

# 430FR

## Technical Data Sheet

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### Chemistry

Comparable Standard:

Analysis %	C	Si	Mn	P	S	Cr	Ni
Min.		1.00			0.25	17.25	
Max.	0.065	1.50	0.80	0.030	0.40	18.25	0.60
	<b>Mo</b>						
Min.							
Max.	0.50						

### Description

- Ugitech's **430FR** is a ferritic stainless steel designed for soft magnetic components operating in corrosive environments. The 17.00% - 18.00% chromium makes corrosion resistance similar to 430F. The increased silicon content in this alloy allows increased magnetic characteristics over 430F in the annealed condition.
- 430FR** has exhibited superior and consistent performance due to its higher electrical resistivity. The alloy was developed for applications that require a weak coercive magnetic force ( $H_c = 1.88 - 3.00$  Oe [ $150 - 240$  A/m]) as needed in solenoid valves. Our controlled processing allows magnetic properties to be typically superior to industry norms. 430FR has an increased hardness over 430F, due to the increased silicon levels, reducing the deformation that occurs during the oscillation impacts that occur in AC and DC solenoid valves.
- Ugitech's **430FR** is chemically balanced to provide superior machinability and deliver heat to heat consistency that is unsurpassed in the industry. Once an optimum machining setup has been established, machinists can take advantage of increased machining efficiency rates (run "lights-out" production).

### Classification

Free Machining Ferritic stainless steel (400 Series).

### Characteristics

- ASTM A838 Alloy 2
- EN 10088-3  
1.4105  
X6CrMoS17

### Applications

- Solenoid Valves
- Injectors

### Available Forms

- SMQ™ Cold drawn bars, Turned bars, Ground bars
- Magnetically annealed, mill annealed, as drawn

Please inquire for additional information on available forms.

### Mechanical Properties (Typical)

Magnetically Annealed (Grade 1)	
Tensile Strength	65 - 80 ksi (450-550 MPa)
Yield Strength(0.2)	45 - 65 ksi (320-450 MPa)
Elongation	25% Minimum
Reduction of Area	40% Minimum
Hardness	80 - 88 HRb (149 - 177 BHN)

### Typical Physical Properties (Typical)

Density:	0.274 lbs/in <sup>3</sup> (7.59 g/cm <sup>3</sup> )
Mean Coefficient of Linear Expansion:	68-392 °F (20-200 °C) = 6.0 x 10 <sup>-6</sup> in/in/°F (10.8 x 10 <sup>-6</sup> cm/cm/°C)
Modulus of Elasticity in Tension:	29.7 x 10 <sup>6</sup> psi (205,000 MPa)
Thermal Conductivity:	14.4 Btu/ft/hr/°F (25.1 W/m/°C) @68°F (20°C)

### Magnetic and Electrical Properties

#### Typical Magnetic Permeability:

Magnetic annealed and ground bars

Relative Permeability ( $\mu$ )	- 1200 - 2200
Coercive Magnetic Field intensity ( $H_c$ )	- 1.88 - 3.00 Oe (150 - 240 A/m)
Residual Flux Density ( $B_r$ )	- 3000 - 7500 G (0.30 - 0.75 G)
Saturation Flux Density ( $B_s$ )	- 16,000 G (1.6 T)

#### Typical delivered magnetic properties:

Magnetic annealed and ground bars

Relative Permeability ( $\mu$ )	- 2100
Coercive Magnetic Field intensity ( $H_c$ )	- 2.3 Oe (183 A/m)
Residual Flux Density ( $B_r$ )	- 6700 G (0.67 G)

#### Standards for the measurement of magnetic values:

- IEC 404-4 Closed circuit measurement method (Permeameter)
- IEC 404-7 open circuit method (Coercimeter)

Note - Magnetic values and complete hysteresis curve available upon request

### Forging (Hot Working)

Ugitech's **430FR** is very workable at elevated temperatures. The alloy is softer and more ductile than austenitic alloys and will shape with relatively little force. The high ductility of the alloy allows thin section parts to be readily obtained. Hot forging may be done by uniformly heating between 750°C/1200°C (1382°F/2192°F). No special cooling precautions are needed. Forgings may be air cooled.

Caution: Extended soak times at forging temperatures can promote grain growth.

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### Corrosion Resistance

#### General Corrosion

430FR has very good corrosion resistance in fresh water, gaseous environments, acid environments of average severity and environments with a low degree of chlorine. Surfaces must be free of all contaminants and dirt to insure maximum corrosion resistance.

The corrosion resistance of a stainless steel depends on many factors related to the composition of the corrosive environment, pH, temperature, velocity, agitation, crevices, deposits, dissimilar metal contact, metallurgical condition, as well as the preparation of the surface. The table here is for comparative purposes only and illustrates the performance in different environments.

Optimum corrosion resistance is achieved on smooth, clean surfaces, free from particulate matter such as machining oils, dirt and foreign particles. Under these conditions, parts will become passive in air. Should passivation be required, one of the following treatment should be followed:

#### Nitric Acid Passivation









- Clean and degrease in 5% solution of sodium hydroxide at 160/180°F (70/\*82°C) for 30 minutes.
- Water Rinse.
- Passivate in a 20% nitric acid solution plus 3 oz./gal (22 g/l) sodium dichromate at 124/140°F (50/60°C) for 30 minutes
- Water rise.
- Neutralize in a 5% solution of sodium hydroxide at 160/180°F (70/\*82°C) for 30 minutes.
- Water rinse.
- Dry.

#### Citric Acid Passivation

- Clean and degrease.
- Water rinse.
- Passivate in a 10% solution of citric acid at room temperature for 30 minutes.
- Water rinse
- Dry

### General Note

All statements regarding the properties or utilization of the materials or products mentioned are for the purposes of description only. Guarantees regarding the existence of certain properties or a certain utilization are only valid if agreed upon in writing.

Environment	Behavior
Nitric Acid	RESTRICTED
Humidity	   
Phosphoric Acid	RESTRICTED
NaCl (Saline Mist)	RESTRICTED
Sulfuric Acid	RESTRICTED
Seawater	RESTRICTED
Acetic Acid	RESTRICTED
Petroleum	RESTRICTED
Sodium Carbonate	   

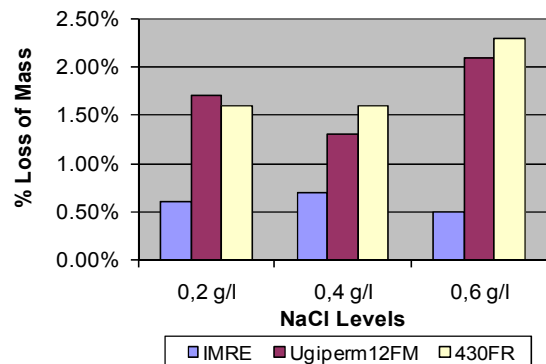
It is important to note, maintaining corrosion resistance at weld zones will require cleaning and passivation.

#### SAE CM85A fuel Testing

430FR has been evaluated in CM85A corrosive fuel mixture tests based on the SAE Cooperative Research Report dated September 1990. The behavior of materials in gasoline mixtures depends on the origin of the fuel and the refining process, thus corrosion studies and comparisons are not possible due to the many fuels possible. Based on the SAE study, a fuel mixture, CM85A, was developed to allow corrosion resistance testing. The fuel mixture is made up of 850 ml aggressive methanol, 75 ml isooctane, and 75 ml Toluene, 1 ml distilled water, 0.005 g sodium chloride (3 ppm), and 0.05 ml formic acid (60ppm).

Testing was performed at three different chlorine levels: 0.2 g/l, 0.4 g/l, and 0.6 g/liter. The samples were placed partially in the solutions which increases the potential for corrosive attack at the point of immersion. The test was cyclical, placing the sample in the solution for two days, out of the solution for one day, and so on, with the solution being replaced weekly to avoid variation in solution concentrations.

**SAE CM85A Fuel Test at Varying Chlorine Levels**  
Test Temp-60C, Duration 500 Hours



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### Heat Treatment

#### Annealing for magnetic properties

Uniformly heat at 840°C/1000°C (1540°F/1830°F) for 2 hours, then cool to 500°C (930°F) at a rate of 50°C (120°F) per hour. This cycle should be done in a dry hydrogen or vacuum atmosphere to prevent oxidation.

For optimum magnetic properties, heat 900°C +/- for 2 hours then cool to 500°C (930°F) at a rate of 50°C (120°F) per hour.

#### Annealing for softening

Uniformly heat 700°C/800°C (1292°F/1472°F) for 1 hour maximum. Air cool.

### Hardenability (Cold Working)

430FR will withstand moderate amounts of cold work. It is not recommended that the parts be cold headed. Because the main application of the material is magnetic properties, the parts will need to be magnetically annealed before use.

### Welding

Welding is not recommended for this grade. If welding is unavoidable, contact the Corporate Office technical support at 800-323-1233 for advice.

If the welding is to be considered, the use of a filler material, minimum heat inputs and minimal base metal dilution, will improve the chances of success.

AWS E/ER430 welding products should be considered, however, post-weld annealing of the weldments should be performed to restore the weld metal ductility and ductility in the heat affected zones.

Good weld ductility has been obtained from the use of austenitic weld metals, such as E/ER309. However, limited ductility in the heat affected zone may occur unless a post-weld anneal is done to the weldments. One caution—the use of an austenitic weld metals will significantly alter the magnetic characteristics of the weldments.

### Machinability

430FR is a highly machineable alloy. The feeds and speeds on the following table are suggested starting points. It is not recommended to machine below the minimum speed and feed values, as it will result in discouraging results.

### Machinability Table Guidelines

1. The table values are initial suggestions and can vary depending on machine and cutting conditions.
2. The use of coated tools increases the tool life by 20% to 50% using the same cutting parameters, or it increases the cutting conditions (speed) by 10% to 15% with similar tool wear.
3. Tooling grades in parenthesis denotes alternate tool material choice.
4. Drill speeds were developed using 118° included angle drills. Increase speeds 10-20% with the use of 130° to 140° angle drills.
5. Drill cutting conditions are valid for hole depths up to 4 times diameter.
6. Machining speeds and feeds apply to highly rigid equipment. Reductions may be necessary on cross slide operations or less rigid equipment.
7. When using C1, C2 or C3 carbides, reduce speeds by 15 - 30%.
8. Care should be taken when machining 430FR in the fully annealed condition. The cold work induced during machining will reduce the magnetic properties in the part and depending on the magnetic requirements, may require further annealing.

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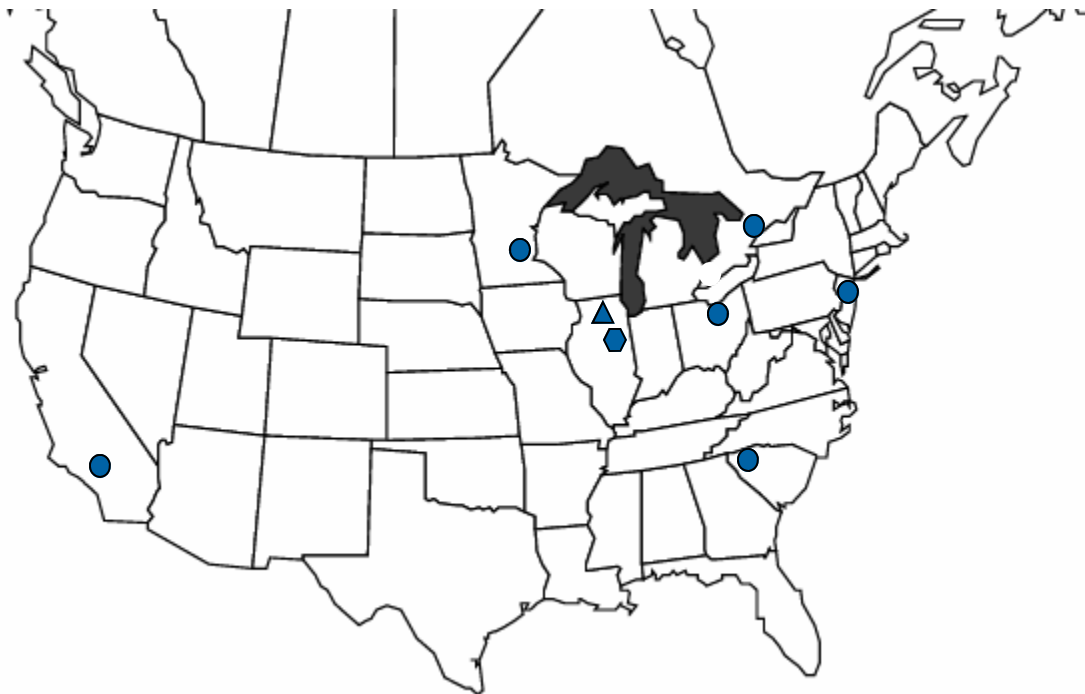


Machining Operation	Metallurgical Condition	Depth of cut Or width (inches)	HSS Tooling			Coated Carbide Tools		
			Cutting Speed SFPM	Feed (ipr)	Type of Tool	Cutting Speed SFPM	Feed (ipr)	Type of Tool
Turning	Cold Drawn	0.04 0.08 0.12	105 - 160 95 - 160 85 - 145	0.003 - 0.008 0.003 - 0.010 0.004 - 0.012	M2—M3 (T15)	345 - 950 325 - 900 305 - 845	0.005 - 0.008 0.006 - 0.010 0.006 - 0.012	C7 C6 C6
	Annealed	0.04 0.08 0.12	145 - 200 131 - 185 105 - 160	0.003 - 0.008 0.003 - 0.010 0.004 - 0.012		395 - 1200 360 - 1125 325 - 990	0.005 - 0.008 0.006 - 0.010 0.006 - 0.012	C7 C6 C6
Forming & Grooving	Cold Drawn	0.08 0.25 0.50 1.00 2.00	125 - 165 105 - 145 85 - 125 85 - 110 79 - 90	0.001 - 0.003 0.003 - 0.005 0.002 - 0.004 0.002 - 0.003 0.002 - 0.003	M2—M3 (T15)	245 - 530 230 - 490 180 - 425 160 - 300 130 - 215	0.002 - 0.003 0.003 - 0.004 0.003 - 0.004 0.002 - 0.003 0.002 - 0.003	C6 C6 C6 C6 C6
	Annealed	0.08 0.25 0.50 1.00 2.00	145 - 200 125 - 165 105 - 150 105 - 150 85 - 110	0.002 - 0.004 0.003 - 0.005 0.002 - 0.005 0.002 - 0.004 0.002 - 0.003		260 - 560 245 - 520 210 - 455 180 - 330 145 - 230	0.002 - 0.004 0.002 - 0.004 0.002 - 0.004 0.002 - 0.003 0.002 - 0.003	C6 C6 C6 C6 C6
Shaving & Skiving	Cold Drawn	0.08 0.25 0.50 1.00 2.00	105 - 150 85 - 125 85 - 125 70 - 110 70 - 110	0.001 - 0.003 0.001 - 0.0025 0.001 - 0.002 0.001 - 0.002 0.001 - 0.002	M2—M3 (T15)	245 - 530 230 - 490 180 - 425 160 - 300 130 - 215	0.002 - 0.003 0.003 - 0.004 0.002 - 0.004 0.002 - 0.003 0.002 - 0.003	C6 C6 C6 C6 C6
	Annealed	0.08 0.25 0.50 1.00 2.00	125 - 165 105 - 145 105 - 145 85 - 125 85 - 125	0.001 - 0.003 0.001 - 0.0025 0.001 - 0.002 0.001 - 0.002 0.001 - 0.002		260 - 560 245 - 520 210 - 455 180 - 330 145 - 230	0.002 - 0.004 0.002 - 0.004 0.002 - 0.004 0.002 - 0.003 0.002 - 0.003	C6 C6 C6 C6 C6
Cut-Off or Part-Off	Cold Drawn	0.04 0.08 0.12	105 - 125 105 - 125 85 - 110	0.001 - 0.002 0.001 - 0.0025 0.0015 - 0.003	M42 (T15)	245 - 350 230 - 325 210 - 300	0.002 - 0.003 0.002 - 0.003 0.002 - 0.003	C6 C6 C6
	Annealed	0.04 0.12 0.25	125 - 145 125 - 145 85 - 125	0.001 - 0.0025 0.0015 - 0.003 0.002 - 0.004		260 - 365 230 - 335 210 - 300	0.002 - 0.003 0.002 - 0.003 0.003 - 0.004	C6 C6 C6
Drilling	All	0.063 0.125 0.250 0.500 0.750	70 - 100 75 - 105 85 - 120 90 - 135 95 - 150	0.0005 - 0.002 0.002 - 0.004 0.003 - 0.006 0.005 - 0.009 0.008 - 0.012	M2	50 - 100 75 - 225 105 - 325 135 - 450 195 - 530	0.0005 - 0.002 0.002 - 0.004 0.002 - 0.005 0.004 - 0.006 0.006 - 0.009	C5 - C6 or C1 - C2 TiN coated
Insert Drilling	All	0.50—0.75 0.75—1.00 1.00—2.50				200 - 550 230 - 580 260 - 620	0.001 - 0.004 0.002 - 0.005 0.002 - 0.006	C7 C6 C5
Reaming	All	0.063 0.125 0.250 0.500 0.750 1.000	70 - 100 75 - 105 85 - 120 90 - 135 95 - 150 95 - 150	0.002 - 0.005 0.004 - 0.008 0.007 - 0.016 0.015 - 0.025 0.015 - 0.030 0.020 - 0.030	M2 (M42)	50 - 100 75 - 225 105 - 325 135 - 450 195 - 530 205 - 530	0.002 - 0.005 0.004 - 0.008 0.007 - 0.016 0.015 - 0.025 0.015 - 0.030 0.020 - 0.030	C5 - C6 Or C3 TiN Coated
Tapping	All	All	20—80		M2-M7 TiN Coated			

The data presented within all tables and graphs represent typical working ranges based on field and laboratory research. Results will vary based on parts to be produced, equipment and tooling utilized, personnel operating the equipment and customer part specifications. For additional information, contact Technical Support at the Corporate Office: (800) 323-1233.



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