METAL CASTING PROCESSES

UNIT I METAL CASTING & JOINING PROCESSES

Die-casting - centrifugal casting

Permanent Mold Casting Processes

Department of Aerospace Engineering

- Economic disadvantage of expendable mold casting: a new mold is required for every casting
- In permanent mold casting, the mold is reused many times
- The processes include:
  - Basic permanent mold casting
  - Die casting
  - Centrifugal casting

The Basic Permanent Mold Process

Uses a metal mold constructed of two sections designed for easy, precise opening and closing

- Molds used for casting lower melting point alloys are commonly made of steel or cast iron
- Molds used for casting steel must be made of refractory material, due to the very high pouring temperatures

Permanent Mold Casting

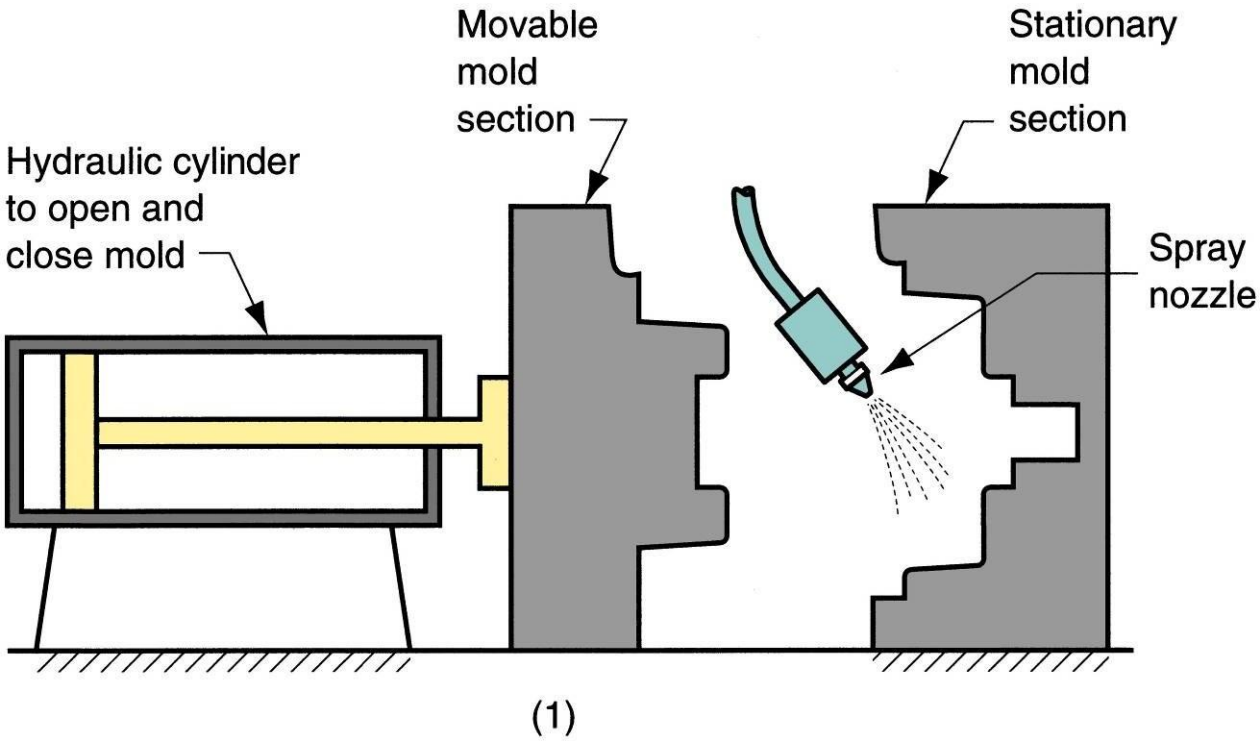


Figure Steps in permanent mold casting: (1) mold is preheated and coated

Permanent Mold Casting

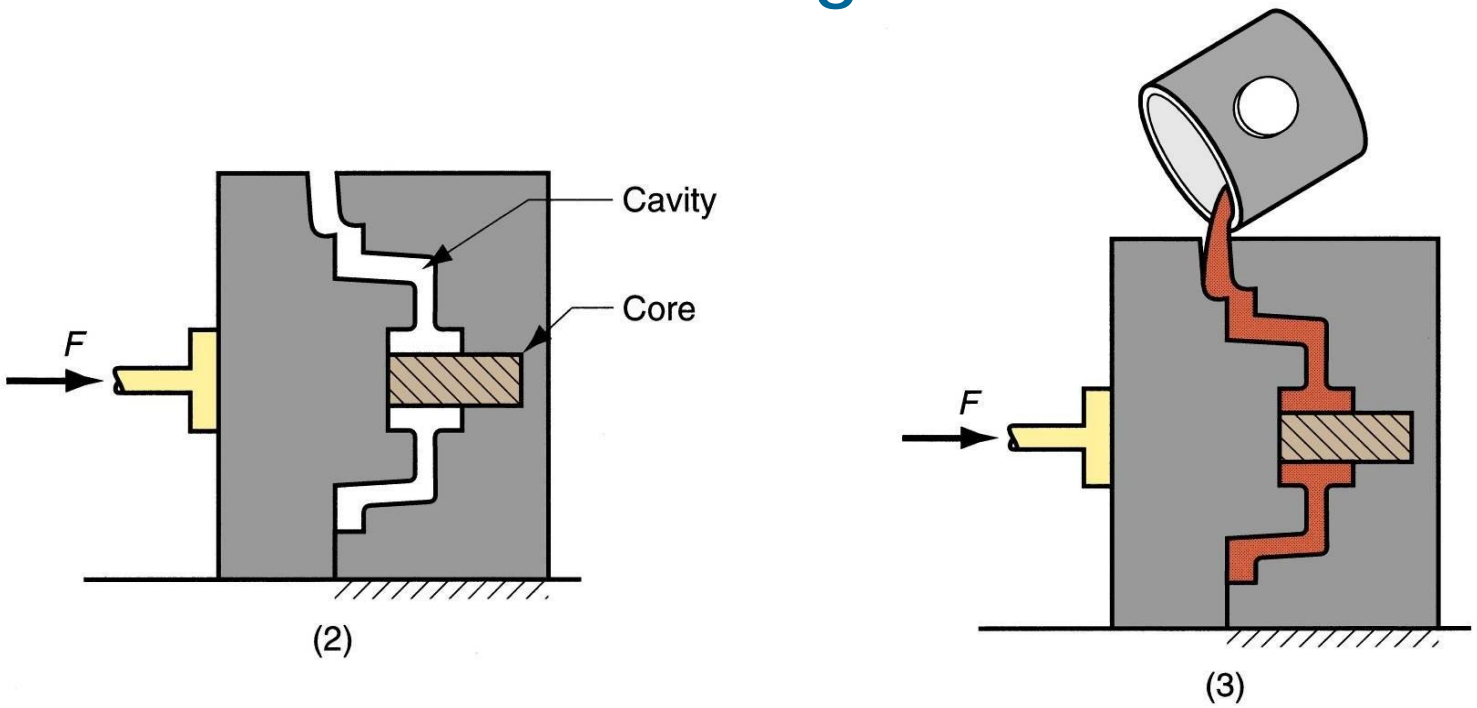


Figure Steps in permanent mold casting: (2) cores (if used) are inserted and mold is closed, (3) molten metal is poured into the mold, where it solidifies.

Advantages and Limitations

- Advantages of permanent mold casting:
  - Good dimensional control and surface finish
  - More rapid solidification caused by the cold metal mold results in a finer grain structure, so castings are stronger
- Limitations:
  - Generally limited to metals of lower melting point
  - Simpler part geometries compared to sand casting because of need to open the mold
  - High cost of mold

Applications of Permanent Mold Casting

- Due to high mold cost, process is best suited to high volume production and can be automated accordingly
- Typical parts: automotive pistons, pump bodies, and certain castings for aircraft and missiles
- Metals commonly cast: aluminum, magnesium, copper-base alloys, and cast iron

A permanent mold casting process in which molten metal is injected into mold cavity under high pressure

Die Casting

- Pressure is maintained during solidification, then mold is opened and part is removed
- Molds in this casting operation are called *dies*; hence the name die casting
- Use of high pressure to force metal into die cavity is what distinguishes this from other permanent mold processes

Die Casting Machines

- Designed to hold and accurately close two mold halves and keep them closed while liquid metal is forced into cavity
- Two main types:
  1. Hot-chamber machine
  2. Cold-chamber machine

Hot-Chamber Die Casting

Metal is melted in a container, and a piston injects liquid metal under high pressure into the die

- High production rates - 500 parts per hour not uncommon
- Applications limited to low melting-point metals that do not chemically attack plunger and other mechanical components
- Casting metals: zinc, tin, lead, and magnesium

Hot-Chamber Die Casting

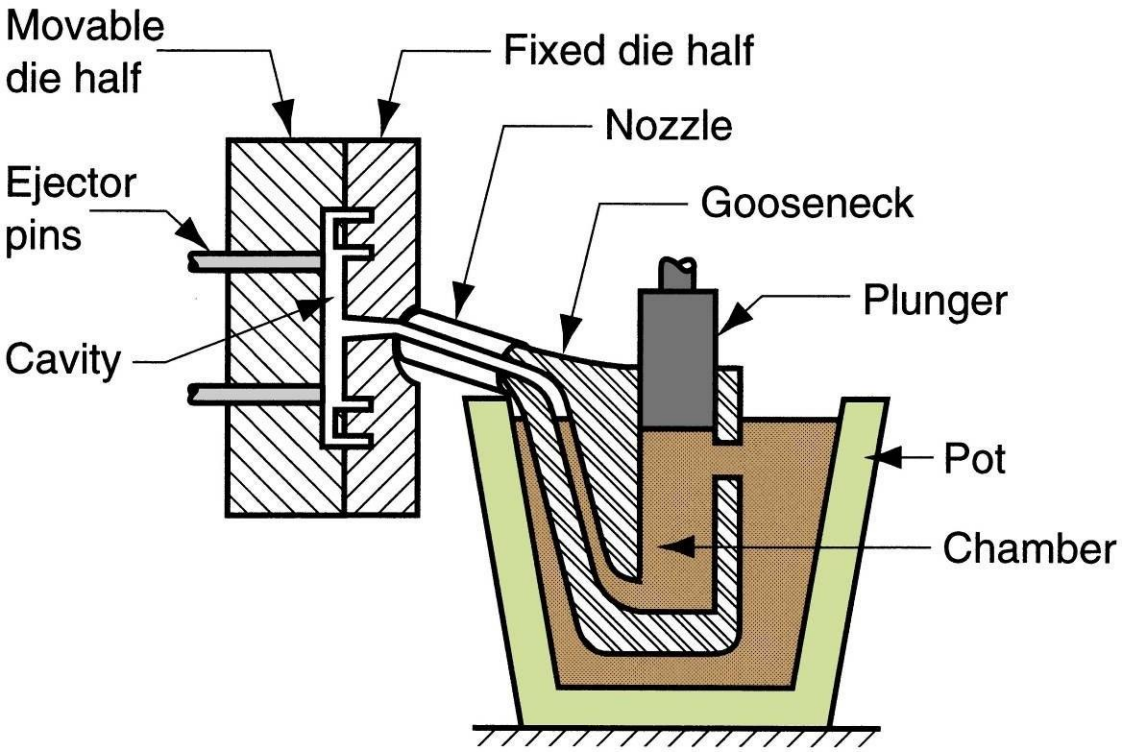


Figure Cycle in hot-chamber casting: (1) with die closed and plunger withdrawn, molten metal flows into the chamber (2) plunger forces metal in chamber to flow into die, maintaining pressure during cooling and solidification.

Cold-Chamber Die Casting Machine

Molten metal is poured into unheated chamber from external melting container, and a piston injects metal under high pressure into die cavity

- High production but not usually as fast as hot-chamber machines because of pouring step
- Casting metals: aluminum, brass, and magnesium alloys
- Advantages of hot-chamber process favor its use on low melting-point alloys (zinc, tin, lead)

Cold-Chamber Die Casting

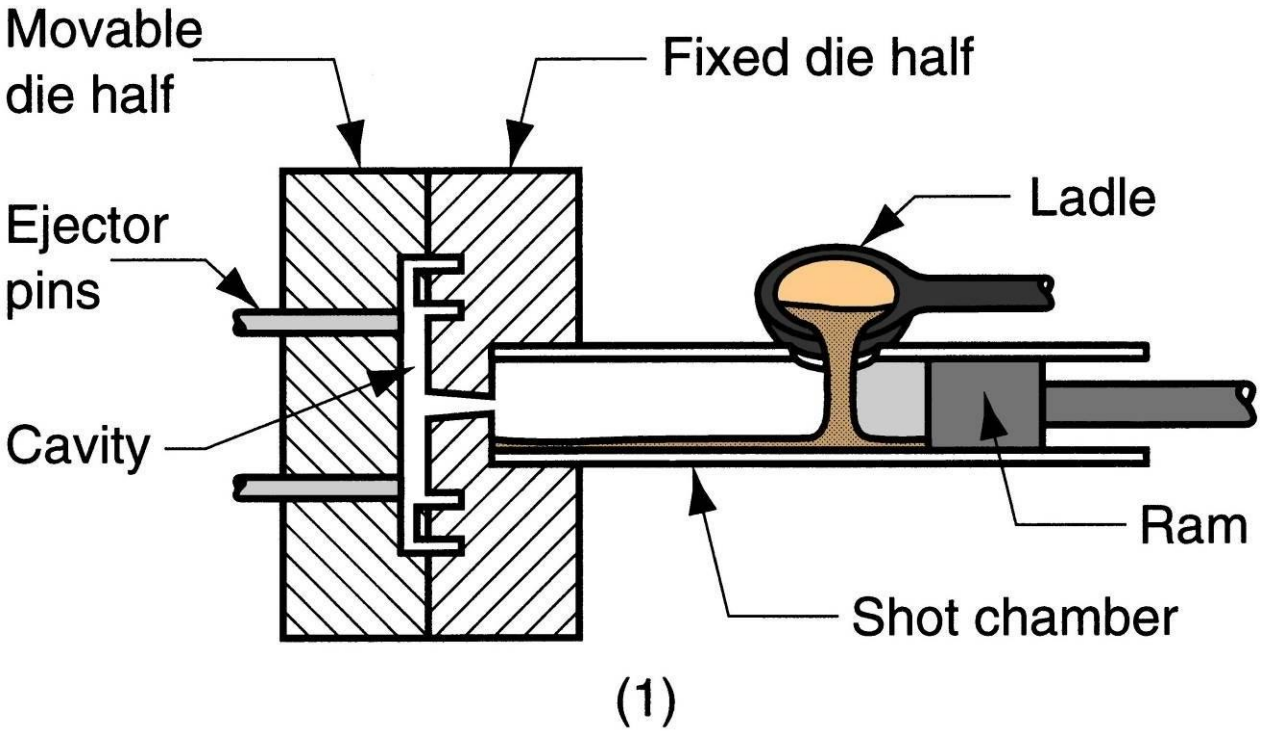


Figure Cycle in cold-chamber casting: (1) with die closed and ram withdrawn, molten metal is poured into the chamber

Cold-Chamber Die Casting

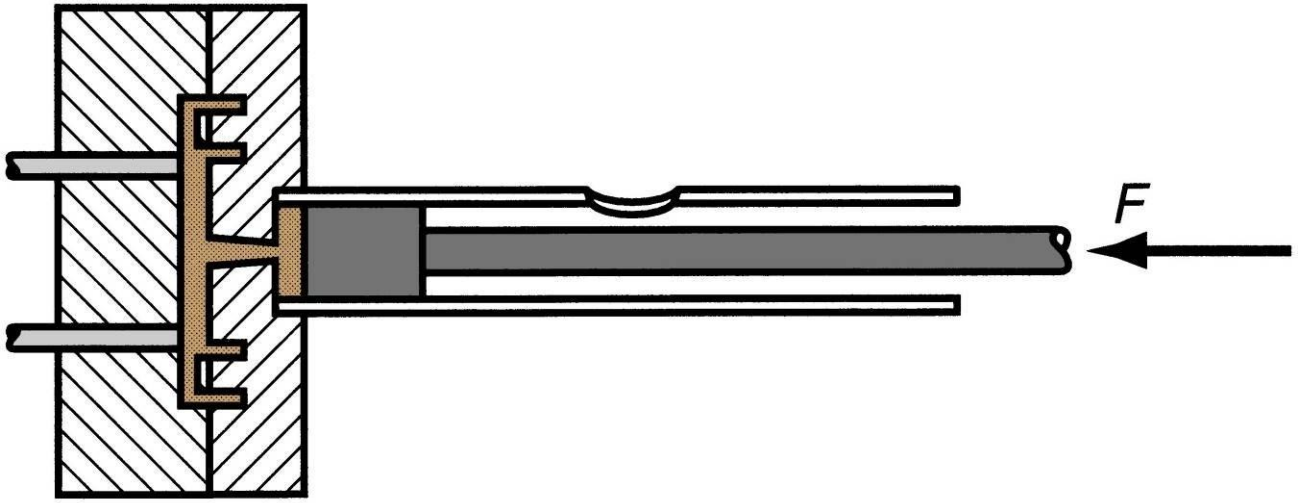


Figure Cycle in cold-chamber casting: (2) ram forces metal to flow into die, maintaining pressure during cooling and solidification.

Molds for Die Casting

- Usually made of tool steel, mold steel, or maraging steel
- Tungsten and molybdenum (good refractory qualities) used to die cast steel and cast iron
- Ejector pins required to remove part from die when it opens
- Lubricants must be sprayed into cavities to prevent sticking

Advantages and Limitations

- Advantages of die casting:
  - Economical for large production quantities
  - Good accuracy and surface finish
  - Thin sections are possible
  - Rapid cooling provides small grain size and good strength to casting
- Disadvantages:
  - Generally limited to metals with low metal points
  - Part geometry must allow removal from die

Centrifugal Casting

A family of casting processes in which the mold is rotated at high speed so centrifugal force distributes molten metal to outer regions of die cavity

- The group includes:
  - True centrifugal casting
  - Semicentrifugal casting
  - Centrifuge casting

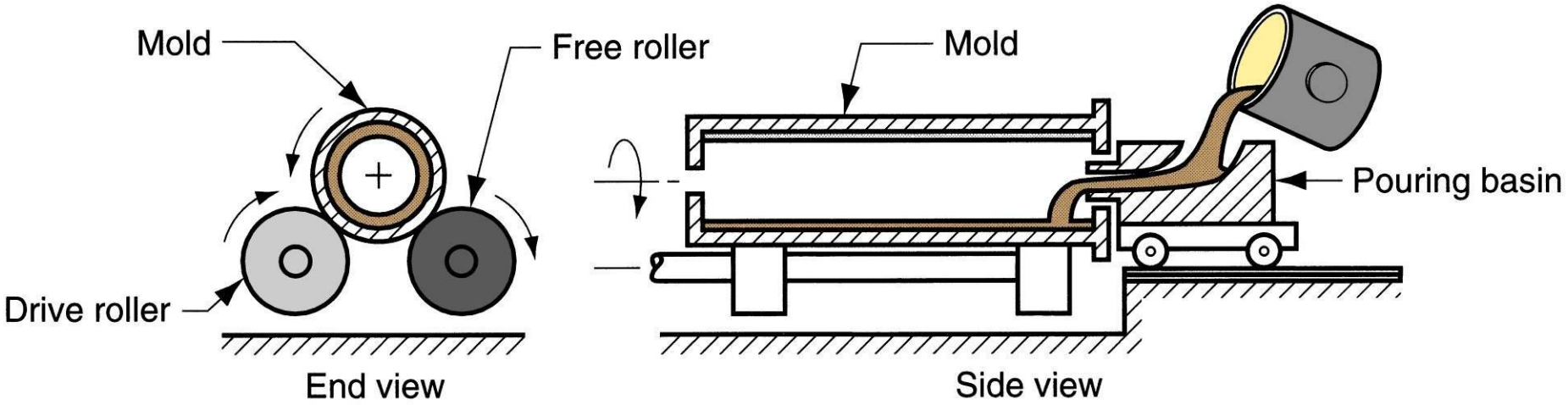
True Centrifugal Casting

Molten metal is poured into rotating mold to produce a tubular part

- In some operations, mold rotation commences after pouring rather than before
- Parts: pipes, tubes, bushings, and rings
- Outside shape of casting can be round, octagonal, hexagonal, etc , but inside shape is (theoretically) perfectly round, due to radially symmetric forces

True Centrifugal Casting

Figure Setup for true centrifugal casting.



Semicentrifugal Casting

Centrifugal force is used to produce solid castings rather than tubular parts

- Molds are designed with risers at center to supply feed metal
- Density of metal in final casting is greater in outer sections than at center of rotation
- Often used on parts in which center of casting is machined away, thus eliminating the portion where quality is lowest
- Examples: wheels and pulleys

Centrifuge Casting

Mold is designed with part cavities located away from axis of rotation, so that molten metal poured into mold is distributed to these cavities by centrifugal force

- Used for smaller parts
- Radial symmetry of part is not required as in other centrifugal casting methods