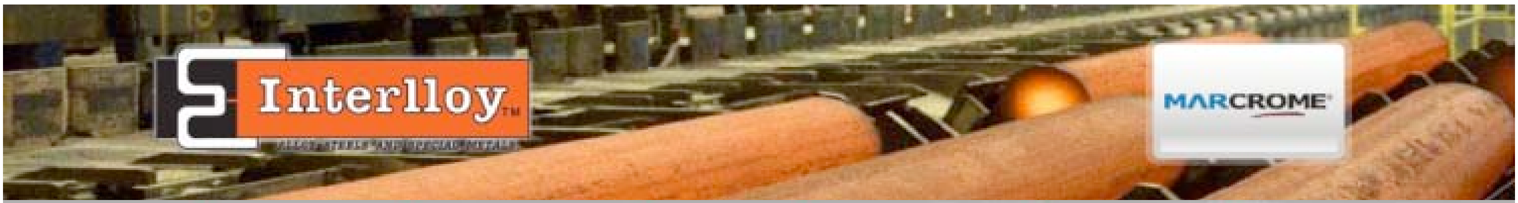


420 Martensitic Stainless Steel Bar

420 is a general purpose medium carbon straight chromium high hardenability martensitic stainless steel with good strength and fairly good corrosion resistance. It is generally supplied hardened and tempered either in the tensile range 700 - 850 Mpa (condition R) Brinell range 201 - 255, or in the tensile range 770 - 930 Mpa (condition S) Brinell range 223 - 277 or in the annealed condition with a maximum Brinell hardness of 241.

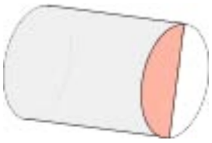
Characterised by good corrosive resistance in mild atmospheric, domestic and industrial environments. It is resistant to ammonia, blood, carbonic acid, crude oil, detergent solutions, dilute nitric acid, fresh water, food acids, many petroleum products, steam and vinegar etc. coupled with good strength and reasonable impact properties in the as supplied hardened and tempered condition.

420 due to its excellent hardenability is capable of being through hardened up to Rc52 or higher depending upon carbon content and section size. Small sections can be air cooled and larger sections oil quenched for maximum through hardness.

Pre hardened and tempered 420 will also respond readily to nitriding achieving a typical surface hardness of over Rc65. The nitriding process however reduces the corrosion resistance and is therefore not generally recommended except for critical applications where the benefit outweighs all other considerations.

Material magnetic in all conditions.

Colour Code



Pink & White (Bar end)

Stocked Sizes	15.88 to 220 mm diameter.
Bar Finish	Peeled, Cold Drawn

Related Specifications

Australia	AS 2837-1986 420
Germany	W.Nr 1.4021 X20Cr13 W.Nr 1.4028 X30Cr13
Great Britain	BS970 Part3 1991 420S37 BS970 Part4 1970/73 420S45 BS970 1955 EN56C and EN56D
Japan	JIS G4303 SuS 420 J1 and SUS 420 J2
USA	ASTM A276-98b 420 SAE 51420 AISI 420 UNS S42000

Chemical Composition	Min. %	Max. %
*Carbon	0.15	0.36
Silicon	0	1.00
Manganese	0	1.00
*Nickel	0	1.00
Chromium	12.00	14.00
Phosphorous	0	0.04
Sulphur	0	0.03

*Carbon range can vary considerably
*Nickel addition optional.

Mechanical Property Requirements For Material in the Annealed and Heat Treated - Condition R and Condition S To AS2837 - 1986 420 and BS970 Part3 1991 420S37 and *BS970 Part 4 1970/73 420S45

Condition	Tensile Strength Mpa Min	Tensile Strength Mpa Max	0.2% Yield Strength Mpa Min	Elongation on $5.65\sqrt{S_0}$* % Min	Izod Impact Value Section Size J mm Min	Hardness HB Min	Hardness HB Max
Annealed							229
R	700	850	495	15	≦63 34	201	255
					≧63 27		
S	770	930	555	13	≦63 27	223	277

				≧63 14		

Material stocked generally in condition R or condition S.
NB. Check the mill certificate if critical for end use.
*Material supplied to BS970 Part4 1970/73 420S45 mechanical property requirements as above with the following exception:
Annealed condition - Hardness HB 241 Max.

Typical Mechanical Properties At Room Temperature - Annealed and *Hardened and Tempered to Condition R and Condition S

Condition	Tensile Strength Mpa	0.2% Yield Strength Mpa	Elongation in 50mm %	Impact Charpy J	Hardness	
					HB	Rc
Annealed	650	350	25		196	15
R	790	635	19	50	240	24
S	900	740	18	40	270	29

*Typical Hardening Temperatures	950 °C - 1020 °C	
*Typical Tempering Temperatures	650 °C - 750 °C	Condition R
*Typical Tempering Temperatures	600 °C - 700 °C	Condition S

Typical Mechanical Properties At Room Temperature - Hardened By Oil Quench at 980 °C and Tempered as Indicated

Tempering Temperature °C	Tensile Strength Mpa	Yield Strength Mpa	Elongation in 50mm %	Impact Charpy J	Hardness	
					HB	RC
150	1630	1385	12		495	52
200	1605	1365	12	20	480	51
300	1570	1360	14	19	465	50
425	1625	1415	11	*9	495	52
500	1450	1240	14	*11	429	46
600	1025	800	19	22	302	33
650	895	675	20	42	262	27

Section Size 30mm
*Note drop in impact properties. Tempering within the range 400 °C - 550 °C should be avoided.

Elevated Temperature Properties

420 displays good resistance to scaling in continuous service up to 650 °C. Its use however at these higher working temperatures results in a substantial drop in tensile strength and hardness, plus a reduction in corrosion resistance.

It is therefore not recommended for use at working temperatures above 400 °C.

Low Temperature Properties

420 is also not recommended for use at sub-zero temperatures due to a substantial drop in impact properties consistent with most steels other than the austenitic steel types.

Cold Bending

In the hardened and tempered as supplied condition will be more difficult due to the high yield strength which must be taken into account.

Hot Bending

In the hardened and tempered as supplied condition it is not recommended due to its affect on the mechanical properties within the heat affected zone.

Corrosion Resistance

420 has a corrosion resistance similar to 410 grade, better than 416 grade, but lower than 431 grade, also lower than most of the 400 series ferritic stainless steels and all of the 300 series austenitic stainless steels.

NB. It has optimum corrosion resistance in the hardened and tempered, ground and polished condition, and is not therefore recommended for use in the annealed condition.

It is most important that oxygen is always allowed to circulate freely on all stainless steel surfaces to ensure that a chrome oxide film is always present to protect it. If this is not the case, rusting will occur as with other types of non stainless steels.

For optimum corrosion resistance surfaces must be free of scale and foreign particles.
Finished parts should be passivated.

Forging

Preheat to 760 °C - 820 °C, then heat uniformly to 1100 °C - 1200 °C, hold until temperature is uniform throughout the section and commence forging immediately.

Do not overheat as this can cause a loss of toughness and ductility.

Do not forge below 900 °C

Finished forgings should be cooled slowly in a furnace, warm dry lime or ashes to room temperature and annealed immediately.

NB. Air cooling after forging may cause cracking.

Heat Treatment

Sub-Critical Annealing

Heat uniformerly to 730 °C - 790 °C hold until temperature is uniform throughout the section.
*Soak as required, cool in air.

Annealing

Heat uniformerley to 840 °C - 900 °C, hold until temperature is uniform throughout the section.
*Soak as required. Cool in furnace.

Hardening

Heat to 950 °C - 1020 °C, hold until temperature is uniform throughout the section. *Soak as required.

Quench in oil or air cool. Temper immediately while still hand warm.

Note: Hardening from 1020 °C - 1060 °C will give optimum corrosion resistance, but hardening from about 980 °C will give the best combination of corrosion resistance and mechanical properties.

Nitriding

Prior to nitriding, the chrome oxide film which protects the surface must be broken down by pickling or fine sand blasting.

Nitriding is carried out at 500 °C - 550 °C followed by slow cooling (no quench) reducing the problem of distortion.

Parts can therefore be machined to near final size, leaving a grinding tolerance only. Always ensure that the tempering temperature employed during the initial heat treatment was higher than the nitriding temperature otherwise the core strength will be affected.

Tempering

Condition R:
Heat to 650 °C - 750 °C, hold until temperature is uniform throughout the section. *Soak as required.
Cool in air.

Condition S:
Heat to 600 °C - 700 °C, hold until temperature is uniform throughout the section. *Soak as required.
Cool in air.

Tempering within the range 150 °C - 200 °C will give optimum corrosion resistance and maximum hardness - up to Rc52 depending upon section size.

NB. Tempering however within the range 400 °C - 550 °C should be avoided due to temper brittleness, resulting in a considerable reduction in impact properties and loss of corrosion resistance.

*Heating temperatures, rate of heating, cooling and soaking times will vary due to factors such as work piece size/shape, also furnace type employed, quenching medium and work piece transfer facilities etc.

Please consult your heat treater for best results.

Machining

420 machines best in the hardened and tempered as supplied condition R or condition S, and despite its relatively high carbon content is still regarded as having reasonable machinability with all operations such as drilling, turning etc. capable of being carried out as per machine manufacturers recommendations for suitable tool type, feeds and speeds. It does not work harden to the same extent as the 300 series austenitic stainless steels, but is more similar in this respect to the low alloy high tensile steels such as 4150 or 6150 etc.

Welding

420 is not generally recommended for welding in either the annealed or hardened and tempered condition, due to its air hardening capability which can lead to the formation of brittle martensite, resulting in cold cracking due to contraction stresses within the weld and heat affected zone. The higher the carbon content the higher the hardening capability and the greater the risk of cracking.

Pre heating and interpass temperature control during welding, plus very slow cooling and post-weld annealing is the best method to prevent cracking.

The following welding procedure and post-weld heat treatment may be taken as a guide only if welding is necessary.

Welding Procedure

Welding electrodes or rods should be low hydrogen types 420 or *similar when strength is required or when post-weld hardening and tempering, otherwise an austenitic stainless electrode or rod such as 309 or *similar may be used to give a more ductile weld, when strength is not so critical and post-weld annealing is not possible or intended.

Pre-heat at 200 ^{o}C - 300 ^{o}C and maintain a high heat input during welding. On completion of welding cool slowly as possible until hand warm and as required:

Post-weld sub-critical anneal at 650 ^{o}C - 750 ^{o}C or full anneal and harden and temper as required.

*Please consult your welding consumables supplier.