Stainless Steel

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1. Stainless steel is a ferrous alloy with a minimum of 11% chromium content which does not stain, corrode or rust as easily as ordinary steel.

Besides chromium, other typical alloying elements are:

- **Nickel**
- **Molybdenum**
- **Manganese**
- **Titanium**
- **Niobium**

These elements are added to enhance structure and properties such as formability, ductility, strength and toughness.

☆ **Stainless steel is 100% recyclable. In fact the main source of raw material for its production comes from re-melted scrap metal.**

Moreover, its life expectancy is usually long and only a minimum of maintenance is needed.

This is why stainless steel is rendered as an environmental friendly material.

2. **The chromium in the steel combines with the atmospheric oxygen to form a very thin (1-5 X 10^{-9}m), chromium rich oxide layer called the "passive" film.**

   This film is invisible meaning the metal stays shiny. However, it is strongly adherent and chemical stable and protects the metal beneath.

   The corrosion resistance durability of stainless steel arises from the ability of the passive film to self repair when scratched from the surface. Where there is sufficient oxygen available more oxide will quickly form and recover the exposed surface.

3. **The main requirement for stainless steel is to be corrosion resistant for a specific application or environment. Also mechanical or physical properties may need to be considered to achieve the overall performance requirements.**

   For these reasons it is important to select the appropriate type and grade of stainless steel.

4. **Three of the main types of stainless steel identified by their microstructure crystal phase are:**

AUSTENITIC stainless steels contain a maximum of 0.15% carbon, 18 – 20% chromium, 8 – 10% nickel and/or manganese. It is the most widely used type of stainless steel.

The added elements make the steel to retain an austenitic structure at all temperatures, give it ductility, good weldability and non-

magnetic properties. Austenitic steels are not hardenable by heat treatment.

FERRITIC stainless steels are highly corrosion resistant, but less durable and ductile than austenitic grades. They are magnetic and can not be hardened by heat treatment.

They have a low carbon content, 13 – 17% chromium, very little nickel if any and some compositions include molybdenum or titanium.

MARTENSITIC stainless steels are less corrosion resistant than the other two types, but they are extremely strong and tough. They are magnetic and can be hardened due to martensite which also reduces its toughness and makes it brittle.

They contain 12% chromium, 0.2 – 1% molybdenum, no nickel and 0.1 – 1.5% carbon.

5. PROPERTY TABLES

DESIGNATIONS

GROUP	Grade	European Designation		USA AISI
		Name	N°	
Basic Austenitics	17-7 C	X10CrNi18-8	1.4310	301
	18-9 E	X5CrNi18-10	1.4301	304
	18-11 ML	X2CrNiMo17-12-2	1.4404	316L
Austenitics with higher resistance to intergranular corrosion	18-9 EL	X2CrNi19-11	1.4306	304L
	18-10 T	X6CrNiTi18-10	1.4541	321
	17-11 MT	X6CrNiMoTi17-12-2	1.4571	316Ti
	18-13 MS	X2CrNiMo18-14-3	1.4435	316L
Austenitics for deep drawing	18-9 D	X5CrNi18-10	1.4301	304
Creep resistant Austenitics	R24-13 S	X12CrNi23-13	1.4833	309S
	R25-20	X8CrNi25-21	1.4845	310S
Basic Ferritics	F 12 T	X2CrTi12	1.4512	409
	F 17	X6Cr17	1.4016	430
	F 17 T	X3CrTi17	1.4510	430Ti
Special Ferritics	F 17 M	X6CrMo17-1	1.4113	434

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PROPERTIES

GROUP	USA AISI	PROPERTIES				
		Cold formability	Weldability	Resistance to irregular corrosion	Resistance to hot oxidation	Mechanical strength
Basic Austenitics	301	■■	■■	■■■	■	■■■■
	304	■■■■	■■■	■■	■■	■■■
	316L	■■■■	■■■■	■■■■■	■■■■	■■■
Austenitics with higher resistance to intergranular corrosion	304L	■■■■■	■■■■■	■■■■■	■■	■■
	321	■■■■	■■■■	■■■■■	■■■	■■
	316Ti	■■■	■■■	■■■■■	■■■	■■■
	316L	■■■■	■■■	■■■■■	■■■■	■■■
Austenitics for deep drawing	304	■■■■	■■■■	■■	■	■■■
Creep resistant Austenitics	309S	■■	■■■■	■■■	■■■■	■■■■
	310S	■■	■■■■	■■■	■■■■	■■■■
Basic Ferritics	409	■■■	■■■	■■■■	■■■	■■
	430	■■	■■	■	■■■	■■■
	430Ti	■■■	■■■	■■■■	■■■	■■
Special Ferritics	434	■■	■■	■	■■	■■

■ Low ■■ Medium ■■■ Good ■■■■ Very good ■■■■■ Excellent

CHEMICAL COMPOSITION

GROUP	USA AISI	Chemical Composition (indicative)							
		C	Si	Mn	Cr	Mo	Ni	Other	Variants
Basic Austenitics	301	0.10	0.60	1.00	17		7.20		
	304	0.05	0.50	1.10	18.20		8.30		
	316L	<0.03	0.50	1.50	17	2.10	10.30		
Austenitics with higher resistance to intergranular corrosion	304L	<0.02	0.50	1.10	18.50		10	N<0.02	
	321	0.03	0.50	1.30	17.50		9.20	Ti=0.30	Ti>5 (C+N)
	316Ti	0.04	0.50	1.50	17	2.10	10.70	Ti=0.35	
	316L	<0.03	0.50	17.80	2.60	12.70			
Austenitics for deep drawing	304	0.04	0.50	1.50	18.20		8.70		
Creep resistant Austenitics	309S	0.06	0.35	1.50	22.50		13.50		
	310S	0.05	0.50	1.70	25		19.80		
Basic Ferritics	409	0.02	0.50	0.30	11.50			Ti=0.18	
	430	0.05	0.35	0.40	16.50				F18 (Cr≥18.5)
	430Ti	0.02	0.35	0.40	16.50			Ti=0.40	
Special Ferritics	434	0.05	0.35	0.40	16.50	1			F17MS (Mo=1.25)

MECHANICAL CHARACTERISTICS

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GROUP	USA AISI	ANNEALED (Indicative)			
		Rm (N/mm2)	Rp0.2 (N/mm2)	A %	HB ou HV
Basic Austenitics	301	670	300	48	215
	304	670	320	50	160
	316L	600	310	48	180
Austenitics with higher resistance to intergranular corrosion	304L	580	240	50	140
	321	610	280	48	180
	316Ti	610	310	47	190
	316L	610	310	45	200
Austenitics for deep drawing	304	630	300	54	160
Creep resistant Austenitics	309S	630	330	45	220
	310S	600	300	42	220
Basic Ferritics	409	410	250	32	130
	430	500	340	26	160
	430Ti	450	300	30	140
Special Ferritics	434	540	370	27	160

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