SALOMON'S METALEN B.V.

431

This heat treatable martensitic, nickel-bearing grade has the best corrosion resistance properties of all the martensitic grades. It has excellent tensile and torque strength, and good toughness, making it ideally suited to shafting and bolt applications. It can be hardened to approximately 40HRC. Because of its high yield strength, this grade is not readily cold worked and is therefore not recommended for use in operations such as cold heading, bending, deep drawing or spinning. 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 usually 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 subzero temperatures and loss of strength by over-tempering at elevated temperatures.

Corrosion Resistance
Grade 431 has excellent resistance to a wide variety of corrosive media. Reasonable resistance to salt water in cold southern waters but is unlikely to be successful in warmer tropical waters. Overall the corrosion resistance of 431 is approximately the same as or slightly below that of Grade 304.
Performance is best with a smooth surface finish, in the hardened and tempered condition.

Heat Resistance
Resists scaling in intermittent service to 925°C and in continuous service to 870°C, but is generally not recommended for use in temperatures above the relevant tempering temperature, because of reduction in mechanical properties.

Heat Treatment

- **Annealing**

Full anneal - not practical for this grade – it hardens even when cooled slowly.
Process Anneal - heat to 620-660°C and air cool.

- **Hardening**

Hardened by heating to 980-1065°C, holding for about 1/2 hour then quenching in air or oil. Pre-heating at 760-790°C may be useful for complex parts or those already hardened. Temper to suit mechanical requirements, at temperatures as indicated in the accompanying table. The tempering range 425-600°C should be avoided due to reduced impact toughness, although the effect is less marked than in most other martensitic grades.

Welding
Welding is difficult due to the risk of cracking. A pre-heat of 200-300°C is recommended prior to welding. Post-weld heat treat at 650°C.

Machining
In the annealed condition this grade is relatively easily machined, but if hardened to above 30HRC machining becomes more difficult.

Typical Applications
Nuts and bolts. Propeller shafting. Pump shafts. Beater bars. Marine hardware.

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 plate and forgings in their respective specifications.

Composition Specification (%)

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
431	min.	-	-	-	-	-	15.00	-	1.25	-
	max.	0.20	1.00	1.00	0.040	0.030	17.00		2.50	

Mechanical Properties (All values are typical except as noted)

Tempering Temperature (°C)	Tensile Strength (MPa)	Yield Strength 0.2% Proof (MPa)	Elongation (% in 50mm)	Hardness Brinell (HB)	Impact Izod (J)
Annealed *	862	655	20	285 max *	-
Condition T **	850 - 1000	635 min.	11 min.	248 - 302	
300	1320	1020	20	380	75
400	1310	1010	22	395	80
500	1350	1030	20	395	55 #
600	1030	800	20	310	45 #
700	920	700	20	290	70

* Annealed tensile properties are typical for Condition A of ASTM A276; annealed hardness listed is the specified maximum. Grade 431 is only rarely stocked in annealed Condition A.

** Grade 431 is frequently stocked and supplied in "Condition T" to AS 1444 or BS 970, with specified tensile strength of 850 - 1000MPa. Yield and elongation are typically in conformance with the limits listed above. ASTM A276 only lists a Condition A version of Grade 431.

Due to associated low impact resistance this steel should not be tempered in the range 425-600°C

Physical Properties (typical values in the annealed condition)

Grade	Density (kg/m³)	Elastic Modulus (GPa)	Mean Coefficient of Thermal Expansion 0-100°C (µm/m/°C)	0-315°C (µm/m/°C)	0-538°C (µm/m/°C)	Thermal Conductivity at 100°C (W/m.K)	at 500°C (W/m.K)	Specific Heat 0-100°C (J/kg.K)	Electrical Resistivity (nΩ.m)
431	7700	200	10.2	12.1	-	20.2	-	460	720

Grade Specification Comparison

Grade	UNS No	Euronorm No	Euronorm Name	Swedish SS	Japanese JIS
431	S43100	1.4057	X17CrNi16-2	2321	SUS 431

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 431
410	Only a lower hardened strength is needed.
416	High machinability is required, and the lower hardened strength and lower corrosion resistance of 416 is acceptable.
440C	A higher hardened strength or hardness than can be obtained from 431 is needed.