

AL-6XN Alloy Selected for Twelve Shipboard Seawater Heated Liquefied Natural Gas Vaporizers



Specifications

UNS: N08367 **ASTM:** B 688, A 240, B 675, A 312, B 676, A 249, B 804, B 691, A 479, B 462, A 182, B 564, B 366, B 472
ASME: SB-688, SA-240, SB-675, SA-312, SB-276, SA-249, SB-691, SA-479, SB-462, SA-182, SB-564, SB-366 Code Case N-438-3, B-31.1 Case 155-1

Chemical Composition, %

	Ni	Cr	Mo	Mn	Cu	Si	C	N	S	P	Fe
MIN	23.5	20.0	6.0	—	—	—	—	0.18	—	—	—
MAX	25.5	22.0	7.0	2.0	0.75	1.0	0.03	0.25	0.03	0.04	balance

Case History

AL-6XN alloy was specified by a power company as the material of construction for twelve shipboard shell and tube heat exchangers used to vaporize liquefied natural gas (LNG) on Floating Storage and Regasification Unit (FSRU) tanker ships. This design uses a single once through heat exchanger to vaporize the LNG as opposed to other methods using a combination of shell & tube and plate frame heat exchangers.

Each vaporizer measures 44 inches in diameter and are 40 feet long. Seawater flows on the shell side and is used to warm the LNG in order to change it from the liquid to vapor phase. The inlet temperature of the seawater is 58.5°F and outlet temperature is 45°F with a flow velocity of 4 ft/sec. LNG flows on the tube side and enters the system at less than -250°F, while exiting at approximately 40°F.

During the preliminary design of these units several criteria needed to be met, which eventually led to the selection of the AL-6XN alloy as the material of choice.

Excellent resistance to pitting and crevice corrosion in seawater to meet the customers 20-year design life

AL-6XN is a 6% molybdenum super austenitic stainless steel with a nitrogen addition. As a result of these additions, AL-6XN offers excellent corrosion resistance in chloride environments including seawater. Because of the outstanding service record in seawater applications by AL-6XN and its predecessor AL-6X, the designers felt very comfortable with its long-term corrosion resistance. In 1973, AL-6X alloy became the first thin wall austenitic stainless tubing material to be successfully used in seawater cooled utility condensers. Original installations are still in service after 40 years. More than 30 million feet of AL-6X and its successor AL-6XN tubing have been put into condenser service. AL-6XN has also successfully been used in desalination plants and offshore drilling platforms for more than 20 years. Over 60,000 square feet of AL-6XN was also selected to construct the artificial ocean bottom in the Biosphere II station in Arizona. This installation required a 100-year design life.

Excellent toughness at cryogenic temperatures

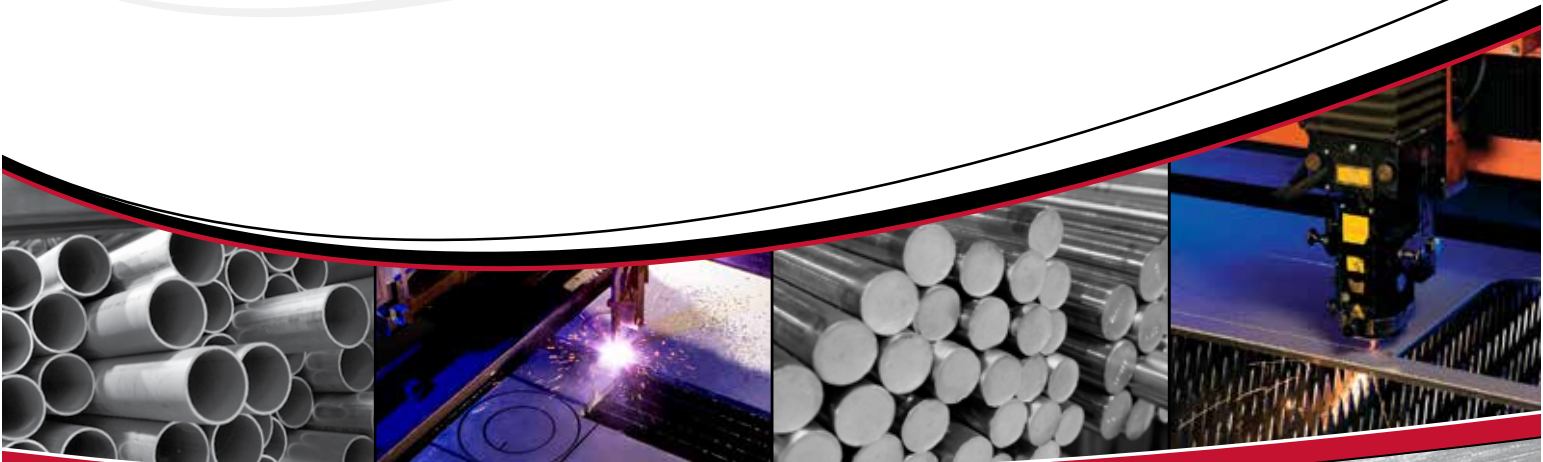
Because AL-6XN is an austenitic stainless steel it retains its toughness and ductility even at cryogenic temperatures. Charpy-Impact testing at -320°F (-196°C) shows AL-6XN resists an impact of up to 85 ft-lbs (115 joules).

Ease of fabrication

AL-6XN is fabricated using the techniques common to other stainless steels and nickel based alloys. This was one of the reasons that AL-6XN was selected over titanium for this application. Fabrication of all twelve units was completed by an Illinois fabricator to ASME Sec. VIII, Division 1. In total, over 350,000 pounds of AL-6XN plate were required to for the shell, baffles, tubesheets, tube supports, and expansion joint. In addition 450,000 feet of AL-6XN tubing were used to construct the twelve vaporizers.

Availability

Rolled Alloys supplies AL-6XN in plate, sheet, bar, billet, pipe, and fittings in order to complete any project bill of materials. Rolled Alloys also supplies the over matching weld fillers with AL-6XN.



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