



416 Stainless Steel

Categories: [Metal](#); [Ferrous Metal](#); [Heat Resisting](#); [Stainless Steel](#); [T 400 Series Stainless Steel](#)

Material Notes: 25 mm diameter bar, oil quenched from 995°C, held at tempering temperature for 2 hours.

Key Words: UNS S41600, ASME SA194, ASTM A194, ASTM A314, ASTM A473, ASTM A581, ASTM A582, FED QQ-W-423, MIL SPEC MIL-S-862, SAE J405(51416), DIN 1.4005, UNI X 12 CrS 13, B.S. 416 S 21, martensitic, ISO 683/13 7

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Physical Properties	Metric	English	Comments
Density	7.80 g/cc	0.282 lb/in³	

Mechanical Properties	Metric	English	Comments
Hardness, Brinell	237	237	Converted from Rockwell C Hardness
	@Temperature 705 °C	@Temperature 1300 °F	
	253	253	Converted from Rockwell C Hardness
	@Temperature 650 °C	@Temperature 1200 °F	
	266	266	Converted from Rockwell C Hardness
	@Temperature 595 °C	@Temperature 1100 °F	
	318	318	Converted from Rockwell C Hardness
	@Temperature 540 °C	@Temperature 1000 °F	
	360	360	Converted from Rockwell C Hardness
	@Temperature 260 °C	@Temperature 500 °F	
	360	360	Converted from Rockwell C Hardness
	@Temperature 370 °C	@Temperature 698 °F	
	360	360	Converted from Rockwell C Hardness
	@Temperature 480 °C	@Temperature 896 °F	
	365	365	Converted from Rockwell C Hardness
	@Temperature 150 °C	@Temoerature 302 °F	
Hardness, Knoop	250	250	Converted from Rockwell C Hardness
	@Temperature 705 °C	@Temperature 1300 °F	
	268	268	Converted from Rockwell C Hardness
	@Temperature 650 °C	@Temperature 1200 °F	
	283	283	Converted from Rockwell C Hardness
	@Temperature 595 °C	@Temperature 1100 °F	
	343	343	Converted from Rockwell C Hardness
	@Temperature 540 °C	@Temperature 1000 °F	
	392	392	Converted from Rockwell C Hardness
	@Temperature 260 °C	@Temperature 500 °F	
	392	392	Converted from Rockwell C Hardness
	@Temperature 370 °C	@Temperature 698 °F	
	392	392	Converted from Rockwell C Hardness
	@Temperature 480 °C	@Temperature 896 °F	
	397	397	Converted from Rockwell C Hardness
	@Temperature 150 °C	@Temperature 302 °F	
Hardness, Rockwell C	20	20	
	@Temperature 705 °C	@Temperature 1300 °F	
	23.5	23.5	
	@Temperature 650 °C	@Temperature 1200 °F	
	26	26	
	@Temperature 595 °C	@Temperature 1100 °F	
	34	34	
	@Temperature 540 °C	@Temperature 1000 °F	
	39	39	
	@Temperature 260 °C	@Temperature 500 °F	
	39	39	
	@Temperature 370 °C	@Temperature 698 °F	
	39	39	
	@Temperature 480 °C	@Temperature 896 °F	
	39.5	39.5	
	@Temperature 150 °C	@Temperature 302 °F	
Hardness, Vickers	242	242	Converted from Rockwell C Hardness
	@Temperature 705 °C	@Temperature 1300 °F	
	260	260	Converted from Rockwell C Hardness
	@Temperature 650 °C	@Temperature 1200 °F	
	275	275	Converted from Rockwell C Hardness
	@Temperature 595 °C	@Temperature 1100 °F	
	332	332	Converted from Rockwell C Hardness
	@Temperature 540 °C	@Temperature 1000 °F	
	378	378	Converted from Rockwell C Hardness
	@Temperature 260 °C	@Temperature 500 °F	
	378	378	Converted from Rockwell C Hardness
	@Temperature 370 °C	@Temperature 698 °F	
	378	378	Converted from Rockwell C Hardness
	@Temperature 480 °C	@Temperature 896 °F	
	383	383	Converted from Rockwell C hardness.
	@Temperature 150 °C	@Temperature 302 °F	
Tensile Strength, Ultimate	741 MPa	107000 psi	
	@Temperature 705 °C	@Temperature 1300 °F	
	796 MPa	115000 psi	
	@Temperature 650 °C	@Temperature 1200 °F	
	865 MPa	125000 psi	
	@Temperature 595 °C	@Temperature 1100 °F	
	1080 MPa	157000 psi	
	@Temperature 540 °C	@Temperature 1000 °F	
	1185 MPa	171900 psi	
	@Temperature 480 °C	@Temperature 896 °F	
	1260 MPa	183000 psi	
	@Temperature 370 °C	@Temperature 698 °F	
	1295 MPa	187800 psi	
	@Temperature 260 °C	@Temperature 500 °F	
	1310 MPa	190000 psi	
	@Temperature 150 °C	@Temperature 302 °F	
Tensile Strength, Yield	600 MPa	87000 psi	
	@Strain 0.200 %, Temperature 705 °C	@Strain 0.200 %, Temperature 1300 °F	
	670 MPa	97200 psi	
	@Strain 0.200 %, Temperature 650 °C	@Strain 0.200 %, Temperature 1200 °F	
	740 MPa	107000 psi	
	@Strain 0.200 %, Temperature 595 °C	@Strain 0.200 %, Temperature 1100 °F	
	895 MPa	130000 psi	
	@Strain 0.200 %, Temperature 540 °C	@Strain 0.200 %, Temperature 1000 °F	
	962 MPa	140000 psi	
	@Strain 0.200 %, Temperature 150 °C	@Strain 0.200 %, Temperature 302 °F	
	962 MPa	140000 psi	
	@Strain 0.200 %, Temperature 260 °C	@Strain 0.200 %, Temperature 500 °F	
	962 MPa	140000 psi	
	@Strain 0.200 %, Temperature 370 °C	@Strain 0.200 %, Temperature 698 °F	
	983 MPa	143000 psi	
	@Strain 0.200 %, Temperature 480 °C	@Strain 0.200 %, Temperature 896 °F	
Elongation at Break	9.0 %	9.0 %	in 50 mm
	@Temperature 150 °C	@Temperature 302 °F	
	9.5 %	9.5 %	in 50 mm
	@Temperature 260 °C	@Temperature 500 °F	
	13 %	13 %	in 50 mm
	@Temperature 540 °C	@Temperature 1000 °F	
	14 %	14 %	in 50 mm
	@Temperature 370 °C	@Temperature 698 °F	
	16 %	16 %	in 50 mm
	@Temperature 480 °C	@Temperature 896 °F	
	17 %	17 %	in 50 mm
	@Temperature 595 °C	@Temperature 1100 °F	
	17.5 %	17.5 %	in 50 mm
	@Temperature 650 °C	@Temperature 1200 °F	
	20 %	20 %	in 50 mm
	@Temperature 705 °C	@Temperature 1300 °F	
Modulus of Elasticity	200 GPa	29000 ksi	
Shear Modulus	83.0 GPa	12000 ksi	
Izod Impact	20.3 J	15.0 ft-lb	
	@Temperature 150 °C	@Temperature 302 °F	
	20.3 J	15.0 ft-lb	
	@Temperature 260 °C	@Temperature 500 °F	
	20.3 J	15.0 ft-lb	
	@Temperature 370 °C	@Temperature 698 °F	
	20.3 J	15.0 ft-lb	
	@Temperature 480 °C	@Temperature 896 °F	
	27.3 J	20.1 ft-lb	
	@Temperature 540 °C	@Temperature 1000 °F	
	54.4 J	40.1 ft-lb	
	@Temperature 595 °C	@Temperature 1100 °F	
	61.1 J	45.1 ft-lb	
	@Temperature 650 °C	@Temperature 1200 °F	
	75.0 J	55.3 ft-lb	
	@Temperature 705 °C	@Temperature 1300 °F	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.0000570 ohm-cm	0.0000570 ohm-cm	
	@Temperature 20.0 °C	@Temperature 68.0 °F	
	0.000108 ohm-cm	0.000108 ohm-cm	
	@Temperature 650 °C	@Temperature 1200 °F	
Magnetic Permeability	700 - 1000	700 - 1000	annealed condition at RT

Thermal Properties	Metric	English	Comments
CTE, linear	9.90 µm/m-°C	5.50 µin/in-°F	
	@Temperature 0.000 - 100 °C	@Temperature 32.0 - 212 °F	
	11.0 µm/m-°C	6.11 µin/in-°F	
	@Temperature 0.000 - 315 °C	@Temperature 32.0 - 599 °F	
	11.5 µm/m-°C	6.39 µin/in-°F	
	@Temperature 0.000 - 540 °C	@Temperature 32.0 - 1000 °F	
	11.7 µm/m-°C	6.50 µin/in-°F	
	@Temperature 0.000 - 650 °C	@Temperature 32.0 - 1200 °F	
Specific Heat Capacity	0.460 J/g-°C	0.110 BTU/lb-°F	
Thermal Conductivity	24.9 W/m-K	173 BTU-in/hr-ft²-°F	
	@Temperature 100 °C	@Temperature 212 °F	
	28.7 W/m-K	199 BTU-in/hr-ft²-°F	
	@Temperature 500 °C	@Temperature 932 °F	
	1480 - 1530 °C	2700 - 2790 °F	
Melting Point			
Solidus	1480 °C	2700 °F	
Liquidus	1530 °C	2790 °F	
Maximum Service Temperature, Air	675 °C	1250 °F	Continuous Service
	760 °C	1400 °F	Intermittent Service

Component Elements Properties	Metric	English	Comments
Carbon, C	<= 0.15 %	<= 0.15 %	
Chromium, Cr	13 %	13 %	
Iron, Fe	84 %	84 %	
Manganese, Mn	<= 1.25 %	<= 1.25 %	
Molybdenum, Mo	<= 0.60 %	<= 0.60 %	
Phosphorous, P	<= 0.060 %	<= 0.060 %	
Silicon, Si	<= 1.0 %	<= 1.0 %	
Sulfur, S	>= 0.15 %	>= 0.15 %	

H.O.:- 414/416, Maulana Azad Rd, Mumbai - 400 004
+91 22 - 2385 0143, 2387 2168, 6639 4243, 6636 3466
© +91 98213 25977 amit.supremesteel@gmail.com

Branch:- 15/1 Dwarkesh Industrial Estate,
Gulwe Vasti, Bhosari, Pune - 411 026.
+ 91 20-2712 4335 / 2712 1060 © +91 94215 41189
supremesteelind@hotmail.co.in