Carbon steel, AISI 1040, annealed

General information

Designation

AISI 1040

Condition	Annealed
UNS number	G10400
US name	ASTM G10420, ASTM 1042, ASTM 1040, ASME G10400, ASME G10390, ASME 1039
EN name	~HS40
ISO name	~CE40E4
JIS (Japanese) name	~STKM16C, ~STKM16A

Typical uses

Heavy duty shafts, axles, crankshafts, couplings, gears (if given a hardening treatment)

Composition overview

Compositional summary

Fe99 / Mn0.6-0.9 / C0.37-0.44 (impurities: S<0.05, P<0.04)

Material family	Metal (ferrous)
Base material	Fe (Iron)

Composition detail (metals, ceramics and glasses)

C (carbon)	0,37	-	0,44	%
Fe (iron)	* 98,6	-	99	%
Mn (manganese)	0,6	-	0,9	%
P (phosphorus)	0	-	0,04	%
S (sulfur)	0	-	0,05	%

Price

Price	* 2,89	-	3,01	BRL/kg
Price per unit volume	* 2,26e4	-	2,38e4	BRL/m^3

Physical properties

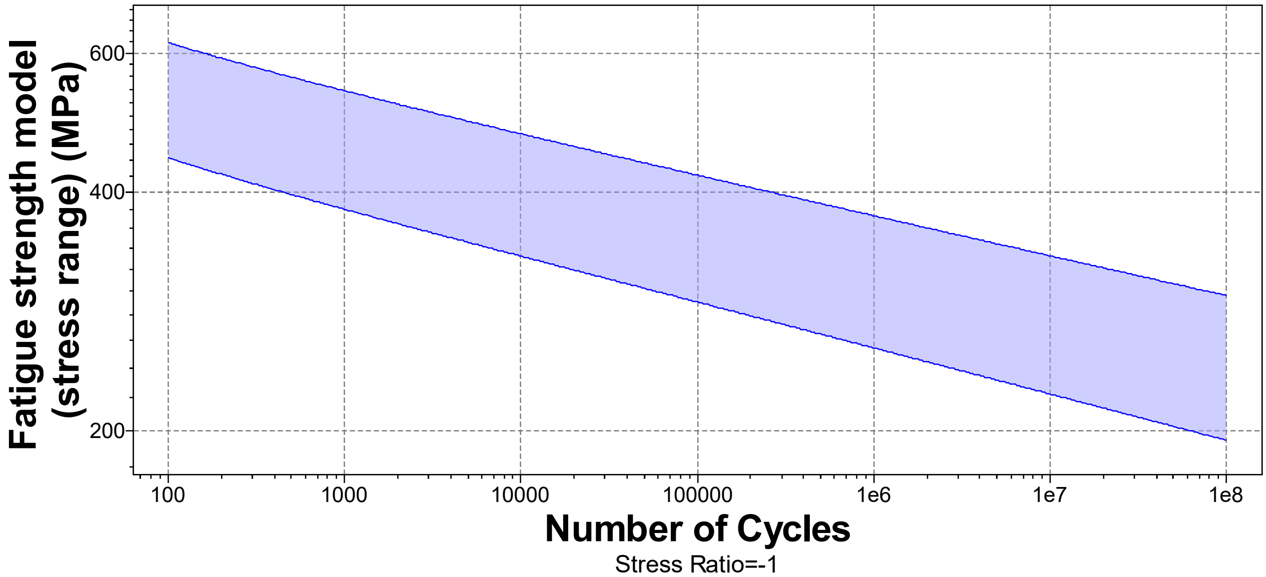
Density	7,8e3	-	7,9e3	kg/m^3

Mechanical properties

Young's modulus	208	-	216	GPa
Specific stiffness	26,5	-	27,5	MN.m/kg
Yield strength (elastic limit)	315	-	390	MPa
Tensile strength	475	-	575	MPa
Specific strength	40,1	-	49,7	kN.m/kg
Elongation	24	-	36	% strain
Compressive strength	* 315	-	390	MPa
Flexural modulus	* 208	-	216	GPa
Flexural strength (modulus of rupture)	315	-	390	MPa
Shear modulus	80	-	85	GPa
Bulk modulus	161	-	176	GPa
Poisson's ratio	0,285	-	0,295	
Shape factor	58			
Hardness - Vickers	143	-	173	HV

Elastic stored energy (springs)	236	-	355	kJ/m^3
Fatigue strength at 10^7 cycles	* 254	-	291	MPa
Fatigue strength model (stress range)	* 222	-	332	MPa

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



Impact & fracture properties

Fracture toughness	* 46	-	72	MPa.m^0.5
Toughness (G)	10,4	-	23,5	kJ/m^2

Thermal properties

Melting point	1,43e3	-	1,51e3	°C
Maximum service temperature	* 323	-	350	°C
Minimum service temperature	* -63	-	-38	°C
Thermal conductivity	50	-	54	W/m.°C
Specific heat capacity	465	-	505	J/kg.°C
Thermal expansion coefficient	10,5	-	12	µstrain/°C
Thermal shock resistance	130	-	167	°C
Thermal distortion resistance	* 4,29	-	5	MW/m
Latent heat of fusion	* 270	-	275	kJ/kg

Electrical properties

Electrical resistivity	16	-	19	µohm.cm
Electrical conductivity	9,07	-	10,8	%IACS
Galvanic potential	* -0,52	-	-0,44	V

Magnetic properties

Magnetic type	Magnetic

Optical, aesthetic and acoustic properties

Transparency	Opaque			
Acoustic velocity	5,14e3	-	5,25e3	m/s
Mechanical loss coefficient (tan delta)	* 8,8e-4	-	0,00109	

Critical materials risk

Contains >5wt% critical elements?	No

Processing properties

Metal casting	Unsuitable			
Metal cold forming	Acceptable			
Metal hot forming	Acceptable			
Metal press forming	Acceptable			
Metal deep drawing	Limited use			
Machining speed	33,5			m/min
Weldability	Good			
Notes	Preheating and post weld heat treatments are required			
Carbon equivalency	0,47	-	0,59	

Durability

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

Notes

Can be used for gears only if hardened. Aluminum bronze is the most suitable mating material to minimize galling.

Flammability	Non-flammable

Corrosion resistance of metals

Stress corrosion cracking	Not susceptible
Notes	Rated in chloride; Other susceptible environments: Nitrate, hydroxide, carbonate, ammonia

Primary production energy, CO2 and water

Embodied energy, primary production	30,8	-	33,9	MJ/kg

Sources

19.4 MJ/kg (Dhingra, Overly, Davis, 1999); 23 MJ/kg (Norgate, Jahanshahi, Rankin, 2007); 27.9 MJ/kg (Ecoinvent v2.2); 29.2 MJ/kg (Hammond and Jones, 2008); 32.8 MJ/kg (Hammond and Jones, 2008); 34.7 MJ/kg (Hammond and Jones, 2008); 35.4 MJ/kg (Hammond and Jones, 2008); 37.2 MJ/kg (Sullivan and Gaines, 2010); 38 MJ/kg (Hammond and Jones, 2008); 45.4 MJ/kg (Hammond and Jones, 2008)

CO2 footprint, primary production	2,26	-	2,49	kg/kg

Sources

0.396 kg/kg (Voet, van der and Oers, van, 2003); 1.75 kg/kg (Ecoinvent v2.2); 1.81 kg/kg (Voet, van der and Oers, van, 2003); 2.23 kg/kg (Voet, van der and Oers, van, 2003); 2.3 kg/kg (Norgate, Jahanshahi, Rankin, 2007); 2.74 kg/kg (Hammond and Jones, 2008); 2.77 kg/kg (Hammond and Jones, 2008); 2.87 kg/kg (Hammond and Jones, 2008); 2.89 kg/kg (Hammond and Jones, 2008); 3.03 kg/kg (Hammond and Jones, 2008); 3.27 kg/kg (Hammond and Jones, 2008)

Water usage	* 43,6	-	48,2	l/kg

Processing energy, CO2 footprint & water

Casting energy	* 10,9	-	12,1	MJ/kg
Casting CO2	* 0,819	-	0,906	kg/kg
Casting water	* 20,7	-	31	l/kg
Roll forming, forging energy	* 3,11	-	3,44	MJ/kg
Roll forming, forging CO2	* 0,233	-	0,258	kg/kg
Roll forming, forging water	* 2,88	-	4,32	l/kg
Extrusion, foil rolling energy	* 5,94	-	6,57	MJ/kg
Extrusion, foil rolling CO2	* 0,446	-	0,492	kg/kg

Extrusion, foil rolling water	* 4,09	-	6,14	l/kg
Wire drawing energy	* 21,5	-	23,8	MJ/kg
Wire drawing CO2	* 1,61	-	1,78	kg/kg
Wire drawing water	* 8,1	-	12,2	l/kg
Metal powder forming energy	* 38,1	-	42	MJ/kg
Metal powder forming CO2	* 3,05	-	3,36	kg/kg
Metal powder forming water	* 41,5	-	62,2	l/kg
Vaporization energy	* 1,09e4	-	1,2e4	MJ/kg
Vaporization CO2	* 815	-	901	kg/kg
Vaporization water	* 4,53e3	-	6,8e3	l/kg
Coarse machining energy (per unit wt removed)	* 0,899	-	0,994	MJ/kg
Coarse machining CO2 (per unit wt removed)	* 0,0674	-	0,0745	kg/kg
Fine machining energy (per unit wt removed)	* 4,72	-	5,21	MJ/kg
Fine machining CO2 (per unit wt removed)	* 0,354	-	0,391	kg/kg
Grinding energy (per unit wt removed)	* 8,96	-	9,9	MJ/kg
Grinding CO2 (per unit wt removed)	* 0,672	-	0,743	kg/kg
Non-conventional machining energy (per unit wt removed)	* 109	-	120	MJ/kg
Non-conventional machining CO2 (per unit wt removed)	* 8,15	-	9,01	kg/kg

Recycling and end of life

Recycle	✓			
Embodied energy, recycling	* 8,1	-	8,96	MJ/kg
CO2 footprint, recycling	* 0,636	-	0,703	kg/kg
Recycle fraction in current supply	39,9	-	44	%
Downcycle	✓			
Combust for energy recovery	✗			
Landfill	✓			
Biodegrade	✗			

Notes

Other notes

Responds to heat treatment and can be flame or induction hardened to 500 HV for gears and for good wear resistance.

Keywords

LASALLE 1045, LaSalle Steel Co. (USA); B/43, Steelmark-Eagle & Globe (AUSTRALIA); S/39, Steelmark-Eagle & Globe (AUSTRALIA);

Standards with similar compositions

• India:
40C8 to IS 1570/2/1, 45C8 to IS 1570/2/1, C40 to IS 1570/2/1, C45 to IS 1570/2/1, IS 6902 to IS 6902
• Mexico:
1038 to NMX-B-301, 1039 to NMX-B-301, 1040 to NMX-B-203-SCFI, 1040 to NMX-B-301, 1042 to NMX-B-301, 1043 to NMX-B-301
• Pan America:
1038 to COPANT 331, 1038 to COPANT 333, 1039 to COPANT 333, 1040 to COPANT 330, 1040 to COPANT 331, 1040 to COPANT 333
• UK:
080M36 to BS 970/1, 080M40 to BS 970/1, 170H41 to BS 970/1
• USA:
1038, 1038 to ASTM A29/A29M, 1038 to ASTM A568/A568M, 1038 to SAE J403, 1039, 1039 to ASTM A29/A29M, 1039 to ASTM A568/A568M, 1039 to SAE J403, 1040, 1040 to ASTM A29/A29M, 1040 to ASTM A513, 1040 to ASTM A519, 1040 to ASTM A568/A568M, 1040 to DoD-F-24669/1, 1040 to FED QQ-S-635B, 1040 to SAE J403, 1042, 1042 to ASTM A29/A29M, 1042 to ASTM A568/A568M, 1042 to SAE J403, 1043, 1043 to ASTM A29/A29M, 1043 to ASTM A568/A568M, 1043 to SAE J403, 1544, C1042 to FED QQ-S-635B, C4 to MIL-S-16788A, CS1040 to MIL-S-11310E, G10380 to ASTM A510/A510M, G10380 to ASTM A576-90b, G10390 to ASTM A510/A510M, G10390 to ASTM A576-90b, G10400 to ASTM A510/A510M, G10400 to ASTM A576-90b, G10420 to ASTM A510/A510M, G10420 to ASTM A576-90b, G10430 to ASTM A510/A510M, G10430 to ASTM A576-90b, UNS G10380, UNS G10380 to UNS, UNS G10390, UNS G10390 to UNS, UNS G10400, UNS G10400 to UNS, UNS G10420, UNS G10420 to UNS, UNS G10430, UNS G10430 to UNS
• Tradenames:
ALLENOY 1038, ASCOMETAL XC38H1-H2, B/43, BOFORS N91, BOHLER V943, DODGE D-4, DONEGAL D-3, DYNAMIC C-1-4, DYNAMIC C-1-5, FORTUNA W3, GREDE 37, HECLA 37, JESSOP A-5, JESSOP STEEL A-5 (S M-40), KRUPP 1730, RED DIAMOND 9S, S/39, SODING WM, SWB-40M4, TULIPE EXTRA NO. 7, UGINE B 38, V4

Links

ProcessUniverse

Producers

Reference

Shape