

Lean Duplex Stainless Steel and Super-Austenitic Stainless Steel: New Options for Enhanced Corrosion Resistance

Introduction

300-series stainless steels are widely recognized in the water supply industry for their exceptional durability and corrosion resistance. Stainless Steel Types 304 and 316L are the favored materials for most facilities because they exhibit exceptional durability in aggressive water conditions. However, in recent years there has been a growing interest to install water supply wells and intake structures to exploit brackish water or seawater as new sources of water supply. Designing viable facilities in these highly aggressive environments has peaked interest in alternative types of stainless steel that offer even greater corrosion resistance. Two alloys are now available which widen the playing field beyond 300-series stainless steel. As explained herein, LDX 2101 and AL-6XN® offer more corrosion resistance than 304 and 316L, and they are extremely well suited to the manufacture of well casing, louvered well screen, buried intakes, and submerged intakes. Brief introductions to each of these materials are presented below.

Chemical Composition (%)

Alloy	LDX 2101 Duplex Stainless		AL-6XN® Alloy	
	Minimum	Maximum	Minimum	Maximum
Nickel	1.35	1.70	23.50	25.50
Chromium	21.00	22.00	20.00	22.00
Molybdenum	0.10	0.08	6.00	7.00
Carbon	-----	0.04	-----	0.03
Nitrogen	0.20	0.25	0.18	0.25
Manganese	4.00	6.00	-----	2.00
Silicon	-----	1.00	-----	1.00
Phosphorus	-----	0.040	-----	0.040
Sulfur	-----	0.030	-----	0.030
Copper	0.10	0.80	-----	0.75
Iron	Remainder	Remainder	Remainder	Remainder

Characteristics of Stainless Steel

Austenitic, or 300 series, stainless steels contain a maximum of 0.15% carbon, a minimum of 16% chromium, and sufficient nickel and/or manganese to retain an austenitic structure at all temperatures. Duplex stainless steels have improved strength over austenitic stainless steels and are also more resistant to localized corrosion, including pitting, crevice corrosion, and stress corrosion cracking. Duplex stainless steels have high chromium (19-28%) and up to 5% molybdenum, and lower nickel content than austenitic stainless steel. "Lean" duplex stainless steel, such as LDX 2101, consists of very low amounts of nickel (1.5%) and molybdenum (0.3%).

Super-austenitic stainless steels, such as AL-6XN®, display great resistance to chloride pitting and crevice corrosion due to their high molybdenum content (>6%) and nitrogen.

Higher nickel content ensures better resistance to stress corrosion cracking versus the 300 series. The higher alloy content of super-austenitic steels also makes them more expensive.

Strength

<i>Alloy</i>	Ultimate Tensile Strength (psi)	0.2% Yield Strength (psi)
	<i>Minimum</i>	<i>Minimum</i>
304	75,000	30,000
316L	75,000	30,000
LDX 2101	94,000	65,000
AL-6XN®	95,000	45,000

Applications

Of the various 300-series stainless steels, Type 304 stainless steel is the most common grade. It is well known to water well designers for its durability and overall suitability for long-term corrosion resistance that it imparts to water supply wells in otherwise potable ground water conditions. For wells installed in areas characterized by high-chloride conditions such as brackish water and seawater, Type 316L stainless steel is most often selected. Type 316L stainless steel is generally first choice for brackish water supply wells, buried beach intakes, and offshore submerged intakes that supply water to desalination plants.

Recently there has been a growing interest to identify other types of stainless steel that exhibit enhanced corrosion resistance beyond Type 304 and Type 316L. This has led Roscoe Moss Company to begin the manufacture of louvered well screen, blank casing, and pipe in LDX 2101 and AL-6XN® using the factory's spiral welding equipment.

LDX 2101 is well suited for facilities (e.g., blank well casing and louvered well screen for wells, buried intakes or submerged intakes) that require greater corrosion resistance than that offered by Type 304 but less than that of Type 316L. Casing and well screen can be manufactured to 0.312-inch wall thickness. As in other duplex stainless steels, LDX 2101 gives superior strength and chloride stress corrosion cracking compared to 300-series stainless steels. Blank casing (i.e., pipe) and well screens manufactured from LDX 2101 are competitively priced between Type 304 and Type 316L.

AL-6XN® is well suited for blank well casing and louvered screens and intakes that require greater corrosion resistance than that of Type 316L. Blank casing (i.e., pipe) and well screens are manufactured from AL-6XN® in 0.250-inch wall thickness. AL-6XN® exhibits extremely high resistance to chloride pitting and crevice corrosion and has greater tensile strength than common austenitic stainless steels.

Summary

The importance of corrosion resistance increases dramatically in aggressive conditions where mine dewatering wells, water supply wells, and brackish water and seawater intakes must operate. While Stainless Steel 304 and 316L have the necessary corrosion resistance for most environments, LDX 2101 and AL-6XN® expand the options beyond 300-series

stainless steel. The two materials offer greater long-term durability for water supply facilities that must operate in highly corrosive environments.

Reference

- Rolled Alloys, *Corrosion Resistant Alloys*, Bulletin 151. 2008.
- _____, AL-6XN® Alloy, Data Sheet, UNS N08367, Bulletin No. 1005, 2008.