CARPENTER TECHNOLOGY

DATASHEET

22CR-13NI-5MN

Applicable specifications: AMS 5764, 5861; ASTM A240, A276, A412, A479, A580, F1314

Associated identifiers: Nitronic 50[1], UNS S20910, XM-19

Type analysis

Single figures are nominal except where noted.

Iron	Balance	**Chromium**	20.50–23.50 %	**Nickel**	11.50–13.50 %
Manganese	4.00–6.00 %	**Molybdenum**	1.50–3.00 %	**Silicon**	Max 1.00 %
Nitrogen	0.20–0.40 %	**Columbium/Niobium**	0.10–0.30 %	**Vanadium**	0.10–0.30 %
Carbon	Max 0.060 %	**Phosphorus**	Max 0.040 %	**Sulfur**	Max 0.030 %

Forms manufactured

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

Description

22CR-13Ni-Mn is a nitrogen-strengthened austenitic stainless steel that provides very good corrosion resistance in combination with high strength. The alloy has better corrosion resistance than Type 316 with approximately twice the yield strength. It can be welded, machined, and cold worked using the same equipment and methods used for the conventional 300 series stainless steels. It remains nonmagnetic after severe cold work.

The alloy has an excellent combination of strength, ductility, toughness, corrosion resistance, and fabricability. Additionally, the alloy has good toughness at cryogenic temperatures and relatively high tensile and yield strengths at moderately high elevated temperatures. These properties further increase the versatility and usefulness of the alloy.

Key Properties:

- High strength and toughness
- Superior corrosion resistance
- Good ductility and fabricability

Markets:

- Automotive
- Industrial
- Consumer

Applications:

- Valve shafts, taper pins
- Fasteners, cables, chains, screens, springs
- Marine components
- Chemical equipment components

[1] *Nitronic 50 is a trademark of Cleveland Cliffs.*

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Corrosion resistance

22Cr-13Ni-5Mn has very good corrosion resistance in many reducing and oxidizing acids, chlorides, and pitting environments. In particular, the alloy provides an excellent level of resistance to pitting and crevice corrosion in sea water; tests have shown it to be completely unaffected after 9 months in quiet sea water. Resistance to intergranular attack in boiling 65% nitric acid and in ferric sulfate-sulfuric acid (ASTM A262, practices B and C) is excellent for both the annealed and sensitized conditions. Like other austenitic stainless steels, 22Cr-13Ni-5Mn, under certain conditions, may stress-corrosion crack in hot chloride environments.

The alloy also demonstrates good resistance to sulfide stress cracking at ambient temperatures. It is included in NACE MR-01-75, "Sulfide Stress Corrosion Cracking Resistant Metallic Materials for Oil Field Equipment" at a maximum hardness of Rockwell C 35. Refer to the current document for details on acceptable conditions.

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	Excellent	**Sulfuric Acid**	Moderate
Phosphoric Acid	Moderate	**Acetic Acid**	Good
Sodium Hydroxide	Moderate	**Salt Spray (NaCl)**	Excellent
Sea Water	Moderate	**Sour Oil/Gas**	Moderate
Humidity	Excellent		

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Corrosion resistance (continued)

TYPICAL CORROSION PROPERTIES — ANNEALED CONDITION

ENVIRONMENT	TIME OF TEST	AVERAGE CORROSION RATE	
		22Cr-13Ni-5Mn	TYPE 316
10 w/o formic acid boiling	3 periods, 48 hours each	2.3 mpy	19.3 mpy
50 w/o aceticic acid boiling	3 periods, 48 hours each	0.1 mpy	0.1 mpy
20 w/o HNO_3 at 200°F (93°C)	3 periods, 48 hours each	0.3 mpy	0.8 mpy
5 w/o H_2SO_4 at 176°F (80°C)	3 periods , 48 hours each	0.2 mpy	33 mpy
10 w/o H_2SO_4 at 176°F (80°C)	3 periods, 48 hours each	15 mpy	112 mpy
10 w/o $FeCl_3$ at RT	10 days	0.002 g[1]	1.1 g[1]
5w/o NaCL spray at 95°F (35°C)	200 hours	superior to Type 316[2]	

[1] *Total weight lost for specimen 0.095 x 1 x 2 in. (2.41 x 25.4 x 50.8 mm).*
[2] *Based on the amount of rusting.*

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Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	—	7.88	7.88
DENSITY	—	0.2850 lb/in^3	
MEAN SPECIFIC HEAT	32 to 212°F (0 to 100°C)	0.1200 Btu/lb/°F	
MEAN COEFFICIENT OF THERMAL EXPANSION (CTE)	70 to 200°F (21 to 93°C)	9.0 x 10^{-6} length/length/°F	16.2 x 10^{-6} length/length/K
	70 to 400°F (21 to 204°C)	9.2 x 10^{-6} length/length/°F	16.6x 10^{-6} length/length/K
	70 to 600°F (21 to 316°C)	9.6 x 10^{-6} length/length/°F	17.3 x 10^{-6} length/length/K
	70 to 800°F (21 to 427°C)	9.9 x 10^{-6} length/length/°F	17.8 x 10^{-6} length/length/K
	70 to 1000°F (21 to 538°C)	10.2 x 10^{-6} length/length/°F	18.4 x 10^{-6} length/length/K
	70 to 1200°F (21 to 649°C)	10.5 x 10^{-6} length/length/°F	18.9 x 10^{-6} length/length/K
	70 to 1400°F (21 to 760°C)	10.8 x 10^{-6} length/length/°F	19.4 x 10^{-6} length/length/K
	70 to 1600°F (21 to 871°C)	11.1 x 10^{-6} length/length/°F	20.0 x 10^{-6} length/length/K
THERMAL CONDUCTIVITY	300°F (149°C)	108.0 Btu-in/hr/ft^2/°F	15.6 W/m·K
	900°F (482°C)	141.0 Btu-in/hr/ft^2/°F	20.3 W/m·K
	1500°F (816°C)	175.0 Btu-in/hr/ft^2/°F	25.2 W/m·K
ELASTIC MODULUS	—	28.0 x 10^3 ksi	
ELECTRICAL RESISTIVITY	70°F	493.0 ohm-cir-mil/ft	

Magnetic properties

MAGNETIC PERMEABILITY	
ANNEALED, 200 OE	1.0040 Mu
COLD DRAWN 27% (WIRE), 200 Oe	1.0040 Mu
COLD DRAWN 75% (WIRE), 200 Oe	1.0040 Mu

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Typical mechanical properties

TYPICAL CRYOGENIC MECHANICAL PROPERTIES — 1 IN (25.4MM) ROUND BAR, ANNEALED 2050°F (1121°C)

TEST TEMPERATURE		0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 2 IN (50.8MM)	REDUCTION OF AREA	CHARPY V-NOTCH IMPACT STRENGTH	
°F	°C	ksi	MPa	ksi	MPa	%	%	FT-LBS	J
-100	-73	85	586	146	1007	50	65	115	156
-320	-196	128	883	226	1558	40	50	50	68

TYPICAL ELEVATED TEMPERATURE TENSILE PROPERTIES — 1 IN (25.4MM) ROUND BAR, ANNEALED 2050°F (1121°C)

TEST TEMPERATURE		0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 2 IN (50.8MM)	REDUCTION OF AREA
°F	°C	ksi	MPa	ksi	MPa	%	%
75	24	65	448	120	827	45	65
600	316	46	317	104	717	36	62
800	427	45	310	98	676	30	62
1000	538	41	283	90	621	40	62
1200	649	41	283	82	565	36	62
1350	732	39	269	68	469	38	64
1500	816	34	234	52	359	42	75

TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES — 1 IN (25.4MM) ROUND BAR, ANNEALED 2050°F (1121°C)

0.2% YIELD STRENGTH		0.2% TENSILE STRENGTH		ELONGATION IN 2 IN (50.8MM)	REDUCTION OF AREA	HARDNESS	CHARPY V-NOTCH IMPACT STRENGTH	
ksi	MPa	ksi	MPa	%	%	HRB	FT-LBS	J
65	448	120	827	45	65	96	160	217

TYPICAL ROOM TEMPERATURE TENSILE PROPERTIES OF COLD DRAWN WIRE — ANNEALED BEFORE COLD DRAWING

WIRE DIAMETER		COLD WORK	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 2 IN (50.8MM)	REDUCTION OF AREA
IN	MM	%	ksi	MPa	ksi	MPa	%	%
0.250	6.35	0	65	448	120	827	40	65
0.230	5.84	15	140	965	165	1138	20	55
0.208	5.28	30	170	1172	190	1310	15	48
0.185	4.70	45	190	1310	215	1482	10	45
0.158	4.01	60	215	1482	230	1586	8	40
0.136	3.45	70	230	1586	245	1689	7	38

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Heat treatment

Annealing	Heat to 1950/2050°F (1066/1121°C) and cool rapidly. Thin sections are usually cooled in air and heavy sections in water.
Hardening	Cannot be hardened by heat treatment. Can be hardened only by cold work.

Workability

Hot working	22Cr-13Ni-5Mn can be forged, hot rolled, hot headed, and upset. An initial forging temperature of 2100/2200°F (1149/1204°C) is normally used. Preheating to an intermediate temperature is not required. Forgings can be rapidly cooled without danger of cracking. For best corrosion resistance, anneal after forging.
Cold working	22Cr-13Ni-5Mn can be cold formed by drawing, bending, upsetting, and stamping. Because of its higher strength and work-hardening rate, the force required is somewhat greater than for Types 302, 304, and 316. The high work-hardening rate can be advantageous when cold working to increase strength; i.e., high strengths with good ductility can be achieved with less reduction.

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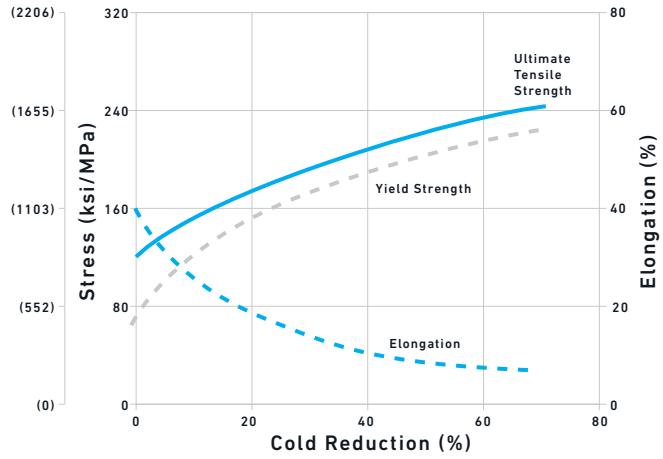
EFFECT OF COLD WORK ON THE TYPICAL TENSILE PROPERTIES OF WIRE



Machinability

22Cr-13Ni-5Mn has a machinability rating about 30% of AISI 1212. Slow to moderate speeds, moderate feeds, and rigid tools should be considered; tools must be kept sharp. Chips tend to be tough and stringy. Chip curlers or breakers are helpful. Use a sulfurized cutting fluid, preferably of the chlorinated type.

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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
				UNCOATED	COATED		
.150	55	.015	M-2	250	300	.015	C-6
.025	70	.007	T-15	300	350	.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		
40	.001	.001	.0015	.0015	.001	.0007	.0007	T-15	—
400	.004	.0055	.0045	.004	.003	.002	.002	—	C-6

ROUGH REAMING

HIGH-SPEED TOOLS		CARBIDE TOOLS		FEED, IPR, REAMER DIAMETER, IN					
SPEED, FPM	TOOL MATERIAL	SPEED, FPM	TOOL MATERIAL	1/8	1/4	1/2	1	1-1/2	2
60	M-7	80	C-2	.003	.005	.008	.012	.015	.018

DRILLING — HIGH-SPEED TOOLS

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	
45–50	.001	.002	.004	.007	.010	.012	.0`5	.018	M-42, T-15

DIE THREADING

SPEED, FPM				TOOL MATERIAL
7 OR LESS	8 TO 15	16 TO 24	25 AND UP, TPI	
4–8	6–10	8–12	10–15	M-42, T-15

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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	65	.001	.002	.003	.004	M-2, M-7	245	.001	.002	.003	.005	C-2

TAPPING — HIGH-SPEED TOOLS

SPEED, FPM	TOOL MATERIAL
12–25	M-1, M-7, M-10

BROACHING — HIGH-SPEED TOOLS

SPEED, FPM	CHIP LOAD, IPT	TOOL MATERIAL
10	.003	M-2, M-7

Additional machinability notes

When using carbide tools, surface speed feet/minute (sfpm) 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 or feeds should be increased or decreased in small steps.

Weldability	22Cr-13Ni-5Mn can be satisfactorily welded by the shielded fusion and resistance welding processes. Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. When a filler metal is required, AWS E/ER209 welding consumables should be considered for welds with strength approaching that of the base metal. If high weld strength is not necessary, then E/ER309 should be considered. Resistance to intergranular corrosion can be restored by a postweld annealing treatment.

For additional information, please contact your nearest sales office:
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