ZINC CASTING ALLOYS

This guide is to help designers and material specifiers to better understand the capabilities of zinc casting alloys for product applications.

ADVANTAGES

Zinc casting alloys are versatile engineering materials. No other alloy system provides the combinaton of strength, toughness, rigidity, bearing performance and economical castability. Listed are zinc alloy attributes which can reduce component costs. Improving precision, quality and product performance are other zinc alloy design advantages discussed in this brochure.

Process Flexibility: Virtually any casting process can be used with zinc alloys to satisfy virtually any quantity and quality requirement. Precision, high-volume die casting is the most popular casting process. Zinc alloys can also be economically gravity cast for lower volumes using sand, permanent mold, graphite mold and plaster casting technology.

Precision Tolerances: Zinc alloys are castable to closer tolerances than other metals or molded plastics, therefore presenting the opportunity to reduce or eliminate machining. "Net Shape" or "Zero Machining" manufacturing is a major advantage of zinc casting.

Strength & Ductility: Zinc alloys offer high strengths (to 60,000 psi) and superior elongation for strong designs and formability for bending, crimping and riveting operations.

Toughness: Few materials provide the strength and toughness of zinc alloys. Impact resistance is significantly higher than cast aluminium alloys, plastics, and grey cast iron.

Rigidity: Zinc alloys have the rigidity of metals with modulus of elasticity characteristics equivalent to other die castable materials. Stiffness properties are, therefore, far superior to engineering plastics.

Anti-Sparking: Zinc alloys are nonsparking and suitable for hazardous location applications such as coal mines, tankers and refineries.

Bearing Properties: Bushing and wear inserts in component designs can often be eliminated because of zinc's excellent bearing properties. For example, zinc alloys have outperformed bronze in heavy duty industrial applications.

Easy Finishing: Zinc castings are readily polished, plated, painted, chromated or anodized for decorative and/or functional service.

Thin Wall Castability: High casting fluidity, regardless of casting process, allows for thinner wall sections to be cast in zinc compared to other metal.

Machinability: Fast, trouble-free machining characteristics of zinc materials minimize tool wear and machining costs.

Low Energy Costs: Because of their low melting temperature, zinc alloys require less energy to melt and cast versus other engineering alloys.

Long Tool Life: Low casting temperatures result in less thermal shock and, therefore, extended life for die casting tools. For example, tooling life can be more than 10 times that of aluminum dies.

Clean and Recyclable: Zinc alloys are among the cleanest melting materials available. Zinc metal is non-toxic, and scrap items are a reusable resource which are efficiently recycled.

ZINC ALLOYS

There are two basic families of zinc casting alloys: ZAMAK alloys and ZA alloys. The ZAMAK alloys were developed for pressure die casting during the 1920's and have seen widespread usage since then. It is for this reason that specifiers often relate zinc as synonymous with die casting. However, the development of the ZA (Zinc-Aluminum) alloys during the 1970's have radically changed zinc's product design and manufacturing capabilities.

ZA alloys were initially developed for gravity casting. Their mechanical properties compete directly with bronze, cast iron and aluminum using sand, permanent mold and plaster mold casting methods. Distinguishing features of the ZA alloys are their high aluminum content and excellent bearing properties.

During the 1980's, ZA alloys evolved as valuable die casting materials. It is important to note that when considering a ZA alloy for die casting, only ZA-8 can be hot chamber die cast. Hot chamber casting (which the ZAMAK alloys employ) is highly automated and the most efficient die casting process. ZA-12 and ZA-27 require special melting procedures and must be die cast like aluminum using the less efficient cold chamber die casting process.

A brief description of each alloy is provided. The ZAMAK alloy family is identified by its numbers 3, 5, 7, & 2. ZA alloys consist of ZA-8, ZA-12 and ZA-27.

NO. 3

No. 3 alloy is usually the first choice when considering zinc for die casting. Its excellent balance of desirable physical and mechanical properties, superb castability and long-term dimensional stability are the reasons why over 70% of all North American zinc die castings are in No. 3 alloy. It is, therefore, the most widely available alloy from die casting sources. ZAMAK No. 3 also offers excellent finishing characteristics for plating, painting and chromate treatments. It is the "standard" by which other zinc alloys are rated in terms of die casting.

NO. 5

No. 5 alloy castings are marginally stronger and harder than No. 3. However, these improvements are tempered with a reduction in ductility which can affect formability during secondary bending, riveting, swaging or crimping operations. No. 5 contains an addition of 1% copper which accounts for these property changes. The alloy is widely die cast in Europe and does exhibit excellent castability characteristics, as well as, improved creep performance over No. 3.

Because of No. 3's wide availabity, material specifiers often strengthen components by design modifications instead of using No. 5. However, when an extra measure of tensile performance is needed, No. 5 alloy castings are recommended. The alloy is readily plated, finished and machined, comparable to No. 3 alloy.

NO. 7

No. 7 alloy is a modification of No. 3 alloy. Lower magnesium content and tighter impurities specification result in improved casting fluidity, ductility and surface finish. Most No. 7 is used for special hardware applications, or when castings require extra formability during assembly operations.

Higher fluidity is sometimes desirable, however, it does present special casting considerations. No. 7 alloy requires good die fit, casting temperature and machine control to avoid excessive flashing along parting lines. Because of high ductility, flash break-off in vibratory and automated deburring equipment is more difficult. Also, better fits on trim dies may be required to obtain a clean trim.

NO. 2

No. 2 is the only ZAMAK alloy which is used for gravity casting; mainly for metal forming dies or plastic injection tools. This alloy is sometimes referred to as KIRKSITE.

For die casting, No. 2 offers the highest strength and hardness of the ZAMAK family. However, its high copper content (3%) results in property changes upon long term aging. These changes include slight dimensional growth (0.0014 in/in/after 20 yrs.), lower elongation and reduced impact performance (to levels similar to aluminum alloys) for die cast products.

Although No. 2 alloy exhibits excellent castability, it has seen limited use by die casters in North America. It does, however, provide some interesting characteristics which may assist designers. Its creep performance is rated higher than the other ZAMAKS and No. 2 maintains higher strength and hardness levels after long term aging. Also, preliminary investigations suggest No. 2 alloy is a good bearing material, and may eliminate bushings and wear inserts in die cast designs.

ZA-8

A good gravity casting alloy, ZA-8 is rapidly growing for pressure die casting. ZA-8 can be hot chamber die cast, with improved strength, hardness and creep properties over ZAMAKS, with the exception of a No. 2 alloy which is very similar in performance. ZA-8 is readily plated and finished using standard procedures for ZAMAKS. When the performance of standard No. 3 or No. 5 is in question, ZA-8 is often the die casting choice because of high strength and creep properties and efficient hot chamber castability.

ZA-12

ZA-12 is the most versatile zinc alloy in terms of combining high performance properties and ease of fabrication using either gravity or pressure die casting. ZA-12 is the best gravity casting alloy for sand, permanent mold and the new graphite mold casting process. It is also a good pressure die casting alloy (cold chamber) which provides a sounder structure than ZA-27, as well as higher die cast elongation and impact properties. For these reasons, die cast ZA-12 often competes with ZA-27 for strength application. An excellent bearing alloy, ZA-12 is also platable, although plating adhesion is reduced compared to the ZAMAK alloys.

ZA-27

ZA-27 is the high strength performer of the zinc alloys whether for gravity or pressure die casting (cold chamber). It is also the lightest alloy and offers excellent bearing and wear resistance properties. ZA-27, however, requires care during melting and casting to assure sound internal structure, particularly for heavy wall sections. It may also need a stabilization heat treatment when tight dimensional tolerances are required. ZA-27 is not recommended for plating. However, when brute strength or wear resistant properties are needed, ZA-27 has demonstrated extraordinary performance.