16 MOULDING AND CORE MAKING

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16.1 INTRODUCTION

Mould : A mould can be described as a void or cavity created in a compact sand mass with the help of pattern which (Mould), when filled with molten metal will produce a casting.

Moulding : The process of making this cavity or mould in the compact sand is called moulding.

Core Making : Sometimes a casting is to be made hollow or with cavities in it. Such type of casting requires the use of cores. A core is defined as a sand shape which is exactly similar to the cavities or holes to be produced in the casting. The cores are generally made separately in a core box. The process of making cores is called core making.

16.2 MOULD MATERIALS

A mould material is one out of which the mould is made.

Casting can be made in

(a) **Permanent moulds :** These are made up of ferrous metals and alloys (steel, grey cast iron). These are normally employed for casting low melting point materials. The moulds

produce small casting with better quality and dimensional accuracy but permanent moulds are costly.

(b) **Temporary refractory moulds :** These are made up of refractory sands and resin. These are used for casting high melting point materials and bigger objects.

16.4 PROPERTIES OF MOULDING SAND

Proper moulding sand must possess the following properties :

1. Porosity or Permeability

- Molten metal always contains a certain amount of dissolved gases which are evolved when the metal freezes.
- Molten metal also coming in contact with the moist sand, generates steam or water vapours.
- Thus to provide a path for free escape of the gases, the moulding sand should be permeable or porous.
- If these gases and water vapours evolved by the moulding sand don't find opportunity to escape completely through the mould, they will form gas holes and pores in the casting called porosity defect.
- Sands which are coarse or have rounded grains exhibit more permeability.
- Soft ramming and clay addition in lower amount also improves permeability.
- Hard ramming and addition of more binder decreases permeability.
- Addition of more water decreases the permeability.

2. Flowability (Plasticity)

- Flowability is the ability of the moulding sand to get compacted to a uniform density.
- Flowability assists moulding sand to flow and pack all around the pattern and take up the required shape.
- Flowability increases as clay and water content increases.
- The sand must retain its shape when the pressure is removed.

3. Refractoriness

- It is the ability of the moulding sand to withstand high temperature of the molten metal without fusion, cracking or buckling.
- Refractoriness is measured by the sinter point of the sand rather than its melting point.
- The degree of refractoriness depends upon the quartz content and the shape and grain size of the particles. The higher the quartz content, rougher the grain shape, higher is the refractoriness of the sand.

4. Adhesiveness

- It is that property of the sand due to which it adhere or cling to the another body (i.e., sides of the moulding box).
- It is due to this property that the sand mass can be successfully held in a moulding box and it does not fall out of the box when it is tilted (roll over).

5. Cohesiveness

This is the ability of sand particles to stick together. It may be defined as the strength of the moulding sand. It is of three types :

(*a*) **Green Strength :** The property (strength) of a sand in its green or moist state is known as green strength.

(*b*) **Dry Strength :** The strength of a sand that has been dried or baked is called dry strength.

(*c*) **Hot Strength :** After the moisture has evaporated, the sand may be required to possess strength at some elevated temperature (above 100°C). So the strength of the sand at elevated temperature is called hot strength.

6. Collapsibility

- ❖ It is that property of the sand due to which the sand mould breaks (collapse) automatically (or with very less forces) after the solidification of the casting occurs.
- ❖ If the mould or core does not collapse easily, it may restrict free contraction of the solidifying metal and cause the same (casting) to tear or crack.
- ❖ If the moulding sand have more strength, then breaking of moulding sand arround the casting becomes difficult or in other sense moulding sand have a poor collapsibility.
- ❖ Addition of binders increases the adhesiveness and cohesiveness *i.e.,* strength of the moulding sand but decreases the collapsibility of the moulding sand. So the moulder has to add the optimum amount of the binder in the moulding sand so that moulding sand have required strength as well as required collapsibility.

7. Durability

The moulding sand should possess the capacity to withstand repeated cycles of heating and cooling during casting operations. This ability of sand is known as durability.

8. Fineness

- ❖ Finer sand mould (grain size small) resists metal penetration and produces smooth casting surface.
- ❖ Fineness and permeability are inversely proportional. They must be balanced for good results.

9. Bench Life

- ❖ It is the ability of the moulding sand to retain its properties during storage or while standing (i.e., in case of any delay).
- ❖ Sometimes moulding sand gets hardened because of the exposure to the atmospheric air *i.e.,* moulder is not able to use that sand. So sand should have good bench life *i.e.,* once it is prepared, it can be used for long hours.

10. Co-efficient of expansion

- ❖ Moulding sand should possess low coefficient of expansion.

11. Moulding sand should be chemically neutral.

12. Moulding sand should be reusable, cheap and easily available.

16.5 MAIN CONSTITUENTS OF MOULDING SAND

The principle constituents of moulding sand are :

- Silica Sand
- Binder
- Additives
- Water

16.5.1 Silica Sand

Silica sand is the major proton of the moulding sand (80 to 82%). Silica sand contains from 80 to 90 percent silicon dioxide and characterized by a high softening temperature and thermal stability. It is a product of the breaking up of quartz rocks or the decomposition of granite, which is composed of quartz and felspar. The silica sand is found in nature on the bottoms and bank of rivers, lakes and large bodies of water.

Silica sand grains imparts refractoriness, chemical resistivity and permeability to the sand.

16.5.2 Binder

The purpose of adding a binder to the moulding sand is to impart the sufficient strength and cohesiveness. However, it produces an adverse effect on the permeability of sand mould. The common binders used in foundry can be grouped as :

1. Organic Binders : Organic binders find their specific use in core making. Examples are :

- Dextrin
- Linseed oil
- Molasses
- Pitch
- Cereal binders
- Resins like phenol and urea formaldehyde.

2. Inorganic Binders : The common binders are clay, sodium silicate and Portland cement. Out of all these, clay binders are commonly used.

Clay : Clay is defined as those particles of sand (under 20 microns in diameter) which fail to settle at a rate of 25 mm per minute when suspended in water. The felspar (obtained from decomposition of granite) when decomposed becomes clay (Hydrous aluminium silicate). Clay consists of two ingredients—fine slit and true clay. Fine slit is a sort of foreign matter or mineral deposit and has no bonding power. True clay imparts the necessary bonding strength to the mould sand. The following types of clays are commonly used :

- Bentonite ($Al_2O_3.4SiO_2.H_2O.nH_2O$)
- Kaolinite or fire clay ($Al_2O_3.2SiO_2.2H_2O$)
- Limonite etc.

Out of the above, Bentonite is widely used. Its deposits are found in Bihar, Rajasthan and Kashmir.

16.5.3 Additives

Additives are those materials which are added to the moulding sand to improve the existing properties of sand. The commonly used additives are :

1. Sea Coal

- ❖ It is added to moulding sand for casting of cast iron to improve the stripping and surface appearance of cast iron.
- ❖ It restricts the mould wall movement but reduces permeability and hot strength of the mould.
- ❖ The amount of sea coal addition varies from 1% (for small casting) to 10% (for large castings).
- ❖ Sea coal is finally powdered bituminous coal.

2. Pitch and Asphalt

- ❖ Pitch is distilled from soft coal at about 600°F and asphalt is a by product of petroleum distillation.
- ❖ It improves hot strength and surface finish on ferrous castings.
- ❖ It may be added from 0.2 to 2%.

3. Silica Flour

- ❖ It is pulverized silica which can pass through 200 mesh sieve.
- ❖ It improves hot strength, surface finish, resists metal penetration, minimizes sand expansion defects.
- ❖ It may be added up to 35%.

4. Graphite

- ❖ It may be natural or synthetic graphite.
- ❖ It improves surface finish and moldability of foundry sand mixtures.
- ❖ It may be added from 0.2 to 2%.

5. Wood Flour

- ❖ They minimize sand expansion defects, improve flowability, collapsibility.
- ❖ It may be added from 0.5 to 2%.

6. Corn Flour

- ❖ It improves collapsibility, increases green and dry strength of the moulding sand and minimizes the sand expansion defects.
- ❖ It lowers the flowability and permeability.
- ❖ It may be added from 0.25 to 2.0 percent.

7. Dextrin and Molasses

- ❖ It increases the dry strength of sand and resists the mould tendency to dry out.

16.5.4 Water

The clay content added to foundry sand will not give the required strength and bond until a suitable quantity of water is added to it. Quantity of water varies from 2 to 8%.

The amount of water used should be properly controlled. This is because a part of the water absorbed by clay helps in bonding while the remainder upto a limit helps in improving the plasticity but more than that would decrease the strength and flowability.

16.7 PREPARATION OF MOULDING SAND

Preparation of sand includes :

1. Mixing of sand 2. Tempering of sand 3. Sand conditioning 4. Sand testing

1. Mixing of Sand

- Sometimes, artificial means are adopted to make the sand suitable for use. Sand mixing is the process through which we add those materials to the sand which are rich in such characteristics in which the sand lacks.
- Generally it is mixed with clay, lime, magnesia, potash, soda etc.

2. Tempering of Sand

- The process by which adequate amount of moisture is added to moulding sand to make it workable is called tempering of sand.
- Adequate amount of water (moisture) is needed to activate the clay binder. Less moisture is not capable of making the film with the clay or not capable to activate the clay binder. More moisture also creates problems. So it must be in adequate quantity.

3. Sand Conditioning

- The proper sand conditioning means the uniform distribution of binder around the sand grains, so that it flows readily around and takes up the detail of the pattern.
- Sand conditioning is done either by manually or by machines. Mullers are used to mix the sand properly.

4. Sand Testing

- A common physical test, which is generally followed by most of the moulders, for judging the sand condition is to grip a handful of the prepared foundry sand and then relieve the pressure of the fingers.
- The sand mass thus produced is broken into two pieces by hand and the edges formed at the broken section are carefully observed.
- If there is no deformation in the edges then it indicates that the sand is properly conditioned. If the upper surface of the broken sand appears to be setting down gradually, it indicates a high moisture content.
- Gradual separation of sand grains indicate a weak bond and low moisture content.
- In semi-mechanised foundries, the sand mixing and riddling is done by machines, but the judgement of the sand condition is again left to the moulders.
- In fully-mechanised foundries mixing, riddling and testing of sand are done by machines.
- Moisture content test, grain size test, clay content test, permeability test, strength test, mould hardness test are performed to test moisture content, grain size, clay content, permeability, strength and hardness respectively.