



**COLUMBUS
STAINLESS**
[Pty] Ltd

Technical Brochure

**DUPLEX
STAINLESS STEELS**

Adding Stainless Quality to life
www.columbusstainless.co.za

Introduction

Duplex stainless steels have a microstructure of nearly equal proportions of austenite and ferrite. This microstructure ensures that they are much more resistant to stress corrosion cracking than conventional austenitic stainless steels such as 304L/1.4307 or 316L/1.4404.

Duplex stainless steels are also tough in gauges up to 40mm and can be successfully welded in these thick gauges. This is in contrast to common ferritic stainless steels, which tend to be brittle in thick gauges, particularly if welded, which limits their use to applications requiring gauges up to 3mm. Duplex stainless steels remain tough between -20°C or lower, depending on the gauge, and 300°C.

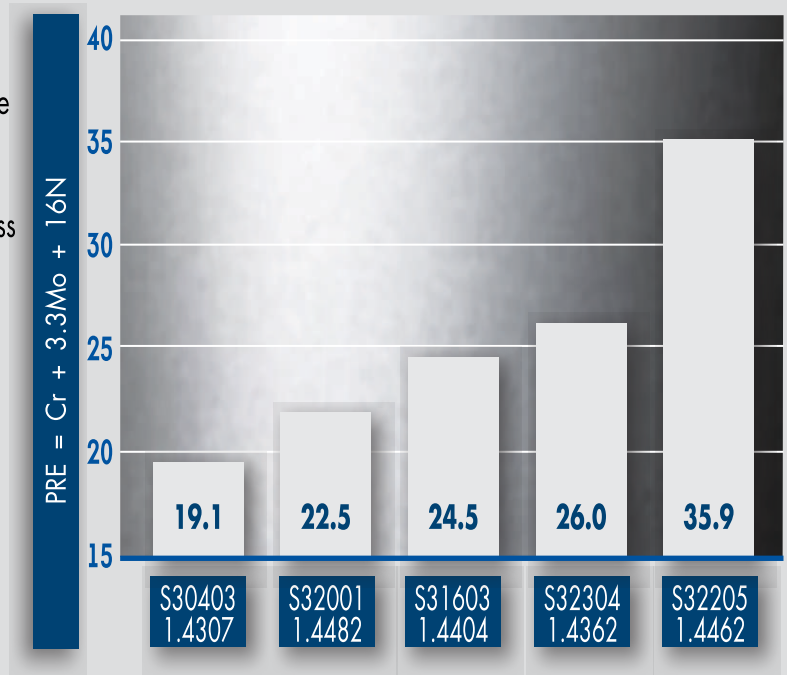
Corrosion resistance

The adjacent figure shows the Pitting Resistance Equivalent (PRE) of the duplex stainless steels compared to the conventional austenitic stainless steels. The PRE is a measure of the pitting resistance in chloride environments.

In most environments, S32001/1.4482 has a similar corrosion resistance to 304L/1.4307, while S32304/1.4362 has a similar corrosion resistance to 316L/1.4404.

S32205/1.4462 has significantly better corrosion resistance than 316L/1.4404 in most environments.

It thus stands to reason that S32001/1.4482 can be seen as a 304L/1.4307 substitute, while S32304/1.4362 can be seen as a 316L/1.4404 substitute.



Strength

The specification 0.2% Proof Stress of duplex stainless steels is about double that of conventional austenitic stainless steels. This often allows down gauging in the design (dependant on buckling and Young's Modulus limitations), with associated cost benefits.

Applications

S32001/1.4482 has good strength, toughness, corrosion resistance and resistance to stress corrosion cracking. Applications include process and storage tanks, ducting and structural applications. S32001/1.4482 is also suitable for pipe supports, walkways, cable racking, strapping, clamps, etc. in aggressive environments.

S32304/1.4362 has a higher chromium and nitrogen content than S32001/1.4482. The resultant composition gives the steel much improved corrosion resistance in many aggressive environments. The higher chromium and nitrogen contents ensure more resistance to pitting and crevice corrosion in chloride containing media and chemical environments such as sulphuric acid compounds as well as phosphoric and acetic acids. The lower rate of general corrosion in mildly corrosive environments gives the steel good atmospheric corrosion resistance in polluted marine atmospheres.

S32205/1.4462 is a highly suitable material for service in environments containing chlorides and hydrogen sulphide such as marine environments and the oil and gas extraction and processing industries. Typical applications also include the chemical industry (processing, transport and storage, e.g. pressure vessels, tanks and piping), the pulp and paper industry (digesters and liquor tanks) and the mining industry. S32205/1.4462 has thus found widespread use in production tubing and flowlines for the extraction of oil and gas from sour wells, in refineries and in process solutions contaminated with chlorides. S32205/1.4462 is also particularly suitable for heat exchangers where chloride bearing water or brackish water is used as the cooling medium.



Cost effective solutions

Duplex stainless steels can provide a cost effective alternative to austenitic stainless steels in many instances. The table below shows the relative price range, based on historical data, as a percentage based on the cost per tonne of the substituted conventional austenitic. The increased strength of duplex stainless steels often allows down gauging, which, depending on Young's Modulus and buckling limitations, is typically between 15 and 40%. This weight (and thus cost) saving, together with the price per tonne difference are presented in the table below.

	Relative price to substituted austenitic	Relative price plus 15% weight reduction (overall saving)	Relative price plus 40% weight reduction (overall saving)
S32001/1.4482 substituting 304L/1.4307	5 to 20% more	0 to 10% saving	30 to 40% saving
S32304/1.4362 substituting 316L/1.4404	10 to 30% less	25 to 40% saving	45 to 60% saving
S32205/1.4462 as a superior alternative to 316L/1.4404	10 to 40% more	5% saving to 20% premium	15 to 33% saving

Conclusion

It can be seen that duplex stainless steels can offer a cost effective alternative to conventional austenitic stainless steels, without the gauge limitations of common ferritic stainless steels and the stress corrosion cracking susceptibility of austenitic stainless steels.



Technical data

Composition

The chemical composition requirements are according to both ASTM A240 and EN 10088-2.

Type			C	Mn	P	S	Si	Cr	Ni	Mo	Cu	N	PRE
UNS	AISI	EN											
S30403	304L	1.4307	0.030 max	2.00 max	0.045 max	0.030 max	0.75 max	17.5 19.5	8.0 10.5	-	-	0.10 max	19.1
S32001	-	1.4482	0.030 max	4.00 6.00	0.035 max	0.015 max	1.00 max	19.5 21.5	1.00 3.00	0.60 max	1.00 max	0.05 0.17	22.5
S31603	316L	1.4404	0.030 max	2.00 max	0.045 max	0.030 max	0.75 max	16.5 18.0	10.0 13.0	2.00 2.50	-	0.10 max	24.5
S32304	2304	1.4362	0.030 max	2.00 max	0.035 max	0.015 max	1.00 max	22.0 24.0	3.5 5.5	0.10 0.60	0.10 0.60	0.05 0.20	26.0
S32205	2205	1.4462	0.030 max	2.00 max	0.035 max	0.015 max	1.00 max	22.0 23.0	4.5 6.5	3.0 3.5	-	0.14 0.20	35.9

Mechanical properties

The mechanical properties requirements are according to both ASTM A240 and EN 10088-2.

Type			Product form thickness	Maximum thickness mm	R _{p0.2} MPa min	R _{p1.0} MPa min	R _m MPa	A ^{a)} <3mm thick % min	A ^{b)} ≥3mm thick % min
UNS									
S30403	304L	1.4307	C	≤6	220	250	520	45	45
			H	≤8	200	240	700		
			P	≤65			500		
S32001		1.4482	C	≤6	500	-	700 - 900	25	30
			H	≤8	480	-	660 - 900	30	
			P	≤65	450	-	650 - 850		
S31603	316L	1.4404	C	≤6	240	270	530	40	40
			H	≤8	220	260	680		
			P	≤65			520		
S32304	2304	1.4362	C	≤6	450	-	650	25	25
			H	≤8	400	-	850		
			P	≤65			-		
S32205	2205	1.4462	C	≤6	500	-	700	25	25
			H	≤8	460	-	950		
			P	≤65			-		

a) 80mm gauge length for EN 10088-2, 50mm gauge length for ASTM A240.

b) Proportional gauge length (5.65 × √cross-sectional area) for EN 10088-2, 50mm (2 in) gauge length for ASTM A240.