CARPENTER ELECTRIFICATION®

DATASHEET

CHROME CORE® 8-FM

Type analysis

Single figures are nominal except where noted

Iron	Balance	**Chromium**	7.50 to 8.50 %	**Silicon**	0.30 to 0.70 %
Manganese (Maximum)	0.20 to 0.70 %	**Molybdenum**	0.20 to 0.50 %	**Sulfur**	0.20 to 0.40 %
Carbon (Maximum)	0.03 %	**Phosphorus**	0.030 %		

Forms manufactured

Bar-Rounds	**Billet**	**Wire**	**Wire-Rod**

Description

Chrome Core 8-FM is in a family of controlled chemistry, chromium-iron alloys that are candidates for use in magnetic components where corrosion resistance superior to that of pure iron, low carbon steel, and silicon-iron alloys is desired without the substantial decrease in saturation induction associated with 18% Cr ferritic stainless steels.

Key Properties:

- Corrosion resistance
- Extended shelf life
- No protective coatings required

Markets:

- Automotive

Applications:

- Fuel injectors
- Fuel pump motor laminations
- ABS solenoids

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Corrosion resistance

Chrome Core 8-FM exhibited no noticeable rusting in 95°F (35°C) - 95% relative humidity tests and have demonstrated corrosion resistance generally similar to 18% chromium ferric stainless steel in certain simulated alcohol-base fuel environments.

Chrome Core alloys were evaluated along with comparison materials in environments designed to simulate or exceed the corrosive effects of some methanol fuels. These included boiling corrosive water (proprietary low-pH solution containing chlorides) and a mixture of 50% ethanol and 50% of this corrosive water at room temperature. As seen in the Corrosion Test Results - Simulated Fuel Environment chart, there was very light or no significant attack of the Chrome Core alloys. Silicon Core Iron "B-FM", a material widely used in less corrosive environments, experienced considerably greater attack than the other alloys listed in the table.

Chrome Core alloys and comparison materials were also evaluated in CM85A corrosive fuel mixture ("Gasoline/Methanol Mixtures of Materials Testing", SAE Cooperative Research Report, September 1990). This was composed of 15% gasoline and 85% aggressive methanol, which contained 0.1% distilled water, 3 ppm chloride ion (NaCl) and 60 ppm formic acid. All specimens were exposed without deaeration in an autoclave at 176°F (80°C) for 250 hours. The following table illustrates that Chrome Core 12 and Chrome Core 12-FM approached the resistance of Type 430F Solenoid Quality. All Chrome Core alloys were superior to Silicon Core Iron "B-FM". Apparently, this test provided an oxidizing chloride environment and was, therefore, more severe than many anticipated service applications.

A second autoclave test using the same solution was performed with the air evacuated and without the Silicon Core Iron "B-FM" specimens to reduce both oxygen and iron contamination. The Chrome Core alloys and Type 430F Solenoid Quality displayed good resistance (corrosion rates of 0.2 mdd or less) in spite of the increased test duration of 763 hours.

Like most ferritic stainless steels, Chrome Core 8-FM will rust in neutral salt spray (fog) testing, although the degree and severity of rusting is substantially less than for either iron, low carbon steel, or silicon-iron alloys.

For optimum corrosion resistance, surfaces must be free of scale and foreign particles. Passivation of Chrome Core 8-FM parts is not currently recommended due to the potential for strong attack by the passivation solutions.

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

Nitric Acid	Restricted	**Humidity**	Restricted

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CORROSION TEST RESULTS IN CM85A FUEL — CHROME CORE ALLOYS, TYPE 430F SOLENOID QUALITY AND SILICON CORE IRON "B-FM"

250 HOURS AT 176°F (80°C) AUTOCLAVE TESTS PERFORMED WITHOUT DEAERATION	
ALLOY	**AVERAGE CORROSION RATE, MDD**
Chrome Core 8	13.0
Chrome Core 8-FM	38.9
Chrome Core 12	3.0
Chrome Core 12-FM	3.1
Type 430F Solenoid Quality	0.2
Silicon Core Iron "B-FM"	84.3

mdd - milligrams per square decimeter per day used rather than mpy corrosion rate because pitting attack occurred.
Duplicate specimens cleaned in ASTM G1 procedure C.3.1 prior to final weighing.

CORROSION TEST RESULTS

SIMULATED FUEL ENVIRONMENT		
ALLOY	**CORROSION RATE, MPY[1]**	
	BOILING[2]	**ROOM TEMPERATURE[3]**
Chrome Core 8-FM	19.1/19.7	0.9/1.1
Chrome Core 12-FM	0.8/1.0	0.6/0.7
Type 430F Solenoid Quality	0/0	0.2/0.2
Silicon Core Iron "B-FM"	244/277	6.9/7.3

[1] mils per year of uniform attack in 24 hour test.
[2] Boiling corrosive water: proprietary low-pH solution containing chloride.
[3] 50% ethanol — 50% corrosive water mixture.

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Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	—	7.70	7.70
DENSITY	—	0.2780 lb/in^3	7695 kg/m^3
MEAN COEFFICIENT OF THERMAL EXPANSION	77 to 212°F (25 to 44.5°C)	6.2 x 10^{-6} length/length/°F	11.16 x 10^{-6} length/length/°C
	77 to 392°F (25 to 200°C)	6.00 x 10^{-6} length/length/°F	10.8 x 10^{-6} length/length/°C
	77 to 572°F (25 to 300°C)	6.2 x 10^{-6} length/length/°F	11.16 x 10^{-6} length/length/°C
	77 to 752°F (25 to 400°C)	6.4 x 10^{-6} length/length/°F	11.52 x 10^{-6} length/length/°C
	77 to 932°F (25 to 500°C)	6.7 x 10^{-6} length/length/°F	12.06 x 10^{-6} length/length/°C
	77 to 1112°F (25 to 600°C)	6.8 x 10^{-6} length/length/°F	12.24 x 10-6 length/length/°C
	77 to 1292°F (25 to 700°C)	7.00 x 10^{-6} length/length/°F	12.6 x 10^{-6} length/length/°C
MODULUS OF ELASTICITY (E)	—	29.0 x 10^3 ksi	—
ELECTRICAL RESISTIVITY	70°F (21°C)	295.0 ohm-cir-mil/ft	49.0 microohm·cm
CURIE TEMPERATURE	—	1380°F	749°C

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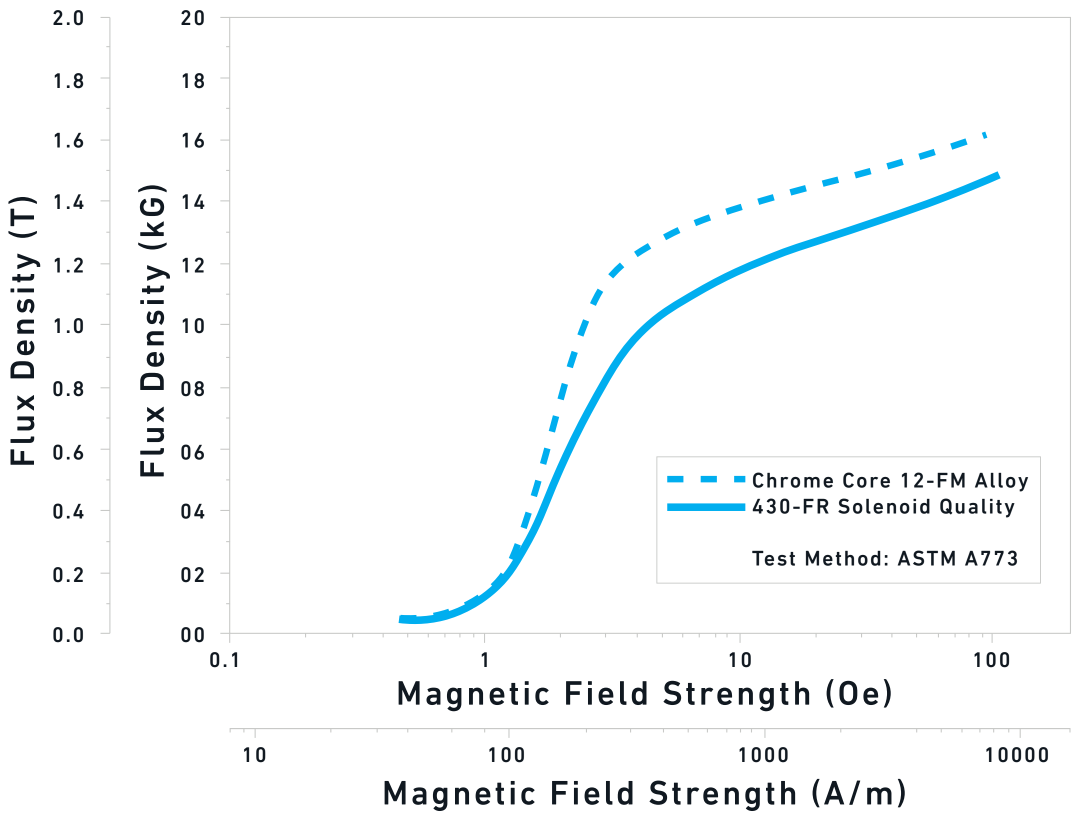
Magnetic properties

**DATA FOR FULLY ANNEALED 0.250-0.625 IN (6.35 TO 15.9 MM) DIAMETER BARS
TESTED ON A FAHY PERMEAMETER PER ASTM METHOD A 341**

TYPICAL DC NORMAL INDUCTION CURVES FOR BAR PRODUCT — CHROME CORE 12-FM VS. 430FR STAINLESS



SATURATION FLUX DENSITY (Bs)	18600 G	18.6 kG
COERCIVITY	2.50 Oe	
MAGNETIC PERMEABILITY	3100	
RESIDUAL INDUCTION	13800 G	13.8 kG

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Typical mechanical properties

CHROME CORE ALLOYS								
HEAT TREATMENT	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION 2 IN (50 MM)	REDUCTION OF AREA	HARDNESS
	ksi	MPa	ksi	MPa	%	%	HRB
Annealed for optimum magnetic properties	33	228	61	421	40	73	73

Heat treatment

Annealing	Due to the relatively low chromium content, Chrome Core 8-FM will form austenite if heated to too high temperature, and some hardening will occur if the austentized part is rapidly cooled. Consequently, the best heat treatment for improved soft magnetic properties is to subcritical anneal. Anneal at a temperature of 780°C +/-14°C (1436°F +/-25°F) for 2 to 4 hours. The cooling rate after the anneal is not critical, although rapid cooling and quenching may induce stresses that impair the magnetic characteristics. Any inert annealing atmosphere such as vacuum, inert gases, or dry forming gas is satisfactory. Attempts to decarburize the alloy using a wet hydrogen atmosphere are not recommended.
Hardening	Similar heat-treating practices can be used to soften the alloy for further forming.

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Workability

Cold working	Chrome Core 8-FM will withstand less cold working than the non-free machining version and is not recommended for parts produced by large amounts of cold deformation.
Machinability	Following are typical feeds and speeds for Chrome Core 8-FM alloy.

Typical feeds and speeds

The speeds and feeds in the following charts are conservative recommendations for initial setup. Higher speeds and feeds may be attainable depending on machining environment.

TURNING — SINGLE-POINT AND BOX TOOLS

DEPTH OF CUT, IN	HIGH-SPEED TOOLS			CARBIDE TOOLS			
	SPEED, FPM	FEED, IPR	TOOL MATERIAL	SPEED, FPM		FEED, IPR	TOOL MATERIAL
				BRAZED	THROW AWAY		
.150	165	.015	M-2	575	750	.015	C-6
.025	185	.007	M-3	650	850	.007	C-7

TURNING — CUT-OFF AND FORM TOOLS

SPEED, FPM	FEED, IPR							TOOL MATERIAL	
	CUT-OFF TOOL WIDTH, IN			FORM TOOL WIDTH, IN				HIGH-SPEED TOOLS	CARBIDE TOOLS
	1/16	*1/8*	*1/4*	*1/2*	*1*	*1-1/2*	*2*		
150	.0015	.002	.0025	.0025	.002	.0015	.001	M-2	—
400	.004	.0055	.007	.005	.004	.0035	.0035	—	C-6

ROUGH REAMING

SPEED, FPM	FEED, IPR OR REAMER DIAMETER, IN						TOOL MATERIAL	
	1/8	*1/4*	*1/2*	*1*	*1-1/2*	*2*	HIGH-SPEED TOOLS	CARBIDE TOOLS
130	.005	.008	.013	.0.18	.022	.025	M-7	—
150	.005	.008	.013	.018	.022	.025	—	C-2

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DRILLING — HIGH-SPEED TOOLS

SPEED, FPM	FEED, IPR — NOMINAL HOLE DIAMETER, IN								TOOL MATERIAL
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
100-150	.001	.003	.006	.010	.014	.017	.021	.025	M-1, M-10

DIE THREADING

SPEED, FPM				TOOL MATERIAL
7 OR LESS	8 TO 15	16 TO 24	25 AND UP, TPI	
15-25	30-40	40-50	50-60	M-1, M-2, M-7, M-10

MILLING — END PERIPHERAL

DEPTH OF CUT, IN	HIGH-SPEED TOOLS						CARBIDE TOOLS					
	SPEED, FPM	FEED, IN PER TOOTH — CUTTER DIAMETER, IN				TOOL MATERIAL	SPEED, FPM	FEED, IN PER TOOTH — CUTTER DIAMETER, IN				TOOL MATERIAL
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.050	140	.002	.002	.004	.005	M-2, M-7	400	.001	.002	.005	.007	C-6

BROACHING — HIGH-SPEED TOOLS

SPEED, FPM	CHIP LOAD, IPT	TOOL MATERIAL
30	.004	M-2, M-7

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Additional machinability notes

When using carbide tools, the surface speed can be increased between 2 and 3 times over the high-speed suggestions. Feeds can be increased between 50 and 100%.

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/or feeds should be increased or decreased in small steps.

Other information

Weldability	Chrome Core 8-FM is not recommended for welding

For additional information, please contact your nearest sales office:
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