Aluminum, 336.0, permanent mold cast, T65

General information

Designation

336.0 (Aluminum Association)

Condition	T65 (Solution heat-treated and artificially
UNS number	A03360

Typical uses

High temperature alloy: pistons, cylinder heads, gear housings, other engine parts

Composition overview

Compositional summary

Al79-86 / Si11-13 / Ni2-3 / Cu0.5-1.5 / Mg0.7-1.3 (impurities: Fe<1.2, Mn<0.35, Zn<0.35, Ti<0.25,

Material family	Metal
Base material	Al (Aluminum)

Composition detail (metals, ceramics and glasses)

Al (aluminum)	* 79	-	85.8	%
Cu (copper)	0.5	-	1.5	%
Fe (iron)	0	-	1.2	%
Mg (magnesium)	0.7	-	1.3	%
Mn (manganese)	0	-	0.35	%
Ni (nickel)	2	-	3	%
Si (silicon)	11	-	13	%
Ti (titanium)	0	-	0.25	%
Zn (zinc)	0	-	0.35	%
Other	0	-	0.05	%

Price

Price	* 1.88	-	2.08	EUR/kg
Price per unit volume	* 5.04e3	-	5.7e3	EUR/m^3

Physical properties

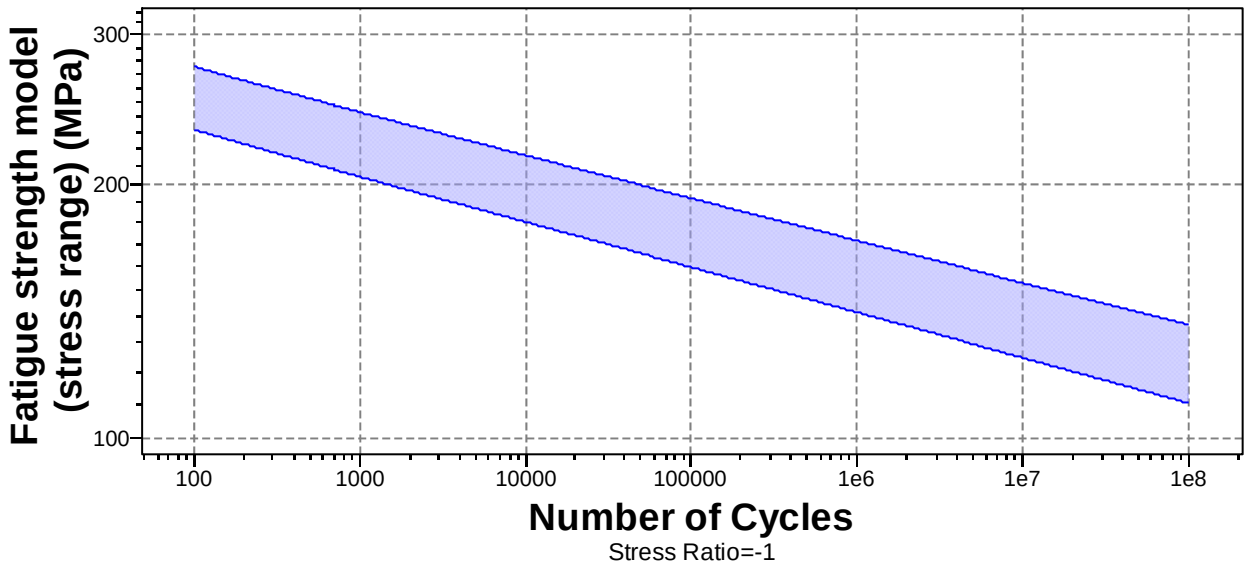
Density	2.69e3	-	2.74e3	kg/m^3

Mechanical properties

Young's modulus	72.5	-	75.5	GPa
Specific stiffness	26.7	-	27.9	MN.m/kg
Yield strength (elastic limit)	281	-	311	MPa
Tensile strength	309	-	341	MPa
Specific strength	103	-	115	kN.m/kg
Elongation	* 1	-	2	% strain
Compressive strength	* 281	-	311	MPa
Flexural modulus	* 73.5	-	76.5	GPa
Flexural strength (modulus of rupture)	* 281	-	311	MPa

Shear modulus	* 27.5	-	28.9	GPa
Bulk modulus	* 68.8	-	78.7	GPa
Poisson's ratio	0.322	-	0.338	
Shape factor	24			
Hardness - Vickers	135	-	150	HV
Elastic stored energy (springs)	534	-	653	kJ/m^3
Fatigue strength at 10^7 cycles	* 134	-	143	MPa
Fatigue strength model (stress range)	* 125	-	153	MPa

Parameters: Stress Ratio = -1, Number of Cycles = 1e7cycles



Impact & fracture properties

Fracture toughness	* 16.5	-	18.6	MPa.m^0.5
Toughness (G)	3.69	-	4.67	kJ/m^2

Thermal properties

Melting point	534	-	576	°C
Maximum service temperature	170	-	200	°C
Minimum service temperature	-273			°C
Thermal conductivity	113	-	122	W/m.°C
Specific heat capacity	944	-	982	J/kg.°C
Thermal expansion coefficient	18.4	-	19.4	µstrain/°C
Thermal shock resistance	199	-	225	°C
Thermal distortion resistance	* 5.91	-	6.5	MW/m
Latent heat of fusion	* 384	-	393	kJ/kg

Electrical properties

Electrical resistivity	5.8	-	6.1	µohm.cm
Electrical conductivity	28.3	-	29.7	%IACS
Galvanic potential	* -0.72	-	-0.64	V

Magnetic properties

Magnetic type	Non-magnetic			

Optical, aesthetic and acoustic properties

Transparency	Opaque			
Acoustic velocity	5.16e3	-	5.28e3	m/s
Mechanical loss coefficient (tan delta)	* 0.01	-	0.1	

Critical materials risk

Contains >5wt% critical elements?	Yes			

Processing properties

Metal casting	Acceptable			
Metal cold forming	Unsuitable			
Metal hot forming	Unsuitable			
Metal press forming	Unsuitable			
Metal deep drawing	Unsuitable			
Machining speed	42.7			m/min
Weldability	Excellent			
Notes	Preheating is not required, post weld heat treatment is required			

Durability

Water (fresh)	Excellent			
Water (salt)	Acceptable			
Weak acids	Excellent			
Strong acids	Excellent			
Weak alkalis	Acceptable			
Strong alkalis	Unacceptable			
Organic solvents	Excellent			
Oxidation at 500C	Unacceptable			
UV radiation (sunlight)	Excellent			
Galling resistance (adhesive wear)	Limited use			

Notes

Aluminum alloys perform poorly when self-mated but can be processed without galling when mated with steels.

Flammability	Non-flammable			

Corrosion resistance of metals

Stress corrosion cracking	Susceptible			
Note	Rated in chloride; Other susceptible environments: Halide, water			

Primary production energy, CO2 and water

Embodied energy, primary production	* 177	-	195	MJ/kg
CO2 footprint, primary production	* 11.4	-	12.6	kg/kg
Water usage	* 952	-	1.05e3	l/kg

Processing energy, CO2 footprint & water

Casting energy	* 10.5	-	11.6	MJ/kg
Casting CO2	* 0.628	-	0.694	kg/kg
Casting water	* 19.9	-	29.8	l/kg
Vaporization energy	* 1.55e4	-	1.71e4	MJ/kg
Vaporization CO2	* 930	-	1.03e3	kg/kg
Vaporization water	* 6.45e3	-	9.68e3	l/kg
Coarse machining energy (per unit wt removed)	* 1.51	-	1.67	MJ/kg
Coarse machining CO2 (per unit wt removed)	* 0.0906	-	0.1	kg/kg
Fine machining energy (per unit wt removed)	* 10.8	-	12	MJ/kg
Fine machining CO2 (per unit wt removed)	* 0.65	-	0.718	kg/kg
Grinding energy (per unit wt removed)	* 21.2	-	23.4	MJ/kg
Grinding CO2 (per unit wt removed)	* 1.27	-	1.41	kg/kg
Non-conventional machining energy (per unit wt removed)	* 155	-	171	MJ/kg
Non-conventional machining CO2 (per unit wt removed)	* 9.3	-	10.3	kg/kg

Recycling and end of life

Recycle	✓			
Embodied energy, recycling	* 30.6	-	33.8	MJ/kg
CO2 footprint, recycling	* 2.4	-	2.65	kg/kg
Recycle fraction in current supply	40.5	-	44.7	%
Downcycle	✓			
Combust for energy recovery	✗			
Landfill	✓			
Biodegrade	✗			

Notes

Standards with similar compositions

• Canada:
SN122 to CSA, SN122 to CSA HA.10, SN122 to CSA HA.3
• Italy:
6250/G-AlSi12.7NiMgCu to UNI
• Spain:
L-2550 to UNE 38-203
• USA:
336, 336 to ASTM B108, 336.1, 336.1 to ASTM B179, 336.2, 336.2 to ASTM B179, A03360 to SAE J452, A332.1 to QQ A-371F, A332.2 to QQ A-371F, UNS A03360, UNS A03361, UNS A03362
• Tradenames:
ALMINAL C13, PERMITE 2003, USCO 336.1

Links

ProcessUniverse

Producers

Reference

Shape