses, flour, or clay are mixed to give strong bond to the sand.
- All parts of mould are completely dried before casting.
- Dry sand moulding is widely used for large size of work such as parts of engine, large size of fly wheel and rolls for rolling mill.
- This process is costlier than green sand moulding but much superior in quality.

3) Loam sand moulding

- Loam sand moulding are prepared with coarse grained silica sand, clay, coke, horse manure and water.
- This process of moulding is performed in different way.
- First, a rough structure of desired shape is made by hand by using bricks and loam sand.
- The surface of structure are blackened and dried before being casted.

4) Core sand moulding

- For core sand moulding, mixture is prepared with silica sand, olivine, carbon and chamotte sands.
- Sand that contains more than 5% clay may not be used as core sand.
- For core making by hand, the core sand is filled and rammed in the core box

  properly.
- The Whole operation takes a short time after the core box is withdrawn and the

(C) Other moulding processes:

1) Shell moulding

2) Permanent mould casting

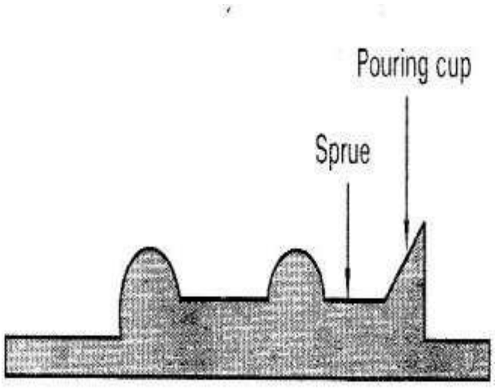
3) Carbon dioxide moulding

1) Shell moulding

- Shell moulding is an efficient and economical method for producing steel castings.
- The process was developed by Herr Croning in Germany during World war-II and is sometimes referred to as the Croning shell process.

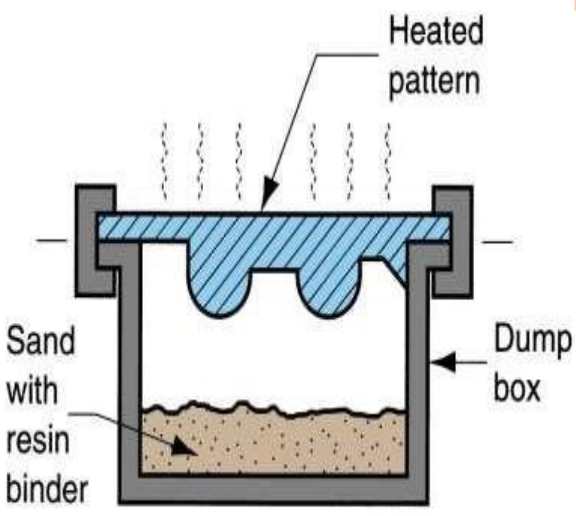
Procedure involved in making shell mould

a. A metallic pattern having the shape of the desired casting is made in one half from carbon steel material. Pouring element is provided in the pattern itself. Refer figure (a).



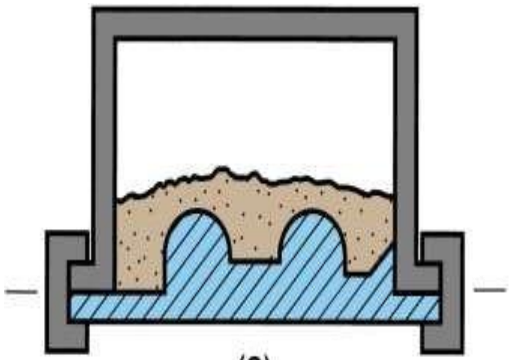
(a) One half of a pattern to produce dumble shaped casting

1. The pattern is inverted and is placed over a box as shown in figure (1). The box contains a mixture of dry silica sand or zircon sand and a resin binder (5% based on sand weight).



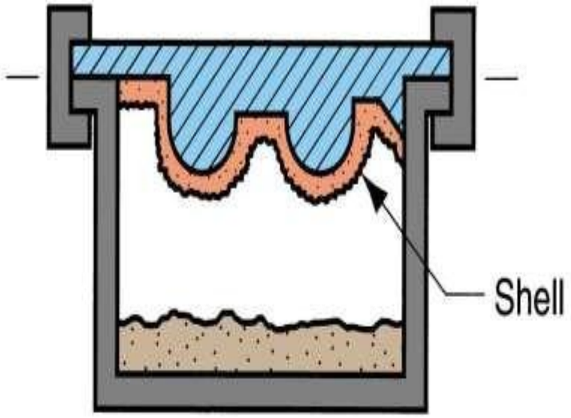
(1)

2. The box is now inverted so that the resin-sand mixture falls on the heated face of the metallic pattern. The resin-sand mixture gets heated up, softens and sticks to the surface of the pattern. Refer figure (2).



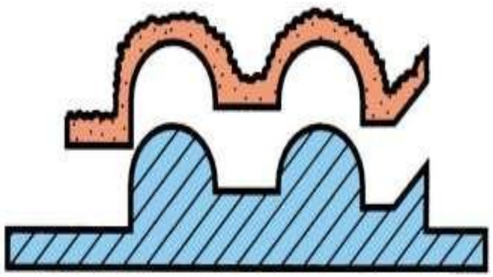
(2)

3. After a few seconds, the box is again inverted to its initial position so that the lose resin-sand mixture falls down leaving behind a thin layer of shell on the pattern face. Refer figure (3).



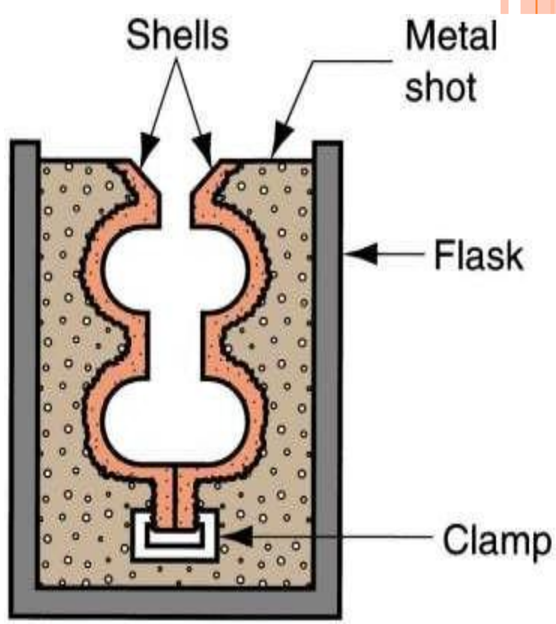
(3)

4. The pattern along with the shell is removed from the box and placed in an oven for a few minutes which further hardens the shell and makes it rigid. The shell is then stripped from the pattern with the help of ejector pins that are provided on the pattern. Refer figure (5).



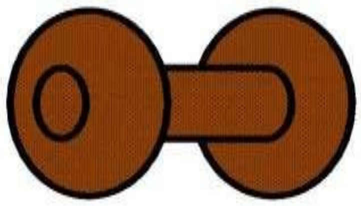
(5)

5. Another shell half is prepared in the similar manner and both the shells are assembled, together with the help of bolts, clips or glues to form a mould. The assembled part is then placed in a box with suitable backing sand to receive the molten metal. Refer figure (6).



(6)

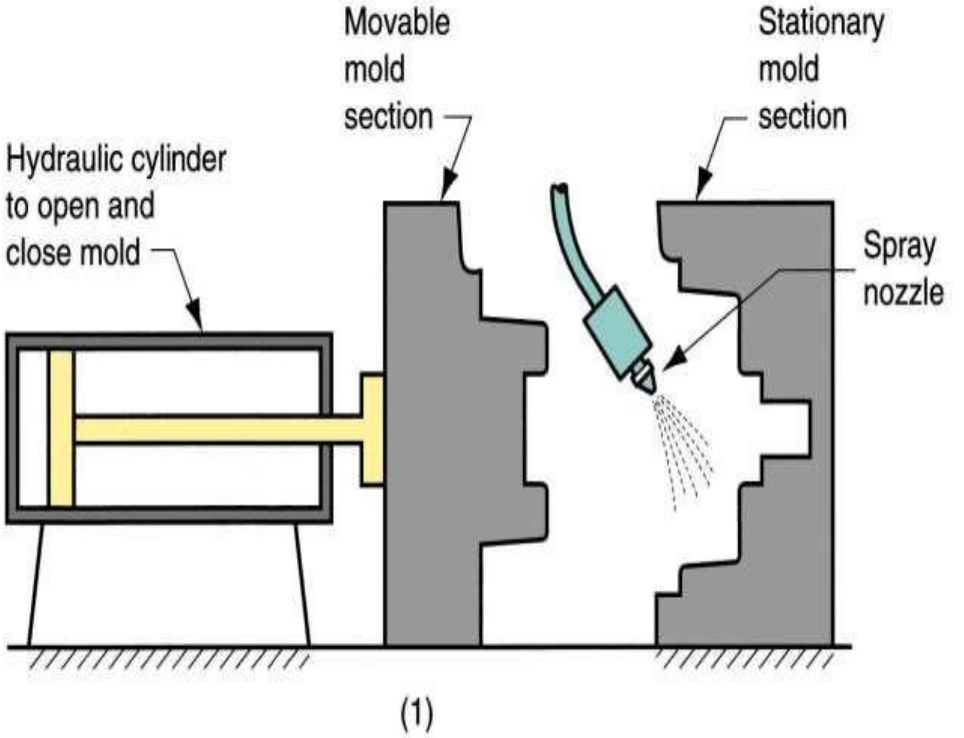
6. After the casting solidifies, it is removed from the mould, cleaned and finished to obtain the desired shape as shown in figure (7).



(7)

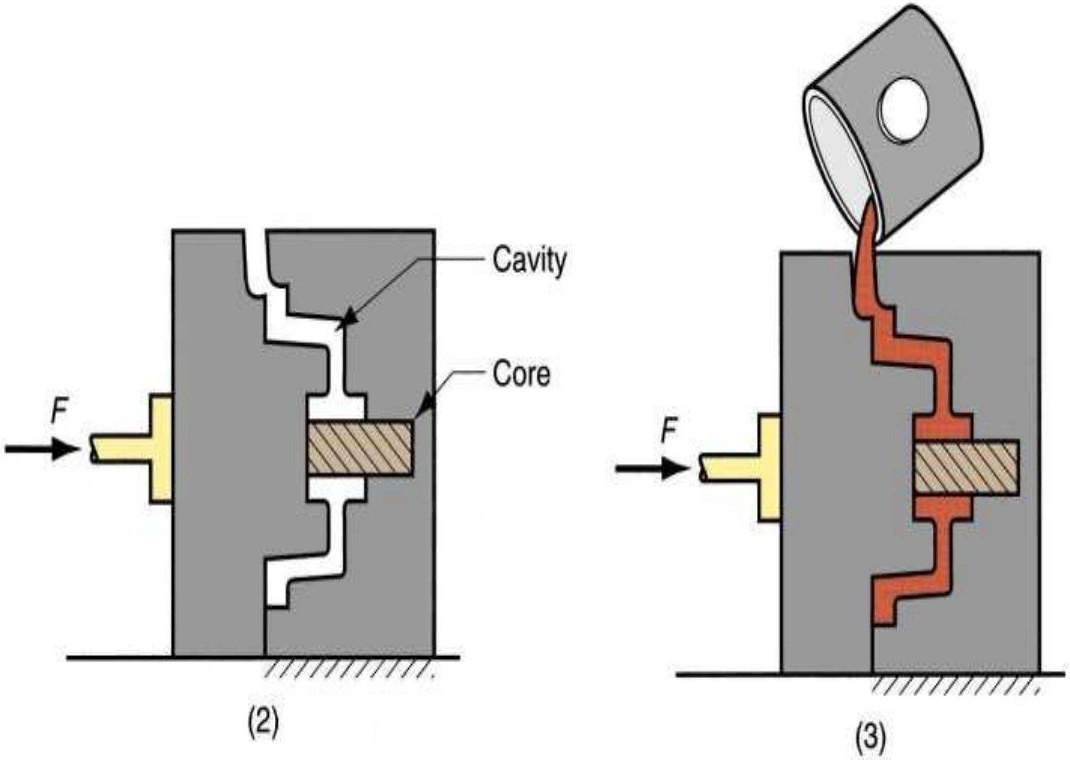
- Advantages
  - ✓Better surface finish and dimensional tolerances.
  - ✓Reduced machining.
  - ✓Requires less foundry space.
  - ✓Semi-skilled operators can handle the process easily.
  - ✓Shells can be stored for extended periods of time.
- Disadvantages
  - ✓ Initially the metallic pattern has to be cast to the desired shape, size and finish.
  - ✓ Size and weight range of castings is limited.
  - ✓ Process generates noxious fumes.

2) Permanent Mold Casting



Steps in permanent mold casting: (1) mold is preheated and coated

Permanent Mold Casting



Steps in permanent mold casting: (2) cores (if used) are inserted and mold is closed, (3) molten metal is poured into the mold, where it solidifies.

3) CARBON DIOXIDE (CO_2) MOLDING

- Carbon dioxide moulding also known as sodium silicate process is one of the widely used process for preparing moulds and cores.
- In this process, sodium silicate is used as the binder. But sodium silicate activates or tend to bind the sand particles only in the presence of carbon dioxide gas. For this reason, the process is commonly known as $C0_2$ process.

❖ Steps involved in making carbon dioxide mould

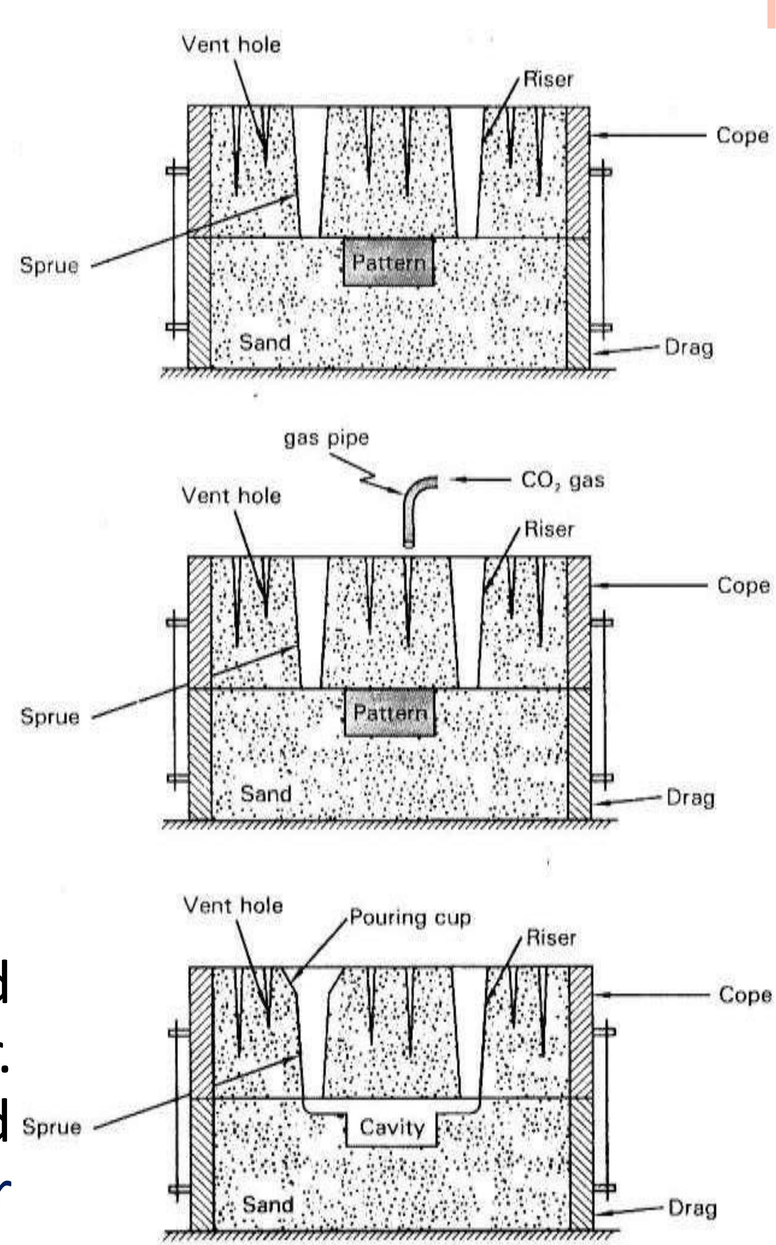
- Suitable proportions of silica sand and sodium silicate binder (3-5% based on sand weight) are mixed together to prepare the sand mixture.
- Additives like aluminum oxide, molasses etc., are added to impart favorable properties and to improve collapsibility of the sand.
- The pattern is placed on a flat surface with the drag box enclosing it. Parting sand is sprinkled on the pattern surface to avoid sand mixture sticking to the pattern.
- The drag box is filled with the sand mixture and rammed manually till its top surface. Rest of the operations like placing sprue and riser pin and ramming the cope box are similar to that of green sand moulding process.

- Figure (a) shows the assembled cope and drag box with vent holes. At this stage, the carbon dioxide gas is passed through the vent holes for a few seconds. Refer figure (b).
- Sodium silicate reacts with carbon dioxide gas to form silica gel that binds the sand particles together. The chemical reaction is given by:

$$Na_2Si03 + C0_2 \text{->} Na_2C0_3 + Si0_2$$

(Sodium Silicate) (silica gel)

The sprue, riser and the pattern Are withdrawn from the mould, and gates are cut in the usual manner. The mould cavity is finished and made ready for pouring. Refer figure (c).



Advantages

- Instantaneous strength development. The development of strength takes place immediately after carbon dioxide gassing is completed.
- Since the process uses relatively safe carbon dioxide gas, it does not present sand disposal problems or any odour while mixing and pouring. Hence, the process is safe to human operators.
- Very little gas evolution during pouring of molten metal.

Disadvantages

- Poor collapsibility of moulds is a major disadvantage of this process.
- There is a significant loss in the strength and hardness of moulds which have been stored for extended periods of time.
- Over gassing and under gassing adversely affects the properties of cured sand.

No Bake Moulding Process

- **Nobake is a casting process that involves the use of chemical binders to bond the molding sand.**
- **Sand is conveyed to the mold fill station in preparation for filling of the mold. A mixer is used to blend the sand with the chemical binder and catalyst.**
- **As the sand exits the mixer, the binder begins the chemical process of hardening. This method of mold filling can be used for each half of the mold (cope and drag).**
- **Each mold half is then compacted to form a strong and dense mold.**

- A rollover is then used to remove the mold half from the pattern box. After the sand has set, a mold wash may be applied.
- Cores, if required, are set into the drag and the cope is closed over the cores to complete the mold.
- A series of mold handling cars and conveyors move the mold into position for pouring. Once poured, the mold is allowed to cool before shake-out.

- The shake-out process involves breaking the molded sand away from the casting. The casting then proceeds to a casting finishing area for riser removal, casting finishing and finalization.
- The broken pieces of molded sand are further broken down until the sand is returned to grain size. The sand can now be either reclaimed for reuse in the casting process or removed for disposal.
- Thermal reclamation is the most efficient, complete method of Nobake sand reclamation.