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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Green Sand Molding	The green sand process utilizes a mold made of compressed or compacted moist sand packed around a wood or metal pattern. A metal frame or flask is placed over the pattern to produce a cavity representing one half of the casting. The sand is compacted by either jolting or squeezing the mold. The other half of the mold is produced in like manner and the two flasks are positioned together to form the complete mold. If the casting has hollow sections, cores consisting of hardened sand (baked or chemically hardened) are used. ***High-Density Molding (High Squeeze Pressure / Impact)*** Large air cylinders, hydraulics, and innovative explosive methods have improved the sand compaction around the pattern, improving the standards of accuracy and finish which can be achieved with certain types of castings.	**Advantages** • Most ferrous / non-ferrous metals can be used. • Low Pattern & Material costs. • Almost no limit on size, shape or weight of part. • Adaptable to large or small quanities. • Used best for light, bench molding for medium-sized castings or for use with production molding machines. **Disadvantages** • Low design complexity. • Lower dimensional accuracy.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
No-Bake Molding	Chemical binders (furan or urethane) are mixed with sand and placed in mold boxes surrounding the pattern halves. At room temperature, the molds become rigid with the help of catalysts. The pattern halves are removed and the mold is assembled with or without cores.	• Most ferrous / non- ferrous metals can be used. • Adaptable to large or small quantities. • High strength mold. • Better as-cast surfaces. • Improved dimensional repeatability. • Less skill and labor required then in conventional sand molding. • Better dimensional control. **Disadvantages** • Sand temperatures critical. • Patterns require additional maintenance.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Resin Shell Molding	Resin-bonded silica sand is placed onto a heated pattern, forming shell-like mold halves. Pattern halves are bonded together with or without cores. Probably the earliest, most automated and most rapid of mold (and coremaking) processes was the heat-curing technique known as the shell process. Ejector pins enable the mold to be released from the pattern and the entire cycle is completed in seconds depending upon the shell thickness desired. The two halves of the mold, suitably cored, are glued and clamped together prior to the pouring of the metal. Shell molds may be stored for long periods if desired. Because of pattern costs, this method is best suited to higher volume production.	• Adaptable to large or medium quantities. • Most ferrous / non-ferrous metals can be used. • Rapid production rate. • Good dimensional casting detail and accuracy. • Shell molds are lightweight and may be stored almost indefinitely. **Disadvantages** • Since the tooling requires heat to cure the mold, pattern costs and pattern wear can be higher. • Energy costs are higher. • Material costs are higher than those for green sand molding.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Permanent Mold	Permanent molds consist of mold cavities machined into metal die blocks and designed for repetitive use. Currently, molds are usually made of cast iron or steel, although Permanent mold castings can be produced from all of the metals including iron and copper alloys, but are usually light metals such as zinc-base, magnesium and aluminum. ***Gravity Permanent Mold*** - The flow of metal into a permanent mold using gravity only is referred to as a gravity permanent mold. There are two techniques in use: static pouring where metal is introduced into the top of the mold through downsprues similar to sand casting; and tilt pouring, where metal is poured into a basin while the mold is in a horizontal position and flows into the cavity as the mold is gradually tilted to a vertical position. Normally, gravity molding is used because it is more accurate than shell molding. It is preferred almost exclusively to shell molding for light alloy components. ***Low-Pressure Permanent Mold*** - Low-pressure permanent mold is a method of producing a casting by using a minimal amount of pressure (usually 5-15 lb/sq in.) to fill the die. It is a casting process that helps	**Advantages** • Produces dense, uniform castings with high dimensional accuracy. • Excellent surface finish and grain structure. • The process lends itself very well to the use of expendable cores and makes possible the production of parts that are not suitable for the pressure diecasting process. • Repeated use of molds. • Rapid production rate with low scrap loss. **Disadvantages**

	to further bridge the gap between sand and pressure diecasting.	• Higher cost of tooling requires a higher volume of castings.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Die Casting	This process is used for producing large volumes of zinc, aluminum and magnesium castings of intricate shapes. The essential feature of diecasting is the use of permanent metal dies into which the molten metal is injected under high pressure (normally 5000 psi or more. The rate of production of diecasting depends largely on the complexity of design, the section thickness of the casting, and the properties of the cast metal. Great care must be taken with the design and gating of the mold to avoid high-pressure porosity to which this process is prone.	**Advantages** • Cost of castings is relatively low with high volumes. • High degree of design complexity and accuracy. • Excellent smooth surface finish. • Suitable for relatively low melting point metals (1600F/871C) like lead, zinc, aluminum, magnesium and some copper alloys. • High production rates. **Disadvantages** • Limits on the size of castings - most suitable for small castings up to about 75 lb. • Equipment and die costs are high.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Investment Casting (Lost Wax)	***Investment Casting*** is the process of completely investing a three-dimensional pattern in all of its dimensions to produce a one-piece destructible mold into which molten metal will be poured. A refractory slurry flows around the wax pattern, providing excellent detail. The wax patterns are assembled on a "tree" and invested with a ceramic slurry. The tree is then immersed into a fluidized bed of refractory particles to form the first layer of the ceramic shell. The mold is allowed to dry and the process repeated with coarser material until sufficient thickness has been built up to withstand the impact of hot metal. When the slurry hardens, the wax pattern is melted out and recovered and the mold or ceramic shell is oven cured prior to casting. Most materials can be cast by this process but the economics indicate that fairly high volume is necessary and the shape and complexity of the castings should be such	**Advantages** • Excellent accuracy and flexibility of design. • Useful for casting alloys that are difficult to machine. • Exceptionally fine finish. • Suitable for large or small quantities of parts. • Almost unlimited intricacy. • Suitable for most ferrous / non-ferrous metals. • No flash to be removed or parting line tolerances. **Disadvantages** • Limitations on size of casting. • Higher casting costs make it important to take full advantage of the process to eliminate all machining operations.

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	that savings are made by eliminating machining.	

Metal Casting Processes

Foundry Process	Process	Pros / Cons
Expandable Pattern Casting (Lost Foam)	Also known as Expanded Polystyrene Molding or Full Mold Process, the EPC or Lost Foam process is an economical method for producing complex, close-tolerance castings using an expandable polystyrene pattern and unbonded sand. The EPC process involves attaching expandable polystyrene patterns to an expandable polystyrene gating system and applying a refractory coating to the entire assembly. After the coating has dried, the foam pattern assembly is positioned on several inches of loose dry sand in a vented flask. Additional sand is then added while the flask is vibrated until the pattern assembly is completely embedded in sand. A suitable downsprue is located above the gating system and sand is again added until it is level to the top of the sprue. Molten metal is poured into the sprue, vaporizing the foam polystyrene, perfectly reproducing the pattern. Gases formed from the vaporized pattern permeate through the coating on the pattern, the sand and finally through the flask vents. In this process, a pattern refers to the expandable polystyrene or foamed polystyrene part that is vaporized by the molten metal. A pattern is required for each casting.	**Advantages** • No cores are required. • Reduction in capital investment and operating costs. • Closer tolerances and walls as thin as 0.120 in. • No binders or other additives are required for the sand, which is reusable. • Flasks for containing the mold assembly are inexpensive, and shakeout of the castings in unbonded sand is simplified and do not require the heavy shakeout machinery required for other sand casting methods. • Need for skilled labor is greatly reduced. • Casting cleaning is minimized since there are no parting lines or core fins. **Disadvantages** • The pattern coating process is time-consuming, and pattern handling requires great care. • Good process control is required as a

		scrapped casting means replacement not only of the mold but the pattern as well.

Metal Casting Processes

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Foundry Process	Process	Pros / Cons
Vacuum ("V") Process Molding	This adaptation of vacuum forming permits molds to be made out of free-flowing, dry, unbonded sand without using high-pressure squeezing, jolting, slinging or blowing as a means of compaction. The V-process is dimensionally consistent, economical, environmentally and ecologically acceptable, energy thrifty, versatile and clean. The molding medium is clean, dry, unbonded silica sand, which is consolidated through application of a vacuum or negative pressure to the body of the sand. The patterns must be mounted on plates or boards and each board is perforated with vent holes connected to a vacuum chamber behind the board. A preheated sheet of highly flexible plastic material is draped over the pattern and board. When the vacuum is applied, the sheet clings closely to the pattern contours. Each part of the molding box is furnished with its own vacuum chamber connected to a series of hollow perforated flask bars. The pattern is stripped from the mold and the two halves assembled and cast with the vacuum on.	**Advantages** • Superb finishes. • Good dimensional accuracy. • No defects from gas holes. • All sizes and shapes of castings are possible. • Most ferrous / non-ferrous metals can be used. **Disadvantages** • The V-process requires plated pattern equipment.

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Metal Casting Processes

Foundry Process	Process	Pros / Cons
Centrifugal Molding	The Centrifugal Casting process consists of a metal or graphite mold that is rotated in the horizontal or vertical plane during solidification of the casting. Centrifugal force shapes and feeds the molten metal into the designed crevices and details of the mold. The centrifugal force improves both homogeneity and accuracy of the casting. This method is ideally suited to the casting of cylindrical shapes, but the outer shape may be modified with the use of special techniques.	**Advantages** • Rapid production rate. • Suitable for Ferrous / Non-ferrous parts. • Good soundness and cleanliness of castings. • Ability to produce extremely large cylindrical parts. **Disadvantages** • Limitations on shape of castings. Normally restricted to the production of cylindrical geometric shapes.