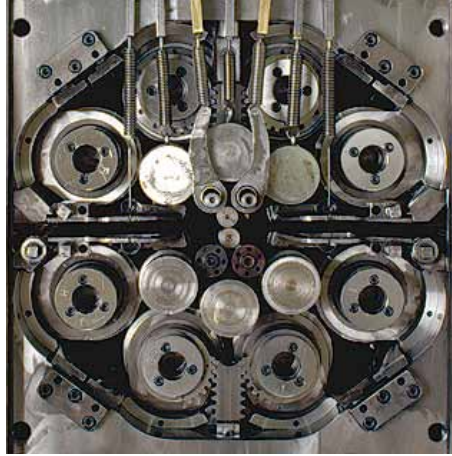


# STAIN LESS STEEL



## Technical Information

The main justification for selecting stainless steel for a given application is its outstanding corrosion and oxidation resistance which, along with other exceptional properties, such as the ability to develop very high strength through cold working or heat treatment, excellent formability and 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.



## STAINLESS STEELS GRADE DESIGNATIONS AND CHEMICAL COMPOSITIONS (% BY WEIGHT)

European Designation BS EN 10088-2 (1995)		ASTM	European Designations Chemical Compositions (%)								
NUMBER	NAME	AISI	C	Si (max)	Mn (max)	P (max)	S (max)	Cr	Ni	Mo	Others
<b>AUSTENITIC</b>											
1.4310	X10 Cr Ni 18-8	301	0.05 to 0.15	*2.00	2.00	0.045	0.015	16.00 to 19.00	6.00 to 9.50	≤ 0.80	*available with Si @ 1% max
1.4307	X2 Cr Ni 18-9	304L	≤ 0.03	1.00	2.00	0.045	0.015	17.50 to 19.50	8.00 to 10.00		
1.4301	X5 Cr Ni 18-10	304	≤ 0.07	1.00	2.00	0.045	0.015	17.00 to 19.50	8.00 to 10.50		
1.4303	X4 Cr Ni 18-12	305	≤ 0.06	1.00	2.00	0.045	0.015	17.00 to 19.00	11.00 to 13.00		
1.4404	X2 Cr Ni Mo 17-12-2	316L	≤ 0.03	1.00	2.00	0.045	0.015	16.50 to 18.50	10.00 to 13.00	2.00 to 2.50	
1.4432	X2 Cr Ni Mo 17-12-3	316L	≤ 0.03	1.00	2.00	0.045	0.015	16.50 to 18.50	10.50 to 13.00	2.50 to 3.00	
1.4401	X5 Cr Ni Mo 17-12-2	316	≤ 0.07	1.00	2.00	0.045	0.015	16.50 to 18.50	10.00 to 13.00	2.00 to 2.50	
1.4436	X3 Cr Ni Mo 17-13-3	316	≤ 0.05	1.00	2.00	0.045	0.015	16.50 to 18.50	10.50 to 13.00	2.50 to 3.00	
1.4571	X6 CrNiMoTi 17-12-2	320	≤ 0.08	1.00	2.00	0.045	0.015	16.50 to 18.50	10.50 to 13.50	2.00 to 2.50	Ti = 5 x C to 0.70 max
1.4541	X6 Cr Ni Ti 18-10	321	≤ 0.08	1.00	2.00	0.045	0.015	17.00 to 19.00	9.00 to 12.00		Ti = 5 x C to 0.70 max
1.4550	X6 Cr Ni Nb 18-10	347	≤ 0.08	1.00	2.00	0.045	0.015	17.00 to 19.00	9.00 to 12.00		Nb = 10 x C to 1.00 max
1.4539	X1 NiCrMoCu 25-20-5	904L	≤ 0.02	0.70	2.00	0.030	0.010	19.00 to 21.00	24.00 to 26.00	4.00 to 5.00	Cu 1.20 to 2.00
<b>FERRITIC</b>											
1.4016	X6 Cr 17	430	≤ 0.08	1.00	1.00	0.040	0.015	16.00 to 18.00			
<b>MARTENSITIC</b>											
1.4006	X12 Cr 13	410	0.08 to 0.15	1.00	1.50	0.040	0.015	11.50 to 13.50	≤ 0.75		
1.4028	X30 Cr 13	420	0.26 to 0.35	1.00	1.50	0.040	0.015	12.00 to 14.00			
<b>PRECIPITATION HARDENING</b>											
1.4568	X7 Cr Ni Al 17-7	17-7 PH	≤ 0.09	0.70	1.00	0.040	0.015	16.00 to 18.00	6.50 to 7.80		Al 0.70 to 1.50
<b>HEAT RESISTING STEELS (pr EN 10095)</b>											
1.4833	X12 Cr Ni 23-13	309	≤ 0.15	1.00	2.00	0.045	0.030	22.00 to 24.00	12.00 to 14.00		
1.4845	X8 Cr Ni 25-21	310	≤ 0.10	1.50	2.00	0.045	0.030	24.00 to 26.00	19.00 to 22.00		

### Material Quality Standards

The grades of stainless steel are shown with the new European designation system but for convenience they are linked with the former British Standard, the American AISI grade and also the Unified Numbering System.

The compositions given equate to European Standard BS EN 10088-2 and are the closest equivalents to BS 1449-2.

The 300 series grades 309 and 310 which did appear in BS 1449-2 do not appear in BS EN 10088-2 and have been placed in BS EN 10095 (provisional), a standard covering heat resisting steels.

## STAINLESS STEEL MECHANICAL PROPERTIES

European Designation BS EN 10088-2 (1995)		ASTM	Mechanical Properties at room temperature in the Annealed Condition			
NUMBER	NAME	AISI	Proof strength 0,2% min. (N/mm <sup>2</sup> )	Tensile strength (N/mm <sup>2</sup> )	Elong. % min. (50 mm Gauge length)	Hardness max. (VPN)
<b>AUSTENITIC</b>						
1.4310	X10 Cr Ni 18-8	301	250	600 – 950	40	220
1.4307	X2 Cr Ni 18-9	304L	220	520 – 670	45	185
1.4301	X5 Cr Ni 18-10	304	230	540 – 750	45	190
1.4303	X4 Cr Ni 18-12	305	220	500 – 650	45	185
1.4404	X2 Cr Ni Mo 17-12-2	316L	240	530 – 680	40	195
1.4432	X2 Cr Ni Mo 17-12-3	316L	240	550 – 700	40	195
1.4401	X5 Cr Ni Mo 17-12-2	316	240	530 – 680	40	205
1.4436	X3 Cr Ni Mo 17-13-3	316	240	530 – 680	40	205
1.4571	X6 CrNiMoTi 17-12-2	320	240	540 – 690	40	205
1.4541	X6 Cr Ni Ti 18-10	321	220	520 – 720	40	200
1.4550	X6 Cr Ni Nb 18-10	347	220	520 – 720	40	200
1.4530	X1 NiCrMoCu 25-20-5	904L	240	530 – 730	35	190
<b>FERRITIC</b>						
1.4016	X6 Cr 17	430	260	450 – 600	20	175
<b>MARTENSITIC</b>						
1.4006	X12 Cr 13	410	-	600 max.	20	200
1.4028	X30 Cr 13	420	-	740 max.	15	235
<b>PRECIPITATION HARDENING</b>						
1.4568	X7 Cr Ni Al 17-7	17-7 PH	-	1030 max.	19	
<b>HEAT RESISTING STEELS (pr EN 10095)</b>						
1.4833	X12 Cr Ni 23-13	309	210	500 – 700	35	205
1.4845	X8 Cr Ni 25-21	310	210	500 – 700	35	205

European Designation BS EN 10088-2 (1995)		ASTM	Service Properties	Applications
NUMBER	NAME	AISI		
<b>AUSTENITIC</b>				
1.4310	X10 Cr Ni 18-8	301	Lower Cr and Ni give increased work hardening rates, to give high strength and abrasion resistance. Particularly suitable for components requiring stretch forming or good spring properties.	SPRINGS, PRESSINGS, CONNECTORS, CHEMICALLY ETCHED COMPONENTS
1.4301	X5 Cr Ni 18-10	304	Most popular grade in the 300 series, exhibits good corrosion resistance and formability. 304 can be used in the welded condition in mild environments, however 304L should be used in more corrosive conditions.	FLOPPY DISKS (SHUTTER), FLEXIBLE TUBE EXPANDED METAL
1.4307	X2 Cr Ni 18-9	304L	Reduced C content for better corrosion resistance in welded structures.	WATER TUBE, BELLOWS, PRESSINGS
1.4303	X4 Cr Ni 18-12	305	Ni increased to lower work hardening rate and therefore develops little magnetism when cold worked. Very popular for deep drawing or spinning operations.	PEN CAPS AND BODIES
1.4401	X5 Cr Ni Mo 17-12-2	316	Mo added to increase corrosion resistance.	BURSTING DISCS, SEALS, BELLOWS, GASKETS, EXPANSION JOINTS, EXPLOSION PANELS, TUBES, DIAPHRAGMS. Components in chemical, petrochemical and marine applications.
1.4404	X2 Cr Ni Mo 17-12-2	316L	Reduced C content for better welded corrosion resistance.	
1.4571	X6 CrNiMoTi 17-12-2	320	Ti "stabilized" version of 316 prevents corrosion of welded structures, by preventing formation of chromium carbides.	
1.4541	X6 Cr Ni Ti 18-10	321	Ti added to oppose chromium carbide precipitation and remove risk of corrosion in welded structures.	EXPANSION JOINTS, SEALS, BELLOWS, GASKETS, HONEYCOMB SEALS, THERMAL INSULATION, TUBE, FLEXIBLE TUBE, DIAPHRAGMS AND BELLOWS. Favoured by the aerospace industry, particularly in engine related applications.
1.4550	X6 Cr Ni Nb 18-10	347	Nb added to oppose chromium carbide precipitation, remove risk of corrosion in welded structures.	
1.4539	X1 NiCrMo-Cu 25-20-5	904L	Cr increased and Ni increased substantially to give much improved corrosion resistance, e.g. Phosphoric Acid Plant & Equipment, Sulphuric Acid Plant. High resistance to solutions contaminated with chlorides.	SEALS, GASKETS AND SHIMS, THERMAL INSULATION PANELS, DESTILLATION COLUMN PACKING.
<b>FERRITIC</b>				
1.4016	X6 Cr 17	430	Popular general purpose ferritic grade. Moderate corrosion resistance, good formability due to low work hardening rate. Applications requiring a stainless steel which respond to a magnet.	AUTOMOTIVE TRIM, DOMESTIC APPLIANCE PANELS, FLOPPY DISKS (HUB), CHEMICALLY ETCHED COMPONENTS
<b>MARTENSITIC</b>				
1.4006	X12 Cr 13	410	The most commonly used alloy in the martensitic family, offers a wide range of mechanical properties obtainable by hardening and tempering.	STAINLESS SPRINGS, HEAT TREATABLE.
1.4028	X30 Cr 13	420	Increased C content to provide increased hardness and abrasion resistance.	CUTLERY, MACHINE KNIVES, SCISSORS.
<b>PRECIPITATION HARDENING</b>				
1.4568	X7 Cr Ni Al 17-7	17-7 PH	Commonly used grade of precipitation hardening stainless steel. Can be used in a hard temper (Condition C) and aged to give increased mechanical properties. Hardness and strength resistant to softening at elevated temperatures up to 350°C.	STAINLESS STEEL SPRINGS, DIAPHRAGMS, ENCAPSULATED BELLOWS.
<b>HEAT RESISTING STEELS (pr EN 10095)</b>				
1.4833	X12 Cr Ni 23-13	309	Heat resisting grade with superior corrosion and oxidation resistance.	GAS BURNER RADIATORS, ELECTRIC HEATING ELEMENT TUBES.
1.4845	X8 Cr Ni 25-21	310	Increased Ni content to enhance even further the corrosion resistance. Can be used at higher temperatures than the 309.	NUCLEAR THERMAL INSULATION