**Fluidity of molten metal**

A term commonly used to describe the capability of the molten metal to fill mold cavities is fluidity. This term consists of two basic factors: (1) characteristic molten metal and (2) casting parameters. The following characteristics of molten metal influence fluidity.

a) **Viscosity**. As viscosity and its sensitivity to temperature (viscosity index) increase, fluidity decreases.

b) **Surface tension**. A high surface tension of the liquid metal reduces fluidity. Oxide films developed on the surface of the molten metal thus have a significant effect on fluidity. For example, the oxide film on the surface of pure molten aluminum triples the surface tension.

c) **Inclusions**. As insoluble particles, inclusions can have a significant adverse effect on fluidity. This effect can be verified by observing the viscosity of a liquid such as oil with and without sand particles in it; the former has higher viscosity.

d) **Solidification pattern of the alloy**. Fluidity is inversely proportional to the freezing range. Thus the shorter the range (as in pure metals and eutectics), the higher the fluidity becomes. Conversely, alloys with long freezing ranges (such as solid-solution alloys) have lower fluidity.

Tests for fluidity. Although none is accepted universally, several tests have been developed to quantify fluidity. One such test is shown in Fig., where the molten metal is made to flow along a channel at room temperature. The distance of metal flow before it solidifies and stops is a measure of its fluidity. Obviously this length is a function of the thermal properties of the metal and the mold, as well as the design of the channel. Such tests are useful and simulate casting situations to a reasonable degree.
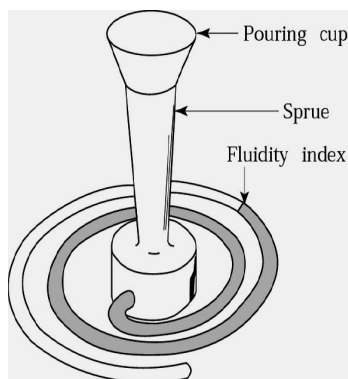
A test method for fluidity using a spiral mold. The *fluidity index* is the length of the solidified metal in the spiral passage. The greater the length of the solidified metal, the greater is its fluidity.

Heat transfer

An important consideration in casting is the heat transfer during the complete cycle from **pouring to solidification and cooling to room temperature.** Heat flow at different locations in the system is a complex phenomenon; it depends on many factors relating to the casting material and the mold and process parameters. For instance, in casting thin sections the metal flow rates must be high enough to avoid premature chilling and solidification. But, the flow rate must not be so fast as to cause excessive turbulence, which its detrimental effects on the casting process.

Solidification time

During the early stages of solidification, a thin solidified skin begins to form at the cool mold walls and, as times passes, the skin thickens. With flat mold walls, this thickness is proportional to the square root of time. Thus doubling the time will make the skin $\sqrt{2} = 1.41$ times, or 41 percent, thicker. The solidification time is a function of the volume of a casting and its surface area (Chvorinov's rule):

$$\text{Solidification time} = C \,(\text{volume/surface area})^2 \qquad\qquad (1)$$

Where C is a constant that reflects mold material, metal properties (including latent heat), and temperature. Thus a large sphere solidifies and cools to ambient temperature at a much slower rate than does a smaller sphere. The reason is that the volume of a sphere is proportional to the cube of its diameter, and the surface area is proportional to the square of its diameter. Similarly, we can show that molten metal in a cube-shaped mold will solidify faster than in a spherical mold of the same volume.

The effects of mold geometry and elapsed time on skin thickness and shape are shown in Fig. As illustrated, the un-solidified molten metal has been poured from the mold at different time intervals, ranging from 5 s to 6 min. Note that the skin thickness increases with elapsed time but that the skin is thinner at internal angles (location A in the figure) than at external angles (location B). This latter condition is caused by slower cooling at internal angles than at external angles.
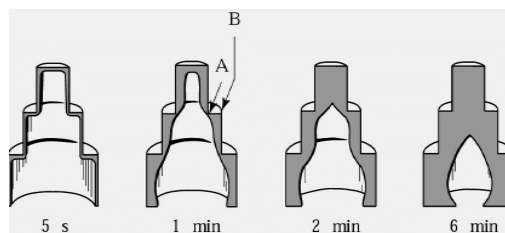
Solidified skin on a steel casting. The remaining molten metal is poured out at the times indicated in the figure. Hollow ornamental and decorative objects are made by a process called slush casting, which is based on this principle.

Example: Solidification times for various shapes

Three pieces being cast have the same volume but different shapes. One is a sphere, one a cube, and the other a cylinder with a height equal to its diameter. Which piece will solidify the fastest and which one the slowest?

SOLUTION: The volume is unity, so we have from Eq. (1):

Solidification time α 1/ (surface area)^2

The respective surface areas are

Sphere: $V = (4/3)\,\pi r^3$, $r = (3/4\pi)^{1/3}$, and $A = 4\pi r^2 = 4\pi\,(3/4\pi)^{2/3} = 4.84$;

Cube: $V = a^3$, $a = 1$, and $A = 6a^2 = 6$;

Cylinder: $V = \pi r^2 h = 2\,\pi r^3$, $r = (1/2\pi)^{1/3}$ and

$A = 2\pi r^2 + 2\pi rh = 6\pi r^2 = 6\,\pi\,(1/2\pi)^{2/3} = 5.54$.

Thus the respective solidification times t are $t_{sphere} = 0.043\ C$, $t_{cube} = 0.028\ C$, and $t_{cylinder} = 0.033\ C$.

Hence the cube-shaped casting will solidify the fastest and the sphere-shaped casting will solidify the slowest.

Shrinkage

Because of their thermal expansion characteristics, metals shrink (contract) d solidification and cooling. **Shrinkage**, which causes dimensional changes-and, sometimes, cracking-is the result of:
a) Contraction of the molten metal as it cools prior to its solidification.
b) Contraction of the metal during phase change from liquid to solid (latent heat of fusion).
c) Contraction of the solidified metal (the casting) as its temperature drops to ambient temperature.

This chapter **[11]** is organized around the major classifications of casting practices. These classifications are related to mold materials, molding processes, and methods of feeding the mold with the molten metal. The two major categories are *expendable-mold* and *permanent-mold casting*. **Expendable molds** are made of sand, plaster, ceramics, and similar materials, which are generally mixed with various binders, or bonding agents. These materials are refractories, that is, they have the capability to withstand the high temperatures of molten metals. After the casting has solidified, the molds in these processes are broken up to remove the casting.

Permanent molds, as the names imply, are used repeatedly and are designed in such a way that the casting can be easily removed and the mold used for the next casting. These molds are made of

metals that maintain their strength at high temperatures and thus can be used repeatedly. Because metal molds are better heat conductors than expendable molds, the solidifying casting is subjected to a higher rate of cooling, which in turn affects the microstructure and grain size within the casting. **Composite molds** are made of two or more different materials, such as sand, graphite, and metal, combining the advantages of each material. They are used in various casting processes to improve mold strength, cooling rates, and overall economics of the process.

Shell-Mold Casting

In this process, a mounted pattern made of a ferrous metal or aluminum is heated to 175-370 °C, coated with a parting agent such as silicone, and clamped to a box or chamber containing a fine sand containing 2.5 to 4.0 percent thermosetting resin <u>binder</u> such as phenol-formaldehyde, which coats the sand particles. The box is either rotated upside down (Fig.) or the sand mixture is blown over the pattern, allowing it to coat the pattern.

The assembly is then placed in an oven for a short period of time to complete the curing of the resin. The oven in most shell-molding machines is a metal box with gas fired burners that swings over the shell mold to cure it. The shell hardens around the pattern and is removed from the pattern using built-in ejector pins.
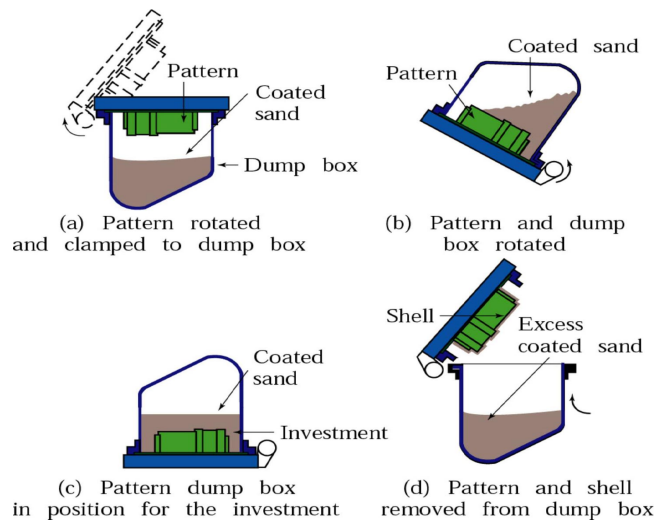
A common method of making shell molds. Called *dump-box* technique, the limitations are the formation of voids in the shell and peelback (when sections of the shell fall off as the pattern is raised).
Source: ASM International.

Two half-shells are made in this manner and are bonded or clamped together in preparation for pouring.

The thickness of the shell can be accurately determined by controlling the time that the pattern is in contact with the mold. In this way, the shell can be formed the required strength and rigidity to hold

the weight of the molten liquid. The shells are light and thin, usually 5-10 mm, and consequently their thermal characteristics are different from those for thicker molds.

The high quality of the finished casting can significantly reduce cleaning, machining, and other finishing costs. Complex shapes can be produced with less labor, and the process can be automated fairly easily. Shell-molding applications include small mechanical parts requiring high precision, such as gear housing, cylinder heads, and connecting rods. Shell molding is also widely used in producing high precision molding cores.

Expandable Pattern Casting (Lost Foam)

The expandable pattern casting process uses a polystyrene pattern, which evaporates upon contact with molten metal to form a cavity for the casting. The process is also known as evaporative-pattern or lost-pattern casting, and has become one of the more important casting processes for ferrous and nonferrous metals, particularly for the automotive industry.

First, raw expandable polystyrene (EPS) beads, are placed in a preheated die, usually made of aluminum. The polystyrene expands and takes the shape of the die cavity. Additional heat is applied to fuse and bond the beads together. The die is then cooled and opened, and the polystyrene pattern is removed. Complex patterns may also be made by bonding various individual pattern sections using hot-melt adhesive.
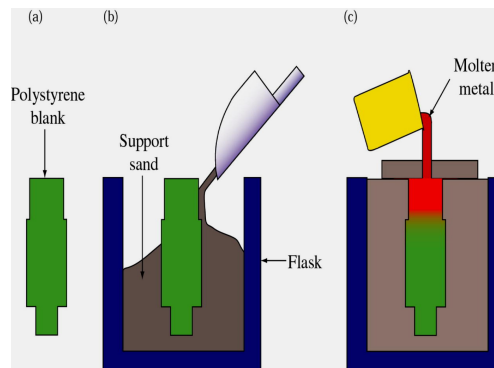
Schematic illustration of the expendable pattern casting process, also known as lost foam or evaporative casting.

The pattern is then coated with a water-base refractory slurry, dried, and placed in a flask. The flask is filled with loose fine sand, which surrounds and supports the pattern. The sand may be dried or mixed with bonding agents to give it additional strength. Then, without removing the polystyrene pattern, the molten metal is poured into the mold. This action immediately vaporizes the pattern and fills the mold cavity, completely replacing the space previously occupied by the polystyrene pattern. The heat degrades the polystyrene and the degradation products are vented into the surrounding sand.

The evaporative-pattern process has a number of advantages over other casting methods:

a) It is a relatively simple process because there are no parting lines, cores, or riser systems; hence it has design flexibility.

b) Inexpensive flasks are sufficient for the process.

c) Polystyrene is inexpensive and can be easily processed into patterns having very complex shapes, various sizes, and fine surface detail.

d) The casting requires minimum finishing and cleaning operations.

e) The process is economical for long production runs. A major factor is the cost to produce the die for expanding the polystyrene beads to make the pattern.

f) The process can be automated.

Typical applications for this process are *cylinder heads, crankshafts, brake components and manifolds for automobiles, and machine bases.* The aluminum engine blocks and other components of the General Motors Saturn automobile are made by this process.
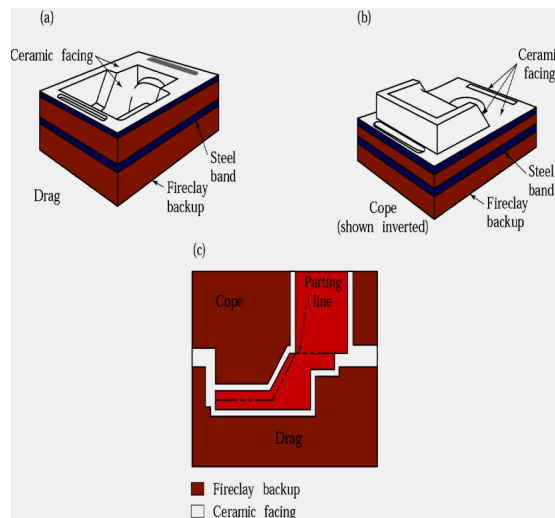
Ceramic-Mold Casting

The process is also called cope-and-drag investment casting. The slurry is a mixture of fine-grained zircon ($ZrSiO_4$), aluminum oxide, and fused silica, which are mixed with bonding agents and poured over the pattern (Fig.), which has been placed in a flask.
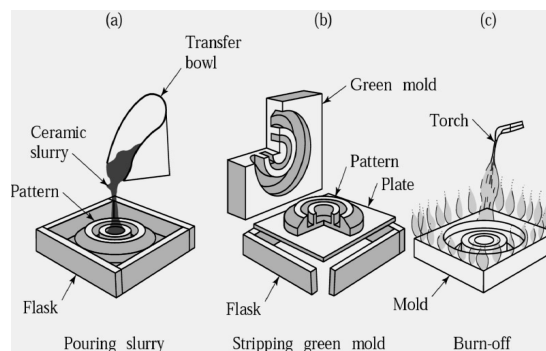
Sequence of operations in making a ceramic mold.

The pattern may be made of wood or metal. After setting, the molds, which are made from refractory materials suitable for high-temperature applications; (ceramic facings) are removed, dried, burned off to remove volatile matter, and baked. The molds are clamped firmly and used as all-ceramic molds. In the Shaw process, the ceramic facings are backed by fireclay (clay used in

making firebricks that resist high temperatures) to give strength to the mold. The facings are then assembled into a complete mold, ready to be poured (Fig.).


A typical ceramic mold (Shaw process) for casting steel dies used in hot forging.

The high-temperature resistance of the refractory molding materials allows these molds to be used in casting ferrous and other high-temperature alloys, stainless steels, and tool steels. The castings have good dimensional accuracy and surface finish over a wide range of sizes and intricate shapes, but the process is somewhat expensive. Typical parts made are impellers, cutters for machining, dies for metalworking, and molds for making plastic or rubber components. Parts weighing as much as 700 kg have been cast by this process.

Investment Casting

The investment-casting process, also called the lost-wax process, was first used during the period 4000-3000 B.C. The pattern is made of wax or a plastic such as polystyrene. The sequences involved in investment casting are shown in Fig. The pattern is made by injecting molten wax or plastic into a metal die in the shape of the pattern.
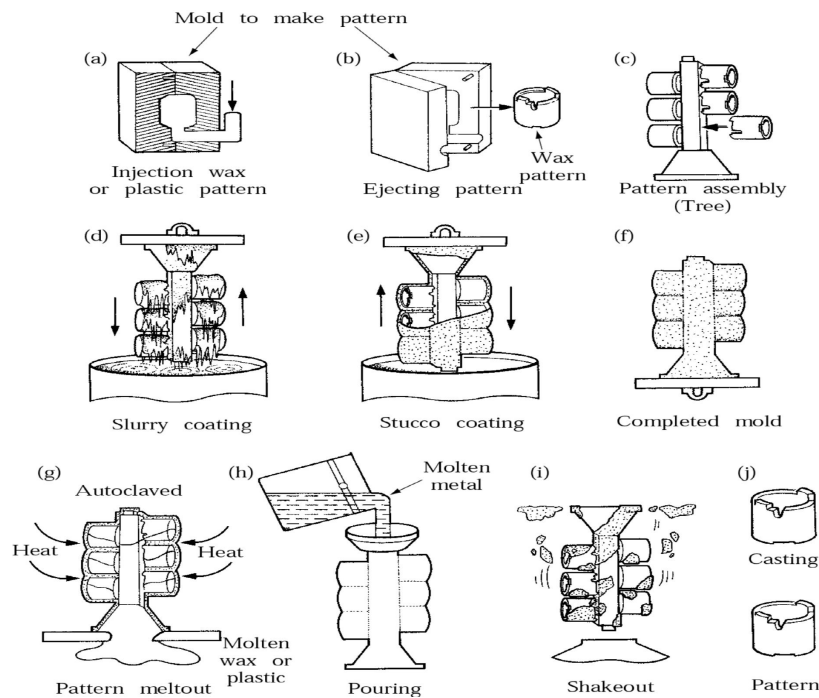
Schematic illustration of investment casting, (lost wax process). Castings by this method can be made with very fine detail and from a variety of metals. *Source:* Steel Founders' Society of America.

The pattern is then dipped into a slurry of refractory material, such as very fine silica and binders, including water, ethyl silicate, and acids. After this initial Coating has dried, the pattern is coated repeatedly to increase its thickness. <u>The term investment comes from the fact that the pattern is invested with the refractory material.</u> Wax patterns require careful handling because they are not strong enough to withstand the forces involved during mold making. However, unlike plastic patterns, wax can be reused. The one-piece mold is dried in air and heated to a temperature of 90-175 °C in an inverted position to melt out the wax for about 12 hours. The mold is then fired to 650-1050 °C for about 4 hours, depending on the metal to be cast, to drive off the water of crystallization. After the mold has been poured and the metal has solidified, the mold is broken up and the casting is removed. A number of patterns can be joined to make one mold, called a tree (Fig.c), thus increasing the production rate.

<u>Although the labor and materials involved make the lost-wax process costly, it is suitable for casting high-melting-point alloys with good surface finish and close tolerances.</u> Thus little or no finishing operations are required, which would otherwise add significantly to the total cost of the casting. This process is capable of producing <u>intricate shapes</u>, with parts weighing from 1 g to 35 kg, from a wide variety of ferrous and nonferrous metals and alloys. Typical parts made are components for office equipment and mechanical components such as **gears, cams, valves, and ratchets.**

Ceramic-shell investment casting A variation of the investment-casting process is ceramic-shell casting. It uses the same type of wax or plastic pattern, which is dipped first in ethyl silicate gel and then into a fluidized bed of fine-grained fused silica or zircon flour. The pattern is then dipped into coarser-grained silica to build up additional coatings and thickness to withstand the thermal shock of pouring. The rest of the procedure is similar to investment casting. This process is economical and is used extensively for precision casting of steels and high-temperature alloys.

The sequence of operations involved in making a turbine disk by this method is shown in Fig.


Investment casting of an integrally cast rotor for a gas turbine. (a) Wax pattern assembly. (b) Ceramic shell around wax pattern. (c) Wax is melted out and the mold is filled, under a vacuum, with molten superalloy. (d) The cast rotor, produced to net or near-net shape.

Example: Investment-cast superalloy components for gas turbines

Since the 1960s, investment-cast superalloys have been replacing wrought counterparts in high-performance gas turbines. Much development has been taking place in producing cleaner superalloys (nickel-base and cobalt-base). Improvements have been made in melting and casting techniques, such as by vacuum-induction melting, using microprocessor controls. Impurity and inclusion levels have continually been reduced, thus improving the strength and ductility of these components. Such control is essential because these parts operate at a temperature only about 50°C below the solidus.

The microstructure of an investment-cast, gas-turbine rotor is shown in the upper portion of Fig.. Note the fine, uniform, equiaxed grain size throughout the cross section. Recent techniques to obtain this result include the use of a **nucleant** addition to the molten metal, as well as close control of its superheat, pouring techniques, and control of cooling rate of the casting. In contrast, the lower portion of Fig. shows the same type of rotor cast conventionally; note the coarse grain structure. This rotor will have inferior properties compared to the fine-grained-rotor. Due to developments in

these processes, the proportion of cast parts to other parts in aircraft engines has increased from 20 percent to about 45 percent by weight.
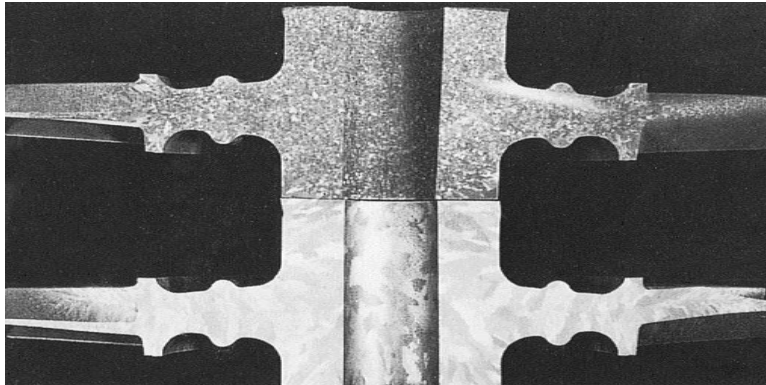
Cross section and microstructure of two rotors: (top) investment-cast; (bottom) conventionally cast.

Permanent-Mold Casting

In this process, *also called hard mold casting*, two halves of a mold are made from materials such as cast iron, steel, bronze, graphite or refractory metal alloys. The mold cavity and gating system are machined into the mold and thus become an integral part of it. To produce castings with internal cavities, cores made of metal or sand aggregate are placed in the mold prior to casting. *Typical core materials are oil-bonded or resin-bonded sand, plaster, graphite, gray iron, low-carbon steel, and hot-work die steel.* Gray iron is the most commonly used, particularly for large molds for aluminum and magnesium castings.

In order to increase the life of permanent molds, the surfaces of the mold cavity are usually coated with a refractory slurry, such as sodium silicate and clay, or sprayed with graphite every few castings. These coatings also serve as parting agents and as thermal barriers, controlling the rate of cooling of the casting. Mechanical ejectors, such as pins located in various parts of the mold, may be needed for removal of complex castings. The molds are clamped together by mechanical means and heated to about 150-200 °C to facilitate metal flow and reduce thermal damage to the dies. The molten metal is then poured through the gating system. After solidification, the molds are opened and the casting is removed.

Although the permanent-mold casting operation can be performed manually, the process can be automated for large production runs. **This process is used mostly for aluminum, magnesium, and copper alloys and gray iron because of their generally lower melting points. Steels can also be cast using graphite or heat-resistant metal molds.**

This process produces castings with good surface finish, close tolerances, uniform and good mechanical properties, and at high production rates. Typical parts made by permanent-mold casting are automobile pistons, cylinder heads, connecting rods, gear blanks for appliances, and kitchenware. Parts that can be made economically generally weigh less than 25 kg, although special castings weighing a few hundred kilograms have been made by this process.

Although equipment costs can be high because of die costs, the process can be mechanized, thus keeping labor costs low. Permanent-mold casting is not economical for small production runs. Furthermore, because of the difficulty in removing the casting from the mold, intricate shapes cannot be cast by this process.

Slush Casting

We noted earlier [solidification time] that a solidified skin first develops in a casting and that this skin becomes thicker with time. Hollow castings with thin walls can be made by permanent-mold casting using this principle. This process is called slush casting. The molten metal is poured into the metal mold, and after the desired thickness of solidified skin is obtained, the mold is inverted, and the remaining liquid metal is poured out. The mold halves are then opened and the casting is removed. The process is suitable for small production runs and is generally used for making ornamental and decorative objects (such as lamp bases and stems) and toys from low-melting-point metals, such as zinc, tin, and lead alloys.

Pressure Casting

In the two permanent-mold processes that have just been described, the molten met flows into the mold cavity by gravity. In the pressure-casting process, also called pressure pouring or low-pressure casting (Fig. a), the molten metal is forced upward by gas pressure into a graphite or metal mold. The pressure is maintained until the metal has completely solidified in the mold. The molten metal may also be forced upward by a vacuum, which also removes dissolved gases and gives the casting lower porosity.

Pressure casting is generally used for high-quality castings. An example of this process is steel railroad-car wheels. These wheels may also be cast in sand molds semipermanent molds made of graphite and sand (Fig. b).
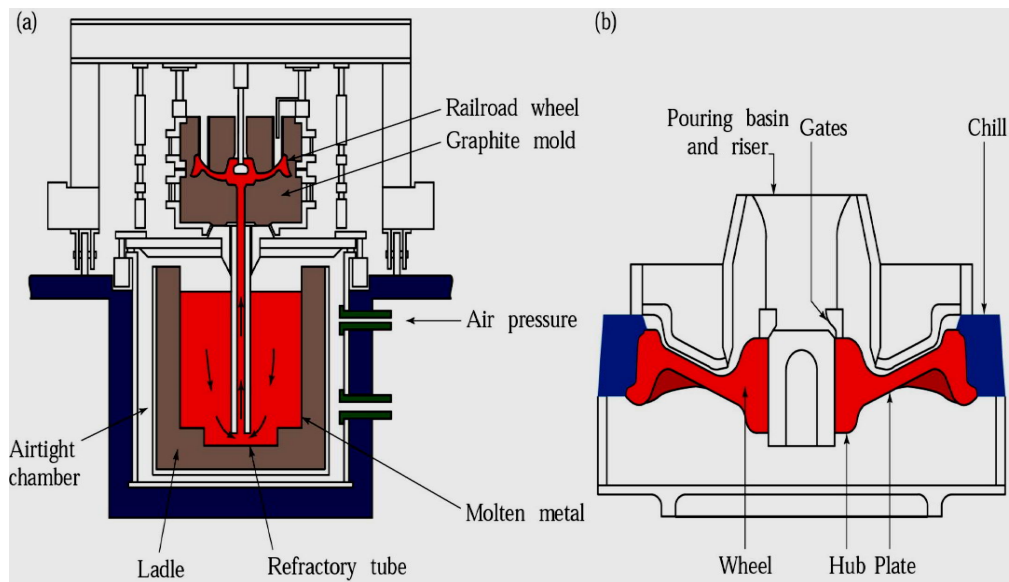
FIGURE: (a) The bottom-pressure casting process utilizes graphite molds for the production of steel railroad wheels. (b) Gravity-pouring method of casting a railroad wheel. Note that the pouring basin also serves as a riser. Railroad wheels can also be manufactured by forging.

Die Casting

The die-casting process, developed in the early 1900s, is a further example of permanent-mold casting. The molten metal is forced into the die cavity at pressures ranging from 0.7 -700 MPa. Typical parts made by die casting are carburetors, motors and appliance components, hand tools, and toys. The weight of most castings ranges from less than 90 g to about 25 kg. There are two basic types of die-casting machines: hot-chamber and cold-chamber.

Hot-chamber process

The hot-chamber process (Fig.) involves the use of a piston, which traps a certain volume of molten metal and forces it into the die cavity through a gooseneck and nozzle. The pressures range up to 35 MPa, with an average of about 15 MPa. The metal is held under pressure until it solidifies in the die. To improve die life and to aid in rapid metal cooling-thus reducing cycle time-dies are usually cooled by circulating water or oil through various passageways in the die block. Cycle times usually range up to 900 shots (individual injections) per hour for zinc, although very small components such as zipper teeth can be cast at 18,000 shots per hour. Low-melting-point alloys such as zinc, tin, and lead are commonly cast by this process.
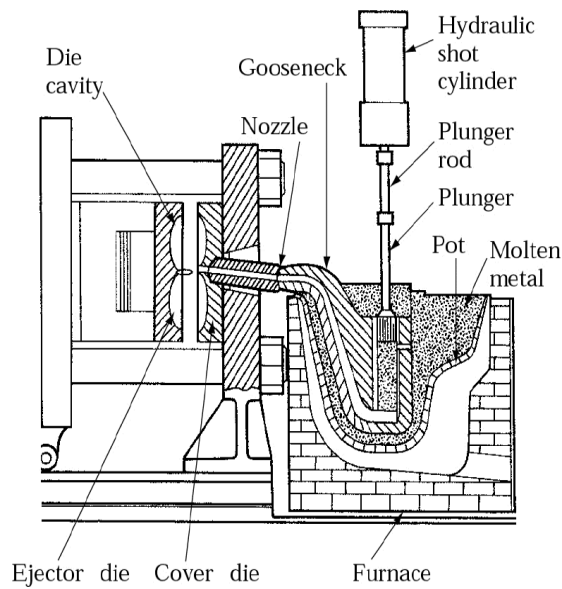
FIGURE: Sequence of steps in die casting of a part in the hot-chamber process. Source: Courtesy of Foundry Management and Technology.

Cold-chamber process

In the cold-chamber process (Fig.), molten metal is poured into the injection cylinder (shot chamber) with a ladle. The shot chamber is not heated-hence the t cold chamber. The metal is forced into the die cavity at pressures usually ranging f 20 MPa to 70 MPa, although they may be as high as 150 MPa.
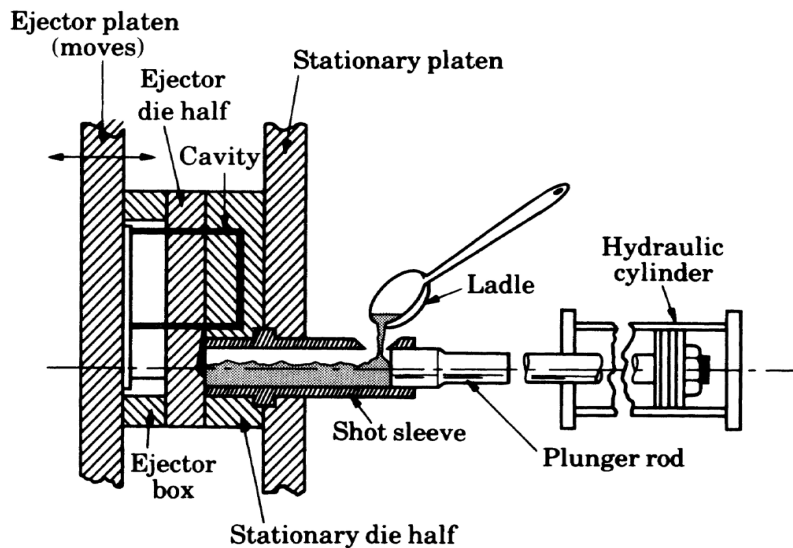

FIGURE: Sequence of operations in die casting of a part in the cold-chamber process. Source: Courtesy of Foundry Management and Technology.

The machines may be horizontal (Fig.) or vertical, in which the shot chamber vertical and the machine is similar to a vertical press.
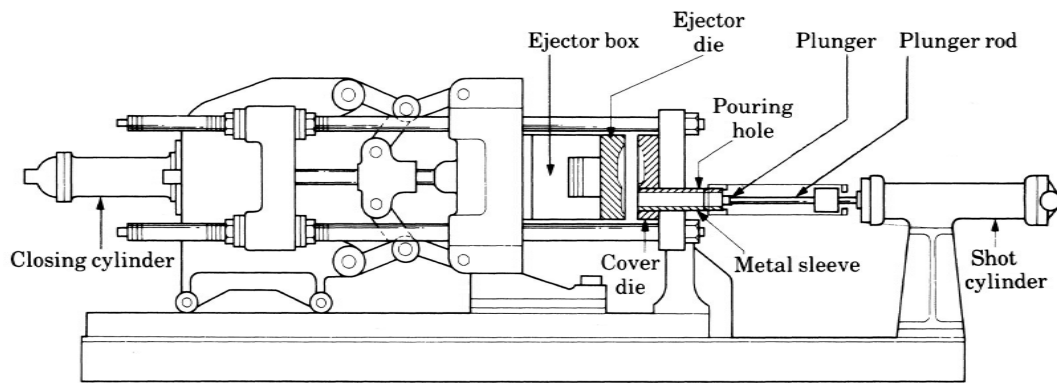
FIGURE: Schematic illustration of a die-casting machine. These machines are large compared to the size of the casting because large forces are required to keep the two halves of the dies closed. Otherwise, the pressure of the molten metal in the die cavities may force the dies apart.

Centrifugal Casting

As its name implies, the centrifugal-casting process utilizes the inertial forces ca by rotation to distribute the molten metal into the mold cavities. In centrifugal casting, hollow cylindrical parts such as pipes, gun barrels, and streetlamp posts, are produced by the technique shown in Fig., in which molten metal is poured into a rotating mold. The axis of rotation is usually horizontal but can be vertical for short work pieces. Molds are made of steel, iron, or graphite and may be coated with a refractory lining to increase mold life. The mold surfaces can be shaped so that pipes with various outer shapes, including square or polygonal, can be cast.
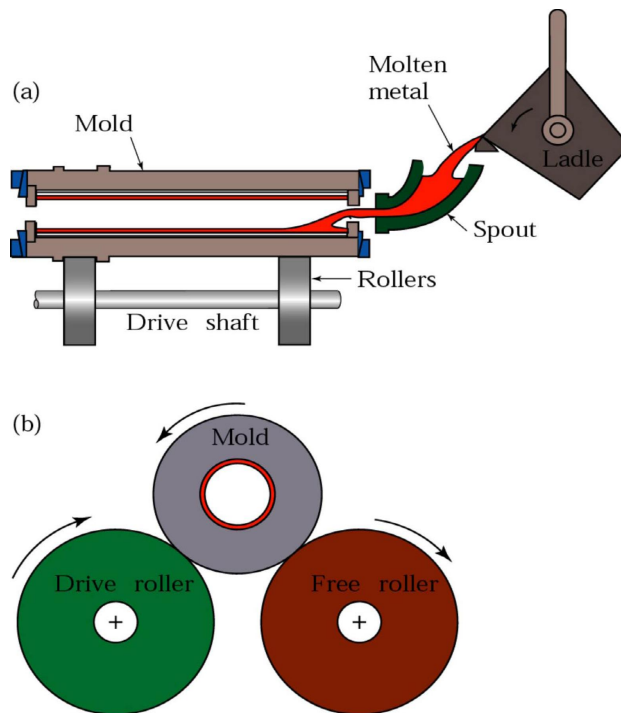

FIGURE: Schematic illustration of the centrifugal casting process. Pipes, cylinder liners, and similarly shaped parts can be cast by this process.

The inner surface of the casting remains cylindrical because the molten metal is uniformly distributed by centrifugal forces. However, because of density differences, lighter elements such as impurities and pieces of the refractory lining tend to collect on the inner surface of the casting.

Cylindrical parts ranging from 13 mm to 3 m in diameter and 16 m long can be cast centrifugally, with wall thicknesses ranging from 6 mm to 125 mm. The pressure generated by the centrifugal force is high and that pressure is necessary for casting thick-walled parts. Castings of good quality, dimensional accuracy, and external surface detail are obtained by this process. In addition to pipes, typical parts made are bushings, engine-cylinder liners, and bearing rings with or without flanges.

Casting Techniques for Single-Crystal Components

Conventional casting of turbine blades

The conventional casting process uses a ceramic mold. The molten metal is poured into the mold and begins to solidify at the ceramic walls. The grain structure developed is polycrystalline and is similar to that obtained using nucleating agents. The presence of grain boundaries makes this structure susceptible to creep and cracking along those boundaries under the centrifugal forces and elevated temperatures common in an operating gas turbine.

Directionally solidified blades In the directional solidification process (Fig. a), the ceramic mold is preheated by radiant heating. The mold is supported by a water-cooled chill plate. After the metal is poured into the mold, the assembly is lowered slowly. **Crystals begin to grow at the chill-plate surface and upward, like the columnar grains shown earlier.** The blade is thus directionally solidified, with longitudinal but no transverse grain boundaries. Consequently the blade is stronger in the direction of centrifugal forces developed in the gas turbine.
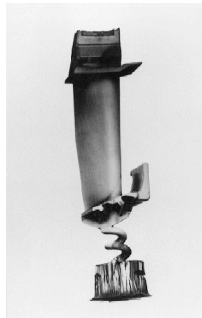
Single-crystal blades
In crystal growing, the mold has constriction in the shape of a corkscrew or helix (Figs. b and c), the cross-section of which allows only one crystal to fit through. The mechanism of crystal growth such that only the most favorably oriented crystals are able to grow through the helix because all others are intercepted by the walls of the helical passage. As the assembly is lowered slowly, a single crystal grows upward through the constriction and begins to grow in the mold. Strict control of the rate of movement is necessary. The solidified mass in the mold is single-crystal blade. Although more expensive than other blades, the lack of grain boundaries makes these blades resistant to creep

and thermal shock. Thus they hay longer and more reliable service life.
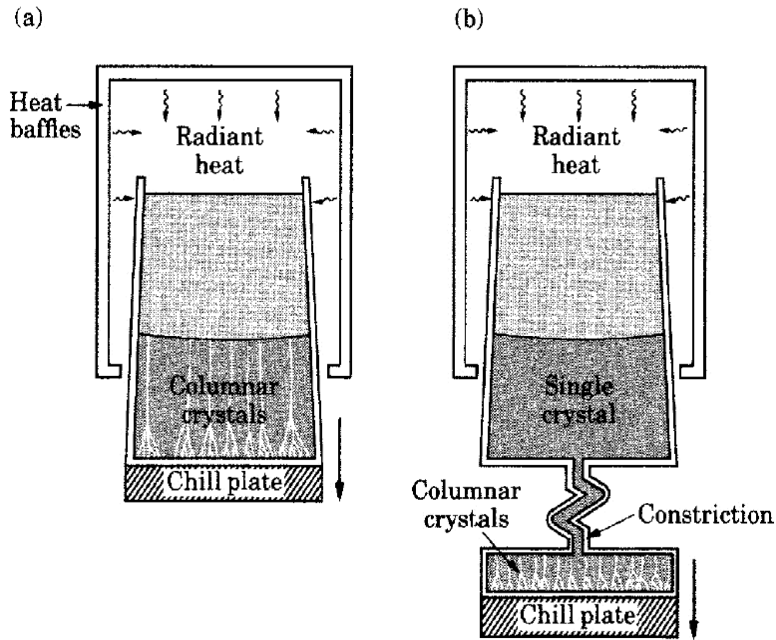
Methods of casting turbine blades: (a) directional solidification; (b) method to produce a single-crystal blade; and

(c) a single-crystal blade with the constriction portion still attached.

Melting Practice and Furnaces

Melting practice is an important aspect of casting operations, because it has a direct bearing on the quality of castings. Furnaces are charged with melting stock consisting of metal, alloying elements, and various other materials such as flux and slag-forming constituents. **Fluxes** are inorganic compounds that refine the molten metal by removing dissolved gases and various impurities. Fluxes have several functions, depending on the metal. *For example, for aluminum alloys there are cover fluxes (to form a barrier to oxidation), cleaning fluxes, refining fluxes, and wall-cleaning fluxes (because of the detrimental effect that some fluxes have on furnace linings, particularly induction furnaces).* Fluxes may be added manually or can be injected automatically into the molten metal.

To protect the surface of the molten metal against atmospheric reaction and contamination-and to refine the melt-the pour must be insulated against heat loss. Insulation is usually provided by covering the surface or mixing the melt with compounds that form a slag. In casting steels, the composition of the slag includes CaO, SiO_2, MnO, and FeO. A small quantity of liquid metal is usually tapped and its composition analyzed. Necessary additions or inoculations are then made prior to pouring the metal into the molds.

The metal charge may be composed of commercially pure primary metals, which are remelted scrap. Clean scrapped castings, gates, and risers may also be included in the charge. If the melting points of the alloying elements are sufficiently low, pure alloying elements are added to obtain the desired composition in the melt.
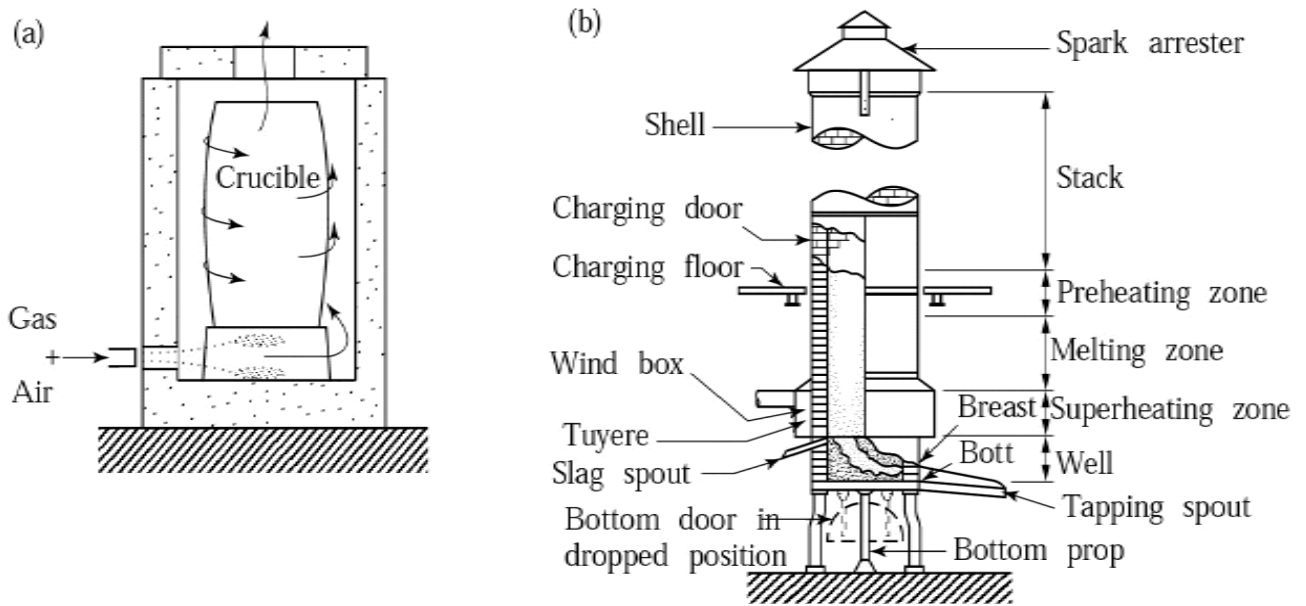
Melting Furnaces

The melting furnaces commonly used in foundries are: Electric-arc, induction, crucible, and cupolas.

Electric-arc furnaces are used extensively in foundries and have advantages such as high rate of melting (thus high production rate), much less pollution than other types of furnaces and the ability to hold the molten metal for any length of time for alloying purposes.

Induction furnaces are especially useful in smaller foundries a produce composition-controlled smaller melts. The coreless induction furnace consists of a crucible completely surrounded with a water-cooled copper coil through which high frequency current passes. Because there is a strong electromagnetic stirring action during induction heating, this type of furnace has excellent mixing characteristics for alloying and adding new charge of metal.

Crucible furnaces (Fig. a), which have been used extensively throughout history, are heated with various fuels, such as commercial gases, fuel oil, fossil fuel as well as electricity. They may be stationary, tilting, or movable. Many ferrous and nonferrous metals are melted in these furnaces.

Cupolas are basically refractory-lined vertical steel vessels that are charged with alternating layers of metal, coke, and flux (Fig. b). Although they require major investments and are being replaced by induction furnaces, cupolas operate continuously, have high melting rates, and produce large amounts of molten metal.

(a)

Crucible

Gas
+
Air

(b)

Spark arrester

Shell

Charging door

Charging floor

Wind box

Tuyere

Slag spout

Bottom door in
dropped position

Stack

Preheating zone

Melting zone

Breast Superheating zone

Bott Well

Tapping spout

Bottom prop

Furnace selection requires careful consideration of several factors that can significantly influence the quality of castings, as well as the economics of casting operations. A variety of furnaces meet requirements for melting and casting metals and alloys in foundries, so proper selection of a furnace generally depends on:

a) Economic considerations, such as initial cost and operating and maintenance costs.

b) The composition and melting point of the alloy to be cast and ease of controlling metal chemistry.

c) Control of the furnace atmosphere to avoid contamination of the metal.

d) Capacity and the rate of melting required.

e) Environmental considerations, such as air pollution and noise.

f) Power supply and its availability and cost of fuels.

g) Ease of superheating the metal.

h) Type of charge material that can be used.