CARPENTER ELECTRIFICATION®

DATASHEET

430F SOLENOID QUALITY STAINLESS

Type analysis

Single figures are nominal except where noted

Iron	Balance	**Chromium**	17.25 to 18.25 %	**Manganese (Maximum)**	0.80 %
Nickel (Maximum)	0.60 %	**Molybdenum (Maximum)**	0.50 %	**Silicon**	0.30 to 0.70 %
Sulfur	0.250 to 0.400 %	**Carbon (Maximum)**	0.07 %	**Phosphorus (Maximum)**	0.030 %

Forms manufactured

Bar-Rounds	**Bar**	
Billet	Hot rolled	Cold drawn
Wire	Centerless ground	Unannealed — Rockwell B 92 min.
	Precision ground	Annealed - Rockwell B 82/91 0.375 in (9.53 mm) min.

Description

430F Solenoid Quality Stainless is a ferritic chromium-iron stainless alloy, the chemical composition and processing of which are controlled within precise limits to assure consistently high magnetic permeability, low coercive force (Hc) and low residual induction (Br), while offering corrosion resistance similar to that of standard 430F Stainless.

This material can be supplied in both the annealed and unannealed conditions.

Key Properties:

- High magnetic permeability
- Low coercive force
- Low residual induction
- Corrosion resistance

Markets:

- Aerospace
- Automotive
- Consumer
- Industrial

Applications:

- Soft magnetic components that must operate in corrosive environments

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Unannealed	430F Solenoid Quality Stainless bar products can be supplied in the cold drawn unannealed condition to a hardness of Rockwell B 92 minimum. This condition is suggested where better machinability is desired and parts will be annealed after machining for improvement of soft magnetic properties.
Mill annealed	Two specific mill annealed conditions are available and should be considered for applications where the machined parts will not be annealed to further improve magnetic properties. One condition is manufactured to a hardness range of Rockwell B 75/82 and exhibits the most magnetically soft properties having highest maximum permeability, lowest coercive force (HC), and lowest residual induction. The second condition is manufactured to a hardness range of Rockwell B 82/91 with properties that are not as magnetically soft. The machinability of this material has been found to be suitable for automatic screw machines and other machining operations. Machinability is sacrificed to some degree when compared to material in the unannealed condition. Annealed centerless ground bar manufactured to standard tolerances is available in sizes .375" (9.53 mm) diameter and above in each of the previously described annealed conditions. Annealed precision ground bar is available only in the Rockwell B 82/91 hardness range in sizes .375" (9.53 mm) diameter and above.

Corrosion resistance

Type 430F Solenoid Quality Stainless displays resistance to corrosive environments such as atmosphere, fresh water, foodstuffs, nitric acid, and dairy products.

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or passivation should be considered.

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

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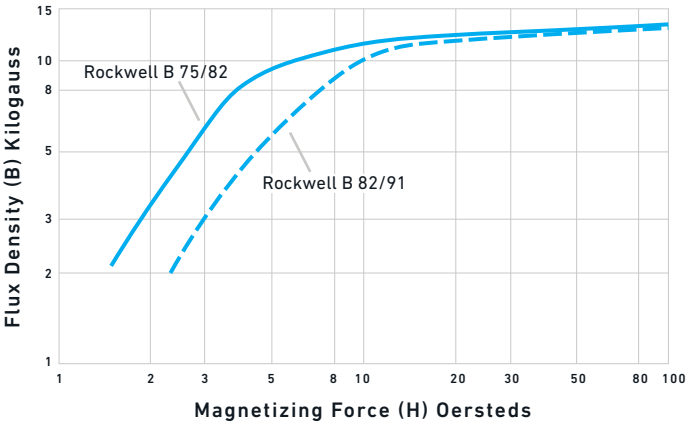
Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	—	7.62	7.62
DENSITY	—	0.2750 lb/in^3	7612 kg/m^3
MEAN SPECIFIC HEAT	32 to 212°F (0 to 100°C)	0.1100 Btu/lb/°F	460.24 kJ/kg/°C
MEAN COEFFICIENT OF THERMAL EXPANSION	32 to 1200°F (0 to 649°C)	6.60 x 10^{-6} length/length/°F	12.996 length/length/°C
ELECTRICAL RESISTIVITY	70°F (21°C)	361.0 ohm-cir-mil/ft	60 microohm·cm
CURIE TEMPERATURE	—	1240°F	671°C

Magnetic properties

SATURATION FLUX DENSITY (Bs)	15600 G	15.6 kG

DC MAGNETIZATION PROPERTIES — MILL ANNEALED BAR — .375/.625 IN (9.53/31.75 MM) DIAMETER



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Typical direct current magnetic properties

ASTM A341 METHOD[1]						
CONDITION	ROCKWELL B HARDNESS MID-RADIUS	MAXIMUM RELATIVE PERMEABILITY	FROM 10,000 Gauss (1 Tesla)			
			COERCIVITY Hc (Oe)	COERCIVITY Hc (A/m)	REMANENCE Br (G)	REMANENCE Br (T)
Unannealed	92 min	300/500	5.0/7.0	400/560	4000/8500	0.4/0.85
Mill annealed PG	82/91	400/700	4.5/6.0	360/480	3000/8500	0.3/0.85
Mill annealed CG	82/91	500/1100	3.0/5.0	240/400	2000/8500	0.2/0.85
Mill annealed CG	75/82	1100/2400	1.5/2.5	120/200	2000/8500	0.2/0.85
Full anneal[2]	72/80	1100/2400	1.5/2.5	120/200	2000/8500	0.2/0.85

[1] ASTM A341 method covers straight length DC magnetic testing of bars. Mill annealed bars .375 to 1.250 in. (9.35 to 31.75 mm) diameter generally exhibit higher permeability, lower Hc and higher Br values as the bar diameter decreases from 1.25 to .375 in. (31.76 to 9.35 mm) within the permeability Hc and Br ranges shown. The variation in Br is primarily a function of the test method rather than material variability. Bars larger than 1.250 in. (31.75 mm) diameter are tested using machined ring specimens and ASTM A596 or ASTM A773 method of test.

[2] Annealed for 2 hours at 1550°F (845°C) in dry hydrogen and cooled nominally at 100°F (55°C) per hour to below 800°F (427°C).

Typical mechanical properties

TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES.

1 IN (25.4 MM) DIAMETER BAR								
HEAT TREATMENT	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 2 IN (50.8 MM)	REDUCTION OF AREA	HARDNESS	
	ksi	MPa	ksi	MPa	%	%	BRINELL	ROCKWELL B
Mill annealed	45	310	75	517	20	60	150	82
Hydrogen annealed	40	276	70	483	20	60	145	78

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Heat treatment

Annealing	**Annealing for magnetic properties** Anneal at 1450/1550°F (788/843°C) for 2 hours, then cool at a rate of 100°F (56°C) per hour to 800°F (427°C). Dry hydrogen or vacuum atmosphere is suggested to prevent oxidation. **Annealing to soften** Heat uniformly to 1250/1400°F (677/760°C), then cool in air. Brinell hardness will be approximately 170.
Hardening	Type 430F Solenoid Quality Stainless does not respond significantly to hardening by heat treatment. Heating to a temperature above 1700°F (927°C) and cooling at a rate equivalent to an air cool or faster will increase hardness to Rockwell B 95/C 22 and will impart less magnetically soft properties than the unannealed product.

Workability

Forging	Type 430F Solenoid Quality Stainless should be heated uniformly to 1500/1600°F (816/871°C), then taken to the forging temperature of 1950/2100°F (1066/1149°C) as rapidly as possible. Do not soak at the forging temperature, as this may result in excessive grain growth. Hot working operations should not be continued when the temperature has dropped below 1500°F (816°C). Forgings should be air cooled.
Cold working	This alloy will withstand moderate cold work but is not recommended for cold upsetting. The primary application for this material is in magnetic components that are machined to shape.
Machinability	Type 430F Solenoid Quality Stainless cuts freely in automatic screw machines. In turning operations, it machines at speeds of about 150 sfpm when cut with high-speed tool steels.

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Typical feeds and speeds

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	160	.015	M-2	525	600	.015	C-6
.025	175	.007	M-3	575	650	.007	C-7

TURNING — CUT-OFF AND FORM TOOLS

SPEED, FPM	FEED, IPR							TOOL MATERIAL
	CUT-OFF TOOL WIDTH, IN			FORM TOOL WIDTH, IN				
	1/16	1/8	1/4	1/2	1	1-1/2	2	
150	.002	.0025	.003	.0025	.002	.0015	.001	M-2
350	.004	.0055	.007	.005	.004	.0035	.0035	C-6

DRILLING

SPEED, FPM	FEED, IPR								TOOL MATERIAL
	NOMINAL HOLE DIAMETER, IN								
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
160	.001	.003	.006	.010	.014	.017	.021	.025	M-1, M-10

TAPPING

SPEED, FPM	TOOL MATERIAL
35-40	M-1, M-7, M-10

MILLING — END PERIPHERAL

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

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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 or feeds should be increased or decreased in small steps.

Weldability

Type 430F Solenoid Quality Stainless is generally not recommended for welding. Its high sulfur content may cause hot cracking and, when welded to a stainless steel with lower sulfur content, may cause the weld to shift off center.

In the event the alloy must be welded, the use of a filler metal, along with minimum heat inputs and minimum base metal dilution, will improve the chances of success.

AWS E/ER 430 welding consumables should be considered; however, the weldments should be post-weld annealed to restore the ductility in the weld metal and heat-affected zones.

The use of austenitic weld metals like E/ER 309 should provide welds of good ductility. Note that xj1

this case, the heat-affected zone may have limited ductility unless the weldment is given a post-weld anneal.

The use of an austenitic weld metal will significantly alter the magnetic characteristics of the weldment.

Other information

Applicable specifications	ASTM A838 Alloy 1, "Free Machining Ferritic Stainless Soft Magnetic Alloys for Relay Applications." ASTM A838 Alloy 1

For additional information, please contact your nearest sales office:
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