Alloy DIGEST

CF8C-PLUS

DATA ON WORLDWIDE METALS AND ALLOYS

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Stainless Steel

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CF8C-PLUS
(Heat- and Corrosion-Resistant Austenitic Stainless Steel)

CF8C-Plus is a newly developed austenitic casting grade similar to CF8C, but with improved chemistry to stay fully austenitic at high temperatures and thus retain good mechanical properties.

Inconel is a registered trademark of the Special Metals Group of Companies

Chemical Composition, wt.%:

(Nominal)

	CF8C-Plus	CF8C
Copper	0.08	0.1
Silicon	0.5	1.0
Manganese	4.0	1.0
Chromium	19.0	19.0
Molybdenum	0.3	0.3
Nickel	12.5	10
Niobium	0.80	0.80
Nitrogen	0.25	...
Iron	bal	bal

Physical Properties:

The thermal expansion and conductivity of CF8C-Plus are basically equivalent to CF8C, so redesign of stainless steel components is not required for replacement with CF8C-Plus from CF8-C.

Mechanical Properties:

CF8C-Plus maintains excellent yield and ultimate strength up to 900 °C (1650 °F); specified minimum tensile properties are shown in Table 1. Creep tests from 650–850 °C (1200–1560 °F), for times up to 24,000 h, demonstrate superior strength over CF8C, as shown in Fig. 1, and demonstrate that CF8C-Plus has superior creep strength and creep ductility compared to various cast irons as well.

The creep behavior as Larson-Miller Parameter is shown in Fig. 2. Cast CF8C-Plus has low-cycle fatigue (LCF) behavior similar to wrought stainless steels due to its excellent ductility. Hold-time LCF tests at 750 °C (1380 °F) with parameters of 0.45%, 0.001/s, and *R*-ratio = 0 show a smaller creep-fatigue interaction for CF8C-Plus compared to CF8C as noted in Fig. 3. Average room-temperature V-notch impact energy after aging 500 h at 700 °C (1290 °F) is shown in Fig. 4.

Table 1 Typical Tensile Properties as Function of Temperature

Temperature		Yield strength		Tensile strength		
°C	°F	MPa	ksi	MPa	ksi	Elongation, %
21	69.8	276	40	587	85	43
		225(a)	33(a)	525(a)	76(a)	20(a)
200	392	194	28	473	69	40
400	752	169	25	476	69	40
600	1112	143	21	398	58	40
700	1292	135	20	324	47	32
750	1382	129	19	333	48	30
800	1472	136	20	255	37	27
850	1562	132	19	243	35	33
900	1652	120	17	170	25	50

(a) Specified minimums

Weldability:

CF8C-Plus is readily weldable per the procedures and requirements of ASME B&PV Code Section IX. CF8C-Plus Weldment Data

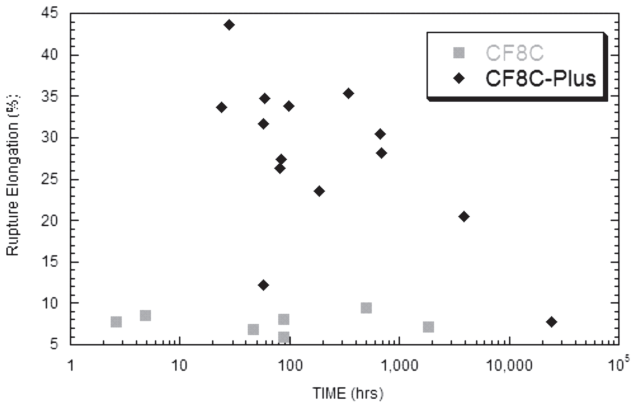

Fig. 1 Creep behavior

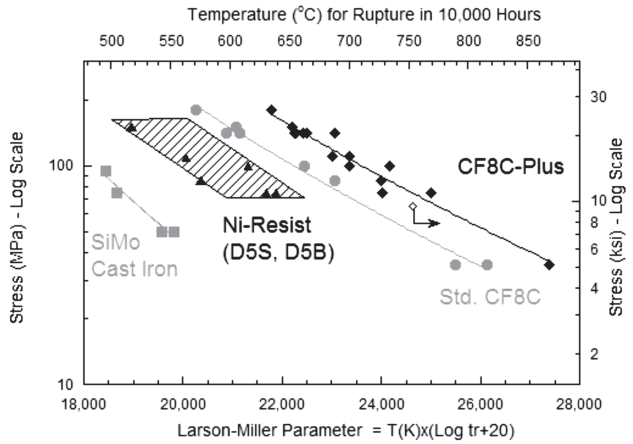

Fig. 2 Creep behavior as Larson-Miller Parameter compared to other alloys

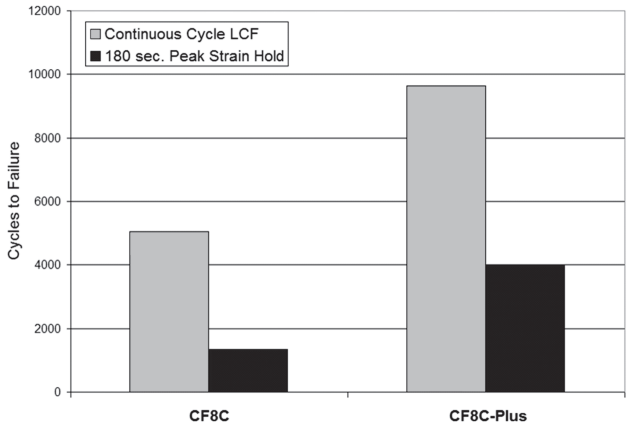

Fig. 3 Low-cycle fatigue behavior

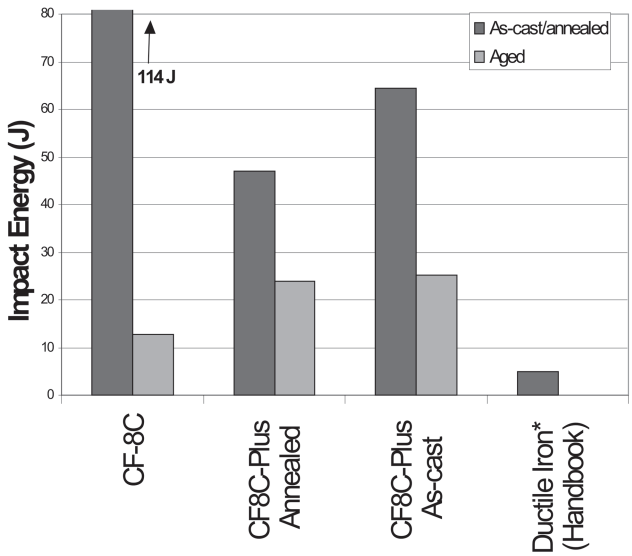

Fig. 4 V-notch impact energy

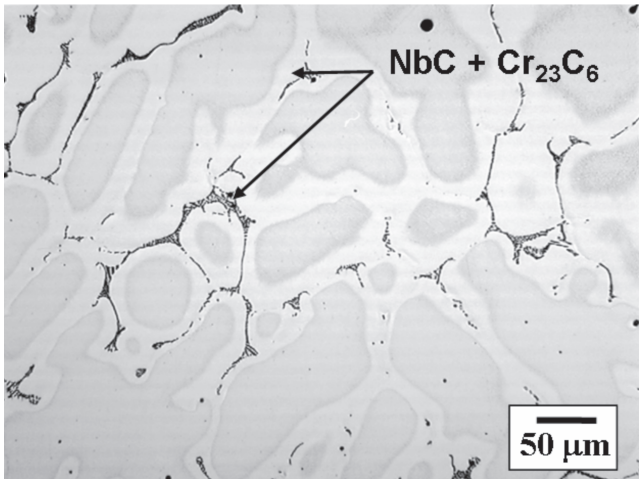

Fig. 5 Typical as-cast microstructure

with Inconel 117 filler are:

- Filler metal: ENiCrCoMo-1 (SMAW)
- Condition: As-welded
- Tensile strength: 621 MPa (90 ksi)
- Elongation: >20%
- Bend Test: Passed

Specification Equivalents:

ASTM A351 as HG10MnN

General Characteristics:

CF8C-Plus is a new grade of heat- and corrosion-resistant cast austenitic stainless steel, developed by the Oak Ridge National Laboratory (Oak Ridge, TN) and the Caterpillar Technical Center (Peoria, IL). CF8C-Plus cast stainless steel shows superior high-temperature mechanical properties; including tensile strength and ductility, creep resistance, fatigue behavior, and aging resistance relative to the standard grade of CF8C cast stainless steel. This new alloy also exhibits excellent castability for both thin and thick section application, and requires no postcasting heat treatment for best properties. CF8C-Plus steel has creep-rupture strength that compares well with nickel-base superalloys such as 617, which have much higher cost. CF8C-Plus exhibits excellent weldability and good weldment properties at room temperature with no need for postweld heat treatment.

Aging and Microstructure. CF8C-Plus is a fully austenitic stainless steel developed using an engineered microstructure approach. Standard CF8C contains delta ferrite that then rapidly transforms to sigma phase during service aging and causes a significant reduction in creep resistance and ambient ductility. By contrast, the microstructure in CF8C-Plus is fully austenitic in the as-cast condition, eliminating the ferrite-to-sigma phase transformation and improving aging response at high-temperature. High-temperature strength comes from stable nano-NbC dispersions within the grains.

Applications:

This steel has a broad range of applications including diesel and reciprocating engine exhaust components (turbocharger housings, manifolds), gas and steam turbine housings, and chemical/petrochemical piping. The first commercial application is the Caterpillar Regeneration System (CRS), for use on all Caterpillar heavy-duty diesel engines beginning in 2007. The CRS uses CF8C-Plus steel for the exhaust combustor housing, which demands resistance to creep, to severe thermal cycling, and to oxidation. CF8C-Plus stainless steel can replace cast irons, other weaker C grades of cast stainless steels, and other comparable or higher-alloy H-grade cast stainless that have less castability and as-cast ductility.

Producer:

For more technical information on CF8C-Plus stainless steel or licensing opportunities, contact M.J. Pollard at the Caterpillar Technical Center, phone (309) 578-2953 or P.J. Maziasz at the Oak Ridge National Laboratory, phone (865) 574-5082.

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