Technical Datasheet

CarTech® CTX-909 Alloy

Identification

UNS Number

• N19909

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.06 %	**Manganese (Maximum)**	0.50 %
Phosphorus (Maximum)	0.015 %	**Sulfur (Maximum)**	0.015 %
Silicon	0.40 %	**Chromium (Maximum)**	0.50 %
Nickel	38.00 %	**Copper (Maximum)**	0.50 %
Cobalt	14.00 %	**Titanium**	1.60 %
Aluminum (Maximum)	0.15 %	**Columbium + Tantalum**	4.90 %
Boron (Maximum)	0.012 %	**Iron**	Balance

General Information

Description

CarTech CTX-909 alloy is a high-strength, precipitation hardenable superalloy which exhibits a low and relatively constant coefficient of thermal expansion over a broad temperature range, high hot hardness and good thermal fatigue resistance.

This alloy offers significant improvement over CarTech CTX-1 alloy and CarTech CTX-3 alloy due to its excellent combination of tensile properties and stress rupture strength in the recrystallized condition combined with the use of common age hardening treatments.

CarTech CTX-909 alloy is weldable, brazable, and can be chromium plated.

Applications

CarTech CTX-909 alloy has been used in compressor and exhaust casings, seals and other gas turbine engine components. It also has excellent characteristics . . . and could be considered for . . . applications such as:

Ordnance hardware
Gauge blocks
Rocket engine thrust chambers
Steam turbine blades
Springs
Die-casting dies

This alloy could also be considered for use in applications requiring resistance to thermal fatigue in non-corrosive environments.

Corrosion Resistance

Pyromet alloy CTX-909 contains only residual levels of chromium in order to achieve the desired expansion properties. As a result, it is readily oxidized and should be coated to prevent oxidation.

In addition, Pyromet alloy CTX-909 resists hydrogen embrittlement better than other alloys with similar strength.

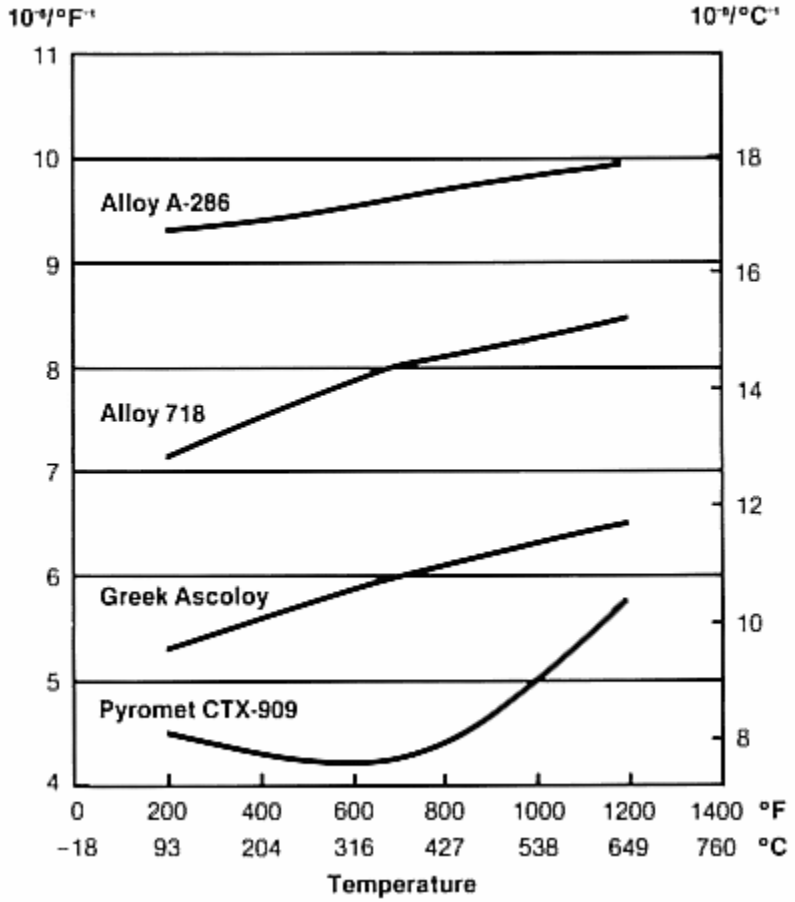
Properties

Physical Properties

Specific Gravity	8.28	
Density	0.2990	lb/in³

Mean CTE	
77 to 200°F	4.50 x 10^{-6} in/in/°F
77 to 400°F	4.30 x 10^{-6} in/in/°F
77 to 600°F	4.20 x 10^{-6} in/in/°F
77 to 800°F	4.30 x 10^{-6} in/in/°F
77 to 1000°F	5.00 x 10^{-6} in/in/°F

Comparative thermal expansion coefficients—various alloys



Mean coefficient of thermal expansion

Temperature		Inflection Temperature— approximately 780° F (416°C)	
°F	°C	10^{-6}/°F	10^{-6}/°C
77- 200	25- 93	4.5	8.1
77- 400	25-204	4.3	7.7
77- 600	25-316	4.2	7.6
77- 800	25-427	4.3	7.7
77-1000	25-538	5.0	9.0

Fahrenheit measurements in/in/°F
Celsius measurements mm/mm/°C

Modulus of Elasticity (E)	23.2 x 10^{3} ksi

Magnetic Properties

Pyromet alloy CTX-909 is ferromagnetic from below room temperature to approximately 750°F (400°C). Above 750°F (400°C) it is essentially nonmagnetic.

Typical Mechanical Properties

Typical Mechanical Properties When Heat Treated for Optimum Mechanical Properties—Pyromet Alloy CTX-909
Solution treated 1800°F (980°C) 1 hour, air cooled, aged 1325°F (720°C) 8 hours, furnace cooled to 1150°F (620°C) at 100°F (55°C) per hour, held 8 hours, air cooled

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area
ksi	MPa	ksi	MPa		
Room Temperature Tensile Properties					
157	1083	194	1338	12	30
Elevated Temperature Tensile Properties—1000°F (540°C)					
142	979	171	1179	14	40
Elevated Temperature Tensile Properties—1200°F (650°C)					
129	889	151	1041	19	57

Stress Rupture Properties—Combination smooth/notch K_t = 3.8 1200°F/74 ksi (650°C/510 MPa)

% Elongation	Life (hours)
25	164

Typical Mechanical Properties When Heat Treated for Use With Brazing Cycles Above 1800°F (980°C)—Pyromet Alloy CTX-909
Solution treated 1900°F (1040°C), air cooled, aged 1425°F (775°C) 8 hours, furnace cooled to 1150°F (620°C) at 100°F (55°C) per hour, held 8 hours, air cooled

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area
ksi	MPa	ksi	MPa		
Room Temperature Tensile Properties					
132	910	176	1214	10	14
Elevated Temperature Tensile Properties—1200°F (650°C)					
106	731	135	931	13	22

Stress Rupture Properties—Combination smooth/notch K_t = 3.8 1200°F/74 ksi (650°C/510 MPa)

% Elongation	Life (hours)
15	150

Typical Mechanical Properties When Heat Treated Using Shorter Aging Cycles—Pyromet Alloy CTX-909

Solution treated 1800°F (980°C) 1 hour, air cooled, aged 1375°F (745°C) 4 hours, furnace cooled to 1150°F (620°C) at 100°F (55°C) per hour, held 4 hours, air cooled

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area
ksi	MPa	ksi	MPa		
Room Temperature Tensile Properties—75°F (24°C)					
152	1048	191	1317	13	29
Elevated Temperature Tensile Properties—1200°F (650°C)					
126	869	146	1007	23	61

Stress Rupture Life—At 1000°F/120 ksi (540°C/828 MPa)—Notch K_t = 2.0-120 hours

Solution treated 1900°F (1040°F), air cooled, aged 1425°F (775°F) 8 hours, furnace cooled at 100°F (55°C) per hour to 1150°F (620°C), held 4 hours, air cooled

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area
ksi	MPa	ksi	MPa		
Room Temperature Tensile Properties—75°F (24°C)					
128	883	173	1193	11	17
Elevated Temperature Tensile Properties—1200°F (650°C)					
99	683	134	924	14	24

Stress Rupture Life—At 1000°F/120 ksi (540°C/828 MPa)—Notch K_t = 2.0-120 hours

Heat Treatment

The optimum heat treatment for Pyromet alloy CTX-909 varies with property requirements:

Heat Treatment For Optimum Mechanical Properties

Warm worked material is solution treated at 1800°F (980°C) for 1 hour and air cooled. Age at 1325/1375°F (720/745°C) for 4 to 8 hours, furnace cool to 1150°F (620°C), hold for 4 to 8 hours, then air cool. (Refer to Typical Mechanical Properties Table).

Heat Treatment For Use With Brazing Cycles Above 1800°F (980°C)

Warm worked material is typically brazed at 1900°F (1040°C) and air cooled. After brazing, age at 1425°F (775 °C) for 8 hours, furnace cool to 1150°F (620°C), hold for 4 to 8 hours, then air cool. (Refer to Typical Mechanical Properties Table).

Note that tensile properties are reduced relative to material heat treated for optimum mechanical properties when a braze temperature above 1850°F (1010°C) is employed.

Workability

Hot Working

A warm worked structure attained through the use of proper hot working practices is required for the best combination of mechanical properties for Pyromet alloy CTX-909.

Initial forging operations should be conducted from a furnace temperature of 1950 to 2000°F (1065 to 1095°C). Additional hot working reductions should be conducted from lower furnace temperatures over a decreasing temperature range. Final hot working should be carried out from a furnace temperature of 1800 to 1850°F (980 to 1010°C) and a 30 to 40% reduction should be achieved below 1800°F (980°C).

The dependence on an appropriate warm worked structure is reduced when the 1900°F (1040°C) heat treatment is employed.

Machinability

Pyromet alloy CTX-909 can be machined in either the solution treated or age hardened condition. Machine tools should have ample power and rigidity and speeds should be slow. Machinability is similar to 718.

Higher cutting speeds and longer tool life are attainable in the solution treated condition.

Weldability

Welding characteristics are similar to Pyromet alloy 718. Some loss of strength and ductility can be expected in the welded area and heat- affected zones.

Brazing

Brazing at 1800°F (980°C) results in higher mechanical properties than brazing at 1900°F (1040°C) or above.

Other Information

Applicable Specifications

- AMS 5884
- AMS 5893

Forms Manufactured

- Bar-Flats
- Bar-Rounds
- Bar-Shapes
- Billet
- Strip
- Wire

Technical Articles

- New Requirements for Ferrous-Base Aerospace Alloys
- Selection of Age-Hardenable Superalloys
- Trends in High Temperature Alloys

Edition Date: 07/01/1989

Visit us on the web at www.cartech.com