ALLOY Data

Carpenter Stainless Type 420

Identification

UNS Number

• S42000

Type Analysis

Carbon (Minimum)	0.15 %	**Manganese (Maximum)**	1.00 %
Phosphorus (Maximum)	0.040 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	12.00 to 14.00 %
Iron	Balance		

General Information

Description

Carpenter Stainless Type 420 is a hardenable 12% chrome steel with higher strength and hardness and better wear resistance than Type 410 Stainless.

Carpenter Stainless Type 420 has been used for cutlery, surgical and dental instruments, scissors, tempered rules, tapes and straight edges, gauges, needle valves, ball check valves, gears, shafts, cams, pivots, ball bearings, magnets, etc. It also has found uses at moderately elevated temperatures-such as springs, valve parts, etc. It should not be used for springs or heavily stressed parts that must operate at sub-zero temperatures.

Plastic molders have found the unique properties of this steel of particular value. A few of the advantages provided by this steel for mold cavities have included:

Corrosion resistance
High strength at room and moderately elevated temperatures
Cleanness and uniformity
Accuracy in heat treatment
Mirror-like finishes
Long production runs
Easy ejection
Chrome plating unnecessary
Less polishing time
Can be hobbed moderately when annealed for maximum softness

When order for plastic mold cavities, orders should specify "Carpenter Stainless Type 420 Mold Steel."

Selection

There are a limited number of other alloys or variations for specific applications.

Grade 420F is characteristic of a free-machining version and TrimRite® stainless has the hardness capability of Type 420 with better corrosion resistance.

Elevated Temperature Use

Carpenter Stainless Type 420 is not usually recommended for high temperature applications since corrosion resistance is reduced when used in the annealed condition or hardened and tempered above about 800°F (427°C). The alloy has been used at moderately elevated temperatures.

Corrosion Resistance

Carpenter Stainless Type 420 has corrosion resistance similar to that of Type 410. It has resisted corrosion from mild atmospheres, fresh water, steam, blood, ammonia, many petroleum products and organic materials and several mild acid environments.

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.

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Important Note: *The following 5-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Moderate	Sulfuric Acid	Restricted
Phosphoric Acid	Restricted	Acetic Acid	Restricted
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Moderate
Sour Oil/Gas	Restricted	Humidity	Good

Properties

Physical Properties

Specific Gravity

--	7.69	

Density

--	0.2790	lb/in³

Mean Specific Heat

32 °F, 210 °F	0.1100	Btu/lb/°F

Mean Coefficient of Thermal Expansion

32.00 °F, 212.0 °F	5.70	x 10 $^{-6}$ in/in/°F

Thermal Conductivity

212 °F	173.0	BTU-in/hr/ft²/°F

Modulus of Elasticity (E)

--	29.0	x 10 ^{3} ksi

Electrical Resistivity

70.0 °F	331.0	ohm-cir-mil/ft

Typical Mechanical Properties

Typical Charpy V-Notch Impact Strength
1.125" (28.6 mm) round bar, hardened 1900°F (1038°C), oil quench, tempered 2 hours

Tempering Temperature		Impact Strength		Rockwell C Hardness
°F	°C	ft-lb	J	
300	149	6	8	55
400	204	15	20	52
500	260	16	22	50½
600	316	14	19	50½
700	371	11	15	51

Typical Elevated Temperature Mechanical Properties
Hardened 1850°F, (1010°C), tempered 1 hour 50°F (28°C) above test temperature

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8mm)	% Reduction of Area	Room Temp. Rockwell C Hardness After Test	Brinell Hot Hardness
°F	°C	ksi	MPa	ksi	MPa				
Room		184	1269	260	1793	—	—	51	—
400	204	227	1565	255	1758	8	14	49½	476
600	316	225	1551	243	1675	9	20	50	401
800	427	198	1365	228	1572	9	19	50½	401
900	482	190	1310	206	1420	8	17	50½	370
1000	538	96	662	99	683	20	57	36½	152
1100	593	55	379	65	448	33	74	28½	—
1200	649	42	290	49	338	35	82	24	—

Typical Room Temperature Mechanical Properties
1" (25.4 mm) round bar

Condition	0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Brinell Hardness
	ksi	MPa	ksi	MPa			
Annealed	50	345	95	655	25	55	196
Hardened + Tempered*	215	1482	250	1724	8	25	512

*1900°F (1038°C), oil quench, tempered 400°F (204°C)

Heat Treatment

Annealing

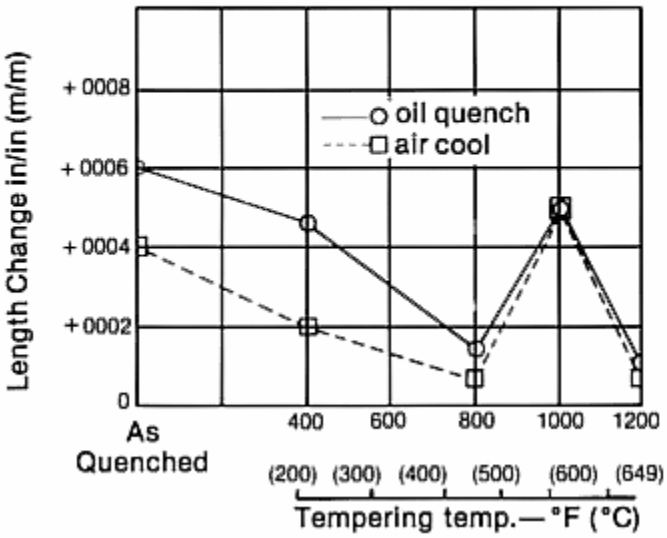
For maximum softness, heat uniformly to 1550/1650°F (843/900°C) and cool slowly in furnace. Brinell hardness 179.

Intermediate or process annealing treatment-heat uniformly to 1350/1450°F (732/788°C) and furnace cool, or cool in air. Brinell hardness 196.

Hardening

Heat to 1850/1950°F (1010/1066°C)-soak at heat and quench in warm oil.

Typical Longitudinal Size Change
After hardening 1900°F (1038°C) and tempering one hour



Tempering

To retain maximum hardness and corrosion resistance, temper at 300/400°F (149/204°C) and cool in air-Rockwell hardness approximately C 52.

For maximum corrosion resistance, Carpenter Stainless Type 420 should not be tempered over 800°F (427°C).

Typical Hardness
1" (25.4 mm) square, hardened 1900°F (1038°C), oil quench, tempered one hour

Tempering Temperature		Hardness	
°F	°C	Brinell	Rockwell C
not tempered		512	52
300	149	512	52
400	204	512	52
500	260	495	50
600	315	495	50
700	371	478	49
800	427	478	49

For maximum corrosion resistance, Carpenter Stainless Type 420 should not be tempered over 800°F (427°C).

Workability

Hot Working

This steel can be readily forged, hot headed and upset.

Forging

Preheat to 1400/1500°F (760/816°C), then heat uniformly to 2000/2200°F (1097/1204°C); forge; then cool forgings in a furnace heated to 1550°F (843°C) if possible. If not, warm dry lime or ashes can be used. If air cooled, cracking may occur. Anneal after forging; cool to room temperature before annealing. Do not forge below 1650°F (900°C)-reheat if necessary.

Cold Working

If annealed dead soft, Carpenter Stainless Type 420 can be moderately cold formed, headed, hobbed and upset.

Machinability

Carpenter Stainless Type 420, because of the high carbon content, machines like a high-carbon tool steel or SAE 3150 or 6150. The chips are tough and stringy. For easier machining, grinding, polishing and nongalling properties, see Carpenter Stainless Type 420F.

Following are typical feeds and speeds for Carpenter Stainless Type 420.

Turning—Single-Point and Box Tools

Depth of Cut (Inches)	High Speed Tools			Carbide Tools (Inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm) Uncoated	Speed (fpm) Coated	Feed (ipr)
.150	T15	85	.015	C6	375	500	.015
.025	M42	100	.007	C7	450	600	.007

Turning—Cut-Off and Form Tools

Tool Material		Speed (fpm)	Feed (ipr)						
			Cut-Off Tool Width (inches)			Form Tool Width (inches)			
High Speed Tools	Carbide Tools		1/16	1/8	1/4	1/2	1	1 ½	2
M2		75	.001	.0015	.002	.0015	.001	.001	.001
	C6	275	.004	.005	.006	.005	.004	.003	.003

Rough Reaming

High Speed		Carbide Tools		Feed (ipr) Reamer Diameter (inches)					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	1/8	1/4	1/2	1	1 ½	2
T15	75	C2	95	.003	.006	.010	.014	.018	.022

Drilling

Tool Material	Speed (fpm)	High Speed Tools: Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1 ½	2
M7,M10	55-65	.001	.003	.006	.010	.013	.016	.021	.025

Die Threading

FPM for High Speed Tools				
Tool Material	7 or less, tpi	8 to 15, tpi	16 to 24, tpi	25 and up, tpi
M1, M2, M7, M10	5-15	10-25	20-35	25-40

Milling, End-Peripheral

Depth of Cut (inches)	High Speed Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (in) 1/4	1/2	3/4	1-2	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (in) 1/4	1/2	3/4	1-2
.050	M2, M7	100	.001	.002	.003	.004	C6	275	.001	.002	.004	.006

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
M1, M7, M10	15-40

Broaching

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M2, M7	15	.003

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

Because it is air-hardening, Carpenter Stainless Type 420 is seldom welded. However, by preheating to 300/400°F (149/204°C) before welding, followed by a 6- to 8-hour anneal at 1350/1450°F (732/788°C) and air-cooling, satisfactory welds have been obtained.

If a filler metal is required, AWS ER 420 should be considered when the mechanical properties of the weld are important. If the mechanical properties of the weld do not have to match those of the base metal, AWS E/ER 309 should be considered.

Other Information

Applicable Specifications

- AMS 5621
- ASTM A276
- ASTM A314
- ASTM A580
- QQ-S-763

Forms Manufactured

- Bar-Flats
- Bar-Hexagons
- Bar-Rounds
- Bar-Squares
- Billet
- Strip
- Wire
- Wire-Rod

Technical Articles

- Alloy Selection for Cold Forming (Part I) [1314k pdf]
- How to Passivate Stainless Steel Parts
- Improved Stainless Steels for Medical Instrument Tubing
- New Ideas for Machining Austenitic Stainless Steels
- Selecting New Stainless Steels for Unique Applications
- Selecting Stainless Steels for Valves
- Selection of High Strength Stainless Steels for Aerospace, Military and Other Critical Applications
- Unique Properties Required of Alloys for the Medical and Dental Products Industry