Materials Engineering Department
General Materials Branch
Fourth Class

Casting Technology I

2018-2019

Lecture Fourteen: **Cleaning and Finishing**

Cleaning and Inspection

1. Removing cores
2. Removing gates and risers
3. Removing fins, flash, and rough spots from the surface
4. Cleaning the surface
5. Repairing any defects

Cleaning and Inspection

1. Trimming,
2. Removing the core,
3. Surface cleaning,
4. Inspection,
5. Repair,
6. Heat treatment.(If required)

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

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

2. Cold Shuts
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

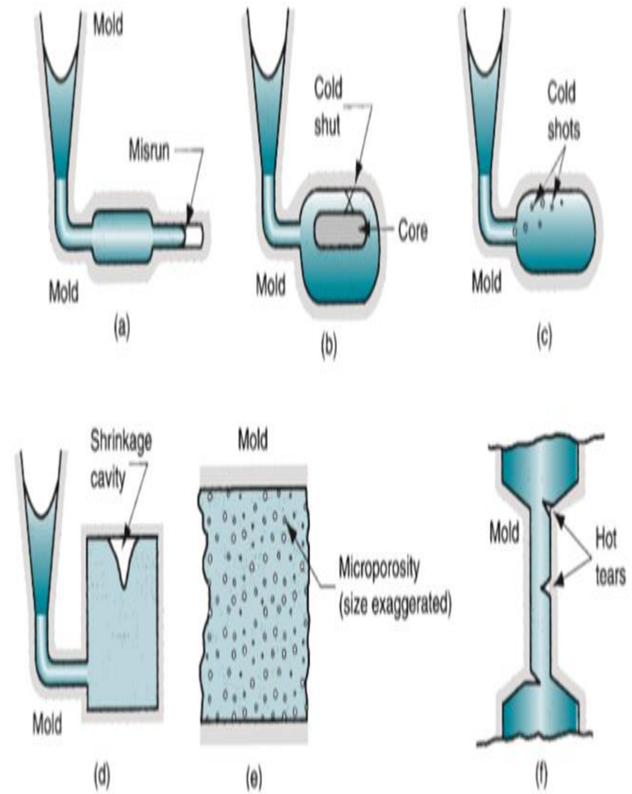


FIGURE 11.22 Some common defects in castings: (a) misrun, (b) cold shut, (c) cold shot, (d) shrinkage cavity, (e) microporosity, and (f) hot tearing.

Casting Quality

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.
5. 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.
6. 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.

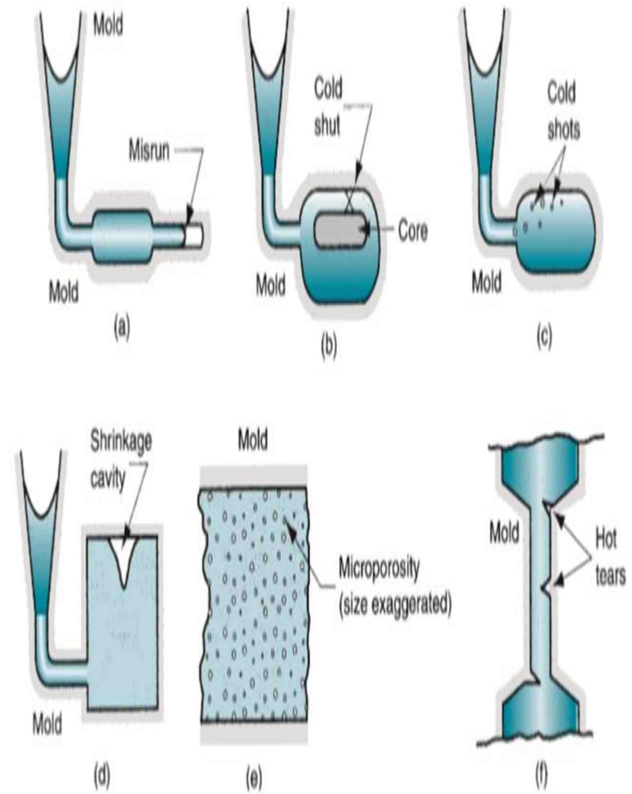


FIGURE 11.22 Some common defects in castings: (a) misrun, (b) cold shut, (c) cold shot, (d) shrinkage cavity, (e) microporosity, and (f) hot tearing.

CASTING QUALITY

1. Sand blow.
2. Pinholes
3. Sand wash
4. Scabs
5. Penetration
6. Mold shift
7. Core shift
8. Mold crack

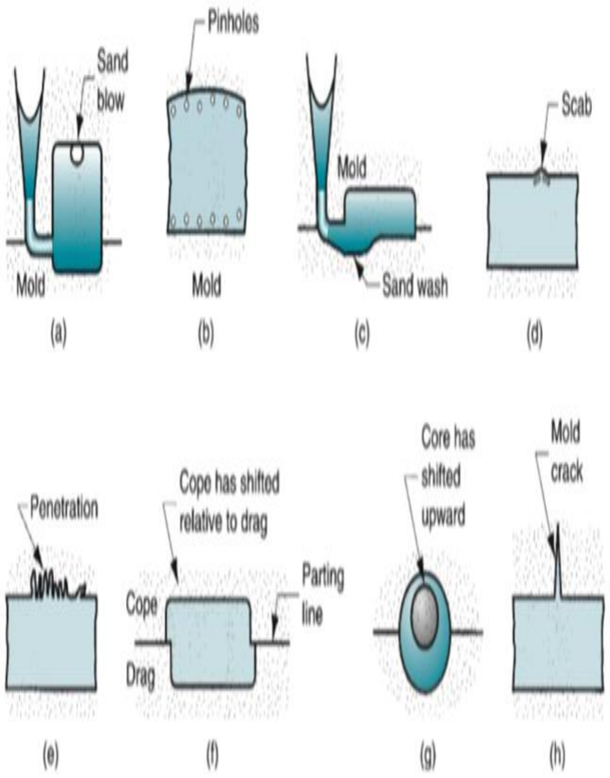


FIGURE 11.23 Common defects in sand castings: (a) sand blow, (b) pin holes, (c) sand wash, (d) scabs, (e) penetration, (f) mold shift, (g) core shift, and (h) mold crack.

Heat Treatment

- Heat treatment of the connectors was a critical process step to produce the required microstructure, mechanical properties, and Charpy Impact values.
- The castings were heat treated per the ASTM A958 specification (a 1700F austenitizing, water quench, and an 1150F temper cycle).

Pacific Steel Heat Treat Furnace

Heat Treatment

1. **Austenitizing -- The cast component is heated to temperatures between 1560F/850C and 1740F/950C and held for 15 to 120 minutes. The austenitizing temperature determines the matrix carbon content, because carbon solubility in austenite increases with temperature.**

2. **Austempering -- After austenitizing, the cast component is quenched in a molten salt bath at a temperature between 460F/238C and 752F/400C and held 30 to 240 minutes, followed by cooling to room temperature. *(A rapid quenching rate is important to avoid the formation of pearlite in the matrix.)***

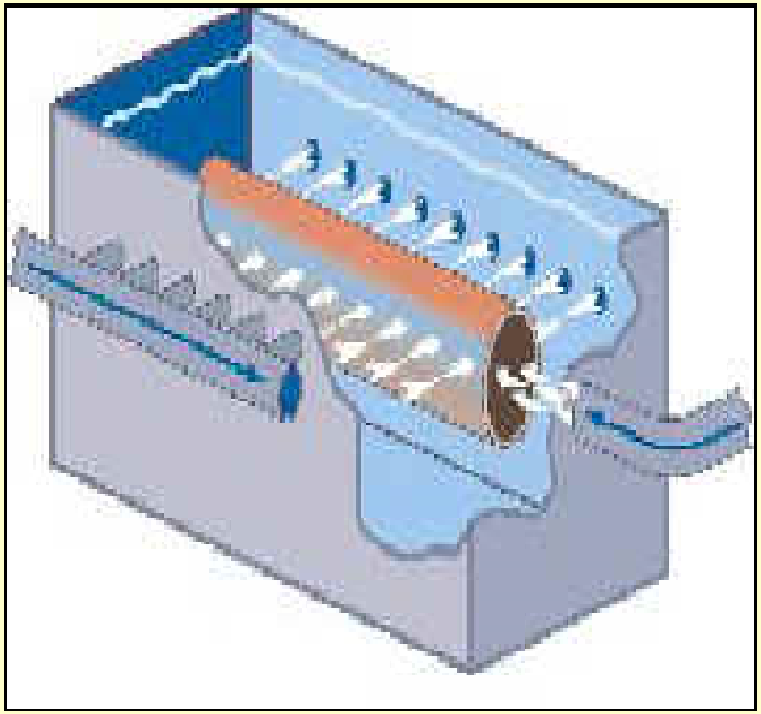
As-Cast Wheel

Heat Treatment

- The A356 aluminum alloy requires a three step heat-treatment (T6 = solution-heat-treat, quench, and artificial aging) to develop the controlled microstructure which gives the alloy its high mechanical strength and ductility.
- Heat treatment is done at Alfe Heat Treat, Defiance, OH.
- After heat-treatment the cylinder block is premachined and internal coolant and oil passages are leak tested to assure pressure tightness.

Cylinder Blocks Exiting the Heat Treat Furnace at Alfe Heat Treat, Defiance, OH

Heat Treatment



Forced Flow Quench Tank at Spuncast

- The accumulator cylinder is furnace heat treated to 2050F and then cooled to 1900F.
- The cylinder is then water quenched in a specially designed immersion bath with forced water flow on the cylinder OD and through the center ID. The forced flow on the OD and ID ensures rapid quenching and the optimum microstructure.

Heat Treatment

- Heat treatment of the snubber arms is a critical process step to produce the required microstructure, mechanical properties, and Charpy Impact values.
- The snubber arm castings were heat treated with a 1700F austenization and water quench. They were then tempered at 1205F and water quenched.
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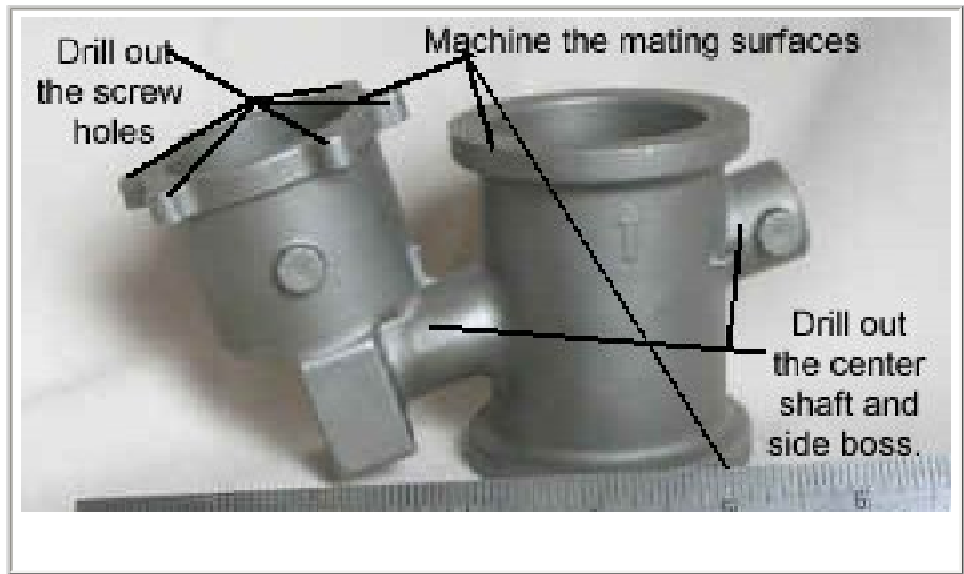
Heat Treatment

1. Two-part heat treat --

- **Homogenize in air at 2100 F for at least 90 minutes and cool to 70F.**
- **Solution heat treat (HT) in air at 1925F for 30-60 minutes and air cool to 70F.**

2. In the solution HT condition, the casting is machined for mating surfaces, screw holes, and the center channel, as shown in the picture to the right.

In the annealed condition, 17-4PH has good machinability, similar to that of 304 stainless steel.



3. After machining, the valve body is precipitation heat treated to develop the desired microstructure, strength, and hardness at 896°F (480°C) for 90 minutes with air cooling.

Heat Treatment

Heat treatment of the shoes was a critical process step to produce the required strength, microstructure, and hardness values in the track shoe.

The castings were heat treated in a proprietary high temperature heat, water quench, and temper cycle.

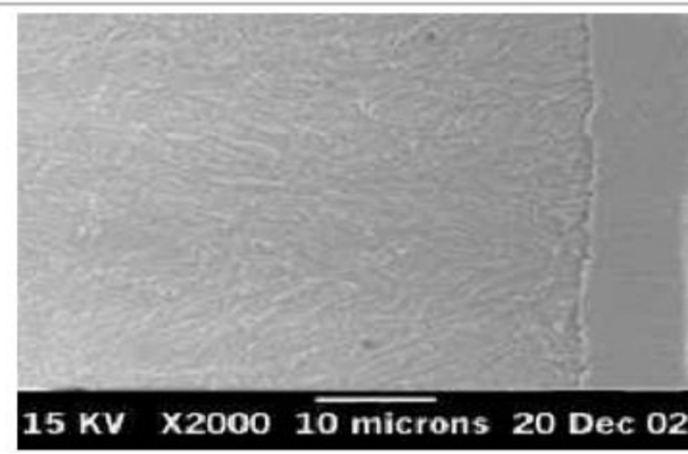
- Control of temperature ramp rates, water agitation and water temperature were required to reduce the risk of quench cracking.

Track Shoe in the Heat-Treat Furnace

Heat Treatment

1. Plasma nitriding (also known as ion nitriding) is a low temperature, low distortion surface engineering process.
2. A D.C discharge plasma is used to transfer nitrogen to the surface of the components at temperatures between 400°C and 750°C at low gas pressures.
3. The nitriding process produces a nitride rich surface layer with high surface hardness and hardened depths up to 0.8mm with minimal high temperature distortion of the component.

Component in Plasma Nitriding Chamber
(from Rubig Plant Technology)



Microstructure of Nitrided Surface

Home Work

The housing for a certain machinery product is made of two components, both aluminum castings. The larger component has the shape of a dish sink, and the second component is a flat cover that is attached to the first component to create an enclosed space for the machinery parts.

Home Work

Sand casting is used to produce the two castings, both of which are plagued by defects in the form of misruns and cold shuts.

The foreman complains that the parts are too thin, and that is the reason for the defects. However, it is known that the same components are cast successfully in other foundries.

What other explanation can be given for the defects?

Home Work

large steel sand casting shows the haracteristic signs of penetration defect: a surface consisting of a mixture of sand and metal.

1. What steps can be taken to correct the defect?
2. What other possible defects might result from taking each of these steps?