THE ADVANTAGES CAN BE YOURS AT DECO

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 combination 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.

Precision Tolerances: Zinc alloys are castable to closer tolerances than other materials 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 aluminum 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.

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.

APPLICATIONS

ZAMK 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. ZAMK 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.

ZAMK 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 availability, 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.

ZAMK NO.7

No. 7 alloy is a modification of No. 3 alloy in which lower magnesium content is specified in order to increase the fluidity. To avoid problems with intergranular corrosion lower levels of impurities are called for and a small quantity of nickel is specified. Alloy No. 7 has slightly better ductility than No. 3 with other properties remaining at the same level.

The alloy is therefore popular for those special cases where the die caster is making thin walled components requiring a good surface finish. However, research testing has shown that metal and die temperatures have a bigger effect than changing alloys. Close attention to control of die casting process parameters is important so as to eliminate defects and achieve consistent quality.

ZAMK 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 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 and 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.

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DECO PRODUCTS CO. DESIGNING WITH ZINC

ZINC ALLOY PROPERTIES

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Alloy	**#3**		**#5**		**#7**		**#2**		**ZA-8**	
Mechanical Properties	Die Cast		Die Cast		Die Cast		Die Cast		Die Cast	
Ultimate Tensile Strength: psi x 10^3 (MPa)	41 (283)		48 (328)		41 (283)		52 (359)		54 (374)	
Yield Strength - 0.2% Offset: psi x 10^3 (MPa)	32 (221)		39 (269)		32 (221)		41 (283)		42 (290)	
Elongation: % in 2"	10		7		13		7		6-10	
Shear Strength: psi x 10^3 (MPa)	31 (214)		38 (262)		31 (214)		46 (317)		40 (275)	
Hardness: Brinell	82		91		80		100		95-110	
Impact Strength: ft-lb (J)	43[2] (58)		48[2] (65)		43[2] (58)		35[2] (48)		31[3] (42)	
Fatigue Strength Rotary Bend - 5x10^8 cycles psi x 10^3 (MPa)	6.9 (48)		8.2 (57)		6.8 (47)		8.5 (59)		15 (103)	
Compressive Yield Strength - 0.1% Offset: psi x 10^3 (MPa)	60[4] (414)		87[4] (600)		60[4] (414)		93[4] (641)		37 (252)	
Modulus of Elasticity - psi x10^6 (MPa x 10^3)	12.4[6] (85.5)		12.4[6] (85.5)		12.4[6] (85.5)		12.4[6] (85.5)			
Poisson's Ratio	0.27		0.27		0.27		.027			
Physical Properties										
Density: lb/cu in (g/cm^3)	.24 (6.6)		.24 (6.6)		.24 (6.6)		.24 (6.6)		0.227(6.3)	
Melting Range: °F(°C)	718-728 (381-387)		717-727 (380-386)		718-728 (381-387)		715-734 (379-390)		707-759 (375-404)	
Electrical Conductivity: % IACS	27		26		27		25		27.7	
Thermal Conductivity: BTU/ft/hr/°F (W/m/hr/°C)	65.3 (113.0)		62.9 (108.9)		65.3 (113.0)		60.5 (104.7)		66.3 (114.7)	
Coefficient of Thermal Expansion 68-212°F µin/in/°F (100-200°C µm/mm/°C)	15.2 (27.4)		15.2 (27.4)		15.2 (27.4)		15.4 (27.8)		12.9 (23.3)	
Specific Heat: BTU/lb/°F (J/kg/°C)	.10 (419)		.10 (419)		.10 (419)		.10 (419)		.104 (435)	
Pattern or Die Shrinkage: in/in	.007		.007		.007		.007		1/8 in/ft	.007
Chemical Specifications (per ASTM) (%by Weight)	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting
Al	3.9-4.3	3.5-4.3	3.9-4.3	3.5-4.3	3.9-4.3	3.5-4.3	3.9-4.3	3.5-4.3	8.2-8.8	8.0-8.8
Mg	.025-.05	.025-.05	.03-.06	.03-.08	.01-.020	.005-.020	.025-.05	.020-.050	.020-.030	.015-.030
Cu	.10 max	.25 max[9]	.75-1.25	.75-1.25	.10 max	.25 max	2.6-2.9	2.5-3.0	0.8-1.3	.08-1.3
Fe (max)	.075	.10	.075	.10	.075	.075	.075	.10	.065	.075
Pb (max)	.004	.005	.004	.005	.0020	.003	.004	.005	.005	.006
Cd (max)	.003	.004	.003	.004	.0020	.002	.003	.004	.005	.006
Sn (max)	.002	.003	.002	.003	.0010	.001	.002	.003	.002	.003
Ni (other)[10]	-	-	-	-	.005-.020	.005-.020	-	-	-	
Zn	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Industry Standards	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting
ASTM	B240 AG40A	B86 AG40A	B240 AC41A	B86 AC41A	B240 AG40B	B86 AG40B	B240 AC43A	B86 AC43A	B240	B86
SAE	J468B 903	J468B 903	J468B 925	J468B 925			Former 921			
UNS	Z33521	Z33520	Z35530	Z35531	Z33522	Z333523	Z35540	Z35541	Z356365	Z35636

[1] 3 hr at 610° F and furnace cool. [2] 1/4" square specimen unnotched [3] 10 mm square specimen unnotched [4] Comprehensive strength [5] Previous industry accepted standard. [6] Estimated values to be confirmed by research.
[7] Values for permanent mold condition which should be similar for other processes except for ZA-27 Sand Cast Heat Treat (HT).
[8] Standard revised 1998.
[9] Per ASTM B86-88, * For the majority of commercial applications, a copper content in the range of 0.25 to 0.75% will not adversely affect the serviceability of die castings and should not serve as a basis for rejection.*
[10] Zamak alloy ingot for die casting (with the exception of % Ni in No. 7) may contain Ni, Cr, Mn, Si, in amounts of up to 0.02, 0.02, 0.06 and 0.035% respectively.
ZA ingot for foundry and pressure die casting may contain Ni, Cr, or Mn in amounts of up to 0.01% each or 0.03% total.

Additional information on backside.