Technical Datasheet

CarTech® 751 Alloy

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.08 %	**Manganese (Maximum)**	0.50 %
Sulfur (Maximum)	0.005 %	**Silicon (Maximum)**	0.50 %
Chromium	14.00 to 17.00 %	**Nickel (Minimum)**	70.00 %
Titanium	2.10 to 2.70 %	**Columbium/Niobium**	0.70 to 1.20 %
Aluminum	1.00 to 1.50 %	**Iron**	5.00 to 9.00 %

General Information

Description

CarTech 751 alloy is a high strength, nickel-base high temperature alloy which responds to age hardening for maximum properties. This alloy is highly resistant to chemical corrosion and oxidation, displays low creep rate under high stresses in the 1200/1500°F (650/820°C) temperature range and possesses good rupture properties to 1600°F (870°C).

Applications

CarTech 751 alloy has been used for engine valves.

Corrosion Resistance

Pyromet alloy 751 exhibits high resistance to oxidation under conditions of repeated heating and cooling. This material forms a strong, closely adherent oxide which protects it from progressive attack.

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Good	Sulfuric Acid	Moderate
Phosphoric Acid	Moderate	Acetic Acid	Moderate
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Good
Sea Water	Restricted	Humidity	Excellent

Properties

Physical Properties

Specific Gravity	8.25	
Density	0.2980	lb/in³
Mean CTE		
100 to 200°F	7.20	x 10 $^{-6}$ in/in/°F
100 to 600°F	7.80	x 10 $^{-6}$ in/in/°F
100 to 1000°F	8.30	x 10 $^{-6}$ in/in/°F
100 to 1400°F	8.90	x 10 $^{-6}$ in/in/°F
100 to 1600°F	9.40	x 10 $^{-6}$ in/in/°F

Mean coefficient of thermal expansion

Temperature		Coefficient of Expansion	
100°F to	38°C to	10^{-6}/°F	10^{-6}/°C
200	93	7.2	13.0
600	320	7.8	14.0
1000	540	8.3	14.9
1400	760	8.9	16.0
1600	870	9.4	16.9

Modulus of Elasticity (E)	31.0	x 10 ^{3} ksi
Electrical Resistivity (76°F)	743.0	ohm-cir-mil/ft
Melting Range	2540 to 2600	°F

Typical Mechanical Properties

Elevated Temperature Stress Rupture Properties – Alloy 751

Test temperature - 1350°F (730°C)

Time (hours)	Stress Required to Produce Rupture	
	ksi	MPa
10	63	434
100	50	345
1000	38	262

Room Temperature Tensile Properties — Pyromet Alloy 751

Heat treated—2100°F (1150°C)/4 hr/air cool + 1550°F (840°C)/24 hr/cool to 1300°F (700°C)/hold 20 hr/air cool

Condition	Ultimate Tensile Strength		0.2% Yield Strength		% Elongation in 4D	Brinell Hardness
	ksi	MPa	ksi	MPa		
Solution Treated	125	862	75	517	50	176
Solution Treated & Aged	175	1207	110	758	20	337

Heat Treatment

In some cases, valves are used as-forged, without further treatment.

Valves may be aged at 1300°F (700°C) after forging.

When a finer grain size is desired for improved tensile properties, at the expense of creep-rupture strength, lower solution heat treatments are used. These temperatures are in the range 1800/1950°F (980/1070°C). The standard aging treatments follow these solution treatments.

Solution Treatment

Heat to 2100°F (1150°C), hold at temperature for 4 hours, then air cool.

Age

Reheat to 1550°F (840°C), hold at temperature for 24 hours, cool to 1300°F (700°C), hold at temperature for 20 hours, then air cool.

Workability

Forging

Pyromet alloy 751 can be forged within the temperature range 1800/2100°F (980/1150°C). Careful control of the forging temperature and frictional heat buildup should be exercised as hot shortness can occur. Also, cold shortness will occur with too much deformation below 1800°F (980°C).

Long soaks are not necessary; an equalized temperature is adequate.

Forging furnace fuels should be low in sulfur content because this element can cause catastrophic oxidation.

Forgings may be air or fan cooled. Care should be exercised in water quenching as quench cracks may occur, especially in large sections.

Machinability

Pyromet alloy 751 is machinable in all conditions. It cannot be machined economically on light machine tools nor machined at the operating speeds for ordinary steel; its machinability is similar to that of annealed high-speed steels.

In general, material given only an intermediate age, 1525/1575°F (829/857°C), is not as readily machined as material given a double age, 1525/1575°F plus 1275/1325°F (829/857°C plus 690/718°C).

Following are typical feeds and speeds for Pyromet alloy 751.

Turning—Single-Point and Box Tools

Condition	Depth of Cut In.	High-Speed Tools			Carbide			
		Speed, fpm	Feed, ipr	Tool Material	Speed, fpm		Feed, ipr	Tool Material
					Brazed	Throw Away		
Solution Treated	.100	20	.010	M-42 M-47	70	80	.010	C-2
	.025	25	.007		80	90	.007	C-3
Aged	.100	20	.010		65	75	.010	C-2
	.025	25	.007		75	85	.007	C-3

Turning—Cut-Off and Form Tools

Condition	Speed, fpm	Feed, ipr							Tool Material
		Cut-Off Tool Width, Inches			Form Tool Width, Inches				
		1/16	1/8	1/4	1/2	1	1-1/2	2	
Solution Treated	15	.002	.004	.005	.004	.002	.002	.001	M-42
	45	.003	.0045	.006	.004	.003	.0025	.0015	C-2
Aged	15	.002	.003	.004	.003	.002	.002	.001	M-42
	45	.003	.003	.0045	.003	.0025	.002	.001	C-2

Drilling

Condition	Speed, fpm	Feed, ipr								Tool Material
		Nominal Hole Diameter, Inches								
		1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
Solution Treated	20	—	.002	.003	.003	.004	—	—	—	M-42
Aged	15	—	.002	.003	.003	.004	—	—	—	

Tapping

Condition	Speed, fpm	Tool Material
Solution Treated	10	M-1;M-7;M-10
Aged	7	M-1;M-7;M-10; Nitrided

Reaming

Condition	High-Speed Tool							Carbide Tool	
	Speed, fpm	Feed, Inches per Rev — Reamer Diameter, Inches					Tool Material	Speed, fpm	Tool Material
		1/8	1/4	1/2	1	1-1/2	2		
Solution Treated	20	.002	.006	.008	.010	.012	.014	M-42	60	C-2
Aged	15	.002	.006	.008	.010	.012	.014		50	

Die Threading

Condition	Speed, fpm				Tool Material
	7 or Less	8 to 15	16 to 24	25 and up T.P.I.	
Solution Treated	4-6	5-8	6-10	8-12	M-2;M-7;M-10
Aged	3-4	3-5	4-8	5-10	M-42

Milling—End Peripheral

Condition	Depth of Cut In.	High-Speed Tools						Carbide Tools					
		Speed, fpm	Feed—Inches per tooth — Cutter Diameter, Inches				Tool Material	Speed, fpm	Feed—Inches per tooth — Cutter Diameter, Inches				Tool Material
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
Solution Treated	.050	15	.002	.002	.003	.004	M-42	60	.001	.002	.003	.004	C-2
Aged		12	.0015	.0015	.002	.003		50	.0015	.0015	.002	.003	

Broaching

Condition	Speed, fpm	Chip Load, Inches per tooth	Tool Material
Solution Treated	8	.002	M-42
Aged	6	.002	

Additional Machinability Notes

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased or decreased in small steps.

Other Information

Forms Manufactured

- Bar-Rounds
- Billet

Technical Articles

- A Designer's Manual On Specialty Alloys For Critical Automotive Components
- Trends in High Temperature Alloys

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