

Training Objective

After watching this video and reviewing the printed material, the student/trainee will become aware of the basics of the die casting process, the machines used and the metallurgy involved.

- Die casting metallurgy is discussed.
- Die casting machinery is detailed.
- Hot and cold chamber casting is explained.
- Die construction is explored.

Die casting is a precision, high volume production process in which molten metal is injected under high pressure into a die having a cavity in the desired shape of the part. Upon solidification, facilitated by a coolant flowing through the die sections, die clamping is relaxed and the part is ejected for additional cooling (quenching) and any required finishing, trimming, or machining.

Die casting production rates can range from dozens to thousands of parts per hour. The most common metals used are aluminum, zinc, and magnesium alloys. Less frequently, due to their higher melting temperatures, copper and copper alloys such as the brasses. Castability is primarily related to a metal's melting temperature, followed by other factors including:

- part complexity
- minimum wall thickness
- minimum draft or taper
- required precision of the part

Zinc alloys are considered to be the most castable, followed by aluminum, magnesium, and lastly, the copper alloys. Alloy type will also influence maximum part size. Although final part weight is considered, the more accurate determinant is material density that is weight per unit of volume. As a comparison, the density of zinc is .24 lb. per cubic centimeter, as opposed to .066 lb. per cc for magnesium. Thus, for a given weight, a part cast in magnesium can be larger in size than a part of zinc or any other metal commonly used.

Die casting machines are most often hydraulically actuated and usually in the horizontal position. There are two principle types of die casting machines in use; the hot chamber type and the cold chamber type. The hot chamber type is used for the lower melting temperature alloys like zinc and in some instances magnesium. In operation a reservoir of molten metal (holding pot) is seated in a furnace from which the metal is injected into the die. Injection pressure can range from 1500 psi to more than 4500 psi.

The cold chamber machine is used primarily for the other alloys due to their higher melting temperatures. The molten material is ladled, or in some way, fed to the die from an external furnace. Both types of machines will use a cylindrical pressure vessel, called an "accumulator," which is charged with nitrogen and will boost injection pressure.

Die casting machines can be rated by clamping force capacity. Die clamping systems can use either hydraulic, pneumatic, mechanical, or a combination of

systems. Machines may also be rated by the shot-weight capacity of the injection system.

Typically, the die halves are attached to platens on the die casting machine. One platen is stationary while the other is movable, usually in a horizontal plane. Both are heavy blocks of steel that will not deflect as molten metal is forced into the die. The stationary platen holds the "cover half" of the die and has a hole that is directly in line with the injection cylinder. The movable platen carries the other half, called the "ejector half." After the metal solidifies and the die opens, ejector pins release the casting from that half of the die mold. Part removal can be mechanical, manual, or by simply allowing the part to be dropped into a chute or conveyor for trimming and/or additional quenching. Before closing for the next injection cycle, the dies are subjected to an air blast to clean the dies, then given a lubricating spray. Excess metal trimmed from the part in a separate operation is conveyed to the melt furnace for recycling.

Both the hot and cold die casting systems can be fully programmed for automated operation. Commands and sequenced operations can be stored in the system computer for retrieval at any time. These commands can include:

- injection speed
- die temperature
- die clamping force

Such parameters can be continually monitored and recorded through statistical process control (SPC) to ensure minimum process variation and quality production.

Die construction is common to hot and cold chamber casting. Besides determining the shape of the finished part, the dies act as a heat sink to cool the casting, provide a vent for trapped air and gases, and contain the mechanism to eject the finished part. These dies are usually made of hot-work tool steel, mold steel, maraging steels, and to a lesser extent, tungsten or molybdenum alloys. They are usually machined from solid wrought blocks, but may also be machined castings. The dies are initially expensive to produce, but their cost can be amortized over thousands and even hundreds of thousands parts.

Typically, the dies may be of single or multiple cavities, usually used to produce multiple and identical parts. If the parts produced are different in design, the dies are said to be "combination dies." If differently shaped parts are to be assembled together, they are called "family dies."

The ejector half of the die will also contain channels or runners to allow metal flow to the die cavity gate or gates. Die cores, either fixed or movable, may be placed in either die half. These allow holes to be cast in various directions. Various inserts may be pre-positioned in the dies to become integral casting features. The dies also have internal cooling conduits through which liquid is circulated. Most dies and cores will be constructed with a slight taper or draft to facilitate part removal. The amount of draft is dependent upon the metal's melting temperature. In most cases, the lower the melting temperature of the melt, the less draft is required.

Die Casting

Review Questions

1. The best castable alloys are:
 - a. aluminum
 - b. copper
 - c. zinc
 - d. magnesium
2. The term "castability" is most related to a metal's:
 - a. tensile strength
 - b. compressive strength
 - c. thermal conductivity
 - d. melting temperature
3. "Hot chamber" die casting machines are used for alloys with:
 - a. high melting temperatures
 - b. low melting temperatures
 - c. low thermal conductivity
 - d. low electric resistance
4. The device used to increase injection pressure is called a:
 - a. surge pump
 - b. feed screw
 - c. accumulator
 - d. compressor
5. The "movable" platen holds the:
 - a. injector pump
 - b. cover half of the mold
 - c. ejector half of the mold
 - d. holding pot
6. A common die material is:
 - a. tungsten
 - b. molbdenum
 - c. cast iron
 - d. hot work tool steel
7. Die cores are placed in the:
 - a. ejector half of the mold
 - b. cover half of the mold
 - c. either half
 - d. no cores are used
8. The alloy's melting temperature will dictate the:
 - a. size of injector pump
 - b. die and core draft
 - c. ejection method
 - d. die material

Die Casting

Answer Key

1. c
2. d
3. b
4. c
5. c
6. d
7. c
8. b