Zinc-Aluminum Foundry Alloys

Sumário:
Zinc-Aluminum Foundry Alloys 8, 12 and 27 comprise a new family of zinc casting alloys that have proven themselves in a wide variety of demanding applications. They are engineering materials well suited to applications requiring high as-cast strength, hardness and wear resistance. These three alloys offer designers and casting specifiers viable, cost-effective alternatives for their component requirements.

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The alloys are designated 8, 12 and 27 because of their approximate aluminum content. Each also contains copper and magnesium to provide an optimum combination of properties, stability and castability. Widespread commercial acceptance of these alloys has resulted in the issuing of national and international standards, notably, ASTM B 669 and ISO/DIS 301.

Zinc-Aluminum Foundry Alloys have several advantages over other commonly used casting alloys based on iron, aluminum or copper.

Compared to cast iron, the alloys have better machinability, can be cast to closer tolerances and have a superior as-cast surface finish. They also are generally better suited for short production runs and less likely to require protective finishes. These advantages have resulted in substantially reduced production costs for numerous applications.

Compared to aluminum, the zinc alloys are harder and stronger, machine more easily, have superior pressure tightness, and have substantially better wear and bearing characteristics. Also, alloys 8 and 12 are not subject to incendive sparking. The alloys become viable choices when aluminum is inadequate in one of these areas. Although they are more expensive on a unit volume basis, castings are potentially cost competitive when aluminum castings require heat treatment, hard anodizing, epoxy impregnation, or bronze bushing inserts.

Compared to copper, the most expensive of the common foundry alloys, the lower inherent cost of the zinc alloys combined with their lower densities can result in a material cost saving of up to 60 per cent. They also have higher as-cast strength and hardness, and equivalent or superior machinability and wear resistance.

The economic benefits and inherent properties of Zinc-Aluminum Foundry Alloys account for their use in a rapidly growing list of industrial applications, including:

- Industrial fittings and hardware
- Pressure tight housings
- Sleeve bearings, thrust washers and wear plates
- Electrical switchgear and hardware
- Hose couplings and connectors
- Fire fighting hardware
- Pneumatic and hydraulic cylinder components
- Industrial machine hardware
- Electrical conduit fittings
- Door hardware and lock components
- Pulleys and sheaves
- Non-sparking mine hardware
- Decorative hardware
- Electronic instrument chassis, hardware and covers.

Advantages to the foundry:

- Low melting costs
- Extended foundry equipment life
- Clean foundry environment
- No fluxing or degassing
- Excellent mould filling characteristics
- Few casting rejects
- Low melt losses
- Excellent as-cast strength

Advantages to the casting specifier:

- High tensile strength and hardness
- Excellent machinability
- Superior pressure tightness
- Good bearing and wear characteristics
- Easily cast in thin sections
- Wide choice of casting methods
- Existing patterns and match plates normally usable

**Foundry Practice**

**Melting.** Zinc-Aluminum Foundry Alloys are readily melted in refractory-lined or non-metallic crucible furnaces similar to those used for other non-ferrous foundry alloys. In general, it is recommended that a separate crucible be reserved for melting because of the low impurity limits specified for the alloys. While crucibles which have previously held aluminum alloys can be used if thoroughly cleaned, those that have held lead or tin-containing copper alloys must be avoided.

The zinc alloys melt in less time and do not require fluxing or degassing as is common with aluminum alloys. Energy requirements for melting are about 1, 1 and 3 those of iron, bronze and aluminum, respectively, which results in substantial energy savings. Melting the alloys produces no fumes and the relatively low casting temperatures, 450-600°C help to extend the service life of foundry equipment. The normal foundry practice of blending foundry returns with fresh ingots is recommended.

**Casting.** The zinc alloys have excellent mould filling characteristics and low casting temperatures compared to most other foundry alloys. These inherent properties account for
fewer casting rejects, reduced metal losses, and the casting versatility of the alloys. They can be cast using all the traditional processes including sand, permanent mould, pressure die, shell and investment casting.

**Sand Casting.** Zinc alloys 12 and 27 are generally selected over alloy 8 for sand casting. They can be poured in virtually any of the non-ferrous sand systems - synthetic or natural. Both alloys are relatively insensitive to variations in mould hardness, permeability and moisture content. The alloys are tolerant of most foundry gating and feeding systems. Castings can be produced using match plates designed for aluminum, bronze or cast iron with little or no modification.

**Permanent Mould Casting.** Alloys 8 and 12 are recommended for permanent mould casting, with alloy 8 offering faster cycle times and a better surface for applying decorative plated finishes. Compared to alloy 8, alloy 12 castings have superior strength, hardness, wear resistance and dimensional stability. Both alloys have very good fluidity which permits casting of thin, intricate sections without misruns. In general, ferrous permanent moulds designed for aluminum are suitable for casting zinc alloys. Permanent moulds also can be made from either bronze, aluminum, rubber or graphite. Thick-walled castings in alloy 12 may require increased feeding because of its wide freezing range.

The commercial availability of alloy 12 led to the development of a new casting technology based on graphite permanent moulds. The low casting temperatures of the alloys make the use of graphite moulds feasible for medium-volume production requirements. Mould life is typically in excess of 25,000 cycles and in most instances is significantly higher. Major benefits of graphite permanent moulding are low tooling costs, excellent castings tolerances, and the ability to produce castings with exceptionally good surface finish.

**Pressure Die Casting.** When die cast, alloys 8, 12 and 27 provide substantial property improvements over conventional zinc and aluminum die casting alloys. The improved strength and wear characteristics of these alloys allow this highly economical process to be selected for applications where the traditional die casting alloys would not be considered. Alloy 8 can be cast in the hot chamber process commonly used with conventional zinc die casting alloys. Alloys 12 and 27 must be cast using the cold chamber process. The life of iron components in the hot chamber process would be unacceptably short at the required casting temperatures for alloys 12 and 27.

**Corrosion resistance and machining**

The excellent corrosion resistance of zinc in many environments has led to its extensive use for corrosion protection. The Zinc-Aluminum Foundry Alloys, like unalloyed zinc, also possess excellent resistance to corrosion in a wide variety of environments. Castings exposed outdoors normally develop a dark, gray patina which slows further oxidation while leaving part performance unaffected. Corrosion data developed for zinc and zinc die casting alloys are a useful guide for estimating the corrosion performance of Zinc-Aluminum Foundry Alloys in specific environments. When castings are to be subjected to environments which are known to be aggressive to zinc, protective finishes should be considered.
**Finishing.** Zinc alloy castings exhibit clean as-cast surfaces which can be anodized, painted, chromated, polished, brushed or plated. The type of finish selected will largely depend on service conditions, aesthetics and cost.

**Anodizing.** Zinc anodizing electrochemically produces a thin, abrasion resistant, ceramic-like film. The film has a fritted structure and is a complex mixture of chemical compounds - mainly zinc ammonium phosphate and chromates. Anodized castings possess excellent resistance to corrosive attack from most natural and industrial corrosive agents including detergents, road salts, soft waters and most organic solvents.

**Painting.** The alloys lend themselves well to, pigmented organic coatings, including those that require baking. Surface pretreatments, such as chromating or phosphating, are necessary to ensure good adherence of paint or lacquer finishes. Coatings can be applied by brushing, spraying or dipping - the method used will depend largely on casting shape, complexity and quantity.

**Chromating** is a low cost chemical conversion treatment used to provide additional corrosion protection to metal products. It provides corrosion protection of the order of 90-100 hours in a 5% neutral salt spray exposure. To obtain the bright, iridescent type finish associated with zinc die-castings or galvanized coatings, foundry alloy castings must be given a cadmium or zinc flash prior to chromating. Without the flash, chromated castings will exhibit varying brownish tones depending on the alloy coated and process variables.

**Machining.** The Zinc-Aluminum Foundry Alloys have excellent machinability and can tolerate wide variations in machining conditions. Tool life compares favorably with that experienced with copper and aluminum alloys and is significantly longer than with cast iron. In general, high-speed steel tools perform well. Best results are obtained with tools having large clearance angles and polished flutes and cutting surfaces. The use of water-soluble coolants is strongly recommended to prevent metal pickup on tools.

**Joining.** Adhesives, mechanical devices and certain solders are suitable for joining the alloys. Each application must be considered separately since the selection of the joining method is dependent on service conditions and required joint strength. Welding of the alloys can be done using inert gas welding techniques. Zinc-aluminum wire and standard aluminum filler rods have been used in TIG (tungsten inert gas) welding the alloys with good results.