Engineering in Zinc, Today's Answer

Enhance Your Brand Product and Reputation:
Engineered Zinc Die Castings for Optimal Design Freedom and Precision.

ZINC DIE CASTINGS CAN BE SIMPLE, SLEEK AND ELEGANT, AND THEY CAN BE BREATHTAKINGLY SOPHISTICATED IN THEIR GEOMETRIC COMPLEXITY AND FUNCTION.

The Advantages of Zinc Casting Alloys

Zinc casting alloys are strong, durable and cost effective engineering materials. No other alloy system provides the combination of strength, toughness, rigidity, bearing performance and economical castability. Zinc's mechanical properties compete with and often exceed those of cast aluminum, magnesium, bronze, plastics and most cast irons. These characteristics, together with their superior finishing capabilities and choice of casting processes make zinc alloys an unrivaled material choice for saving time and money.

Assembly operations are reduced. Entire assemblies can be cast as a single unit, eliminating the need for expensive manual assembly operations.

Less material is required. Zinc's superior casting fluidity, strength and stiffness permits the design of thin wall sections for reduced weight and material cost savings.

Machining operations are reduced. Due to the superior net-shape casting capability of zinc alloys, machining can be eliminated or drastically reduced.

Faster production and extended tool life. Die casting production rates for zinc are much faster than for aluminum or magnesium. Coupled with a tool life often exceeding 1 million parts, tooling and machine usage charges are dramatically reduced.

Eliminate bearings and bushings. Zinc's excellent bearing and wear properties allow greater design flexibility and reduce secondary fabrication costs by eliminating small bushings and wear inserts.

Choice of low, medium, and high production. A variety of casting processes are available to economically manufacture cast parts of whatever size and quantity required.

Surface finishing. When a finish is properly selected and applied to cast zinc, almost any desired aesthetic characteristic and coating durability can be achieved.

Environmental harmony. Pollution and greenhouse gases are minimized with zinc casting alloys.

Alloys Tailored to Meet Your Needs: General Purpose and Specialty Alloys.

There are two basic families of zinc casting alloy. The conventional or 'ZAMAK' alloys are commonly named based on their sequential development, preceded by the word alloy. These include Alloy 2, Alloy 3, Alloy 5, and Alloy 7. The most recent addition to the ZAMAK family is the new high-fluidity or 'HF' alloy. Zinc alloys with higher amounts of aluminum than the conventional alloys use the prefix ZA followed by their approximate aluminum content. These include ZA-8, ZA-12 and ZA-27. ZA alloys offer higher strength, and useful bearing properties.

Several different systems of naming the two classes of zinc alloys have evolved along with them, as indicated in parenthesis next to the main alloy names below.

Major Alloy Characteristics

Alloy 3: (ZAMAK 3, ZP3, ZL3, ZP0400, ZnAl4, ZDC2)
Alloy 3 is the most widely used zinc alloy in North America. Its popularity is due to an excellent balance of desirable physical and mechanical properties, superb castability and long-term dimensional stability. 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.

Alloy 5: (ZAMAK 5, ZP5, ZL5, ZP0410, ZnAl4Cu1, ZDC1)
Alloy 5 is the most widely used zinc alloy in Europe. No. 5 has excellent castability characteristics and improved creep performance over No. 3. No. 5 castings are also marginally stronger and harder than No. 3, however, these improvements are accompanied by a reduction in ductility that 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. When an extra measure of tensile performance is needed, No. 5 castings are recommended. The alloy is readily plated, finished and machined, comparable to No. 3 alloy.

Alloy 7: (ZAMAK 7, ZL7)
Alloy 7 is a modification of No 3 with a lower magnesium content and tighter impurities specification. This results in improved casting fluidity, ductility and surface finish, making the alloy popular where the die caster is making thin walled components requiring a good surface finish. However, several new high fluidity alloys have recently been developed with superior thin wall characteristics (see high fluidity alloy).

Alloy 2: (ZAMAK 2, ZP2, ZL2, ZP0430, ZnAl4Cu3, Kirksite)
Alloy 2 offers the highest strength and hardness of the conventional zinc alloys. The high copper content (3%) in No. 2 results in property changes upon long-term aging. These changes include slight dimensional growth, lower elongation and reduced impact performance (to levels similar to aluminum alloys) for die cast products. No. 2 alloy exhibits excellent castability and maintains higher strength and hardness levels after long term aging. No. 2 alloy is a good bearing material, and may eliminate bushings and wear inserts in die cast designs.

High Fluidity Alloy: (HF)
The HF alloy shares the good mechanical, electric and thermal conductivity property characteristics of the conventional alloys but possesses up to 40% better fluidity. Because of its optimization of composition for high fluidity, the HF alloy s best suited for casting parts with section thickness less than 0.45 mm. It can also be used for casting parts that are difficult to fill with Alloy 3, 5 or 7 or have high surface finish requirements.

ZA-8: (ZP8)
A good gravity casting alloy, ZA-8 can also be hot chamber die cast and is readily plated and finished using standard procedures for conventional zinc alloys. When the performance of Alloys 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 best gravity casting alloy for sand, permanent mold and the graphite mold casting process. It is also a good (cold chamber) die casting alloy. ZA-12 often competes with ZA-27 for strength applications. An excellent bearing alloy, ZA-12 is also platable, although plating adhesion is reduced compared to the conventional zinc alloys.

ZA-27: (ZP27)
This is an exceptionally strong alloy with a reported yield strength of 380 MPa (55ksi). It is light, and has excellent bearing and wear performance. Like ZA-12, this is a cold chamber die casting alloy and additional care is needed to ensure a sound casting. ZA-27 is not recommended for plating. When brute strength or wear resistance properties are needed, ZA-27 has demonstrated excellent performance.

ACuZinc5:
Developed by General Motors, this alloy has improved tensile strength, hardness and creep performance compared to the conventional zinc alloys. ACuZinc5's strength and hardness properties are comparable to ZA-12. Testing has also shown ACuZinc5 to have excellent wear characteristics. Although this alloy is a hot chamber die casting alloy, it is more difficult to die cast with a higher wear rate of the shot end components in the die casting machine.

EZAC™:
This recently developed alloy is the most creep resistant of all the zinc die casting alloys with an order of magnitude improvement over Alloy 5 and ZA-8. This is also a very strong alloy with a yield strength 393 MPa (57 ksi) and hardness (102-140 Brinell) comparable to ZA-27. Due to its low melting temperature, EZAC can be hot chamber die cast and does not exhibit the same die casting equipment wear and tear as shown with ACuZinc5.

GDSL: (Superloy)
Guss-Druck-Sonderlegierung "GDSL" is an ultra-thin zinc die casting alloy with fluidity characteristics similar to the HF alloy, but with a higher aluminum and copper content.

™. A trademark or Eastern Alloys

Material Properties That Help Solve Today's Engineering Problems.

Strength
The Ultimate Tensile Strengths (UTS) of zinc alloys can outperform Aluminum 380 and Magnesium AZ91D. Engineering Plastics struggle to deliver equivalent performance of zinc alloy's UTS. Even glass-reinforced Nylon cannot achieve zinc alloy's UTS. Ambient temperature Yield Strengths of zinc alloys are far superior to those of Aluminum 380, Magnesium AZ91D and the strongest plastics. Zinc alloys also display a high degree of energy absorbing ductility when subjected to abusive or destructive levels of loading.

Rigidity
Zinc alloys are rigid engineering materials. Their strength - in shear, torsion, under bending and in compression - is far superior to aluminum, magnesium and plastics. This combined with their high strength allows the volume of individual castings to be markedly reduced, saving space and weight.

Toughness and Ductility
High impact strength and good ductility are qualities of zinc alloys that are rarely found in most other casting alloys. Ductility is important for bending and crimping in post-casting assembly operations, while impact strength provides performance in rough environments. At normal ambient temperatures, zinc die castings have a much greater impact resistance than Aluminum 380 and Magnesium AZ91D, and ABS plastics. At minus 30ºC zinc alloys still remain far better. Even at minus 40ºC zinc at least matches the impact resistance of die cast aluminum. Zinc alloys fracture toughness is also superior to most aluminum alloys and engineering plastics.

Hardness
Zinc alloys are significantly harder than aluminum and magnesium. Alloying additions such as copper, contribute to the good wear resistance exhibited by zinc alloys. Hence these alloys are used in moderately demanding applications where their natural bearing properties can be exploited.

Conductivity
As zinc alloys conduct both heat and electricity, they can be used for heat dissipating devices such as heat sinks. Zinc's excellent casting fluidity permits thinner fin and cooling pin design to better dissipate heat. Zinc's excellent electrical conductivity also provides good EMI, RFI and ESD shielding.

Non-sparking and non-magnetic
All zinc alloys except ZA-27 are classified as "non-sparking" and are the perfect low-cost alternative to bronze in potentially explosive environments. Unlike plastics and some other materials, zinc will not normally sustain fire during processing or use. It is a relatively fire safe material. Zinc's non-magnetic properties are ideal for use in electronics and other applications where delicate moving parts are subject to magnetic disturbances.

Fatigue Strength
This measure of a material's ability to withstand cyclic loading is an important design criterion. Fatigue is one of the most frequent failure mechanisms in components. Zinc, like other die cast metals is between 7 to 10 times more resistant to fatigue than ABS.

Design (Creep) Stress
For applications involving continuous loading at elevated temperatures, such as locks, zinc has superior creep strength to reinforced injection molded plastics. The room temperature design stress of die cast ZA-27, as defined by the ASME Boiler Code, is 69 MPa or 10,000 psi (stress required for creep of 1% in 100,000 hours). This property allows zinc alloys to be used in applications subject to significant static loading. However, permissible design stress drops with increasing temperature and a careful review of all constant load applications at temperature is required to determine the suitability of zinc alloys.

Pressure Tightness
The soundness of castings is largely related to product design, tooling layout, and process control. The tight tolerance levels of zinc alloys provide reliability and consistency required for pressure tight applications.

Damping Capacity
The damping capability of zinc alloys - their ability to absorb energy and sound caused by externally induced mechanical vibration - is comparable to magnesium, and is 5 to 10 times greater than aluminum. This property makes zinc alloys the perfect choice for housings where vibration absorption is required.

Corrosion Resistance
Zinc has excellent corrosion resistance under normal atmospheric conditions, and in many aqueous, industrial and petroleum environments. Corrosion resistance can be enhanced by such treatments as plating, chromating, painting and zinc anodizing.

Superior bearing properties ensure built-in reliability.

All zinc alloys, particularly ZA-12 and ZA-27, demonstrate excellent bearing and wear resistance qualities thanks to their high hardness and natural lubricity characteristics. ZA alloy bearings should be considered wherever bronze bearings are currently being specified. They generally operate best in lubricated, high-load, low-speed applications under moderate temperature conditions, however they have also been successfully used in high speed, low load applications.

ZA alloys are direct substitutes for larger bronze industrial bushings and bearings since they cost less and are up to 43% lighter. For smaller components, zinc's natural lubricity may contribute to lower secondary fabrication costs by eliminating small bushings and wear inserts, thus allowing greater design flexibility.

Engineering Characteristics That Answer Your Most Critical Needs.

Accuracy
Zinc alloys are castable to closer tolerances than any other metal or molded plastic. Zinc die casting can produce repeatability of less than ± 0.001” for small components, often rivaling machining tolerances. Few other processes can easily achieve the same net shape performance presenting the opportunity to reduce or eliminate machining. “Net Shape” or “Zero Machining” manufacturing is a major advantage of zinc casting.

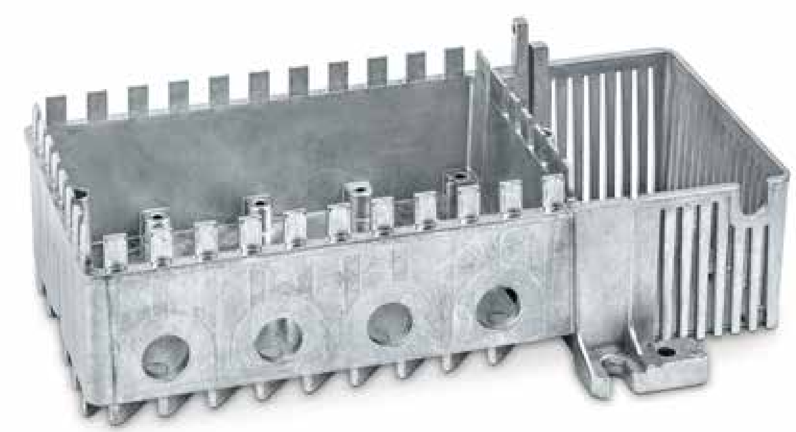
Machinability
Fast, trouble-free machining characteristics of zinc materials minimize tool wear and machining costs which is a major advantage of zinc alloys over competitive materials.

Thin Wall Capability
Exceptional casting fluidity is displayed by all conventional zinc and ZA alloys, which provides superior thin-wall castability, regardless of the casting process employed. Wall thicknesses of 0.15mm for die casting and 2.3mm for permanent mold casting are being produced. This thin-wall capability results in smaller, lighter, low cost components compared to other metals.

Zero Draft Angle Castability
Draft angle is the taper on the surface of a die required to facilitate removal of the cast part from the die cavity. Zinc alloys can be die cast with less draft angle than competitive materials. In fact, zinc components can sometimes be cast with zero draft angles which is a major advantage when producing parts in moving mechanical contacts such as gears. Zero internal draft permits net shape manufacturing resulting in lower cost production.

Dimensional Stability
Conventional zinc alloys, along with ZA-8 and ZA-12, have excellent dimensional stability characteristics in their ‘as cast’ condition. ZA-27, however, may require artificial aging treatment to minimize aging effects where exceptional tolerances are required. This is accomplished by heating the part to 95°C for 24 hours.

Joining
If required, the high ductility of zinc will allow parts to be distorted in a controlled manner to achieve a final desired shape, or be inexpensively joined to an adjacent component through bending, forming, spinning or heading. Threaded fasteners, along with flaring, riveting and crimping techniques are common low cost joining methods. Zinc alloys can also be joined using adhesive bonding or MIG and TIG welding, although welding is normally not an economical joining method for zinc die castings due to the high production volumes involved.



A Variety of High Quality Surface Finishes is Another Major Advantage.

When clever design is combined with the versatility of the zinc die casting process, it maximizes the aesthetic appeal of products.

Zinc die castings are an outstanding choice for countless decorative and functional applications. Due to its unique physical and mechanical properties, zinc can be cast into virtually limitless shapes and sizes ranging from simple toy cars to complex connector housings.

The majority of zinc die cast applications are not exposed to corrosive environments and the aesthetic requirements of the part defines which finish should be used, which in many cases means no finish at all.

For applications where the service environment is aggressive, or where aesthetics dictate, an unrivaled range and quality of conversion coatings, organic paint and superb electroplated metal finishes (e.g. nickel, satin and bright chrome) can be easily and reliably applied to any selected surfaces of your component.

Excellent substrates help yield excellent finishes. Inexpensive bulk vibratory finishing can be used to improve the 'as cast' surface. Exceptionally smooth finishes can be obtained prior to finishing by lightly buffing or chemical polishing.

Due to the high fluidity of zinc alloys, a precisely defined surface texture can be added to part or all of the 'as cast' product. As a result, zinc castings can be made to look like solid gold, weathered brass, stainless steel, and even leather. Other external features such as lettering and logos can be 'cast in'.

Zinc alloy's density and its counter pointing ability to be very thinly cast allow the designer to influence the user's perception of weight, balance, solidity and inertia. For instance, coolness in hand, a premium quality metallic feel and other perceived sensations are factors valued by many users of zinc die castings. On the other hand, 'warm feel' coatings and plastic over-molding are also tactile options that the designer can utilize.

For maximum impact and success, the designer is advised to consult the die caster at an early stage to agree on the best way of designing an economical and aesthetically attractive product.

Photo Credit: Arcus carabiner by SVORN

Casting Versatility Leads to Further Savings.

Process Flexibility: Virtually any casting process can be used with zinc alloys to satisfy 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 technologies.

Die Casting
This is the most efficient process for high-volume precision casting, producing the best tolerances and rapid production rates, but having high initial tooling costs.
Die casting should be considered for components requiring a production run of at least 10,000 pieces. All tolerances depend on part size and complexity; however, tolerances of ± 0.025mm (0.001") are common. Hot chamber die casting cycle rates range from roughly 150 parts per hour for large components to over 2000 per hour for small ones.
The traditional zinc alloys and ZA-8 can be used in a "hot chamber" die casting machine, while ZA-12 and ZA-27 must be "cold chamber" die cast - like the aluminum alloys. The hot chamber process offers faster cycle times, resulting in lower production costs.
Due to the low melting temperatures of zinc alloys, dies for zinc parts last longer—often 3-4 times longer than the same dies when used for casting aluminum alloys.

Permanent Mold Casting
ZA-8 and ZA-12 are generally considered for permanent mold applications. Permanent mold casting has traditionally been done using steel or cast iron molds, but is now also performed in graphite molds. Permanent mold casting often competes with sand casting by providing tighter tolerances and a smoother surface finish, which can reduce machining operations.
Ferrous permanent molds designed for aluminum alloys are generally suitable for casting zinc alloys. However, due to the superior casting fluidity of zinc, thinner sections can be cast. This process is well suited for medium production runs of 500-10,000 pieces. Ferrous permanent mold casting has great flexibility in terms of part size, ranging from ounces up to 100 lbs.
Graphite permanent mold casting offers some distinct advantages over metal tooling. Improved tolerances, lower tooling costs, and a superior surface finish are all benefits of the graphite mold process. Drawbacks are limited component size, complexity and coring.

Sand Casting
All the ZA alloys are suitable for sand casting; however, ZA-12 is the most popular. Sand casting offers the greatest design flexibility in terms of size, complexity and quantity requirements. Tooling costs are generally low, therefore facilitating low volume production. However, surface smoothness and tolerance capabilities are limited, usually requiring machining.

Hot chamber zinc die casting offers minimum processing costs.

Production time savings
This process combined with the relatively low casting temperature needed for zinc alloys allows exceptionally high production rates. For medium sized zinc components, 400 to 1000 shots per hour are common. Extremely small detailed zinc castings can be produced at up to 3500 shots per hour on specialized machines. By comparison, typical shot speed ranges for medium sized aluminum, magnesium and plastic components from 100 to 250, 200 to 300 and 100 to 300, respectively.

Energy savings
For an equal number of same size die castings, aluminum will use at least 50% more energy than zinc, while magnesium will need at least 15% more energy per casting than zinc. This is in addition to the high energy requirements needed to produce the aluminum and magnesium.

Near Net Shape castings
Clever design of product and tool, combined with zinc alloy's inherent accuracy and excellent surface, can result in Near Net Shape zinc castings that require, if any, just the minimum of further processing stages.

Low tooling wear
For large volumes, zinc offers considerable further cost savings because its tooling typically lasts between 750,000 shots to 2 million shots. Aluminum and magnesium will struggle to achieve 250,000 and 500,000 shots respectively.

Hot Chamber Zinc Die casting is the most cost efficient production technique for 3D components due to its production speed and the low volume of scrap produced.

Table 1. Mechanical and Physical Properties of Zinc Die Casting Alloys

Alloy	Alloy 3	Alloy 5	Alloy 7	Alloy 2	ZA-8			ZA-12			ZA-27			GDSL	Acuzinc5	EZAC	HF alloy
Other names	Zamak3, ZP0400, ZnAL4	Zamak5, ZP0410, ZnAl4Cu1	Zamak7	Zamak2, ZP0430, ZnAl4Cu3		ZP0810, ZnAl8Cu1			ZP1110, ZnAl11Cu1			ZP2720, ZnAl27Cu2			ZP0350, ZnAl3Cu5		
Mechanical Properties	Die Cast	Die Cast	Die Cast	Die Cast	Sand Cast	Perm Mold	Die Cast	Sand Cast	Perm Mold	Die Cast	Sand Cast	Sand Cast HT1	Die Cast	Die Cast	Die Cast	Die Cast	Die Cast
Ultimate Tensile Strength: (MPa) (1) (5)	315	331	283	397	263	221-255	386	276-317	310-345	400	400-441	310-324	421	387	407	414	276
Yield Strength - 0.2% Offset: (MPa) (1) (5)	276	295	32 (221)	360	200	206	318	214	269	317	372	255	379	315	337	393	234
Elongation: % in 70mm (1) (2) (5)																	
e at UTS	2	3		2			2							1			
e at rupture	7	3	9	5	1-2	1-2	3	1-2	1-2	3-4	2-4	6-8	1-2	1	6	1	5
Modulus of Elasticity (Young): (GPa) (1)(4)(5)	84	84	84	84	85	85	82		82			77		84		84	84
Shear Strength: (MPa)	214	262	214	317	-	241	275	255	-	296	290	228	325	245	280		
Poison coefficient	0	0	0	0			0			0			0				0
Hardness: Brinell (1)	97	114	80	130	110	85-90	95-110	89-105	89-105	95-115	110-120	90-110	105-125	119	115	140	93
Impact strength																	
IZOD Unnotched 20°C: J/cm² (A)							42	25		29	47	58	5				
IZOD Notched 20°C: J/cm²	2	2					1										
Charpy Unnotched 20°C: J/cm²	116	131	116	96										162			95
Charpy Notched 20°C: J/cm²	4	5		9													
Fatigue Strength Rotary Bend (MPa) (3)																	
$5x10^8$ cycles	48	57	47	59	-	52	103	103	-	117	172	103	145				
$1x10^7$ cycles	81	86		104			63								139		
Compressive Yield Strength: MPa (6)(7)																	
0.1% Offset: MPa					199	214		227	234	269	331	255	385				
0.2% Offset: MPa	274	199		257			233										
2% Offset: MPa	373	266		379			321										
Physical Properties																	
Density: (g/dm³) at RT	6660	6760	6600	6800		6300			6000			5000		6560	6850	6600	6600
Melting Range: (°C)	381°-387°	380°-386°	381°-387°	379°-390°		375°-404°			377°-432°			376°-484°		379°	402°-502°	379°-413°	381°-387°
Electrical Conductivity: % IACS	27	27	27	25		27			28			29		26	26		27
Thermal Conductivity: W/m.°C	113	108	113	104		144			116			125		112	106		113
Coefficient of Thermal Expansion (ppm/°C)	27	27	27	27		23	27		24			26		27	24		26
Specific Heat: (J/kg.°C)																	
at 100°C	451	422	451	446		435			448			534		435			451
at 20°C	391	398	391	422										395			391
Coefficient of friction	0	0		0		0											
Die Shrinkage: mm/mm	.007	.007	.007	.007			0	.0104	.013	.0075	.013	.013	.008	0	0		0

(A) Machined sample from bulk ingot
(1) Flat test specimen, thickness 1,5mm; Property measured 8 weeks after casting. Test speed 10mm/minute.
(2) Strain measured with extensometer. L0 =70 for alloy 2, 3, 5, ZA8 and GDSL. L0=50mm for other alloys.
(3) Fatigue test sample diameter = 5,55mm. Fatigue limit determined with staircase method (see REF 12)
(4) Young modulus of elasticity calculated from stress strain graph.
(5) Tensile properties in function of temperature, thickness and aging are given in REF_1_2_3. Stress strain graphs are given in REF_1, REF_2 and REF_3
(6) The test specimen is a cylinder of 0.24" diameter and 0.48" height. The cylinders were machined from die cast impact test samples. Test speed: 1,1 MPa/sec. Strain is based on cross-head displacement.
(7) Compressive properties in function of temperature and stress strain graphs are given in REF_4

Table 2. Chemical Specifications and Industry Standards for Zinc Die Casting Alloys

Chemical Specifications ASTM	Alloy 3		Alloy 5		Alloy 7		Alloy 2	
% by weight (ASTM B240 and B86) [A]	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting
Al	3.9-4.3	3.7-4.3	3.9-4.3	3.7-4.3	3.9-4.3	3.7-4.3	3.9-4.3	3.7-4.3
Mg	.03-.06	.02-.06	.03-.06	.02-.06	.01-.02	.005-.020	.005-.020	.02-.06
Cu	.10max	.1max	.7-1.1	.7-1.2	.10max	.1max	2.6-2.9	2.6-3.3
Fe (max)	.035	.050	.035	.050	.035	.050	.035	.050
Pb (max)	.004	.005	.004	.005	.003	.003	.004	.005
Cd (max)	.003	.004	.003	.004	.0020	.002	.003	.004
Sn (max)	.0015	.002	.0015	.002	.0010	.001	.0015	.002
Ni (other) 10	-	-	-	-	.005-.020	.005-.020	-	-
Zn	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance

Chemical Specifications ASTM	ZA-8		ZA-12		ZA-27		GDSL	Acuzinc5	EZAC	HF alloy
% by weight (ASTM B240 and B86) [A]	Ingot	Casting	Ingot	Casting	Ingot	Casting		Casting	Casting	Casting
Al	8.2-8.8	8.0-8.8	10.8-11.5	10.5-11.5	25.5-28.0	25.0-28.0	6,4-7,0	2.8-3.3	6	4,3-4,7
Mg	.020-.030	.01-.03	.020-.030	.01-.03	.012-.020	.010-.020	<.05	0.025-0.05	0	.005-.012
Cu	0.9-1.3	.8-1.3	0.5-1.2	0.5-1.2	2.0-2.5	2.0-2.5	3,0-3,5	5.0-6.0	5	.035
Fe (max)	.035	.075	.050	.075	.070	.075	.050	0.075	0.075	.03
Pb (max)	.005	.006	.005	.006	.005	.006	.005	0.005	0.005	.003
Cd (max)	.005	.006	.005	.006	.005	.006	.004	0.004	0.004	.002
Sn (max)	.002	.003	.002	.003	.002	.003	.002	0.003	0.003	.001
Ni (other) 10	-	-	-	-	-	-		-	-	
Zn	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance

(A) For all notes pertaining chemical specification, please refer to ASTM B240 (ingots) and ASTM B86 (castings).
Above listed specification are from version 2013.

Chemical Specifications EN	Alloy 3		Alloy 5		Alloy 7		Alloy 2	
% by weight (EN1774 and EN12844) [B]	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting
Al	3.8-4.2	3.7-4.3	3.8-4.2	3.7-4.3			3.8-4.2	3.7-4.3
Mg	.035-.06	.025-.06	.035-.06	.025-.06			.035-.06	.025-.06
Cu	.03max	.1max	.7-1.1	.7-1.2			2.7-3.3	2.7-3.3
Fe (max)	.02	.050	.02	.050			.02	.050
Pb (max)	.003	.005	.003	.005			.003	.005
Cd (max)	.003	.005	.003	.005			.003	.005
Sn (max)	.001	.002	.001	.002			.001	.002
Ni (max)	.001	.02	.001	.02			.001	.02
Si (max)	.02	.03	.02	.03			.02	.03
Zn	Balance	Balance	Balance	Balance			Balance	Balance

Chemical Specifications EN	ZA-8		ZA-12		ZA-27	
% by weight (EN1774 and EN12844) [B]	Ingot	Casting	Ingot	Casting	Ingot	Casting
Al	8.2-8.8	8.0-8.8	10.8-11.5	10.5-11.5	25.5-28.0	25.0-28.0
Mg	.020-.030	.015-.03	.020-.030	.015-.03	.012-.020	.010-.020
Cu	0.9-1.3	.8-1.3	0.5-1.2	0.5-1.2	2.0-2.5	2.0-2.5
Fe (max)	.035	.06	.050	.07	.070	.1
Pb (max)	.005	.006	.005	.006	.005	.006
Cd (max)	.005	.006	.005	.006	.005	.006
Sn (max)	.002	.003	.002	.003	.002	.003
Ni (max)	-	.02	-	.02	-	.02
Si (max)	.035	.045	.050	.06	.070	.08
Zn	Balance	Balance	Balance	Balance	Balance	Balance

(B) For all notes pertaining chemical specification, please refer to EN 1774 (ingots) and EN 12844 (castings).
Above listed specification are from version EN 1774 : 1998 and EN 12844 : 1999.

Industry Standards	Alloy 3		Alloy 5		Alloy 7		Alloy 2	
	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Casting
ASTM -standard	B240-13	B86-13	B240-13	B86-13	B240-13	B86-13	B240-13	B86-13
-designation	AG40A	AG40A	AC41A	AC41A	AG40B	AG40B	AC43A	AC43A
SAE	J468B	J468B	J468B	J468B			Former	
Specification No.	903	903	925	925			921	
EN (Europe)	EN1774	EN12844	EN1774	EN12844	EN1774	EN12844	EN1774	EN12844
Japan	JIS H2201	JIS H5301	JIS H2201	JIS H5301	JIS H2201	JIS H5301	JIS H2201	JIS H5301
Australia AS 1881	SAA H63	SAA H64	SAA H63	SAA H64	SAA H63	SAA H64	SAA H63	SAA H64
Canada	CSA HZ3	CSA HZ11	CSA HZ3	CSA HZ11	CSA HZ3	CSA HZ11	CSA HZ3	CSA HZ11
ISO	ISO 301		ISO 301		ISO 301		ISO 301	
UNS designation	Z33524	Z33525	Z35532	Z35533	Z33526	Z33527	Z35544	Z35545

Industry Standards	ZA-8		ZA-12		ZA-27		Acuzinc5	EZAC	HF alloy
	Ingot	Casting	Ingot	Casting	Ingot	Casting	Ingot	Ingot	Ingot
ASTM -standard	B240-13	B86-13	B240-13	B86-13	B240-13	B86-13	B892-10		B989
-designation									
SAE									
Specification No.									
EN (Europe)	EN1774	EN12844	EN1774	EN12844	EN1774	EN12844			
Japan	JIS H2201	JIS H5301	JIS H2201	JIS H5301	JIS H2201	JIS H5301			
Australia AS 1881	SAA H63	SAA H64	SAA H63	SAA H64	SAA H63	SAA H64			
Canada	CSA HZ3	CSA HZ11	CSA HZ3	CSA HZ11	CSA HZ3	CSA HZ11			
ISO	ISO 301		ISO 301		ISO 301				
UNS designation	Z35637	Z35638	Z35632	Z35633	Z35842	Z35841	Z46541	Z46541	

Table 3. Comparison with Other Materials

Material	UTS	Yield stress	Elongation at break	Young's modulus	Creep modulus	Specific gravity	Thermal expansion	Thermal conductivity	Heat capacity	Electrical Conductivity
	MPa	MPa	%	GPa	1000hrs @ 20°C, GPa	kg/dm^3	m m/m/oC	W/m-°K	J/g- °C	% IACS
Zinc					>50					
ZP3	315	276	7.73	84.3		6.66	27	113	0.391	27
ZP5	331	295	3.43	84.5		6.76	27.2	108.9	0.398	27
ZP2	397	360	5.99	84.4		6.8	27.2	104.7	0.422	25
ZP8	386.8	318.6	3.41	82.7		6.3	27.4	144.7	0.411	27.7
Aluminum					~70					
380 (equivalent to EN1706 AC46500)	324	159	3.5	71		2.76	21.1	109	0.963	26.9
356 T6 permanent mold	228 min.	152 min.	3 min.	72.4		2.68	21.4	151	0.963	39
Brass					97					
Free Cutting Brass, UNS 36000	338 - 469	124 - 310	53 max	97		8.49	20.5	115	0.377	26
Steel					200					
AISI 1020, 0.2% Carbon Normalized	440	345	36	200		7.87	12.1	51.9	0.486	10.8
Magnesium					~44					
AZ91D	230	150	3	44.8		1.81	26	72.7	1,047	12.1
Polymers										
ABS	30 - 65	29.5 - 65	2 - 110	1.8 - 3.2	<2	1.02 - 1.21	65 - 150	0.128 - 0.19	1.96 - 2.13	
Nylon PA66	40 - 85.5	40 - 86	4.8 - 300	0.7 - 3.3	<1	1.03 - 1.16	65 - 150	0.25 - 0.28	1.6 - 2.75	
PA66 30% glass fiber reinforced	70 - 210	128 - 210	1.9 - 150	3.2 - 11	<6	1.11 - 1.41	17 - 104	0.22 - 0.5	1.2 - 2.35	
Polycarbonate	54 - 72	59 - 70	8 - 135	1.6 - 2.4	<2	1.17 - 1.45	32 - 120	0.19 - 0.21	1 - 1.2	
Polycarbonate 30% glass fiber reinforced	76 - 138	114 - 128	2 - 4	6.9 - 9.7		1.33 - 1.45	22 - 23.4	0.35		
Polypropylene	19.7 - 80	12 - 43	3 - 887	0.5 - 7.6	<0.5	0.9 - 1.24	25 - 185	0.1 - 0.13	2	
Polypropylene 30% glass fiber reinforced	42 - 100	55 - 79	1.5 - 16	4.8 - 8.3		1.08 - 1.47	32 - 41	0.32 - 0.33		
Acetal Copolymer	37 - 66	37 - 69	3 - 250	1.4 - 3.2	<1.5	1.29 - 1.43	12 - 162			
Acetal Copolymer 30% glass fiber reinforced	66 - 140	140	1.5 - 7	6.2 - 10	5.7	1.52 - 1.71	25 - 43.2	0.32 - 0.33		
Polyester (Thermoset)	33.5 - 70	70	0.5 - 5	3.1 - 10.6		1.3 - 2.0	135	0.17		
Polysulfone	70 - 76	69 - 80	10 - 75	2.48 - 2.7	2.3 – 2.5	1.24 - 1.25	55 - 100	0.12 - 0.26	1.2	
30% glass fiber reinforced	107 - 125	110	1.8 - 1.3	7.58 - 9.9	8.3	1.46 - 1.49	21 - 29	0.3		

Resource Efficient

Pollution and greenhouse gases are minimized with zinc die casting:

- Negligible emissions to air, land and water.
- Much smaller energy consumption than comparable alternative mass manufacturing processes.
- Any 'scrap' product from processing can be recycled.

Zinc alloys, as defined by international chemical composition standards, comfortably conform to the requirements of the End of Life Vehicle (ELV), Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) legislation.

Zinc die castings are premium quality low cost products that are highly resilient to many hostile conditions. They display considerable corrosion and wear resistance thus resulting in very long and reliable service, frequently measured in decades, and saving resources by not needing to be frequently replaced.

A recycling infrastructure is actively in place to treat today's zinc processing scraps and tomorrow's end of life cast zinc alloy products. Zinc castings can be marked with ISO recycling mark as featured in EN 12844 for easy alloy recognition and future recycling.

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