How to Select a Casting Process and Alloy

How Design Interacts with Process and Alloy

Because the capabilities specific to different manufacturing processes have a great influence on design, a designer must select the process before finishing the drawing for purchasing a part. Alloy, size, shape, thickness, tolerance, texture and weight must be taken into account for each process, whether it be casting, stamping, forging, powdered metal or others.

A designer with experience in stampings and who has made similar parts as stampings in the past may decide to use stamping early on. A selection made on this kind of basis, however, will exclude some potentially beneficial design possibilities. For example, new methods of investment casting make some parts at prices competitive with stampings while providing much greater flexibility in design and alloy selection. Each year at Hitchiner, millions of automotive rocker arms are made as investment castings instead of stampings because countergravity casting has proven to yield the best overall value.

A good approach for the designer, then, is to avoid choosing a manufacturing method at the beginning of the design process.

Let the part function, shape, stress distribution and any special requirements such as wear, magnetism, corrosion, etc. drive the rough drawing shape. Call in a few manufacturers of metal parts who are knowledgeable about the different processes and see what ideas they can contribute in terms of design and alloy selection. Consider all aspects that affect performance, cost, assembly, reliability and weight to see if one or two processes offer the best overall value. If so, work with the vendors of those processes who have the engineering capability to assist in finalizing a satisfactory design for optimum producibility. Then go out for competitive bidding.

Selecting a Casting Process

If your investigations indicate a casting, there are still a number of casting processes from which to choose. Often a few part characteristics will determine which process will be most applicable, but it is a good idea to contact foundries to get input as to which process is likely to be the best.

Casting processes are mostly determined by the type of mold used. These are of two broad categories:

1. Reusable molds

- Permanent mold gravity cast
- Permanent mold countergravity cast
- Semipermanent mold gravity cast
- Semipermanent mold countergravity cast
- Squeeze casting
- Squeeze casting with inserts
- Semisolid metal forming
- Hot chamber die casting
- Cold chamber die casting
- Bimetal casting in all of the preceding

2. Expendable molds

- Clay bonded sand
- Oil bonded sand
- Chemically set resin bonded sand mold
- Heat set resin bonded sand mold
- Silicate bonded sand
- All of the preceding processes with mold formed by blowing or compaction and cast by gravity, countergravity or gravity pour with vacuum assist
- Unbonded sand with foam patterns
- Unbonded sand with plastic film
- Thin shell mold backed with unbonded sand
- Thick shell mold cast unsupported
- Thin shell mold backed with unbonded sand organically and inorganically (investment casting) bonded
- Thick shell mold cast unsupported organically and inorganically (investment casting) bonded
- The six previous processes cast by gravity pour, countergravity casting, or gravity pour with vacuum assist
- Inorganically bonded cast in vacuum or inert gas, gravity or countergravity cast
- Plaster bonded sand molds lost wax
- Plaster bonded sand molds, permanent pattern

Selecting an Alloy

All common alloys can be cast in expendable molds of some kind, but their availability from reusable mold processes relates to their melting points. In general, the higher the melting point, the less likely a reusable mold process can be used (Table: Alloy Fitness for Reusable Mold Processes). The alloys listed in the table include over 200 subcategories. Most of these subcategories can be supplied in different hardnesses and strength levels.

For a given part, only a few properties other than strength may be important, but there are many to consider, including:

- Cost
- Availability
- Strength
- Hot strength
- Hardness
- Density (weight limitations)
- Bearing qualities (galling resistance)
- Machinability
- Weldability
- Brazability
- Castability
- Abrasion resistance
- Corrosion resistance
- Oxidation resistance
- Fatigue properties
- Resistance to crack propagation
- Electrical conductivity
- Magnetic properties
- Thermal conductivity
- Coefficient of thermal expansion
- Thermal cycling distortion and fatigue
- Electrochemical potential
- Modulus of elasticity
- Dampening characteristics

The process may affect the importance of a property. If a part is cast to size, for example, machinability is not important, if a part is welded into an assembly, weldability is important.

Almost all investment casting alloys can be welded. This characteristic makes them appropriate for welding into assemblies.

Each casting process has its own strengths and weaknesses with regard to cost, reliability, dimensions held, metallurgical quality, volume production and competitive situation, and the important factor of company service must be considered.

Service

Hitchiner's highly experienced engineers and metallurgists will assist you in selecting the best process—investment casting or not—from the large number of possibilities. If a process other than investment casting is indicated, they will assist you in finding a source for that process. Since 1946, Hitchiner has made more than 40,000 different configurations in more than 200 different alloys for all types of industries. In addition to advising you, we can scan our parts database to see if we have made parts of similar design. That can be most helpful—and Hitchiner wants to help you!

Alloy Fitness for Reusable Mold Processes

(Ordered lowest to highest by melting point)

Base	Maximum Strength (1000s psi)	Reusable Mold
Zinc	61	Yes
Aluminum	60	Some alloys
Magnesium	40	Yes
Copper	150	Some alloys
Cast iron	60	Some alloys
Cobalt	110	No
Nickel	130	No
Stainless steel	200	No
Tool steel	220	No
Maraging steel	240	No
Low alloy steel	220	No
Carbon steel	150	No
Titanium	160	No