SAND CASTING

Sand Casting is simply melting the metal and pouring it into a preformed cavity, called mold, allowing (the metal to solidify and then breaking up the mold to remove casting. In sand casting expandable molds are used. So for each casting operation you have to form a new mold.

Basic Requirements for metal casting

(1). A mold cavity (2). Melting process (3). Pouring technique (4). Solidification process (5). Removal of casting (6). Finishing draft allowance

Sand Casting is the most important and mostly used casting technique. To perform sand casting we have to form a pattern (a full sized model of the part), enlarged to account for shrinkage and machining allowances in the final casting.

Patterns have also some identifiers such as colors on them, each of which has different meaning that represent different treatments and requirements far the patterns. The color-coding for patterns in sand casting is as follows

(1) Red indicates that the surface of the material should be left as it is after casting.

(2) ***Black indicates that the surface needs core and shows the position of the sand core.***

(3) ***Yellow indicates that the surface needs machining.***

AUTOMATED SAND CASTING IN FOUNDRIES

Today 70 % of the casting processes are achieved with automation. Because up to 200 components sand casting is ideal but in the case of long production lines arid for higher number of components arid far small components sand casting is not economic. For this purpose automated foundry is the right choice. High melting temp metals are used for castings. There are three kinds of production

(1) Jobbing factory up to 100 parts but lots of varieties

(2) Batch factory 500-1000 parts

(3) Mass production: lots of parts ,can be more than 1000.

In automated foundries there is continuous pouring on a conveyor into the pre-formed molds. This continuous process has two levels:

(1) Pouring the metal continuously into the molds.

(2) Charging metal into the tables from the furnace (mostly gray iron) (each of tables holding 6 tones)

In automated sand casting sand is carried automatically arid pattern is made of metal. More water is added to the sand. But sand must riot be too damp otherwise it easily disintegrates.

The pattern is pressed into prepared sand by automatic hydraulic press and the mold is formed. By the same procedure many molds are formed then non-stop casting operation starts on a conveyor.

- After the castings have cooled down completely, molds are destroyed arid they are passed through a rotating recycling drum in which sand is removed arid added again to the sand carrying system and the casting is moved in the drum for further operations such as the removal of the excess parts.

(risers arid runners) from their bodies, and blasting arid finishing operations. For small numbers of large components to be casted with high melting temp, metals, sand casting is suitable But the as a disadvantage every time you need a new mold so this technique would riot be economic for low melting temp metals.

Advantages of Sand Casting:

1) Casting can be used to create complex pad geometries, including Goth external arid internal shapes.
2) Some casting operations are capable of producing parts to net shape. No further manufacturing parts are needed.
3) Casting can be used to produce
4) Casting process can be performed on any metal that can be heated to the liquid state.

5) Some casting methods are highly suited far mass production.

6) Casting is the easiest and quickest way (technique) from drawing (design) to the production.

Disadvantages of Sand Casting

(1) Limitation on mechanical properties

(2) Porosity (empty spaces within the metal - reduces the strength of metal)

(3) Poor dimensional accuracy and surface finish

(4) Safety hazards to humans and environmental problems

(5) Removal of pattern of the thin and small parts is very difficult

Casting Quality:

- There are numerous opportunities for things to go wrong in a casting operation, resulting in quality defects in the cast product.

Casting Defects:

- 1) *Misruns (due to rapid solidification in the runner)*
- 2) *Cold shuts (due to rapid solidification before complete filling of the mold)*
- 3) *Cold shots (due to splattered globules of metal during pouring)*

- 4) Shrinkage cavity (due to lack of riser system)
- 5) *Microporosity (due to localized solidification shrinkage)*
- 6) *Hot tearing (due to the die's prevention of contraction)*

Defects related with sand molds :

- 1) Sand blow
- 2) Pinholes
- 3) Sand wash

- 4) Scabs
- 5) Penetration
- 6) Mold shift
- 7) Core shift
- 8) Mold crack

Inspection Methods:

- 1) Visual Inspection to detect obvious defects such as Misruns, surface flaws.
- 2) Dimensional measurements to ensure that

- tolerances have been met.
- 3) Metallurgical, chemical, physical, and other tests related with the quality
  - a) Pressure testing to locate teaks in the casting
  - b) Radiographic methods magnetic particle tests, use of fluorescent penetrants, and supersonic testing to detect either surface or internal defects in casting.
  - c) Mechanical testing to determine properties such as tensile strength and hardness.

- If defects are discovered but are not too serious, it is often possible to save the casting by welding, grinding or other salvage methods to which the customer has agreed.

DIE CASTING

- Sand casting is suitable for small numbers of large components and for metals that melt at high temperatures. But it has a disadvantage that every time you need a new mold. As a result this technique is quite uneconomic for low melting temperature metals.

For low melting temperature metals there is another suitable casting technique. Die casting. The usage of die-casting depends on the melting temperature of metal being tasted. (Bronze & brass door handles are made from this technique- Also certain types of car wheels complex transmission cases, and carburetor parts can be produced by die casting).

- **Properties of die-casting:**

- 1) Huge numbers of small, light castings can be produced with great accuracy.

- 2) Little surface finishing is required.
- 3) Permanent mold (dies can be used over and over)
- Simplest method of die-casting is gravity die-casting. It is just pouring from a label; no pressure or external forces are involved. Mainly Magnesium (Mg) is suitable for this technique. Before pouring the metal a powder called french chalk is put into the die made of cast iron to prevent sticking of the metal.

Magnesium is heated continuously during the process to keep right thermal ingredients and to maintain the fluidity of magnesium while is kept under flask to prevent contact with air (0_2) to inhibit its explosive property and for this reason while pouring Mg, again the surface is being powdered. This powdering result in inert gases ($S0_2$) heavier than air, which prevents explosive reactions and also keeps the metal surface clean and shiny. Mg is ideal for making rising wheels by using gravity die-casting, because it is tight and strong.

Low-pressure die-casting:

- In this technique die is surrounded by gas burner to keep right thermal ingredients. One of the great advantages of this process; there is no need to remove riser and runner, so wastes are minimized. Little final machining is needed. Aluminum is suitable for this process because it doesn't readily react with oxygen gas, so it is easier than Mg to work with (It can be shaped, and carried easily). Solidification starts at the edges of the rim and moves inwards to the center.

To check if there are any cracks, the casting is painted with engineering blue color. In aeroplane industry X-ray technique is used instead.

- High Pressure die-casting:
- In high pressure die casting to shorten the time For the metal to be solidified and to increase the output metal is infected into a water cooled die under high pressure and squeezed two times.

- Between each injection of metal, metal is sprayed with graphite-based oil, to prevent sticking of metal to the die. Because of high pressures involved safety regulations should be obeyed with great accuracy.
- The metal injection:
  - 1) Metal in the plunger, closing of pouring hole
  - 2) Moving the metal into the die
  - 3) Filling the cavity by the metal
  - 4) Intensification to compact the metal and reduce the cavitations (applying high pressure)

- Speed of operation depends on the cooling rate. In this technique careful die design is important and usually a die made of steel is used High output justifies the quality of the output. A plunger makes metal injection into the die. The metal is injected into 2 identical dies at the same time producing two identical castings, which increases output. Higher the melting point of metal being tasted, lower the life of the die.
- High-pressure die-casting provides a good surface and good die dimensions.

- It is suitable for all nonferrous alloys. This technique is also successful in thin walled structures. Ideal for a mass production.

INVESTMENT CASTING

- For high melting temperature metals, if small numbers of specialized castings with high tolerances are required investment casting is ideal. Investment casting produces bioengineering components, and some used in aerospace industry.

This technique provides us with good dimensional accuracy and at the end little surface finishing operations are needed. Light allay materials are used. Because of these properties products should be produced on time and be at right value. Die will be used over and over.

Lost wax method of investment casting: First is prepared for wax injection. After injection of wax (30 sec) die is opened, then the wax pattern is put into very dilute HCI acid. This process is for dissolving out the soluble core..

(Core dissolved in 12 hours) Then the tree holding the small patterns is hold into isopropanol and tridoroethene, then into pure isopropanol and dried by compressed air. We then give the pattern a ceramic coating; this will eventually form the foal mold. (By dipping it in zircon, coated with foe refractory powder; now it is called mold). We dry the mold by passing it through ammonia vapor. Then dewaxing process comes, any wax left could ruin a costly casting.

For the process a 900°C gas fire oven is used. We then left the work to be cooled down on shelves. Now, it is extremely heavy and brittle. Molds are heated again for four hours, now the mold is ready for casting. This is very economic because you gel many castings from one melt of the furnace.

Investment casting is an ideal method for the metals that cannot be successfully machined such as Tungsten and Cobalt. It is a profitable production method; and you have the possibility to make both small and large castings.

SAND ADDITIVES (Casting Sand)

GENERAL PROPERTIES OF MOLDING SANDS

1. Green strength. The green sand, after water has been mixed into it, must have adequate strength and plasticity for making and handling of the mold.
2. Dry strength. As a casting is poured, sand adjacent to the hot metal quickly loses its water as steam. The dry sand must have strength to resist erosion, and also the metallostatic pressure of the molten metal, or else the mold may enlarge.

3.Hot strength. After the moisture has evaporated, the sand may be required to possess strength at some elevated temperature, above 100^{o}C. Metallostatic pressure of the liquid-metal bearing against the mold walls may cause mold enlargement, or if the metal is still flowing, erosion, cracks, or breakage may occur unless the sand possesses adequate hot strength.

- 4. Permeability. Heat from the casting causes a green-sand mold to evolve a great deal of steam and other gases. The mold must be permeable, i.e. porous, to permit the gases to pass off, or the casting will contain gas holes.
- 5. Thermal stability. Heat from the casting causes rapid expansion of the sand surface at the mold-metal interface. The mold surface may then crack, buckle, or flake off (scab) unless the molding sand is relatively stable dimensionally under rapid heating.

6. Refractoriness. Higher pouring temperatures, such as those for ferrous alloys at 2400 to 3200 F, require greater refractoriness of the sand. Low-pouring-temperature metals, for example, aluminum, poured at 1300 F, do not require a high degree of refractoriness from the sand.

7. Flowability. The sand should respond to molding processes.

8. Produces good casting finish.

9. Collapsibility. Heated sand which becomes hard and rocklike is difficult to remove from the casting and may cause the contracting metal to tear or crack.

10. Is reusable.

11. Offers ease of sand preparation and control.

12. Removes heat from the cooling casting.

Sand Properties

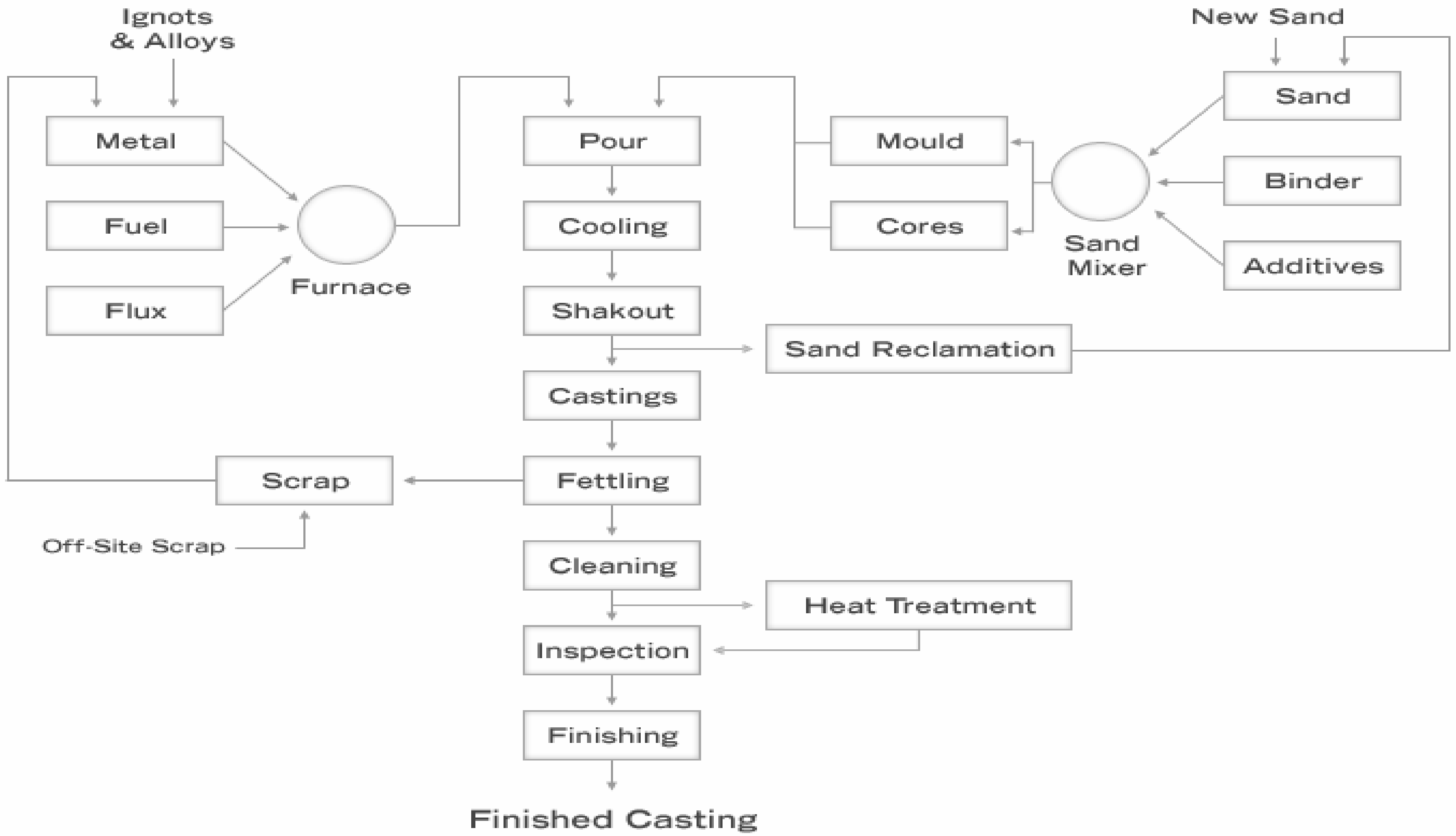
- Green Compression Strength
- Dry Compression Strength
- Hot Compression Strength
- Moisture (water)
- Permeability
- Flowability
- Refractoriness
- Thermal Stability
- Collapsibility

- Produces good casting finish
- Mold Hardness
- Deformation
- Is reusable
- Remove heat from the cooling casting

Casting Sands

- ***Silica Sands***
- ***Zircon***
- ***Olivine***
- ***Chromite***
- ***Aluminum Silicates***

Flow Chart of a Metal Casting System



SAND ADDITIVES

- Clays
- Water
- Carbons
- Cellulose
- Oil-Chemicals

Clays

- Clays
- Bentonite, Southern (Ca-Bentonite)
- Bentonite, Western (Na-Bentonite)
- Fireclay
- Kaolin Clay

Water

- Water
- H_20

Carbons

- Carbons
- Asphalt
- Gilsonite (a kind of asphalt)
- Graphite
- Lamp Black
- Lignite (brown coal)
- Pitch, Coal Tar
- Seacoal (pulverized coal)

Cellulose

- Cellulose
- Cob Flour
- Furfural Residue
- Oat Hulls
- Walnut Shell Flour
- Wood Flour

Oils-Chemicals

- Oils-Chemicals
- Asphalt Emulsion
- Asphaltic Oils
- Kerosene
- Soda Ash
- Wetting Agent

Refractories (other than clays)

- Alumina
- Chromite Flour
- Fly Ash
- Iron Oxide
- Olivine Flour
- Silica Flour