2507 SDSS

Material

S32750, 1.4410, X2CrNiMoN2574, 022Cr25Ni7Mo4N
S32760, 1.4501, X2CrNiMoCuWN2574, 022Cr25Ni7Mo4WCuN

Overview

2507 SDSS contains 25% chromium, 4% molybdenum, and 7% nickel are designed for demanding applications which require exceptional strength and corrosion resistance, such as chemical process, petrochemical, and seawater equipment. The steel has excellent resistance to chloride stress corrosion cracking, high thermal conductivity, and a low coefficient of thermal expansion. The high chromium, molybdenum, and nickel levels provide excellent resistance to pitting, crevice, and general corrosion.

2507 SDSS like S32750 and S32760, is a mixed microstructure of austenite and ferrite (50/50) which has improved strength over ferritic and austenitic steel grades. The main difference is that Super Duplex has a higher molybdenum and chromium content which gives the material greater corrosion resistance than standard duplex grades.

The balanced duel phase microstructure combines high strength with cost effective corrosion resistance particularly in high chloride environments. Super Duplex has the same benefits as its counterpart – it has lower alloying costs when compared with similar ferritic and austenitic grades with equipment corrosion resistance in chloride containing environments due to the material's increased tensile and yield strength. In many cases this gives the purchaser the welcomed option of purchasing smaller thicknesses without the need to compromise on quality and performance.

Characteristics

◇ Excellent resistance to stress corrosion cracking (SCC) in chloride-bearing environments
◇ Excellent resistance to pitting and crevice corrosion
◇ High resistance to general corrosion
◇ Very high mechanical strength
◇ Physical properties that offer design advantages
◇ High resistance to erosion corrosion and corrosion fatigue
◇ Good weldability

Application

2507 SDSS are widely used in industries of oil-gas, chemical processing, subsea control line, heat exchangers, offshore plateforms, fire-fighting system, injection & ballast water systems, vessels, desalination plants, energy industry FGD system, industrial scrubbing system, absorption tower, etc.

Typical applications

Oil and gas industry
Chloride-containing environments such as seawater handling and process systems. Hydraulic and process fluid tubes in umbilicals.

Seawater cooling
Tubing for heat exchangers in refineries, chemical industries, process industries and other industries using seawater or chlorinated seawater as coolant.

Salt evaporation industry
Evaporator tubing for production of corrosive salts, e.g. chlorides, sulphates and carbonates.

Desalination plants
Pressure vessels for reverse osmosis units, tube and pipe for seawater transport, heat exchanger tubing.

Geothermal wells
Heat exchangers in geothermal exploitation units, systems exposed to geothermal or high salinity brines, tubing and casing for production.

Refineries and petrochemical plants
Tubes and pipes where the process environment contains a high amount of chlorides, or is contaminated with hydrochloric acid.

Pulp and paper industry
Material for chloride-containing bleaching environments.

Chemical industry
Organic acid plants, also when process solutions are contaminated with e.g. chlorides.

Mechanical components requiring high strength
Propeller shafts and other products subjected to high mechanical load in seawater and other chloride-containing environments.

Desulphurisation units
As reheater tubes in flue gas desulphurisation systems. The good mechanical and corrosion properties make 2507 SDSS an economical choice in many applications by reducing the life cycle cost of equipment.

Chemical composition (wt% as per ASTM A789 / A790)

Material	C	Si	Mn	P	S	Cr
S32750	≤0.03	≤0.80	≤1.20	≤0.030	≤0.020	24.0~26.0
S32760	≤0.03	≤1.0	≤1.0	≤0.030	≤0.020	24.0~26.0
Material	Ni	Mo	N	Cu	W	
S32750	6.0~8.0	3.0~5.0	0.24~0.32	≤0.50		
S32760	6.0~8.0	3.0~4.0	0.20~0.30	0.50~1.00	0.50~1.00	

S32750: PREN ≥ 41, S32760: PREN ≥ 40.

Physical property

Density: 0.285 lbs/in^3 (7.88 g/cm^3)
Melting Point: 2570-2660°F (1410-1460°C)
Specific Heat (0-100°C): 500 $J.kg^{-1}.°K^{-1}$
Thermal Conductivity at 68-212°F (20-100℃): 9.0(17.0) $W.m^{-1}.°K^{-1}$
Thermal Expansion at 32-212° F: 7.2×10^{-6} (13) in/in/°F(um/mK)
Modulus Elasticity: 200 GPa
Modulus of Elasticity: 29×10^3 ($200x\ 10^3$) ksi (MPa)
Electrical Resistivity: 8.12 μohm/cm
Magnetic permeability: ferromagnetic

Corrosion resistance

General corrosion resistance
Due to 2507's high chromium content (≈25%), SDSS has good resistance to oxidizing acid concentrations. Reducing acid concentrations that can be tolerated are not as high due to moderate and low levels of molybdenum (≈4%) and nickel (≈7%).

Pitting corrosion resistance
Pitting and crevice corrosion resistance is generally a function of an alloy's chromium, molybdenum and nitrogen contents. Calculated indexes have been devised to roughly predict and rank alloys for pitting resistance based on these elements (in weight-%). The higher the index the higher the predicted pitting corrosion resistance.
The most common index used for duplex alloys is:
Pitting Resistance Equivalence Number (PRE or PREN) = %Cr + (3.3 x %Mo) + (16 x %N).

Stress corrosion cracking resistance
To achieve resistance to stress corrosion cracking in stainless steels, the nickel content must either be low as in the ferritic group of steels, or very high making them correctly nickel base alloys. The ferritic stainless steels are nearly immune to SCC, but are difficult to fabricate and are subject to brittle behavior at low temperatures. Nickel, and high nickel alloys also possess excellent SCC resistance but are costly due to their high nickel content. The low nickel austenitic stainless steels (304, 316, 317) have poor SCC resistance compared to ferritic stainless and high nickel alloys.

Duplex stainless steel are essentially a compromise possessing some of the ferritic SCC resistance and much of the superior formability of the common austenitic stainless alloys, at a cost saving over the high nickel alloys.

Intergranular corrosion
2507 SDSS is a member of the family of modern duplex stainless steels whose chemical composition is balanced to give quick reformation of austenite in the high temperature heat affected zone of a weld. This results in a microstructure that provides the material with good resistance to intergranular corrosion.

Erosion corrosion
The mechanical properties combined with corrosion resistance give 2507 SDSS a good resistance to erosion corrosion. Testing in sand containing media has shown that 2507 SDSSS has an erosion corrosion resistance better than corresponding austenitic stainless steels.

Mechanical property

Material	Tensile strength ksi (MPa)	Yield strength ksi (MPa)	Elongation in 2″ % min.	Hardness HBW /HV max.
S32750	116 (800)	80 (550)	15	300 / 300
S32760	109 (750)	80 (550)	25	310 / 310

Heat treatment

S32750: 1880-2060 (1025-1125), rapid cooling in water or air.
S32760: 1960-2085 (1070-1140), rapid cooling in water or air.
While the SDSS have rather high room temperature strength, they have surprisingly low strength at annealing temperatures. Relative to the common austenitic steels the SDSS generally distort slightly more during annealing.

This is believed to be a result of the higher yield strength, where parts store more stress due to cold-work, which is relaxed during annealing. Parts, structures and tubes can also deform from their own weight during annealing depending on the temperature, time and support.

Stress relieving or deliberate slow cooling is not recommended due to possible embrittlement, which can result from exposure in the range of 650 - 1830˚F.

Hardening
It cannot be hardened by heat treatment. Can be hardened only by cold working.

Fabrication

Hot working
Heat uniformly to 2200/2300°F (1204/1260°C). Reheat as often as necessary, keeping the temperature above 1850°F (1010°C).

Cold forming
Cold working increases strength and hardness. The work hardening rate of Duplex 2507 stainless is lower than Type 304 austenitic stainless steel. Most cold working methods of ordinary stainless steel can be used for cold working 2507 SDSS. SDSS has higher yield strength and lower plasticity than austenitic steel, so it needs greater forming force, greater bending radius and greater springback allowance when machining the steel. It is more difficult to carry out deep drawing, drawing and similar processes for 2507 SDSS than for austenitic stainless steel. Solution annealing and quenching are recommended when more than 10% of cold deformation is required.

Weldability
2507 SDSS has excellent weldability and can be welded to similar or dissimilar steel materials by gas shielded metal arc welding (SMAW), gas shielded tungsten Arc welding (GTAW), plasma arc welding (PAW), or submerged arc welding (SAW). When welding using any welding process, it is important to clean the metal surface quickly before welding. Preheating is not necessary except to prevent condensation on cold metals. Interlayer welding temperature shall not exceed 300°F or welding integrity shall not be adversely affected. For maximum corrosion resistance, the root of the weld should be welded under the protection of argon gas or 90% N_2/10% H_2 blowout gas, which provides the best corrosion resistance.

Machinability
The machinability of 2507 SDSS generally has been similar to that of conventional Type 316 stainless steel.

Electropolishing of SDSS
Many pharmaceutical and biotechnology applications require product contact surfaces to be electropolished. The ability to achieve a high quality electropolished surface is, therefore, an important material characteristic. The 2507 SDSS can be electropolished to a smoothness of 15 micro-inches (0.38 micro-meters) or smoother, which meets or exceeds the surface finish requirements for electropolished surfaces in the ASME BPE Standard. Although 2507 SDSS can readily meet the pharmaceutical and biotechnology industry's surface finish requirements, an electropolished 2507 surface is not as bright and lustrous as an electropolished 316L surface. This difference is due to the tendency for slightly higher metal dissolution rates in the ferrite phase compared to the austenite phase during electropolishing.

Available Process

(1) Hot formed, solution annealed, descaled
(2) Cold worked and bright annealed
(3) Cold worked, annealed and descaled
(4) Cold worked, polished (MP, EP etc.)
(5) Cold worked, bright annealed, polished (MP, EP etc.)

Common Tests

Chemical composition
Tension
Hardness
Flaring
Flange
Flattening
Micro structure
Hydrostatic
NDT
Intergranular Corrosion
Surface condition
Shape and dimension
Positive Material Identification