Technical Datasheet

CarTech® Thermo-Span® Alloy

Type Analysis

Single figures are nominal except where noted.

Carbon	0.05 %	**Manganese**	0.50 %
Silicon	0.50 %	**Chromium**	5.50 %
Nickel	24.50 %	**Cobalt**	29.50 %
Titanium	1.00 %	**Columbium/Niobium**	5.00 %
Aluminum	0.60 %	**Iron**	Balance

General Information

Description

CarTech Thermo-Span alloy is a precipitation hardenable superalloy which exhibits a low coefficient of thermal expansion over a broad temperature range, high tensile and rupture strengths, and good thermal fatigue resistance.

This alloy offers a significant improvement in environmental resistance over CarTech CTX-1, CTX-3, and CTX-909 alloys due to the addition of chromium.

The alloy also possesses and excellent combination of tensile properties and stress rupture strength in the recrystallized condition with the use of common solution and age hardening treatments.

Unlike the CarTech CTX-family of alloys, the use of specific braze-cycle age hardening treatments is not required for CarTech Thermo-Span alloy due to the higher solution treating temperature.

Applications

CarTech Thermo-Span alloy should be considered for use in all applications for which the current low expansion superalloys are suited. These include compressor and exhaust casings, seals and other gas turbine components.

Additional high temperature applications where moderate oxidation resistance is required are feasible with CarTech Thermo-Span alloy.

This alloy should also be considered for use in applications requiring resistance to thermal fatigue.

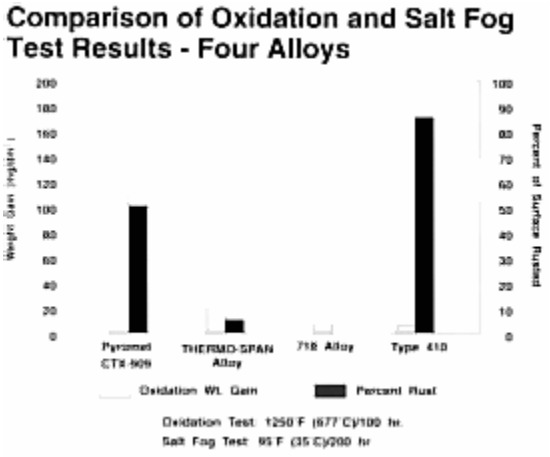
Corrosion Resistance

Unlike the other controlled thermal expansion superalloys, Thermo-Span alloy contains chromium to provide a level of oxidation resistance previously unattainable in conjunction with low thermal expansivity. The alloy also exhibits improved performance in salt fog testing

Thermo-Span alloy also possesses excellent resistance to embrittlement by high temperature high pressure hydrogen.

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.*

Salt Spray (NaCl)	Restricted	Humidity	Moderate



Properties

Physical Properties

Specific Gravity	8.23	
Density	0.2970	lb/in³
Mean Specific Heat		
73°F	0.1107	Btu/lb/°F
400°F	0.1239	Btu/lb/°F
800°F	0.1245	Btu/lb/°F
1200°F	0.1312	Btu/lb/°F
1300°F	0.1338	Btu/lb/°F

Specific heat and thermal conductivity

Test Temperature		Specific Heat		Thermal Conductivity	
°F	°C	Btu lb^{-1} F^{-1}	Wsgm^{-1}K^{-1}	Btu in Hr^{-1} ft^{-2} F^{-1}	Wm^{-1}K^{-1}
73	23	0.1107	0.463	78.2	11.3
400	202	0.1239	0.518	103.7	15.0
800	427	0.1245	0.521	125.8	18.1
1200	652	0.1312	0.549	153.2	22.1
1300	705	0.1338	0.560	160.9	23.2

Mean CTE		
77 to 400°F	4.30	x 10^{-6} in/in/°F
77 to 600°F	4.60	x 10^{-6} in/in/°F
77 to 800°F	5.40	x 10^{-6} in/in/°F
77 to 1000°F	6.10	x 10^{-6} in/in/°F
77 to 1200°F	6.70	x 10^{-6} in/in/°F

Mean coefficient of thermal expansion

Temperature		Coefficient	
77°F to	25°C to	10^{-6}/°F	10^{-6}/°C
400	204	4.3	7.7
600	316	4.6	8.3
800	427	5.4	9.7
1000	538	6.1	11.0
1200	649	6.7	12.1

Inflection temperature approx. 610°F (321°C)

Thermal Conductivity		
73°F	78.20	BTU-in/hr/ft²/°F
400°F	103.7	BTU-in/hr/ft²/°F
800°F	125.8	BTU-in/hr/ft²/°F
1200°F	153.2	BTU-in/hr/ft²/°F
1300°F	160.9	BTU-in/hr/ft²/°F

Modulus of Elasticity (E)		
75°F	27.4	x 10^3 ksi
320°F	26.7	x 10^3 ksi
600°F	26.0	x 10^3 ksi
900°F	24.9	x 10^3 ksi
1200°F	23.8	x 10^3 ksi
1500°F	22.6	x 10^3 ksi
1800°F	21.0	x 10^3 ksi

Dynamic modulus of elasticity

Temperature		Modulus	
°F	°C	psi x 10^6	MPa x 10^3
75	24	27.4	189
320	160	26.7	184
600	316	26.0	179
900	482	24.9	172
1200	649	23.8	164
1500	815	22.6	156
1800	982	21.0	145

Typical Mechanical Properties

Solution treated 2000°F (1094°C) 1 hour, air cooled, aged 1325°F (718°C) 8 hours, furnace cooled to 1150°F (621°C) at 100°F (55°C) per hour, held 8 hours, air cooled.

Stress Rupture Properties - Thermo-Span Alloy

Test Temperature		Stress		Rupture Life (Hours)	% Elongation
°F	°C	ksi	MPa		
		Specimen Type - Notch (K_t=2)			
1000	538	120	827	512	—
				980	—
		Specimen Type - Combo (K_t=3.8)			
1200	649	74	510	800	17
				1048	29

Tensile Properties - Thermo-Span Alloy

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elong.	% Red. of Area
°F	°C	ksi	MPa	ksi	MPa		
75	24	127	876	178	1227	16	32
500	260	122	841	166	1145	16	34
1000	538	117	807	158	1089	15	35
1200	649	118	814	153	1055	20	49
1250	677	108	745	131	904	19	35
1300	705	96	662	116	800	24	46
1350	732	84	579	98	678	25	50
1400	760	72	496	84	579	30	67

Heat Treatment

Solution Treatment

Heat to 2000°F (1094°C), hold for 1 hour at heat, air cool.

Age

Heat to 1325°F (718C°), hold for 8 hours at heat, furnace cool at 100°F (55°C) per hour to 1150°F (621 °C), hold for 8 hours at heat, air cool.

Workability

Hot Working

Thermo-Span alloy is readily workable using soak temperatures between 1850 and 2050°F (1010 and 1120°C).

To attain the desired fine grain structure, a substantial forging reduction below 1900°F (1038°C) is recommended. Hot working may continue to workpiece temperatures below 1700°F (927°C). The use of low finishing temperatures provides a microstructure containing a dispersion of globular Ni-Co-Cb-rich precipitates which prevent substantial grain coarsening during solution treating steps.

Machinability

Thermo-Span alloy 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 Alloy 718.

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

Solution treated 2000°F (1094°C) 1 hour, air cooled, aged 1325°F (718°C) 8 hours, furnace cooled to 1150°F (621°C) at 100°F (55°C) per hour, held 8 hours, air cooled.

Weldability

Welding characteristics are similar to Alloy 718.

Some loss of strength and ductility can be expected in the welded area and heat-affected zones.

Brazing

Due to the high solution temperature, Thermo-Span alloy can be brazed in the solution treated condition. This should provide consistent strength capability regardless of brazing temperature.

Other Information

Forms Manufactured

- Bar-Rounds
- Billet
- Strip
- Wire

Technical Articles

- A Guide to Etching Specialty Alloys for Microstructural Evaluation
- New Requirements for Ferrous-Base Aerospace Alloys
- Selection of Age-Hardenable Superalloys
- Trends in High Temperature Alloys

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