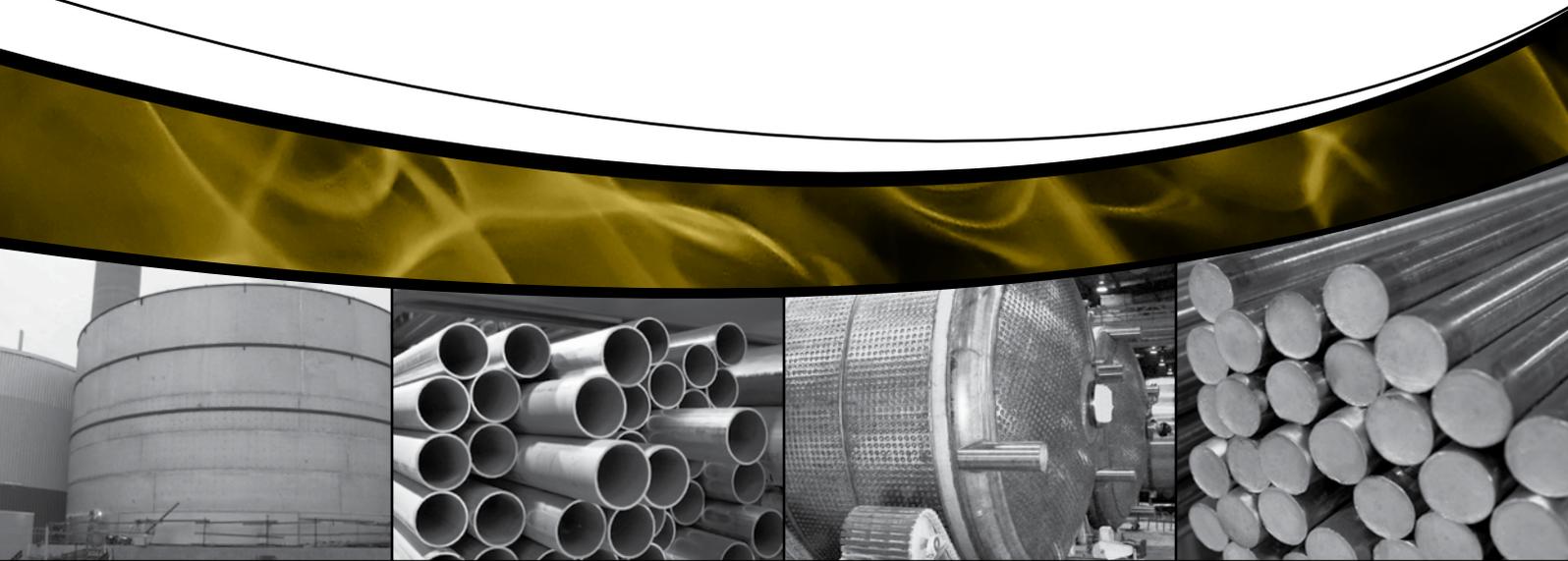




LDX 2101[®] Data Sheet

LDX 2101[®] is a lean duplex stainless steel designed for general purpose use. Like other duplex stainless steels, LDX 2101 provides both superior strength and chloride stress corrosion cracking resistance compared to 300 series stainless steels.



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LDX 2101® is a lean duplex stainless steel designed for general purpose use. Like other duplex stainless steels, LDX 2101 provides both superior strength and chloride stress corrosion cracking resistance compared to 300 series stainless steels. The use of manganese ensures proper ferrite-austenite phase balance, while allowing a reduction in nickel content. As a result, LDX 2101 is priced competitively with 304/304L and 316/316L stainless steels.

The combination of a duplex structure and high nitrogen content provide significantly higher strength levels than 300 series stainless steels. Often a lighter gauge of LDX 2101 can be utilized, while maintaining the same strength as a 300 series fabrication. The resultant weight savings can dramatically reduce the material and fabrication costs of a component.

Specifications

UNS: S32101 W. Nr./EN: 1.4162 ASTM: A 240 ASME: SA-240

Chemical Composition, %

	Ni	Cr	Mo	Mn	Cu	Si	C	N	S	P	Fe
MIN	1.35	21.0	0.1	4.0	0.1	—	—	0.2	—	—	—
MAX	1.7	22.0	0.8	6.0	0.8	1.0	0.04	0.25	0.03	0.04	balance

Features

- High resistance to chloride stress corrosion cracking (SCC)
- High strength
- Good fatigue strength
- Chloride pitting resistance comparable to type 316L stainless
- Good general corrosion resistance
- Good machinability and weldability
- Useful up to 600°F

Applications

- Chemical process pressure vessels, piping and heat exchangers
- Pulp and paper mill equipment
- Mixers and agitators
- Storage tanks
- Waste water handling systems
- Ethanol production

Physical Properties

Density: 0.281 lb/in³ Melting Range: 2525-2630°F Poisson's Ratio: 0.3 Electrical Resistivity: 481 Ohm-circ mil/ft

Temperature, °F	70	212	392	572
Coefficient* of Thermal Expansion, in/in°F x 10 ⁻⁶	—	7.2	7.5	7.8
Thermal Conductivity Btu • ft/ft ² • hr • °F	8.6	9.2	9.8	10.4
Modulus of Elasticity Dynamic, psi x 10 ⁶	29	28.1	27	26.1

* 70°F to indicated temperature.

Mechanical Properties

Minimum Specified Properties, ASTM A 240

Ultimate Tensile Strength, ksi	94
0.2% Yield Strength, ksi	65
Elongation, %	30
Hardness MAX, Brinell	290

Minimum Elevated Temperature Tensile Properties, Plate

Temperature, °F	212	302	392	572
Ultimate Tensile Strength, ksi	85.6	81.2	78.3	78.3
0.2% Yield Strength, ksi	55.1	50.8	47.9	43.5

ASME Boiler & Pressure Vessel Code, Section VIII, Division 1, Allowable Stress Values, ksi

Temperature, °F	200	300	400	500	600
LDX 2101	26.9	25.6	24.7	24.7	24.7
304	20.0	18.9	18.3	17.5	16.6
316	20.0	20.0	19.3	18.0	17.0
2205	25.7	24.8	23.9	23.3	23.1
2304	24.0	22.5	21.7	21.3	21.0

Tensile Properties Cold Rolled Plate And Sheet >1/4"

	LDX 2101	304/304L	316/316L	2205	2304
Ultimate Tensile Strength, ksi	94	75	75	95	87
0.2% Yield Strength, ksi	65	30	30	65	58
Elongation, %	30	40	40	25	25
Hardness, Brinell	290	201	217	293	290

Tensile Properties Cold Rolled Plate And Sheet ≤1/4"

	LDX 2101	304/304L	316/316L	2205	2304
Ultimate Tensile Strength, ksi	101	75	75	95	87
0.2% Yield Strength, ksi	77	30	30	65	58
Elongation, %	30	40	40	25	25
Hardness, Brinell	290	201	217	293	290

The following table shows the results of a pulsating tensile fatigue test (R=0.1) in air at room temperature. The fatigue strength has been evaluated at 2 million cycles and probability of rupture 50%. Since the test was made using round polished test bars from hot rolled plate, correction factors for surface roughness, notches, welds, etc. are required in accordance with classical theory relating to fatigue failure. As shown by the table, the fatigue strength of the duplex steels corresponds approximately to the yield strength of the material.

	LDX 2101	2205	316/316L
0.2% Yield Strength, ksi	69.3	72.1	40.6
Ultimate Tensile Strength, ksi	100.9	111.2	83.8
Fatigue Strength, ksi	72.5	74.0	52.2

Corrosion Resistance

The corrosion resistance of LDX 2101 is generally good. As a result, the grade is suitable for use in a wide range of applications and environments. The corrosion resistance of LDX 2101 is in general terms better than 304/304L stainless, and in most cases comparable to the molybdenum bearing 316L stainless steel. A review of LDX 2101 and its resistance to specific types of corrosion can be found on the following page..

General Corrosion

General corrosion is characterized by a uniform attack of the surface in contact with a corrosive medium. The corrosion resistance is generally considered good if the corrosion rate is less than 0.005 in/yr. LDX 2101 has better resistance than 304/304L and in some cases performs as well as 316/316L.

SCC Stress Corrosion Cracking

300 series stainless steels are widely utilized in the process industries due to their good general corrosion resistance. The onset of stress corrosion cracking is one of the most common reasons for stainless equipment failure. SCC failures commonly occur without warning and can be catastrophic in pressurized equipment. This can result in increased operational risk, potential high dollar losses and even loss of life.

SCC can be instigated by chlorides in the process or in many instances by chlorides on the outside of process vessels and piping. Under insulation cracking and operation in coastal areas are also common causes of external SCC of stainless equipment. As a result, some in the process industry resort to painting or coating their stainless steel vessels. This can add significantly to the initial cost of a vessel and to its life cycle cost due to increased maintenance.

Because of its duplex structure, LDX 2101 offers excellent resistance to SCC. It also offers corrosion resistance comparable to 304/304L and 316/316L stainless steel. This makes LDX 2101 an excellent candidate to replace 300 series stainless steels in a wide variety of applications.

U-Bend Testing In A 40% CaCl₂ Boiling Solution 212°F for 500 Hours

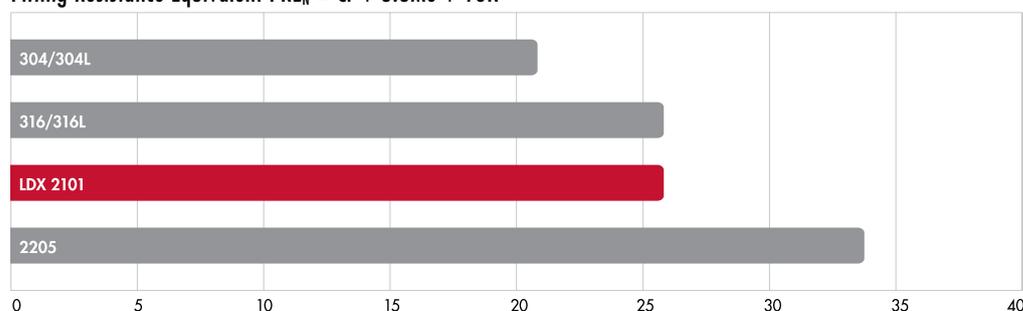
Alloy	LDX 2101	304/304L
Longitudinal/Transverse	No SCC	SCC Cracking (<150 hours)

Pitting and Crevice Corrosion Resistance

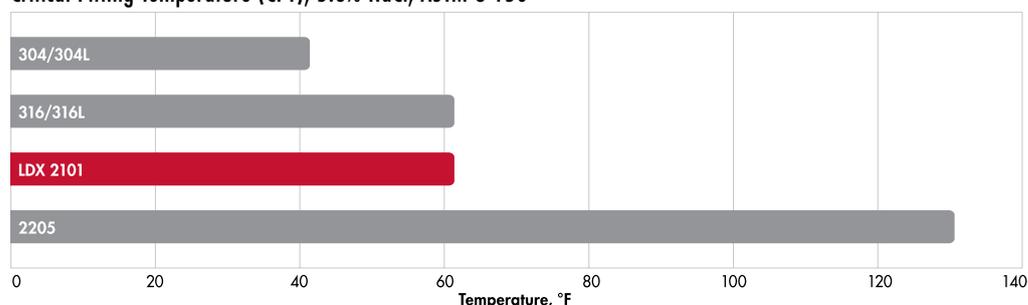
Resistance to localized corrosion, such as pitting and crevice attack, are improved through additions of chromium, molybdenum and nitrogen. Commonly these forms of attack are encountered in chloride containing environments.

A numerical relationship between pitting resistance and alloying content has been developed to compare stainless steels. This is known as the pitting resistance equivalent to PRE_N. The following figure compares the PRE_N for LDX 2101 with other common stainless steels.

Pitting Resistance Equivalent $PRE_N = Cr + 3.3Mo + 16N$



Critical Pitting Temperature (CPT), 5.8% NaCl, ASTM G 150



Intergranular Corrosion

Due to its duplex microstructure, LDX 2101 offers very good resistance to intergranular corrosion. LDX 2101 passes intergranular corrosion tests according to ASTM A 262 method B (Streicher) and method E (Strauss). Such results are as expected for duplex steels, which are less susceptible to this type of corrosion than austenitic stainless steels.

Caustic

White Liquor Testing

Test Solution

Chemical Concentration, g/l		Calculated Composition	
92	NaOH	Total Alkali	188.5 g/l Na ₂ O
4.1	NaCl	TTA	173.5 g/l Na ₂ O
55	Na ₂ S	AA	147.0 g/l Na ₂ O
7.9	Na ₂ SO ₃	EA	119.5 g/l Na ₂ O
7.1	Na ₂ SO ₄	Activity	85%
26.5	Na ₂ CO ₃	Causticity	78% (Na ₂ O basis)
	PH- 11.0 after test	Sulfidity	37% (Na ₂ O basis)

Liquor Phase Testing at 194°F, 21 Days

Grade	Weight Loss, mg	Corrosion Rate, mpy
LDX 2101	0.6, 0.4	0.000, 0.000
2205	0.3, 0.7	0.000, 0.000
304/304L	1.3, 1.0	0.001, 0.000
316/316L	4.5, 3.4	0.002, 0.002
2304	0.6, 0.3	0.000, 0.000

Liquor Phase Testing at 217°F, 21 Days

Grade	Weight Loss, mg	Corrosion Rate, mpy
LDX 2101	0.4, 0.4	0.000, 0.000
2205	0.8, 0.5	0.000, 0.000
304/304L	1.0, 0.8	0.000, 0.000
316/316L	4.7, 4.8	0.002, 0.002
2304	0.6, 0.6	0.000, 0.000

Sodium Hydroxide

Critical Temperature For 0.005 ipy, Corrosion, °C

Solution	Concentration	LDX 2101	316/316L	2205
NaOH	50%	85	90	90

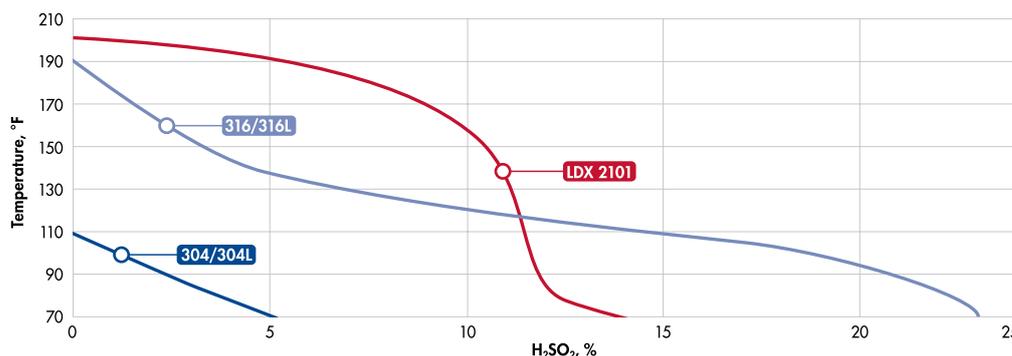
Sulfuric and Hydrochloric Acids

Table 13 - Critical Temperature For 0.005 Ipy, Corrosion, °C

Solution	Concentration	LDX 2101	316/316L	2205
HCl	1%	55	30	85
H ₂ SO ₄	10%	75	50	60
H ₂ SO ₄	96.4%	30	45	25

Sulfuric Acid

Isocorrosion, 4 mpy



Nitric Acid

Critical Temperature For 0.005 lpy, Corrosion, °C

Solution	Concentration	LDX 2101	316/316L	2205
HNO ₃	10%	> bp	> bp	> bp
HNO ₃	65%	105	100	105

Organic Acids

Critical Temperature For 0.005 lpy, Corrosion, °C

Solution	Concentration	LDX 2101	316/316L	2205
Acetic Acid	80%	> bp	> bp	> bp
Acetic Acid/ Acetic Anhydride	50% 50%	105	120	100
Formic Acid	50%	95	40	90

Phosphoric Acid

Critical Temperature For 0.005 lpy, Corrosion, °C

Solution	Concentration	LDX 2101	316/316L	2205
H ₃ PO ₄ HF	83% 2%	40	65	50
WPA 1	75%	60	< 10	45
WPA 2	75%	< 25	< 10	60

Heat Treatment

LDX 2101 is solution annealed at 1870-1975°F. Rapid cooling is recommended after annealing to minimize precipitation of secondary phases, which may negatively impact the properties of LDX 2101. More detailed fabrication information is available in the LDX 2101 fabrication manual available at www.rolledalloys.com.

Power Plants
Applications

LDX 2101 has been used on a 2205 duplex stainless FGD absorber tower for external stiffeners in the western United States. LDX 2101 was used rather than 304L because it allowed a lighter cross section, would not require painting, and matched the strength and expansion properties of 2205 duplex stainless.

Desalination
Applications

“Dual Duplex” construction at the Taweelah B extension and Jebel Ali units. The evaporators at these plants will be constructed with 2205 duplex stainless steel on bottom portion of the evaporators that is exposed to deaerated seawater. LDX 2101 duplex stainless steel will be used on the top portion of the evaporators, which is exposed to the less aggressive condensate.

Pulp and Paper
Applications

Screw conveyor in a mechanical pulping mill. The 316/316L stainless shaft used previously suffered fatigue failure after 12 months. LDX 2101 was selected to replace the shaft based on its improved mechanical properties.



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