DIE CASTING ALLOYS

A wide variety of die casting alloys, a mixture of two or more metals, are available with a comprehensive range of physical and mechanical properties for almost any application a designer or engineer may require.

Die casting alloys are normally non-ferrous alloys. Non-ferrous means no iron. Non-ferrous alloys are a mixture of two or more metals that do not contain a significant amount of iron or steel.

Aluminum die casting alloys are among the most lightweight structural metals and a majority of die castings produced worldwide are made from aluminum alloys.

Aluminum and Zinc alloys are the most widely used die casting alloys, followed by Zinc-Aluminum (ZA) alloys, magnesium, copper, lead and tin.

- Aluminum: lightweight, excellent dimensional stability, complex shapes, thin walls, high thermal and electrical conductivity, good corrosion resistance, machine-ability, electroplating and strength properties.

- Zinc: the most fluid and easiest metal to die cast, easily plated, high ductility, high impact strength, economical for small parts, low melting point promotes long die life.

Aluminum alloys have a high melting point, transforming from solid into liquid at about 1150°F to 1300°F (621°C to 704°C). Zinc alloys have a lower melting point at less than 725°F (385°C). Zinc-Aluminum (ZA) alloys have a slightly higher melting range of 800°F to 900°F (427°C to 482°C).

Aluminum die casting alloys are high melting point alloys and are die cast in cold chamber die cast machines, a die-casting process in which molten aluminum metal is transferred manually or mechanically by a ladle into a relatively cold shot cylinder and whereby a piston inside the shot cylinder forces the molten metal under hydraulic pressure into the die cavities and the molten metal is held under high pressure until it solidifies, hence the term high pressure die casting.

Zinc die casting alloys are low melting point alloys and are die cast in hot chamber die cast machines, a die-casting process in which a piston is driven through a reservoir of molten metal injecting the molten metal into the die cavities.

It is critical to use only high purity (99.99+ %) aluminum and zinc based alloys in order to obtain and maintain a casting's material integrity, meaning wholeness or perfect condition.

ALUMINUM ALLOYS

Aluminum die casting alloys are lightweight, offer good corrosion resistance, ease of casting and machine-ability, good mechanical properties and dimensional stability. Designers and engineers can choose from a wide variety of standard aluminum and zinc die casting alloys listed below. Special alloys for unique applications are also available but their use may involve additional costs:

A360 - Excellent pressure tightness and electrical conductivity properties, but is more difficult to cast than A380.

A380 - Most common and cost effective of all aluminum die casting alloys, offering the best combination of material properties, characteristics, ease of production and cost. Specified for most product applications.

A383 & A384 - Alternatives to A380 alloy for intricate components requiring improved die filling characteristics. Both provide better fluidity, but with a sacrifice in other characteristics such as machine-ability, polishing and anodizing appearance. The mechanical properties of A380, A383 and A384 are substantially interchangeable.

A390 - Excellent for special applications where high strength, thermal conductivity and wear-resistance/bearing properties are required.

A413 (A13) - Excellent pressure tightness, hardness and corrosion resistance.

A518 - Excellent corrosion resistance, machine-ability, polishing and anodizing appearance but with sacrifice in other characteristics such as pressure tightness, fluidity and cast-ability.

ALUMINUM DIE CASTING ALLOYS

(Composition, Properties & Characteristics)

ALLOY COMPOSITION (% max or range)	A360	A380	A383	A384	A390	A413 (A13)	A518
Silicon	9-10	7.5.-9.5	9.5-11.5	10.5-12	16-18	11-13	0.35
Iron	1.3	1.3	1.3	1.3	1.3	1.3	1.8
Copper	0.6	3-4	2-3	3.4.5	4-5	1.0	0.25
Manganese	0.35	0.50	0.50	0.50	0.50	0.35	0.35
Magnesium	0.40-0.60	0.10	0.10	0.10	0.45-0.65	0.10	7.5-8.5
Nickel	0.50	0.50	0.30	0.50	0.10	0.50	0.15
Zinc	0.50	3.0	3.0	3.0	1.5	0.50	0.15
Tin	0.15	0.35	0.15	0.35	0.20	0.15	0.15
Titanium	-	-	-	-	0.20	-	-
Total others	0.25	0.50	0.50	0.50	0.20	0.25	0.25
Aluminum	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.
PROPERTIES	**A360**	**A380**	**A383**	**A384**	**A390**	**A413 (A13)**	**A518**
Ultimate Tensile Strength (ksi)	46	47	45	48	40.5	42	45
Tensile Yield Strength (ksi)	24	23	22	24	35	19	28
Elongation (% in 2" G.L.)	3.5	3.5	3.5	1-2.5		3.5	5.0
Hardness (BHN)	75	80	75-80	85	85	120	80
Shear Strength (ksi)	26	27	25	29	-	29	29
Charpy impact strength (ft. lb.—unnotched)	4.2	3.5	-	-	-	2.0	7.0
Fatigue strength (ksi) (limit @ 500 million cycles)	18	20	19	20	-	20	20
Density (lb./in.^{3})	0.095	0.098	0.097	0.098	0.099	0.096	0.093
Melting range (°F) (Approx.)	1035-1105	1000-1105	960-1100	960-1100	945-1200	1065-1080	995-1150
Specific heat (Btu/lb. °F)	0.23	0.23	-	-	-	-	-
Coefficient of thermal expansion (in./in./ °F)	11.8	11.7	11.5	11.3	11.7	10.3	13.4
Thermal conductivity (Btu/ft hr. °F)	65.3	55.6	55.6	56	78.6	67.7	55.6
Electrical conductivity (% IACS)	29	23	23	23	25	31	24
Modulus of elasticity (10^6 psi)	10.3	10.3	10.3	10.3	11.9	10.3	-
CHARACTERISTICS 1 – most desirable 5 – least desirable	**A360**	**A380**	**A383**	**A384**	**A390**	**A413 (A13)**	**A518**
Resistance to Hot Cracking	2	2	1	2	4	1	5
Pressure Tightness	1	2	2	2	4	1	5
Polishing	3	3	3	3	5	4	1
Fluidity	2	2	1	1	1	1	5
Corrosion Resistance	2	4	3	4	3	2	1
Machine-ability	2	2	2	3	5	4	1
Strength at Elev. Temp.	3	2	2	2	3	2	4
Anti-Die Soldering Tend.	3	1	2	2	2	2	5
Electroplating	1	1	1	2	3	3	5
Anodizing Appearance	4	3	3	4	5	5	1

ksi - 1,000 pounds per square inch;
BHN - Brinell Hardness Number;
Btu - British Thermal Units;
G.L. - Gauge Length of initial material
psi - Pounds per Square Inch;
IACS - International Annealed Copper Standard

ZINC ALLOYS

Zinc alloys are the easiest alloys to die cast. Ductility, plate-ability and impact strength are excellent, making zinc die cast alloys suitable for a wide range of products. Zinc alloys can be cast with thin walls and excellent surface smoothness and finishes that are ideal for plating and painting.

ZINC #3 - Excellent all-around properties. (Primary zinc alloy used by KenWalt Die Casting)
ZINC #5 - Higher strength properties with less elongation.
ZINC #7 - Essentially equivalent to Zinc #3.

ZINC-ALUMINUM (ZA) ALLOYS

Zinc-Aluminum (ZA) alloys contain higher aluminum content than standard zinc alloys. ZA alloys provide high strength and hardness characteristics, thin wall cast-ability characteristics and good bearing properties. ZA-8 is normally cast using a hot chamber zinc die casting machine. ZA-12 and ZA-27 must be cast using a cold chamber aluminum die casting machine. ZA alloys are known to have superior properties compared to standard zinc alloys such as Zinc #3, 5, and 7. However, ZA-27 alloys are known to degrade die cast furnaces much faster than common aluminum alloys such as A380, thus their use may involve additional costs.

ZA-8 - Good pressure tightness, electroplating, anodizing characteristics. (8.0-8.8% Aluminum)
ZA-12 - Excellent bearing properties, hardness and pressure tightness characteristics. (10.5-11.5 Aluminum)
ZA-27 - Excellent mechanical properties, machine-ability and strength characteristics. (25-28% Aluminum)

Painting, chromating, phosphate coating, chrome plating are used for decorative finishes.

Painting, chromating, anodizing and iridite coatings are used as corrosion barriers.

Hard chrome plating can be used to improve wear resistance, except for ZA-27.

Bright chrome plating characteristics of all Zinc Alloys and ZA-8 make these alloys the first choice choice for hardware and decorative applications.

ZINC DIE CASTING ALLOYS

(Composition, Properties & Characteristics)

ALLOY COMPOSITION (% max or range)	ZINC #3	ZINC #5	ZINC #7	ZA-8	ZA-12	ZA-27
Aluminum	3.5-4.3	3.5-4.3	3.5-4.3	8.0-8.8	10.5-11.5	25-28
Copper	0.25	0.75-1.25	0.25	0.8-1.3	0.5-1.25	2-2.5
Magnesium	0.02-0.05	0.03-0.08	0.005-0.020	0.015-0.030	0.015-0.030	0.010-0.020
Iron	0.100	0.100	0.075	0.10	0.075	0.10
Lead	0.005	0.005	0.003	.004	.004	.004
Cadmium	0.004	0.004	0.002	.003	.003	.003
Tin	0.003	0.003	0.001	.002	.002	.002
Nickel	-	-	0.005-0.020	-	-	-
Zinc	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.
PROPERTIES	**ZINC #3**	**ZINC #5**	**ZINC #7**	**ZA-8**	**ZA-12**	**ZA-27**
Ultimate Tensile Strength (ksi)	40	48	41	54	58.5	61
Tensile Yield Strength (ksi)	-	-	-	42	46	53
Elongation (% in 2" G.L.)	10	7	13	6-10	4-7	1-3
Hardness (BHN)	82	91	80	95-110	95-115	105-125
Shear Strength (ksi)	31	38	-	35	37	42
Charpy impact strength (ft. lb.—unnotched)	43	48	43	31	21	3
Fatigue strength (ksi) (limit @ 500 million cycles)	6.9	8.2	-	7.5	15	25
Density (lb./in.^{3})	0.24	0.24	0.247	0.227	0.218	0.181
Melting range (°F) (Approx.)	718-728	717-727	718-728	707-759	710-810	708-903
Specific heat (Btu/lb. °F)	0.10	0.10	0.10	0.104	0.107	0.125
Coefficient of thermal expansion (in./in./°F)	15.2	15.2	15.2	12.9	13.4	14.4
Thermal conductivity (Btu/ft hr. °F)	65.3	62.9	65.3	66.3	67.1	72.5
Electrical conductivity (% IACS)	27.0	26.0	27.0	27.7	28.3	29.7
Modulus of rupture (10_6psi)	95,000	105,000	-	-	-	-
Modulus of elasticity (10_6psi)	-	-	-	10.2	10.3	10.3
Die shrinkage (in./in.)	0.007	0.007	0.007	0.007	0.0075	0.008
CHARACTERISTICS 1 – most desirable 5 – least desirable	**ZINC #3**	**ZINC #5**	**ZINC #7**	**ZA-8**	**ZA-12**	**ZA-27**
Resistance to Hot Cracking	1	1	1	2	3	4
Pressure Tightness	1	1	1	2	1	3
Polishing	1	1	1	2	3	4
Fluidity	1	2	1	2	3	3
Corrosion Resistance	1	1	1	2	2	1
Machine-ability	1	1	1	1	1	1
Strength at Elev. Temp.	4	4	4	3	2	1
Anti-Die Soldering Tend.	1	1	1	2	3	4
Electroplating	1	1	1	2	3	4
Anodizing Appearance	1	1	1	1	2	4

ksi - 1,000 pounds per square inch;
BHN - Brinell Hardness Number;
Btu - British Thermal Units;
G.L. - Gauge Length of initial material
psi - Pounds per Square Inch;
IACS - International Annealed Copper Standard

For more information: Call 1-800-KENWALT or Click Here to Email us

KenWalt Die Casting Company
8719 Bradley Ave.
Sun Valley, CA 91352 USA
Phone: (818) 768-5800 | Fax: (818) 768-0854
Email: sales@kenwalt.com
Website: http://www.kenwalt.com/

KenWalt Die Casting Company Website