

A-21®

Associated specifications: A-21® QT150, UNS S41429

Type analysis

Single figures are nominal except where noted.

Iron	Balance	Chromium	10.50–14.00 %	Nickel	2.00–3.00 %
Molybdenum	0.40–0.80 %	Titanium	0.15–0.75 %	Cobalt	max 1.0 %
Silicon	max 1.0 %	Manganese	max 0.75 %	Copper	max 0.50 %
Vanadium	max 0.25 %	Columbium/Niobium	max 0.20 %	Carbon	max 0.13 %
Aluminum	max 0.05 %	Phosphorus	max 0.03 %	Sulfur	max 0.03 %
Tin	max 0.02 %	Boron	max 0.01 %		

Forms manufactured

Bar	Rod	Strip
Billet	Ring	Tube
Plate	Sheet	Wire

Description

A-21 is an advanced martensitic stainless steel that offers a unique combination of high strength, excellent toughness, and outstanding stainless properties in the carburized, nitrided, and quenched and tempered conditions. It is available as VIM-VAR, VAR, or air melt. In the carburized condition, A-21 is unique because it develops a deep, hard, stainless case, and a strong, tough, ductile core. The minimum ultimate tensile strength (UTS) in the carburized condition is 180 ksi. Carburized A-21 can also be used for cutlery applications that require good edge retention, high hardness, and stainless properties. In the nitrided condition, A-21 can be used for wear- and galling-resistant applications that require very high surface hardness, excellent toughness, and good corrosion resistance. Nitriding is typically done on finished parts and involves minimal distortion. In the quenched and tempered condition, A-21 can be used for structural applications that require a good combination of high strength, outstanding toughness, and stainless properties. It also exhibits excellent heat check (thermal fatigue) resistance and is an economical alternative to many precipitation-hardening stainless steels. A-21 is shipped in the quenched and tempered (950°F) condition to a minimum UTS of 150 ksi, but could be tempered at higher temperatures to achieve a different combination of strength and toughness.

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Key Properties:

- High strength
- High toughness
- High surface hardness (carburized, nitrided)
- Good thermal fatigue resistance
- Good rotating beam and axial fatigue resistance

Markets:

- Aerospace
- Consumer
- Defense
- Energy
- Industrial
- Medical
- Transportation

Applications:

- Bearings, gears, actuators, splines, shafts, races
- Valve seats and stems
- Drilling rotors, frack pump/valve parts, housings
- Gun barrels, bolts/bolt carriers, firing pins
- Fuel injector nozzles, fuel pump parts
- Everyday carry knives, kitchen cutlery
- Blender blades
- Mining chains
- Medical saw blades, rasps, scalpels, drivers

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Corrosion resistance

A-21 is the world's first and only truly stainless carburizing steel. In the carburized and heat treated condition, it remains rust-free after 200-hour exposure to salt fog (ASTM B117). See below for a comparison to other stainless steels with hardness \geq 58 HRC.

SALT FOG CORROSION TEST (ASTM B117) AFTER 200 HOURS

Conventional carburized stainless steel (62 HRC)



CPM S90V (58 HRC)



440C (58 HRC)



BG-42 (61 HRC)



Carburized A-21 (62 HRC)



IMPORTANT NOTE:

The following 4-level rating scale (Excellent, Good, Moderate, Restricted) is intended for comparative purposes only and is derived from experiences with wrought product. Additive manufactured material may perform differently; 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.

Humidity	Excellent (all conditions)
Salt Spray (NaCl)	Excellent (carburized, quenched & tempered), Good (nitrided)
Sour Oil/Gas	Moderate (quenched & tempered)

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Corrosion resistance (continued)

CORROSION TEST RESULTS

ASTM B117

TREATMENT

 Carburized and quenched & tempered
 Nitrided, salt bath

AVERAGE CORROSION RATE, MDD

 Nil (200 hours)
 Isolated corrosion spots (24 hours)

ASTM D1735

TREATMENT

 Carburized
 Nitrided, salt bath

AVERAGE CORROSION RATE, MDD

 Nil (200 hours)
 Nil (24 hours)

NACE MR-0175/ISO 15156

CONDITION

Room temperature

CORROSION RATE, mpy

No failure (YS ≤ 120 ksi, 27 Rc, max; pH ≥ 4.5 (tubing))

NACE TM-0177, Method A

Typical mechanical properties, longitudinal, mid-radius (1/4 T)

1.125, 0.5 X 5.0, AND 1.625 IN.

FORM	TEMPER °F	ORIENTATION	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D or 2IN	REDUCTION OF AREA	CHARPY V-NOTCH		HARDNESS
			ksi	MPa	ksi	MPa			%	%	
1.125 in. quenched & tempered	950	Longitudinal	147	1014	162	1117	20	70	124	168	35.2
	975	Longitudinal	148	1020	160	1103	21	73	125	170	34.8
	1000	Longitudinal	146	1007	159	1096	21	72	133	180	34.6
	1025	Longitudinal	148	1020	157	1083	21	73	135	183	34.3
	1050	Longitudinal	142	979	153	1055	21	73	142	193	33.1
	1075	Longitudinal	141	972	150	1034	21	74	150	203	32.2
	1100	Longitudinal	125	862	134	924	23	75	169	229	28.2
0.5 x 5.0 in. pseudo-carb	325	Longitudinal	145	1000	180	1241	14	40	38	52	38.8
1.625 in. pseudo-carb	350	Longitudinal	158	1089	197	1358	17	61	63	85	40.0

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Heat treatment

Annealing	1100–1175°F
Hardening	1550°F
Normalizing	1550°F
Tempering	250–1175°F

**For additional information, please
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