Langley Alloys

Super-Duplex

Ferralium® 255 - SD50 (Bar)

Specifications:

ASTM A182 Grade F61 UNS 532550, ASTM A240 UNS S32520, ASTM A479 UNS S32550, ASTM A276 UNS S32550 Condition A, EN 10088.3 1.4507, Norsok MDS D54, Norsok MDS D57, NACE MR0175 / ISO 15156, API 6A, ASME Aproval as Table UHA23 and Code Case 1883

Ferralium® 255 - SD50 is a super duplex stainless steel supplied in the hot worked and annealed condition. It achieves higher strengths than most other stainless steels and alternative corrosion resistant alloys, offering the potential to reduce section size and therefore weight and cost.

As a 25% Chromium alloy, with significant additions of Copper, it offers excellent corrosion resistance in a wide variety of corrosive chemicals including sulphuric, nitric and phosphoric acid. In seawater and other chloride containing environments it also provides outstanding resistance to pitting and crevice corrosion, with Critical Pitting Temperature exceeding 50°C. Excellent ductility and impact strength at both ambient and sub-zero temperatures combine with a high resistance to abrasion, erosion and cavitation erosion.

Listed in NACE MR0175 for sour service and having gained ASME Approval for Pressure Vessel applications, Ferralium® 255-SD50 is tested to the highest degree using tests designed to guarantee that the trade-marked product possesses high integrity, a correct phase balance and the absence of sigma and other deleterious phases.

Key Features:

- Originally developed in 1960's, pioneering the addition of nitrogen, to create the first super duplex stainless steel
- Continuously developed through 1990's to extend PREN > 40, and more recently to increase mechanical properties
- First super duplex stainless steel to achieve 586N/mm^2 as a minimum 0.2% Proof Stress, up to 12" (300mm) section sizes
- Pitting Resistance Equivalent Number (PREN) >40, indicating outstanding resistance to pitting and crevice corrosion
- Very low levels of Sulphur minimise the likelihood of inclusions as sites for potential pitting corrosion
- Higher Copper content provides self-healing effect at sites of pitting to inhibit further growth
- Available as bars, plate, pipe and fittings with complementary weld wire
- Particularly suitable for larger components as the formation of sigma phase is much less likely than it is for other super duplex stainless steels

Typical Applications:

- Oil & Gas industry pumps, valves, wellhead and subsea equipment
- Pollution control scrubbers, precipitators, fans and pumps
- Marine propellers, shafts, rudders, seals, pumps, valves
- Bolts and fasteners
- Process industry equipment in sulphuric acid, nitric acid, phosphoric acid, PP / PVC / TiOx production, agrochemicals
- Grain and vegetable processing plant, sugar cane centrifuges
- Pulp and paper digester blow vales, feed valves, washers, black liquor heater tubes, bleaching components
- Copper smelting fans, tuyere bars, wet scrubbers, leaching area precipitators
- Water and sewage treatment, desalination, swimming pools

Product Forms Available:

Bar	✓
Plate	✓
Tube	✓
Fittings	✓
Forgings	To order
Castings	To order

Physical Properties:

Density at 20°C g/cc	7.81	
Mean Coefficient of Thermal Expansion (m/m/°C)	20 - 100°C	11.1 x 10-6
	20 - 200°C	11.5 x 10-6
	20 - 300°C	12.0 x 10-6
Thermal Conductivity (W/m.K)	20°C	14.2
	100°C	16.3
	200°C	18.4
Specific Electrical Resistance (Ω-m)	20°C	0.80
	100°C	0.88
	200°C	0.93
Specific Heat (J/kg.K)	20°C	475
	100°C	500
	200°C	532
Magnetic Permeability	33	
Young's Modulus (kN/mm^2)	199 x 103	
Compression Modulus (N/mm^2)	150 x 103	
Torsional Modulus (N/mm^2)	75 x 103	
Fracture Toughness, KQ (N/mm^2 - m½	98	
Poisson's Ratio	0.32	

Mechanical Properties:

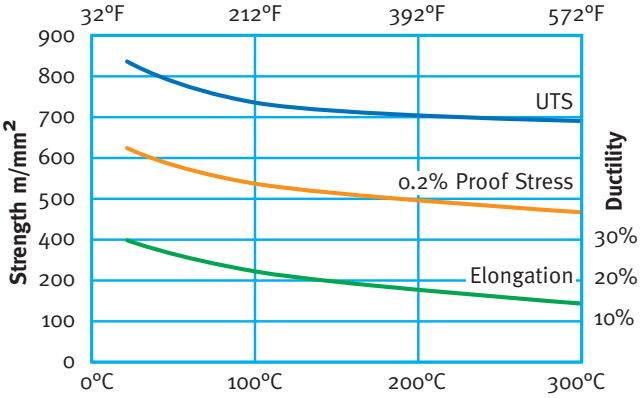
	Bars up to and including 4.0" (100mm) diameter or section		Bars greater than 4.0" (100mm) and up to 12.0" (300mm) diameter or section		Bars greater than 12.0" (300mm) diameter or section	
0.2% Proof Stress	586 N/mm^2	85ksi	586 N/mm^2	85ksi	570 N/mm^2	83ksi
Tensile Strength	790 N/mm^2	114.5ksi	790 N/mm^2	114.5ksi	760 N/mm^2	110ksi
Elongation, 5.65√S0 and 4D	25%		25%		25%	
Reduction of Area	50%		50%		50%	
Hardness (Brinell)	220-270		220-270		220-270	
Impact Strength (Room Temp)	80J	59 ft.lb	80J	59 ft.lb	80J	59 ft.lb
Impact Strength (-46°C)	45J av (35J min)	33 ft.lb av (25.8 ft.lb min)	45J av (35J min)	33 ft.lb av (25.8 ft.lb min)	45J av (35J min)	33 ft.lb av (25.8 ft.lb min)

Notes:

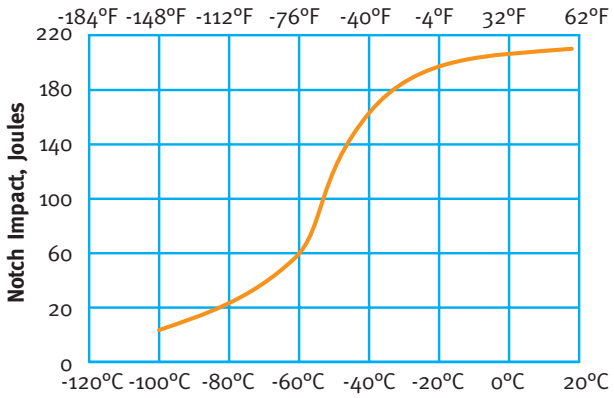
1. Testing shall be carried out in accordance with ASTM A370 or EN ISO 6892-1 (tensile), EN ISO 6506-1 (hardness)
2. Minimum properties quoted (tested at room temperature in a longitudinal direction)
3. Testing performed on each melt of material per heat treatment batch
4. Hardness shall be in accordance with NACE MR0175 with a maximum HRC value of 28 (270HB)
5. Additional tests routinely undertaken:
   a) ASTM G48A corrosion test (at 50°C) - No pitting and < 0.8g/m^2 weight loss
   b) Ferrite content - 35-55%
   c) Microstructure certified free from grain boundary carbides, sigma, chi and laves phases

Typical mechanical properties - non-ambient temperatures

Typical mechanical properties and impact properties achieved over a range of temperatures are shown in the graphs below. It can be seen that FERRALIUM 255-SD50 maintains a high level of notch ductility at subzero temperatures. In common with all duplex and superduplex stainless steels, the recommended maximum continuous operating temperature for FERRALIUM 255-SD50 is 275°C [527°F]. The alloy can be used for occasional short periods at slightly elevated temperatures but care should be exercised.



Graph showing the typical mechanical properties of FERRALIUM 255-SD50 at elevated temperatures



Graph showing the typical impact properties of FERRALIUM 255-SD50 at ambient and subzero temperatures

Chemical composition:

	Cr	Ni	Mo	Co	Nb (+Ta)	Ti	V	W	Cu	C	Mn	N	Si	P	S	Fe	Al
Min	24.50	5.50	3.10						1.50		0.80	0.20					
Max	26.50	6.50	3.80						2.00	0.025	1.20	0.25	0.70	0.025	0.005	Bal	

Product Comparison:

Alloy Comparisons	Ferralium® 255-SD50	S17400 (17- 4PH)	S32205	N07718	S31254
Pitting Resistance Equivalent number	>40	16	34	31	43
0.2% Proof Strength (N/mm²)	586	1100	510	500	325
Corrosion Rate (mm/year) - Seawater	<0.01	~1	<0.01	<0.01	<0.01
Corrosion Rate (mm/year) - 10% sulphuric acid at 80°C	<0.15	10	0.4	<0.15	1.5
Corrosion Rate (mm/year) - Boiling 50% nitric acid	<0.15	<0.15	<0.15	<0.15	0.4
Wear Properties related to Hardness (HRC), maximum	28	38	25	20	20

Machining Advice:

Operation	Cutting Speed m/min (ft/min)	Feed Rate mm/rev (in/rev)	Depth of cut mm (in)
Milling	40 (130)	0.05 - 0.13 mm/tooth 0.02 - 0.005 in/tooth	0.5 - 6.0 (0.02 - 0.25)
Drilling 6.4mm (1/4") dia	250 rpm	0.075 (0.003)	
Drilling 12.7mm (1/2") dia	250 rpm	0.125 (0.005)	
Drilling 25.4mm (1") dia	150 rpm	0.28 (0.011)	
Turning - Roughing	30 - 45 (100 - 150)	0.2-0.38 (0.008 - 0.015)	3 (0.125)
Turning - Finishing	50 - 60 (165 - 200)	0.13-0.20 (0.005 - 0.008)	0.5 (0.02)
Tooling	Milling/Turning: Carbide (SANDVIK GC 235, SECO T25M) Drilling: HSS, point angle 118°, chisel angle 120°		

Production Route:

Ferralium® 255 - SD50 is produced through high-precision steelmaking processes to ensure cleanliness and consistency.

a) All material shall be refined by Vacuum Oxygen Decarburisation (VOD) or Argon Oxygen Decarburisation (AOD)

b) Further refinement by Electric Slag Refining (ESR) is allowable if required for particular customer specifications.

c) The minimum forging ratio utilised is at least 4:1, between 1050-1250°C.

d) Solution treatment shall be carried out at a temperature between 1060-1120°C.

e) This will be followed by immediate water quench

f) Bars are supplied peeled and polished to a surface finish of 125CLA or better

g) Each bar is ultrasonically tested and visually inspected

Further Processing:

- Order processing and stock control is facilitated by a fully-integrated computer system which links to item production and inspection.
- Automated band saws are available for accurate stock cutting up to a section size of 650mm.
- First-stage processing, including water jet cutting, turning, boring and grinding can be undertaken to help manage your overall supply chain.
- Additional documentation and certification can be supplied as required.

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