Knight® Precision Wire...

Stainless Steel

PW02

Product Information

Technical Information

The main justification for selecting stainless steel for a given application is its outstanding corrosion and oxidation resistance which, alongside other exceptional properties, such as the ability to develop very high strength through cold working or heat treatment, excellent formability and the capability to withstand cryogenic temperatures, makes it a very versatile material.

Stainless steels have a wide range of microstructures which are controlled by composition and, although all stainless steels must contain chromium to form the complex oxide surface which gives stainless steel its protection, other alloying elements have significant effects. In discussing the generic group "Stainless Steels" it is convenient to categorise them in terms of microstructure.

There are four major groups of stainless steels in the wire industry:

Courtesy of ISOPAD Limited

Fine wire braiding

1. Austenitic Stainless Steels

The high temperature form of iron with carbon in solid solution is known as austenite which is non-magnetic. The structure can remain non-magnetic at room temperature with appropriate alloying additions, the most common being nickel. The traditional austenitic stainless steels are based on an 18% chromium, 8% nickel alloy, commonly known as 18/8 stainless. The chromium and nickel contents can be increased to further improve corrosion resistance and other elements, such as molybdenum, can be added, again to improve corrosion resistance. Similarly the nickel content can be varied to give a range of mechanical properties, due to differing work hardening rates.

This has lead to the familiar group of 300 Series alloys, which were developed to exploit the full range of possibilities available, when altering alloying levels. In the fully annealed condition they are essentially non-magnetic, but cold working of the less alloyed grades will induce structural changes leading to increased levels of magnetism.

2. Ferritic Stainless Steels

This group is so named because the alloys have the same structure as iron at room temperature. These alloys are based on a minimum chromium level of 11% and contain no nickel but provide fair corrosion resistance and good formability at low cost. Chromium levels can be increased to improve corrosion resistance but these alloys have low work hardening rates, do not develop high strength from cold working and remain magnetic in all tempers.

3. Martensitic Stainless Steels

Martensitic stainless steels are similar to plain carbon steels that are austenitised, hardened by quenching and tempered to give improved toughness and ductility.

These alloys are magnetic and are generally formed in the annealed condition, then heat treated. The strength generated by heat treatment is dependant on the carbon content of the alloy; increasing carbon increases strength but at the expense of toughness and ductility.

4. Precipitation Hardening Stainless Steels

These alloys can be heat treated to improve their strength through a process that is associated with the formation of a precipitate. These alloys have high work hardening rates and very high strengths.

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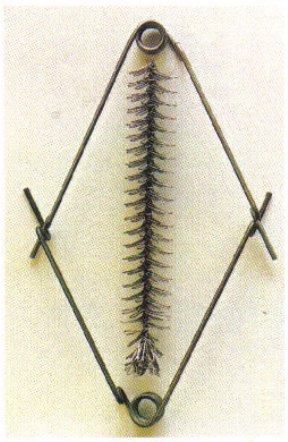
Materials Quality Standards

At the time of publication, no European Standard is available for stainless steel wire. Compositions shown in the following tables reflect current British Standards. However, the closest equivalent in European Standard BS EN 10088-1 is listed for comparative purposes.



Courtesy of Specialist Heat Exchangers Ltd

STAINLESS STEEL WIRE GRADE DESIGNATIONS & CHEMICAL COMPOSITIONS *(% by weight)*

EUROPEAN DESIGNATION BS EN 10088-1 (1995)		CURRENT STANDARD	ASTM		BS 1554 - 1990 CHEMICAL COMPOSITIONS (%)								
NUMBER	NAME	BS 1554 - BS 1990	AISI	UNS	C (max)	Si (max)	Mn (max)	P (max)	S (max)	Cr	Ni	Mo	OTHERS
AUSTENITIC													
1.4310	X10 Cr Ni 18-8	302 S31	302	S 30200	0.12	1.00	2.00	0.045	0.030	17.00 to 19.00	8.00 to 10.00		
1.4307	X2 Cr Ni 18-9	304 S11	304L	S 30403	0.03	1.00	2.00	0.045	0.030	17.00 to 19.00	9.00 to 12.00		
1.4301	X5 Cr Ni 18-10	304 S31	304	S 30400	0.07	1.00	2.00	0.045	0.030	17.00 to 19.00	8.00 to 11.00		
1.4303	X4 Cr Ni 18-12	305 S11	305	S 30500	0.03	1.00	2.00	0.045	0.030	17.00 to 19.00	11.00 to 13.00		
1.4404	X2 Cr Ni Mo 17-12-2	316 S14	316L	S 31603	0.03	1.00	2.00	0.045	0.030	16.00 to 18.50	10.00 to 14.00	2.00 to 3.00	
1.4401	X5 Cr Ni Mo 17-12-2	316 S19	316	S 31600	0.07	1.00	2.00	0.045	0.030	16.00 to 18.50	10.00 to 14.00	2.00 to 3.00	
1.4436	X3 Cr Ni Mo 17-13-3	316 S33	316	S 31600	0.07	1.00	2.00	0.045	0.030	16.50 to 18.50	11.00 to 14.00	2.50 to 3.00	
1.4541	X6 Cr Ni Ti 18-10	321 S31	321	S 32100	0.08	1.00	2.00	0.045	0.030	17.00 to 19.00	9.00 to 12.00		Ti=5xC min to 0.80 max
1.4550	X6 Cr Ni Nb 18-10	347 S20	347	S 34700	0.08	1.00	2.00	0.045	0.030	17.00 to 21.00	9.00 to 12.00		Nb=10xC min - max 1.0
FERRITIC													
1.4016	X6 Cr 17	430 S18	430	S 43000	0.10	1.00	1.00	0.040	0.030	16.00 to 18.00	1.00 max		
MARTENSITIC													
1.4006	X12 Cr 13	410 S21	410	S 41000	0.09 to 0.15	1.00	1.00	0.040	0.030	11.50 to 13.50	1.00 max		
1.4028	X30 Cr 13	420 S45	420	S 42000	0.28 to 0.36	1.00	1.00	0.040	0.030	12.00 to 14.00	1.00 max		

STAINLESS STEEL SPRING WIRE GRADE DESIGNATIONS & CHEMICAL COMPOSITIONS *(% by weight)*

EUROPEAN DESIGNATION BS EN 10088-1 (1995)		CURRENT STANDARD	ASTM		BS 2056 - 1993 CHEMICAL COMPOSITIONS (%)								
NUMBER	NAME	BS 2056 - 1993	AISI	UNS	C	Si (max)	Mn (max)	P (max)	S (max)	Cr	Ni	Mo	OTHERS
AUSTENITIC													
1.4310	X10 Cr Ni 18-8	302 S26	302	S 30200	0.12	1.00	2.00	0.045	0.030	17.00 to 19.00	7.50 to 10.00		
1.4401	X5 Cr Ni Mo 17-12-2	316 S42	316	S 31600	0.07	1.00	2.00	0.045	0.030	16.00 to 18.50	9.50 to 13.50		
MARTENSITIC													
1.4028	X30 Cr 13	420 S45	420	S 42000	0.28 to 0.36	1.00	1.00	0.040	0.030	12.00 to 14.00	1.00 max		
PRECIPITATION HARDENING													
1.4568	X7 Cr Ni Al 17-7	301 S81	6310	S 17700	0.09	1.00	1.00	0.045	0.030	16.00 to 18.00	6.50 to 7.75		Al 0.70 to 1.50

Martensitic Stainless Steel

Martensitic stainless steel (Grade 420 S45) is supplied in the annealed or cold drawn condition...

TEMPER	TENSILE STRENGTH (N/mm²)
Annealed	820 max
Cold Drawn	850 max

It is necessary to harden and temper the wire after spring forming to develop the required mechanical properties.

These heat treatment processes are temperature and time dependant and general guidelines are as follows...

Hardening

Heat to 1050°C until component achieves temperature and then air cool or oil quench. In this condition the wire has a tensile strength of 1750 N/mm² but very little ductility.

Tempering

Temperatures up to 480°C only have a stress relieving effect and tensile strength shows little change. Above 480°C up to 650°C the tensile strength decreases substantially and the structure exhibits increasing ductility demonstrated by increasing elongation in a tensile test.

Typically tempering ...at 540°C gives a UTS of 1200 N/mm²
...at 650°C gives a UTS of 800 N/mm²

Above 650°C the wire is in the softened condition and little change occurs in the UTS of the wire.

It can be seen that a whole range of mechanical properties can be made available by the correct choice of heat treatment.

Precipitation Hardening

Type 301 S81 (17/7 PH) is generally supplied in the cold drawn condition for spring forming and finally heat treated to give maximum mechanical properties as below...

DIAMETER (mm)		TENSILE STRENGTH (N/mm²) 301 S81			
Over	Up to & including	Cold Drawn Condition		After Heat Treatment	
		Min	Max	Min	Max
0.25	0.32	1880	2110	2230	2530
0.32	0.40	1860	2090	2210	2510
0.40	0.56	1820	2050	2170	2470
0.56	0.70	1800	2030	2150	2450
0.70	1.00	1770	2000	2120	2420
1.00	1.30	1710	1940	2030	2330
1.30	1.70	1650	1880	1970	2270
1.70	2.20	1630	1860	1930	2210
2.20	2.80	1560	1790	1860	2140
2.80	3.40	1500	1730	1800	2080
3.40	4.00	1460	1690	1760	2040
4.00	4.50	1420	1650	1720	2000
4.50	5.50	1400	1630	1680	1950
5.50	6.00	1380	1610	1660	1930
6.00	7.50	1350	1580	1600	1870
7.50	8.00	1330	1560	1530	1800
8.00	10.00	1270	1500	1470	1740

Note: Heat treatment to be carried out at 482 ±6°C for 1 hour followed by air cooling after removal from furnace.

STAINLESS STEEL WIRE MECHANICAL PROPERTIES

MAXIMUM TENSILE STRENGTH OF ANNEALED STAINLESS STEEL *(N/mm²)*

EUROPEAN DESIGNATION BS EN 10088-1 (1995)	BRITISH STANDARD BS 1554 - 1990	WIRE DIA. 13.0 mm to 6.0 mm	WIRE DIA. Under 6.0 to 1.50 mm	WIRE DIA. Under 1.50 to 0.50 mm	WIRE DIA. Under 0.50 to 0.10 mm
AUSTENITIC					
1.4310 X10 Cr Ni 18-8	302 S31	750	800	880	900
1.4307 X2 Cr Ni 18-9	304 S11	650	750	775	850
1.4301 X5 Cr Ni 18-10	304 S31	700	770	820	870
1.4303 X4 Cr Ni 18-12	305 S11	650	750	775	850
1.4404 X2 Cr Ni Mo 17-12-2	316 S14	650	750	775	850
1.4401 X5 Cr Ni Mo 17-12-2	316 S19	700	770	820	870
1.4436 X3 Cr Ni Mo 17-13-3	316 S33	700	770	820	870
1.4541 X6 Cr Ni Ti 18-10	321 S31	700	770	820	870
1.4550 X6 Cr Ni Nb 18-10	347 S20	700	800	940	950
FERRITIC					
1.4016 X6 Cr 17	430 S18	610	620	630	650
MARTENSITIC					
1.4006 X12 Cr 13	410 S21	700	700	750	780
1.4028 X30 Cr 13	420 S45	780	780	800	820

The tensile strength of wire supplied in the cold drawn condition should be agreed at the time of order.

STAINLESS STEEL SPRING WIRE

MECHANICAL PROPERTIES IN THE COLD DRAWN CONDITION (TENSILE STRENGTH IN N/mm²) BS 2056 - 1991

AUSTENITIC

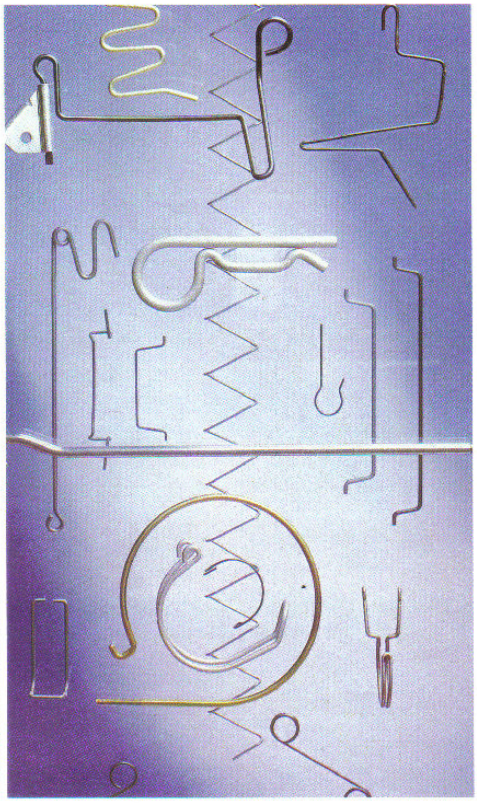
Diameter (mm)		302 S26				316 S42	
Over	Up to & including	Grade I		Grade II			
		Min	Max	Min	Max	Min	Max
0	0.2	1880	2160	2160	2400	1680	1920
0.2	0.4	1800	2060	2060	2300	1640	1880
0.4	0.7	1720	1960	1960	2200	1600	1840
0.7	1.0	1620	1860	1860	2100	1580	1820
1.0	1.5	1530	1770	1770	2010	1550	1790
1.5	2.0	1430	1670	1670	1910	1460	1700
2.0	2.8	1330	1570	1570	1810	1360	1600
2.8	4.0	1230	1470	1470	1710	1260	1500
4.0	6.0	-	-	1370	1610	1100	1340
6.0	8.0	-	-	1280	1520	1030	1270
8.0	10.0	-	-	1230	1470	860	1100

Courtesy of Gemini Tackle Co. Ltd.

Stainless Steel

	SERVICE PROPERTIES	APPLICATIONS
AUSTENITIC		
Type 302	The general purpose 18/8 Cr/Ni grade can be cold worked to high tensile strengths. Good corrosion resistance.	SPRINGS, CLIPS, FASTENERS, ROPES, WEAVING, KNITTING, BRAIDING, FISHING TACKLE, FOOD CUTTING WIRE, ORTHODONTIC WIRES & CONNECTORS
Type 304	Low carbon higher nickel version of 302.	ROPES, WEAVING, KNITTING, BRAIDING
Type 305	Lower work hardening rate than 302 or 304. Good for severe cold heading requirements. Low level of magnetism.	WEAVING, KNITTING, BRAIDING
Type 316	Improved corrosion resistance over 302/304 due to addition of Mo.	SPRINGS, CLIPS, FASTENERS, WEAVING, KNITTING, BRAIDING IN MARINE OR CHEMICAL PROCESSING ENVIRONMENTS
Type 321	Stabilised grade to prevent loss of corrosion performance in and around welded joints.	AIRCRAFT FASTENERS, FURNACE PARTS, WIRE FABRICATIONS
Type 347	As 321 but stabilised with Nb rather than Ti.	AIRCRAFT FASTENERS
FERRITIC		
Type 430	General purpose alloy, moderate corrosion resistance, good formability due to low work hardening rate. Lower strength than 300 Series.	SCREWS, BOLTS, WIRE SHAPES
MARTENSITIC		
Type 420	Popular grade in the martensitic family. Offers a wide range of mechanical properties by heat treating after forming.	SPRINGS, CLIPS
PRECIPITATION HARDENING		
17-7 PH	(301 S81) Commonly used grade of precipitation hardening stainless steel. Can be used in a hard drawn condition (Condition 'C') and heat treated after forming to further enhance the mechanical properties.	HIGH TEMPERATURE FASTENERS, SPRINGS

A speciality product is AIRCRAFT LOCKING WIRE, made to Aircraft Approval.
It is available in diameters from 0.25 mm to 1.6 mm and is generally supplied on specified spools. Certified: DTD 189A MS 20995, AS 44725



Courtesy of Kato Entex Limited

STAINLESS STEEL STOCK RANGE

	DIAMETER (mm) Min	Max
AUSTENITIC Annealed	0.05	8.00
Cold Drawn ($^1/_4$H - $^1/_2$H - Spring Hard)	0.05	6.00
MARTENSITIC Annealed & Cold Drawn	0.50	4.00
PRECIPITATION HARDENING (17/7 PH Condition 'C') Cold Hard Drawn	0.45	10.00

Other sizes available on request. For our full product range and processing capability, please see Section PW01.

The data printed in the above sections is based on information from our own and other organisations; although every effort has been made to ensure its accuracy, no guarantee or warranty is given or implied as to fitness for specific applications. Those suggested are for the purpose of illustration only and it is the responsibility of the user to decide on the most suitable product for any use or purpose whatsoever.

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