Grade Data Sheet

440C

Grade 440C is capable of attaining, after heat treatment, the highest strength, hardness (Rockwell C 60) and wear resistance of all the stainless alloys. Its very high carbon content of 1.0% is responsible for these characteristics, which make 440C particularly suited to such applications as ball bearings and valve parts.

Grades **440A** and **440B** are identical except for slightly lower carbon contents (0.60 - 0.75% and 0.75 - 0.95% respectively); these have lower attainable hardnesses but slightly higher corrosion resistances. Although all three versions of this grade are standard, in practice 440C is more available than the A or B variants; none of these are regularly stocked in Australia however.

A free-machining variant **440F** (UNS S44020) also exists, with the same high carbon content as 440C. Again this grade is not readily available in Australia.

Martensitic stainless steels are optimised for high hardness, and other properties are to some degree compromised. Fabrication must be by methods that allow for poor weldability and also allow for a final harden and temper heat treatment. Corrosion resistance is generally lower than the common austenitic grades, and their useful operating temperature range is limited by their loss of ductility at sub-zero temperatures and loss of strength by over-tempering at elevated temperatures.

Corrosion Resistance

Good resistance to the atmosphere, fresh water, foods, alkalies and mild acids. Best resistance in the hardened and tempered and passivated condition. A smooth polished surface also assists.

The corrosion resistance of Grade 440C is close to that of grade 304 in many environments.

Consult Atlas Technical Assistance for specific environmental recommendations.

Heat Resistance

Not recommended for use in temperatures above the relevant tempering temperature, because of reduction in mechanical properties by over-tempering.

Heat Treatment

Annealing

Full anneal - 840-870°C, slow furnace cool to about 600°C and then air cool.
Sub-critical Annealing - 735-760°C and slow furnace cool.

Hardening

Heat to 1010-1065°C, followed by quenching in warm oil or air. Oil quenching is necessary for heavy sections. Immediately temper at 150-370°C to obtain the hardness values and mechanical properties as indicated in the accompanying table.

Best corrosion resistance is when tempered below 425°C. Tempering in the range 425-565°C is to be avoided because of reduced impact resistance and corrosion resistance. Tempering in the range 600-675°C results in lower hardness – the product becomes machinable.

Maximum achievable hardnesses are approximately HRC56 for Grade 440A, HRC58 for 440B and HRC60 for 440C.

Welding

Welding is seldom carried out because of the grades' high hardenability. If welding is necessary pre-heat at 250°C and follow welding with a full anneal. Grade 420 filler will give a high hardness weld (although not as high as the 440C), but 309 or 310 will produce soft welds with higher ductility.

Machining

In the annealed condition this grade is relatively easily machined; approximately the same as for high speed steel. Chips are tough and stringy so chip breakers are important. If these grades are hardened machining becomes more difficult and probably impossible.

Typical Applications

Rolling element bearings, valve seats, high quality knife blades, surgical instruments and chisels.

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440C

Specified Properties

These properties are specified for bar product in ASTM A276. Similar but not necessarily identical properties are specified for other products such as wire and forgings in their respective specifications. These grades are not normally available in flat rolled or fluids products.

Composition Specification (%)

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
440A	min.	0.65	-	-	-	-	16.00	-	-	-
	max.	0.75	1.00	1.00	0.040	0.030	18.00	0.75		
440B	min.	0.75	-	-	-	-	16.00	-	-	-
	max.	0.95	1.00	1.00	0.040	0.030	18.00	0.75		
440C	min.	0.95	-	-	-	-	16.00	-	-	-
	max.	1.20	1.00	1.00	0.040	0.030	18.00	0.75		

Mechanical Properties - 440C - typical and specified values

Tempering Temperature (°C)	Tensile Strength (MPa)	Yield Strength 0.2% Proof (MPa)	Elongation (% in 50mm)	Hardness Rockwell (HR C)	Impact Charpy V (J)
Annealed *	758	448	14	269HB max #	-
204	2030	1900	4	59	9
260	1960	1830	4	57	9
316	1860	1740	4	56	9
371	1790	1660	4	56	9

* Annealed properties are typical for Grade 440C ASTM A276 annealed condition.

\# Brinell Hardness is ASTM A276 specified maximum for annealed 440A, B and C, hot finished.

Physical Properties

(typical values in the annealed condition)

Grade	Density (kg/m^3)	Elastic Modulus (GPa)	Mean Coefficient of Thermal Expansion		Thermal Conductivity		Specific Heat	Electrical Resistivity
			0-100°C (µm/m/°C)	0-200°C (µm/m/°C)	at 100°C (W/m.K)	at 500°C (W/m.K)	0-100°C (J/kg.K)	(nΩ.m)
440A/B/C	7650	200	10.1	10.3	24.2	-	460	600

Grade Specification Comparison

Grade	UNS No	Euronorm		Swedish SS	Japanese JIS
		No	Name		
440A	S44002	-	-		SUS 440A
440B	S44003	1.4112	X90CrMoV18		SUS 440B
440C	S44004	1.4125	X105CrMo17	-	SUS 440C

These comparisons are approximate only. The list is intended as a comparison of functionally similar materials **not** as a schedule of contractual equivalents. If exact equivalents are needed original specifications must be consulted.

Possible Alternative Grades

Grade	Why it might be chosen instead of 440C
440A/B	Slightly softer and more corrosion resistant grade needed
440F	High machinability required, with same hardness and hardenability as 440C
420	Lower strength and hardness needed than any of the 440 grades
416	Higher machinability required, and the much lower hardness and strength is still adequate