# Department of Materials Engineering
# General Materials Branch

**Fourth Class**

**Casting Technology**

**Lecture Thirteen : Casting Quality and Heat Treatment**

**Class Code :ofp4npn**

# SHAKEOUT, CLEANING, AND FINISHING

- **Shakeout operations** are designed to separate the molds and sand from the flasks (i.e., containers), separate the castings from the molding sand, and separate or remove the cores from the castings.

# Punch-out machines

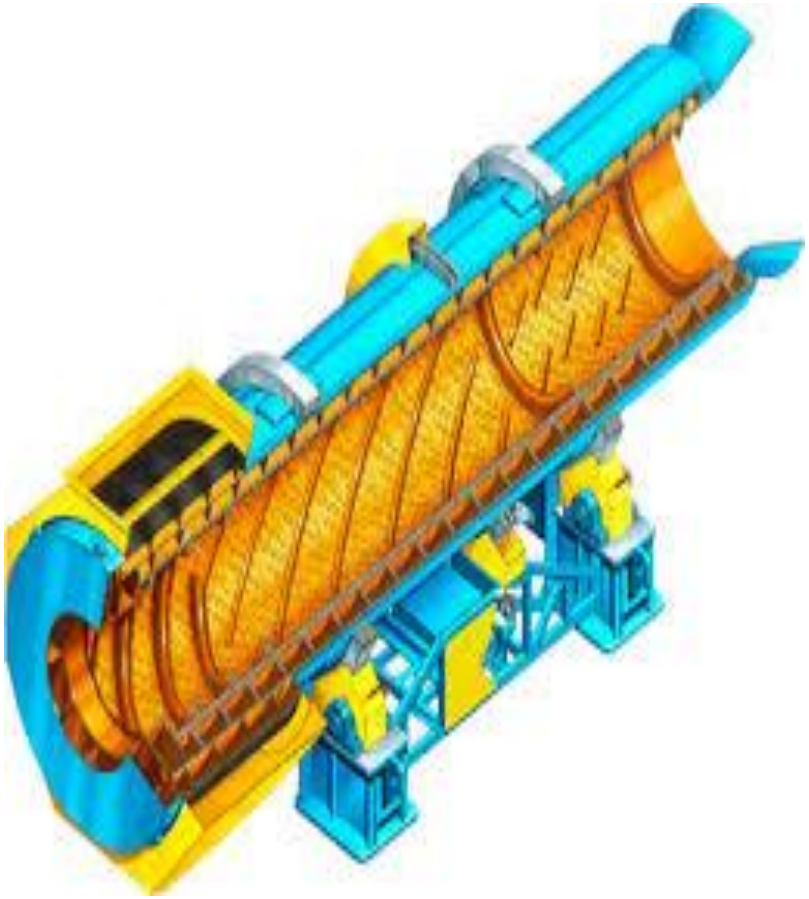
- **Punch-out machines** can be used to force the entire contents of a flask (both molding sand and casting) from the container

# Vibratory Machines

- Vibratory machines, which can operate on either the entire flasks or the extracted contents, are available in a range of styles, sizes, and vibratory frequencies.

# Rotary Separators

- Rotary separators remove the sand from castings by placing the mold contents inside a slow-turning, large-diameter, rotating drum



# SHAKEOUT, CLEANING, AND FINISHING

- The tumbling action breaks the gates and runners from the castings, crushes lumps of sand, and extracts the cores.
- Because of possible damage to lightweight or thin-sectioned castings, rotary tumbling is usually restricted to cast iron, steel, and brass castings of reasonable thickness.
- Processes such as blast cleaning can be used to remove adhering sand, oxide scale, and parting-line burrs. Compressed air or centrifugal force is used to propel abrasive particles against the surfaces of the casting. The propelled media can be metal shot (usually iron or steel), fine aluminum oxide, glass beads, or naturally occurring quartz or silica.
- The blasting action may be combined with some form of tumbling or robotic manipulation to expose the various surfaces.
- Additional finishing operations may include grinding, trimming, or various forms of machining.

# Ablation

- It is  an emerging process, the sand and binder of a sand mold is rapidly removed to facilitate rapid cooling of the casting.
- Shortly after the metal is poured, a liquid or liquid-gas mixture is directed onto the mold, where it dissociates the binder and allows the cooling liquid to come into direct contact with the metal.
- The high cooling rates produce a fine metal structure that enhances mechanical properties, and progressive movement of the ablation stream can create directional solidification.

# Cleaning and Inspection

1. **Trimming :**Involves removal of sprues, runners, risers, parting-line flash, fins, chaplets, and any other excess metal from the cast part. In the case of brittle casting alloys and when the cross sections are relatively small, these appendages on the casting can be broken off. Otherwise, hammering, shearing, hack-sawing, band-sawing, abrasive wheel cutting, or various torch cutting methods are used.
2. **Removing the core :**If cores have been used to cast the part, they must be removed. Most cores are chemically bonded or oil-bonded sand, and they often fall out of the casting as the binder deteriorates. In some cases, they are removed by shaking the casting, either manually or mechanically. In rare instances, cores are removed by chemically dissolving the bonding agent used in the sand core. Solid cores must be hammered or pressed out.

3. **Surface cleaning** Surface cleaning is most important in the case of sand casting. In many of the other casting methods, especially the permanent-mold processes, this step can be avoided. involves removal of sand from the surface of the casting and otherwise enhancing the appearance of the surface. Methods used to clean the surface include tumbling, air-blasting with coarse sand grit or metal shot, wire brushing, buffing, and chemical pickling .

# Cleaning and Inspection

4. Inspection, Defects are possible in casting, and inspection is needed to detect their presence
5. Repair, When required, they are usually labor intensive and costly.
6. Heat treatment.(*If required*) Castings are often heat treated to enhance their properties, either for subsequent processing operations such as machining or to bring out the desired properties for application of the part.

# Inspection Methods

1. Visual inspection to detect obvious defects such as misruns, cold shuts, and severe surface flaws;
2. Dimensional measurements to ensure that tolerances have been met.
3. Metallurgical, chemical, physical, and other tests concerned with the inherent quality of the cast metal .

# Metallurgical Inspection Method

1. Pressure testing—to locate leaks in the casting;
2. Radiographic methods, magnetic particle tests, the use of fluorescent penetrants, and supersonic testing—to detect either surface or internal defects in the casting
3. 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

# CASTING QUALITY

**1.Misruns**, which are castings that solidify before completely filling the mold cavity.

Typical causes include

1. Fluidity of the molten metal is insufficient
2. Pouring temperature is too low,
3. Pouring is done too slowly,
4. Cross-section of the mold cavity is too thin.

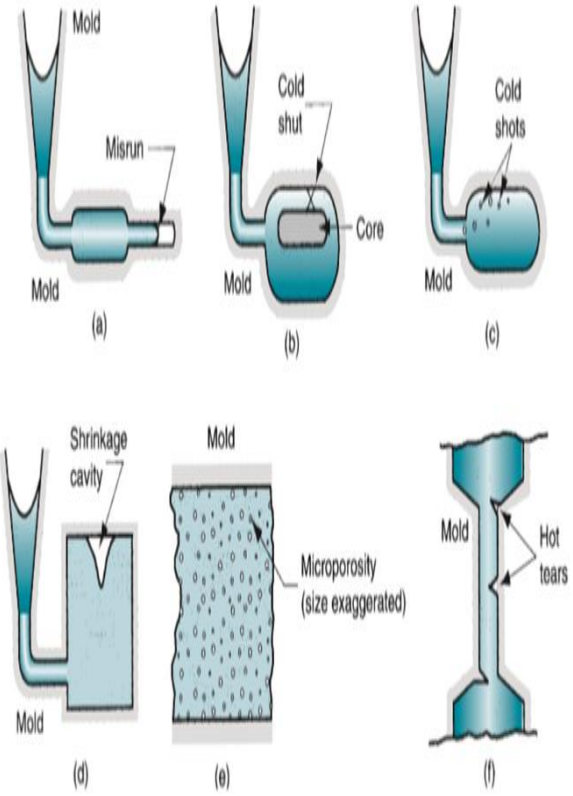
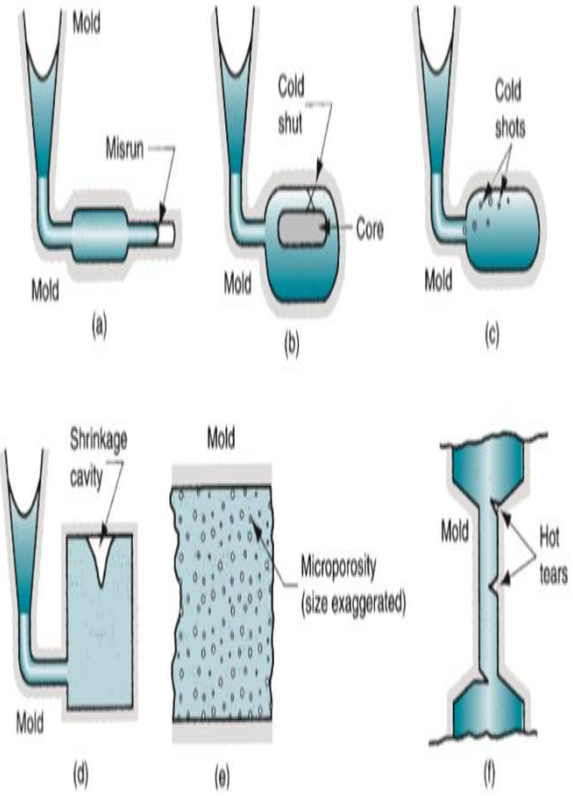



FIGURE 11.22 Some common defects in castings: (a) misrun, (b) cold shut, (c) cold shot, (d) shrinkage cavity, (e) microporosity, and (f) hot tearing.

# CASTING QUALITY

2. **Cold Shuts :-** which occur when two portions of the metal flow together but there is a lack of fusion between them due to premature freezing. Its causes are similar to those of a misrun.

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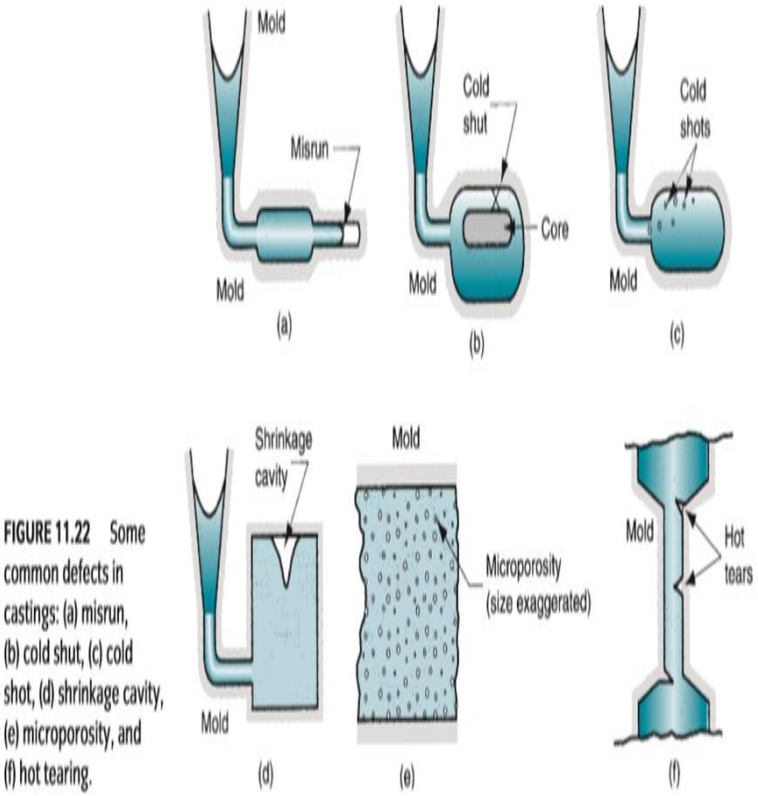
# CASTING QUALITY

3. **Cold Shots**, which result from splattering during pouring ,causing the formation of solid globules of metal that become entrapped in the casting. Pouring procedure sand gating system designs that avoid splattering can prevent this defect

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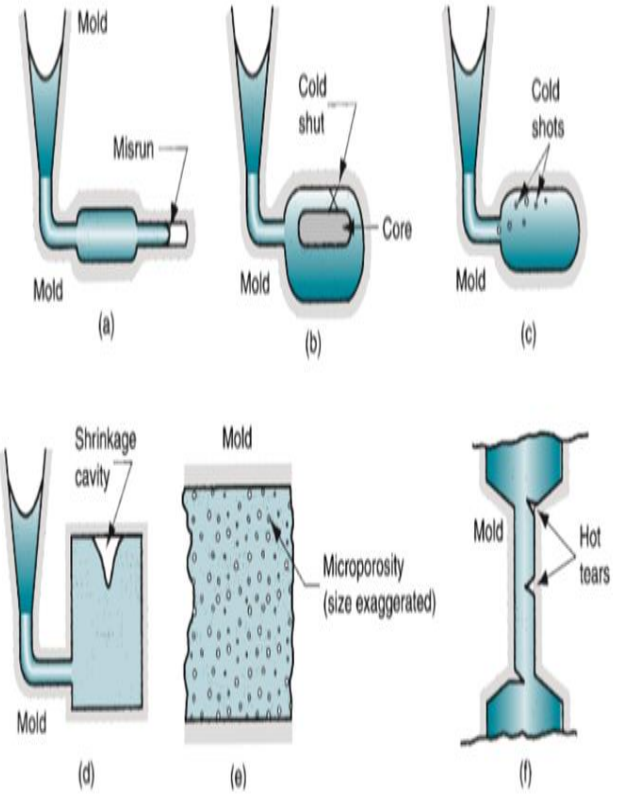
# Casting Quality

4. **Shrinkage cavity** is a depression in the surface or an internal void in the casting, caused by solidification shrinkage that restricts the amount of molten metal available in the last region to freeze. It often occurs near the top of the casting, in which case it is referred to as a ‘‘pipe.’’ The problem can often be solved by proper riser design.

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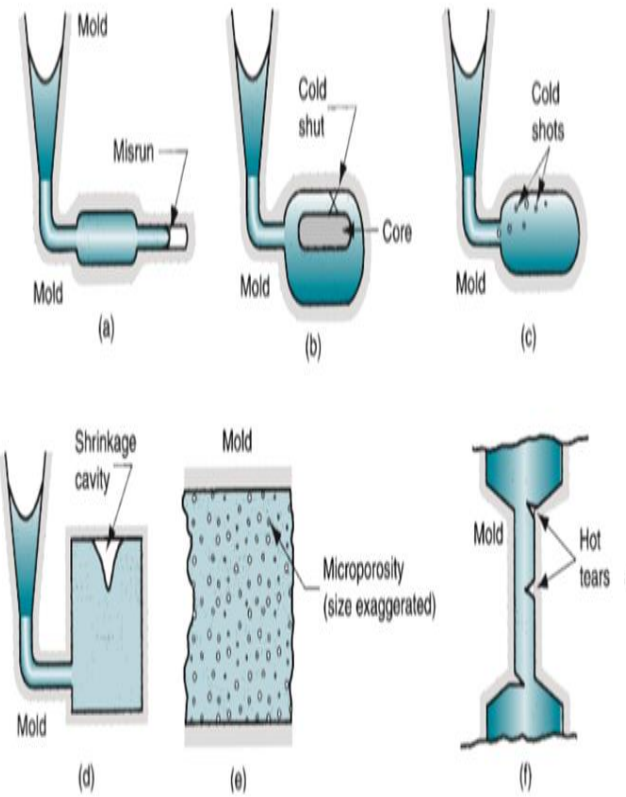
# Casting Quality

5. **Hot tearing**, also called hot cracking, occurs when the casting is restrained from contraction by an unyielding mold during the final stages of solidification or early stages of cooling after solidification

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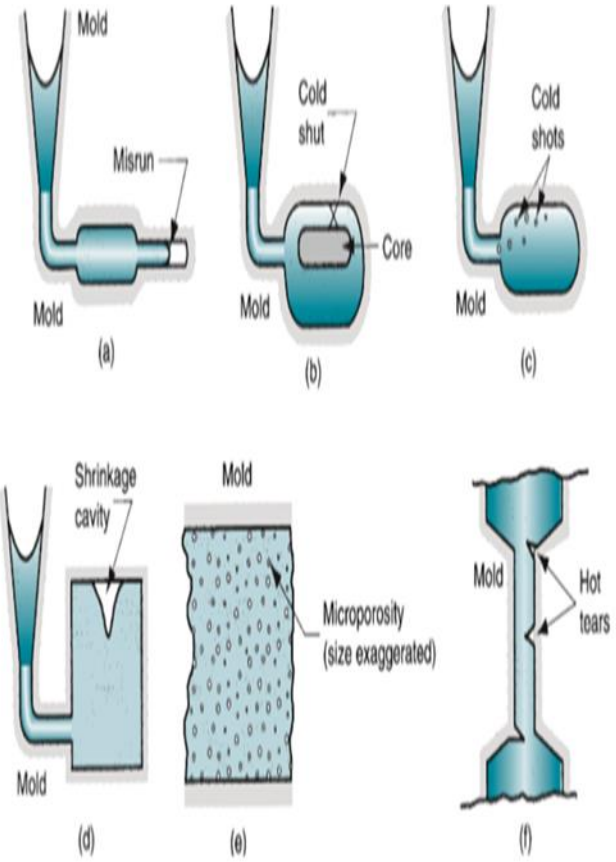
# CASTING QUALITY

6. **Microporosity** consists of a network of small voids distributed throughout the casting caused by localized solidification shrinkage of the final molten metal in the dendritic structure.

- The defect is usually associated with alloys, because of the protracted manner in which freezing occurs in these metals.

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# Sand Casting Quality

- **1- Sand blow**. is a defect consisting of a balloon-shaped gas cavity caused by release of mold gases during pouring.
- It occurs at or below the casting surface near the top of the casting.

1. Low permeability,
2. Poor venting,
3. High moisture content of the sand mold are the usual causes

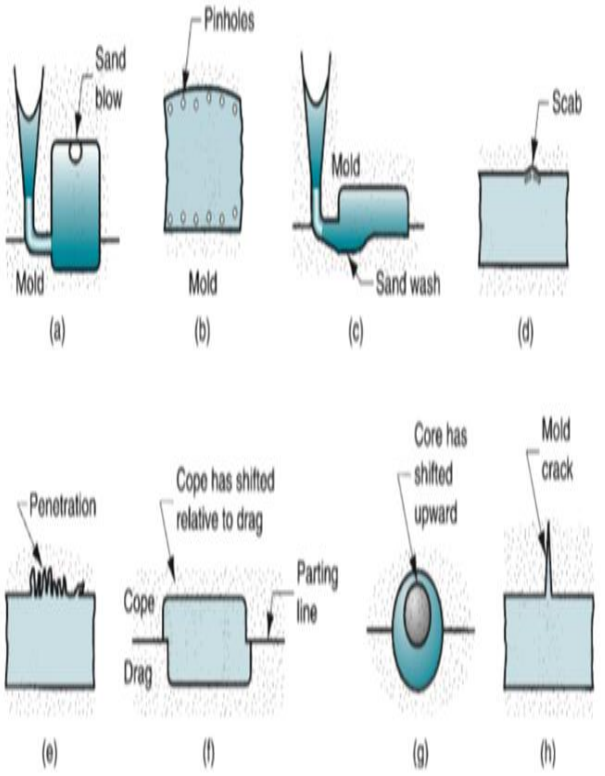
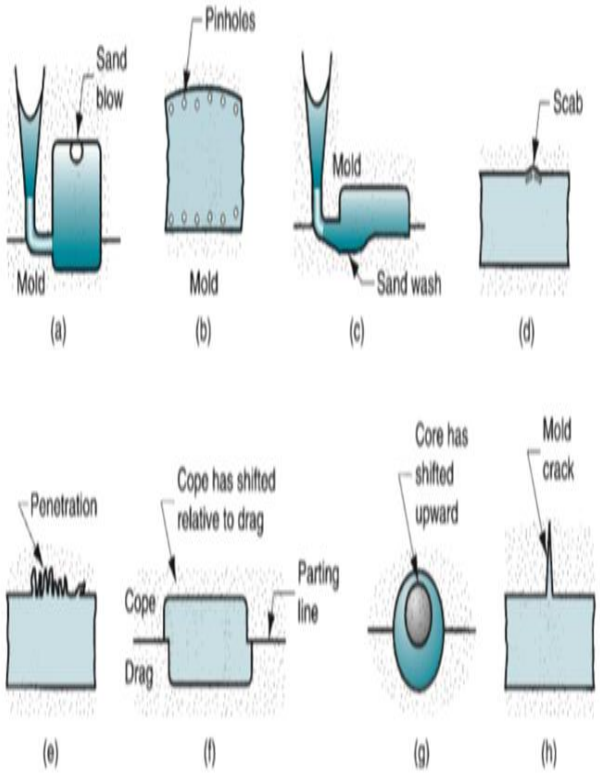



FIGURE 11.23
Common defects in sand castings: (a) sand blow, (b) pin holes, (c) sand wash, (d) scabs, (e) penetration, (f) mold shift, (g) core shift, and (h) mold crack.

# Sand Casting Quality

2- Pinholes also caused by release of gases during pouring, consist of many small gas cavities formed at or slightly below the surface of the casting.

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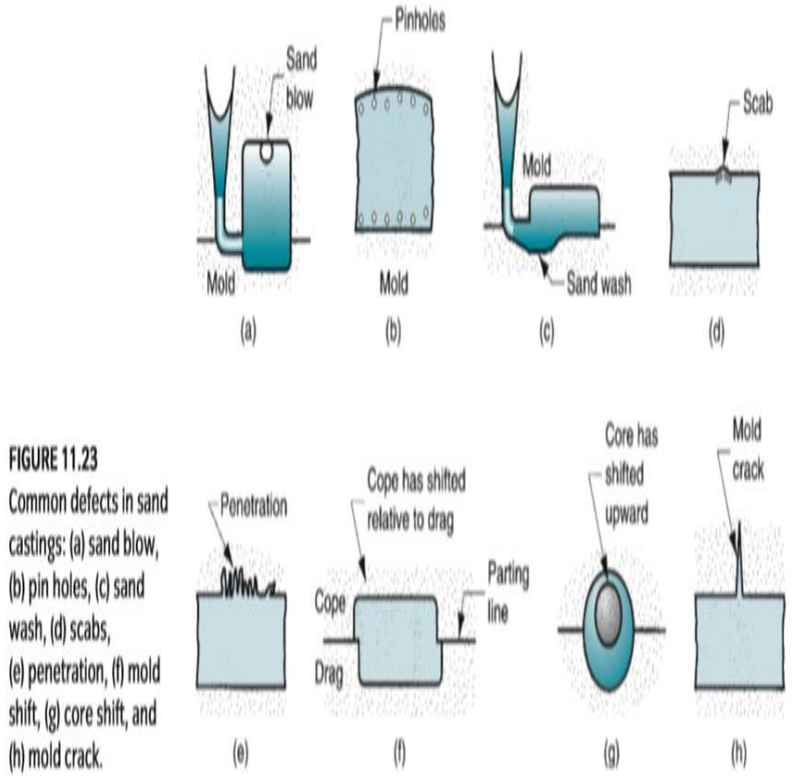
# Sand Casting Quality

**3- Sand wash**, which is an irregularity in the surface of the casting that results from erosion of the sand mold during pouring, and the contour of the erosion is formed in the surface of the final cast part.

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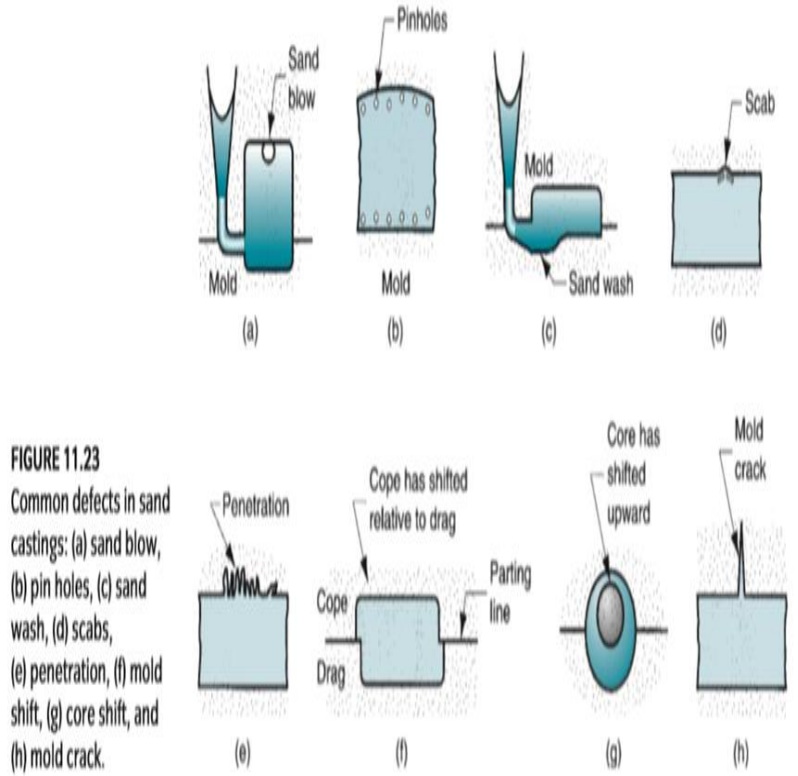
# Sand Casting Quality

**4-Scabs** are rough areas on the surface of the casting due to encrustations of sand and metal. It is caused by portions of the mold surface flaking off during solidification and becoming imbedded in the casting surface.

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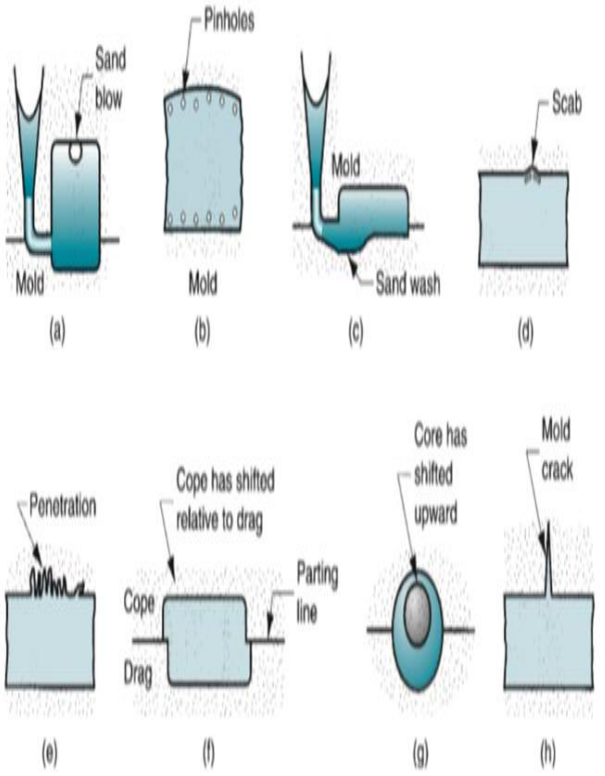
# Sand Casting Quality

**5- Penetration** refers to a surface defect that occurs when the fluidity of the liquid metal is high, and it penetrates into the sand mold or sand core.

Upon freezing, the casting surface consists of a mixture of sand grains and metal.

Harder packing of the sand mold helps to alleviate this condition.

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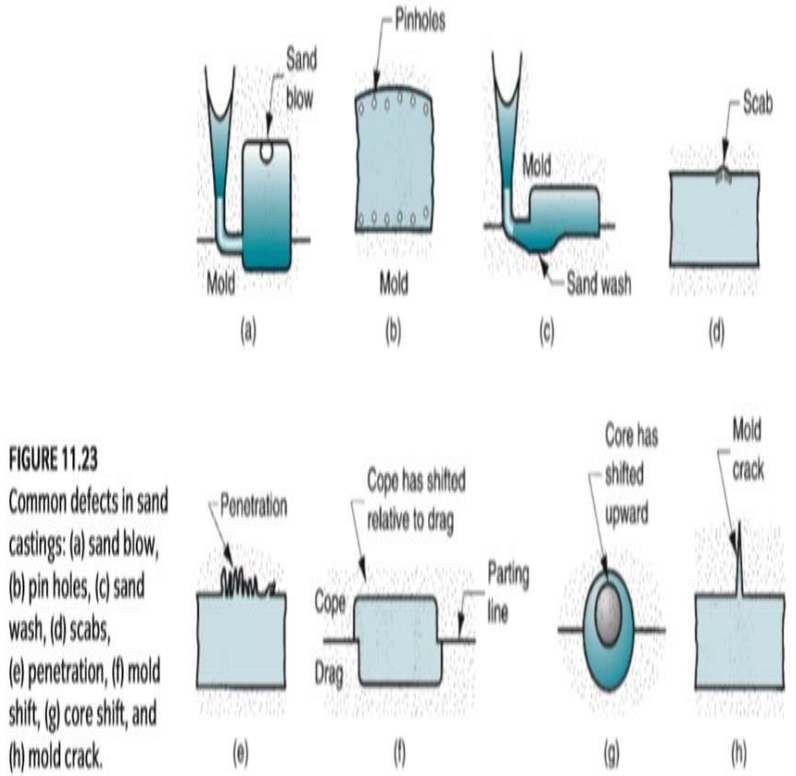
# Sand Casting Quality

**6- Mold shift** refers to a defect caused by a sidewise displacement of the mold cope relative to the drag, the result of which is a step in the cast product at the parting line

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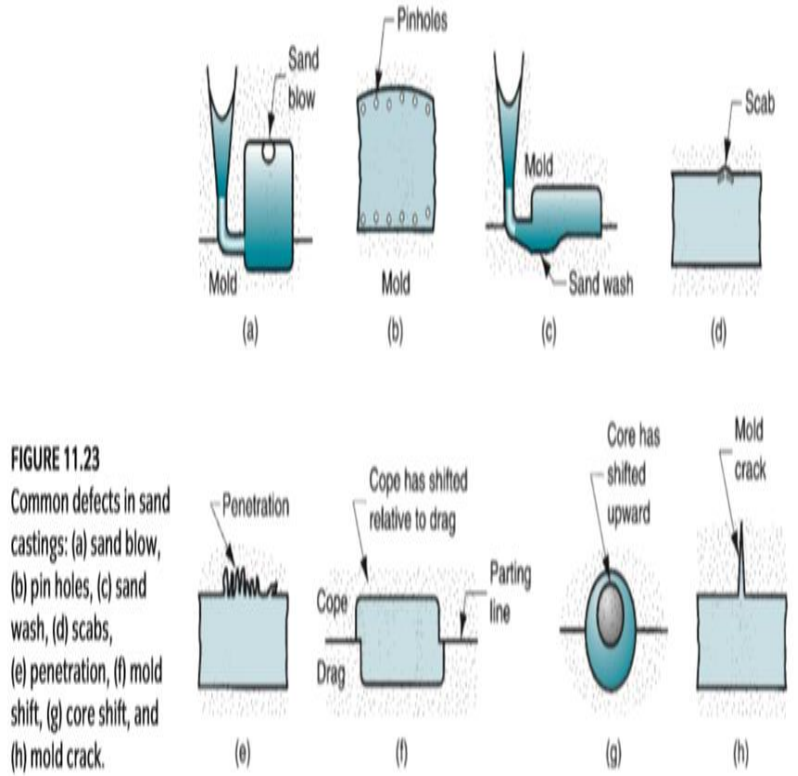
# Sand Casting Quality

**7- Core shift** is similar to mold shift, but it is the core that is displaced, and the displacement is usually vertical. Core shift and mold shift are caused by buoyancy of the molten metal

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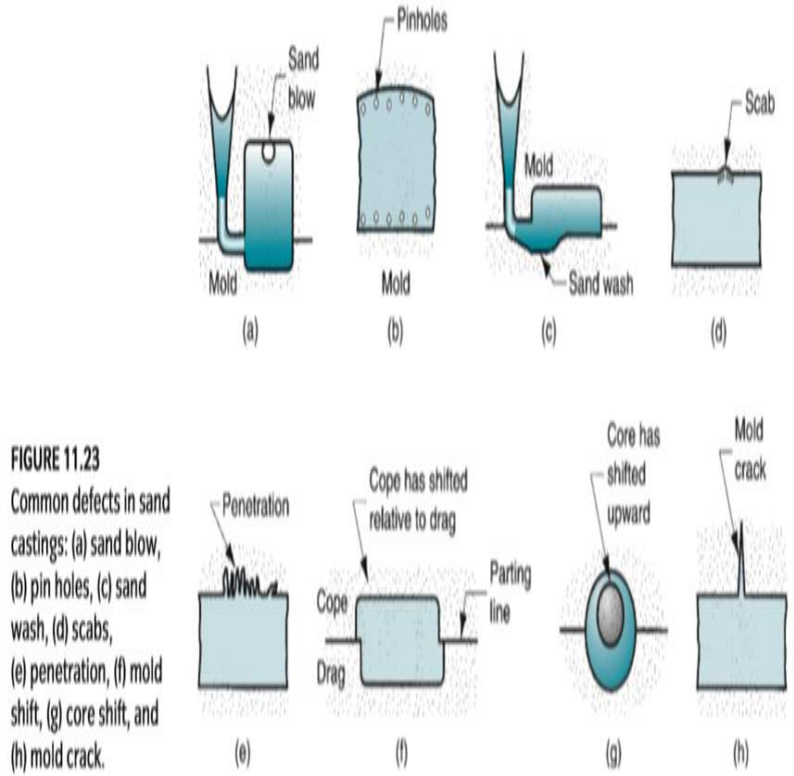
# Sand Casting Quality

**8-Mold crack** occurs when mold strength is insufficient, and a crack develops, into which liquid metal can seep to form a ‘‘fin’’ on the final casting.

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# Heat Treatment (Homogenization of Castings)

- Most alloy castings have significant segregation present in the as-cast structure, a result which is usually detrimental to the mechanical properties of the casting. ($T=0.45\text{-}0.5T_m$)
- This segregation can take the form of gradients in composition across dendrites or as interdendritic phases which would not be present at equilibrium.
- Removal or elimination of this segregation requires heating to temperatures near the melting point and holding for a period of time sufficient to allow diffusion of the atomic species involved.