CARPENTER TECHNOLOGY

DATASHEET

TRIM RITE®

Applicable specifications: ASTM A276, ASTM A493

Associated specifications: UNS S42010

Type analysis

Wt.%. Single figures are nominal except where noted.

Iron	Balance	**Chromium**	13.50–15.00 %	**Manganese**	Max 1.00 %
Silicon	Max 1.00 %	**Molybdenum**	0.40–1.00 %	**Nickel**	0.25–1.00 %
Carbon	0.15–0.30 %	**Phosphorus**	Max 0.040 %	**Sulfur**	Max 0.030 %

Forms manufactured

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

Description

Trim Rite is a hardenable martensitic stainless steel that provides a moderately high level of corrosion resistance, hardness up to Rockwell C 51, good cold formability, and ease of heat treatment, all of which combine to provide an alloy that has been used for many applications. Trim Rite is balanced to be fully martensitic in the hardened condition and is magnetic in all conditions. The alloy can be hot worked, cold worked, machined, and heat treated using the same equipment and methods used for 410 stainless steel.

Trim Rite is used in fasteners, especially self-drilling types, medical and surgical applications for cutting and scraping tools, and demanding industrial and energy applications. In laboratory tests, self-drilling fasteners of Trim Rite heat treated to Rockwell C 50 have shown good drilling capability. At a constant drill load of 35 pounds and a speed of 2500 rpm, No. 8 x 3/4 in. self-drilling fasteners drilled through 0.062 in.-thick cold-rolled 1010 carbon steel at Rockwell B 80 in 3.0 seconds or less.

Key Properties:

- Superior corrosion resistance vs. other stainless steels
- High hardness and strength
- Excellent ductility and toughness
- Good formability and machinability

Markets:

- Consumer
- Industrial
- Energy
- Medical

Applications:

- Fasteners
- Medical and dental tools
- Food processing
- Valves, gauges, and chains
- Drills and shafts
- Instruments

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Elevated temperatures

Trim Rite is not usually recommended for elevated temperature applications, since corrosion resistance and toughness will be reduced if the alloy is heated above about 700/800°F (371/427°C) after hardening and tempering as recommended.

Corrosion resistance

Laboratory tests have shown Trim Rite to have better corrosion resistance than 410, 420, and 440 in a number of environments. It has good resistance to rusting and corrosion by atmospheric conditions and various chloride-containing environments. Cones of Trim Rite ground with 400 grit paper and passivated in 20% nitric acid containing 2% sodium dichromate showed a high level of corrosion resistance when tested for 22 hours in copper acidified salt spray (ASTM B368-CASS test) and also when tested for 200 hours in 95°F (35°C), 5% neutral salt spray (ASTM B117).

Additionally, the alloy has good resistance to mild atmospheres, mild chemicals, most foodstuffs, and many petroleum products.

For maximum corrosion resistance, parts must be free of scale, foreign particles, free iron, and surface imperfections, which can trap foreign material and contribute to pitting and crevice corrosion, especially in the presence of chlorides. The presence of any of these conditions will decrease resistance to rusting in accelerated corrosion tests. Finished parts should be passivated.

IMPORTANT NOTE:
The following 4-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	**Sodium Hydroxide**	Moderate
Salt Spray (NaCl)	Moderate	**Sea Water**	Restricted
Humidity	Moderate		

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Physical properties

SPECIFIC GRAVITY	7.75
DENSITY	0.2800 lb/in^3
MEAN SPECIFIC HEAT (32 TO 212°F)	0.1100 Btu/lb/°F
MEAN CTE (32 TO 212°F)	5.61 x 10^{-6} in/in/°F
MODULUS OF ELASTICITY (E)	29.0 x 10^3 ksi
ELECTRICAL RESISTIVITY (70°F)	335.0 ohm-cir-mil/ft

Typical mechanical properties

ANNEALED

In the annealed condition, relatively low hardness, tensile, and yield strengths are conductive to cold forming.

TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES — ANNEALED CONDITION

PRODUCT FORM	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION	REDUCTION OF AREA	HARDNESS
	ksi	MPa	ksi	MPa	%	%	HRB
Wire	57	393	94	648	35	68	92
Bar	54	372	88	607	28	66	88
Strip	50	345	88	607	26	—	88

HARDENED AND TEMPERED

To avoid loss in toughness, tempering temperatures should not exceed 600°F (316°C).

TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES — BAR

TEMPERING TEMPERATURE*		0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA	CHARPY V-NOTCH IMPACT STRENGTH		HARDNESS
°F	°C	ksi	MPa	ksi	MPa	%	%	FT-LBS	J	HRC
400	204	185	1276	250	1724	14	45	14	19	50
500	260	172	1186	235	1620	15	50	16	22	47
600	316	172	1186	235	1620	15	50	13	18	47
700**	371	178	1227	237	1634	14	50	10	14	48
850**	454	190	1310	240	1655	14	48	5	7	48
950**	510	176	1213	248	1710	15	50	7	9	49

** Hardened 1900°F (1038°C), 1/2 hr., oil quench plus tempered 2 hr., air cool.*
*** Hardened plus tempered 400°F (204°C).*

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TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES — STRIP

CONDITION	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION	HARDNESS
	ksi	MPa	ksi	MPa	%	
Annealed	50	345	88	607	26	88 HRB
Tempered 300°F (149°C)*	179	1234	288	1986	9	55 HRC
Tempered 350°F (177°C)*	180	1241	270	1862	9	54 HRC
Tempered 400°F (204°C)*	183	1262	260	1793	10	52 HRC

** Hardened 1900°F (1038°C) 1/2 hr., fan air cool plus tempered 2 hr., air cool.*

In the hardened condition, Trim Rite has hardness and tensile strength comparable to 420 but possesses the higher ductility expected for 410.

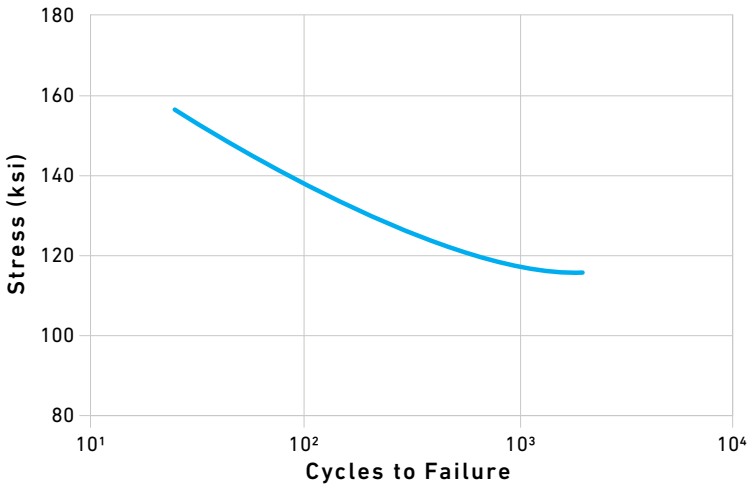
TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES — 410 AND 420 BAR

ALLOY AND CONDITION	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA	HARDNESS
	ksi	MPa	ksi	MPa	%	%	
410, Annealed	50	345	85	586	35	75	83 HRB
410, Hardened*	150	1035	190	1310	15	55	42 HRC
420, Annealed	55	380	95	656	25	55	94 HRB
420, Hardened*	215	1482	250	1724	8	25	52 HRC

** Hardened plus tempered 400°F (204°C).*

TYPICAL FATIGUE STRENGTH

Fatigue strength determined by a rotating beam test for bar tempered at 400°F (204°C), Rockwell C 50. Bar hardened 1900°F (1038°C). Endurance limit (typical value) is 115 ksi (793 MPa).



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Heat treatment

Annealing	Heat uniformly to 1350/1400°F (732/760°C) for two to four hours on heat, remove from furnace and cool to room temperature. The hardness will be approximately Rockwell B 88/90 or equivalent. For lowest hardness (Rockwell B 82/87) heat to 1560°F (850°C), one to two hours on heat, cool in the furnace at a rate not exceeding 50°F (28°C) per hour to 1200°F (650°C), and then remove from the furnace and cool in air to room temperature.
Hardening	Trim Rite readily lends itself to heat treating in both batch and continuous types of heat treating furnaces. For the maximum attainable hardness of Rockwell C 49/52, the alloy should be heated to 1900°F (1040°C) and rapidly cooled to room temperature by quenching in oil or by forced air or gas cooling. Fifteen minutes on heat at 1900°F (1040°C) is generally adequate for screws, clips, pins, wire, and other small parts. A longer time (up to a maximum of about one hour) is required for larger sections. When heat treating in a protective atmosphere, nitrogen or argon with a dew point no higher than -40°F (-40°C) is suggested. Dissociated ammonia is considered unsuitable because of the risk of nitriding the work and the resulting reduction in corrosion resistance.
Tempering	After hardening, parts should be tempered one to two hours at 350/400°F (177/204°C). When less than maximum hardness is required, parts may be tempered up to 600°F (316°C).

Workability

Cold Working	The cold forming characteristics of Trim Rite in operations such as heading, thread rolling, slotting, extrusion, drawing, and flattening are similar to a number of other 400 series martensitic stainless steels. Field trials have shown the cold headability to be only slightly less than 410.
Machinability	Trim Rite is normally machined in the annealed condition and is similar to 420. Cutting tools must be kept sharp. A coolant consisting of a chlorinated mineral oil with sulfur should be satisfactory for most machining operations.

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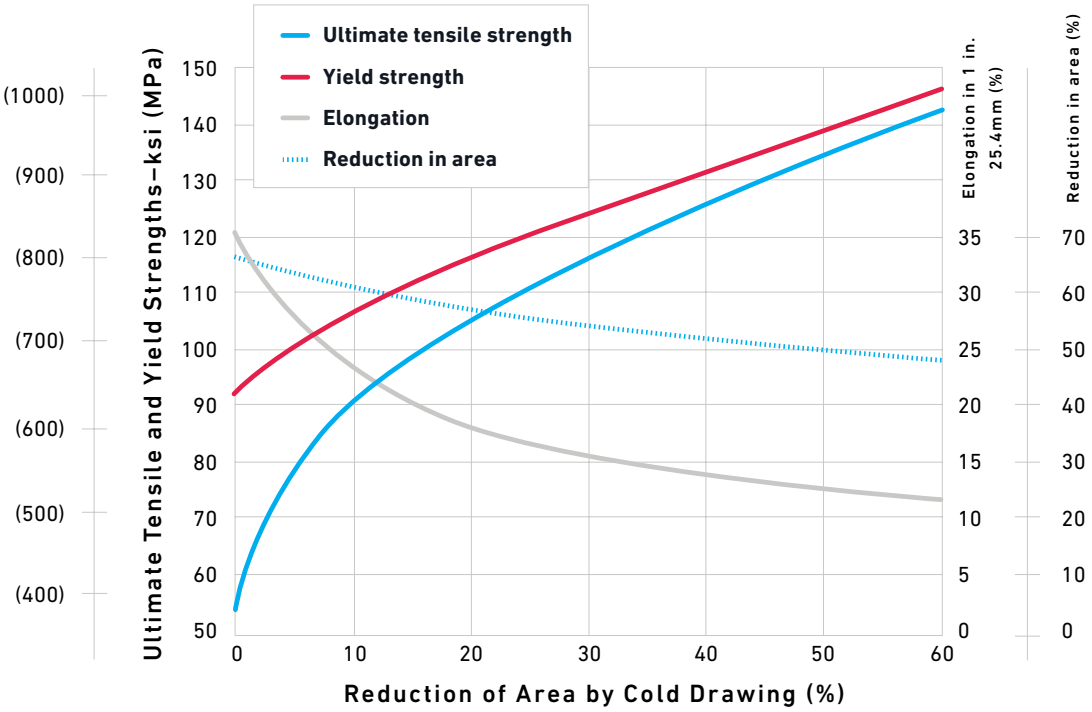
THE EFFECT OF COLD WORK ON ROOM TEMPERATURE TENSILE PROPERTIES

Starting from the annealed condition.



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Typical feeds and speeds

The feeds and speeds in the following charts are conservative recommendations for initial setup. Higher feeds and speeds 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	85	.015	T-15	375	500	.015	C-6
.025	100	.007	M-42	450	600	.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*		
75	.001	.0015	.002	.0015	.001	.001	.001	M-2	—
275	.004	.005	.006	.005	.004	.003	.003	—	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*
75	T-15	95	C-2	.003	.006	.010	.014	.018	.022

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*	
55–65	.001	.003	.006	.010	.013	.016	.021	.025	M-7, M-10

DIE THREADING — HIGH-SPEED TOOLS

SPEED, FPM				TOOL MATERIAL
7 OR LESS, TPI	8 TO 15, TPI	16 TO 24, TPI	25 AND UP, TPI	
5–15	10–25	20–35	25–40	M-1, M-2, M-7, M-10

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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, IPT — CUTTER DIAMETER, IN PER TOOTH				TOOL MATERIAL
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.050	100	.001	.002	.003	.004	M-2, M-7	275	.001	.002	.004	.006	C-6

TAPPING — HIGH-SPEED TOOLS

SPEED, FPM	TOOL MATERIAL
15–40	M-1, M-7, M-10

BROACHING — HIGH-SPEED TOOLS

SPEED, FPM	CHIP LOAD, IPT	TOOL MATERIAL
15	.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 adjustments 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.

DRILL CAPACITY

In laboratory tests, self-drilling fasteners of Trim Rite heat-treated to Rockwell C 50 have shown good drilling capability. At a constant drill load of 35 pounds and a speed of 2500 rpm, No. 8 x 3/4 in. self-drilling fasteners drilled through 0.062 in.-thick cold-rolled 1010 carbon steel at Rockwell B 80 in 3.0 seconds or less.

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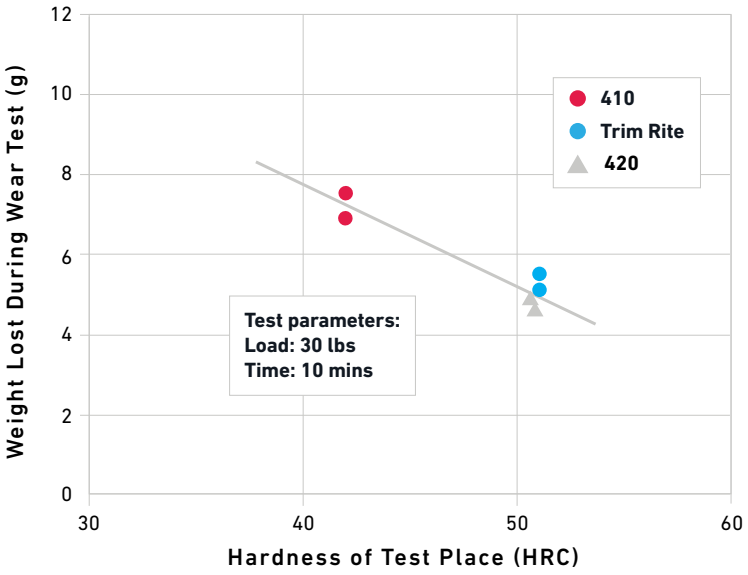
Wear resistance

Dry-sand abrasive wear tests per ASTM G65, Practice B have shown Trim Rite to be equivalent to 420.

DRY-SAND ABRASIVE WEAR



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Descaling (cleaning)

Prior to heat treating	In those cases where metal will not be removed from the surface of the part after heat treating by grinding, machining, or some other method, it is imperative that the surface of the steel be cleaned to remove all foreign materials such as soap, oil, grease, coatings including copper, sulfur-bearing compounds, and other substances that can react with the metal at a high temperature (e.g., hardening temperature). Most lubricants and grease can be removed by tumbling or vibratory washing in 140°F (60°C) alkaline solution followed by water rinsing or cleaning in an organic solvent. When stripping copper after cold heading, parts should be degreased and then stripped in 20% by volume nitric acid at 120/140°F (49/60°C) followed by a thorough water rinse.
After hardening	After hardening and tempering, parts in a finished condition should be passivated.

For additional information, please contact your nearest sales office:
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