Avesta Sheffield's new austenitic grade resists chlorine dioxide

The worldwide pulp and paper industry must reduce or totally exclude chlorine bleach from its processes to eliminate the traces of dioxin remaining in the pulp. The short-term solution is a much more intensive use of chlorine dioxide as a bleaching agent, because it does not lead to dioxin formation. The problem with this approach is that chlorine dioxide at the high levels required is extremely corrosive.

At the moderate pH levels reached during paper production, high molybdenum nickel-base alloys suffer from transpassive corrosion, a severe form of uniform attack that significantly reduces the effective service life of the equipment. To deal with the corrosion mechanism of chlorine dioxide over the full range of service conditions, Avesta Sheffield has developed 654 SMO, a high-molybdenum, high-nitrogen austenitic stainless steel.

In 1976, Avesta Sheffield (then Avesta AB) introduced 254 SMO, a nitrogen-alloyed 6% molybdenum austenitic stainless steel. Our first bleach washer vat was installed in 1977 and is still in operation.

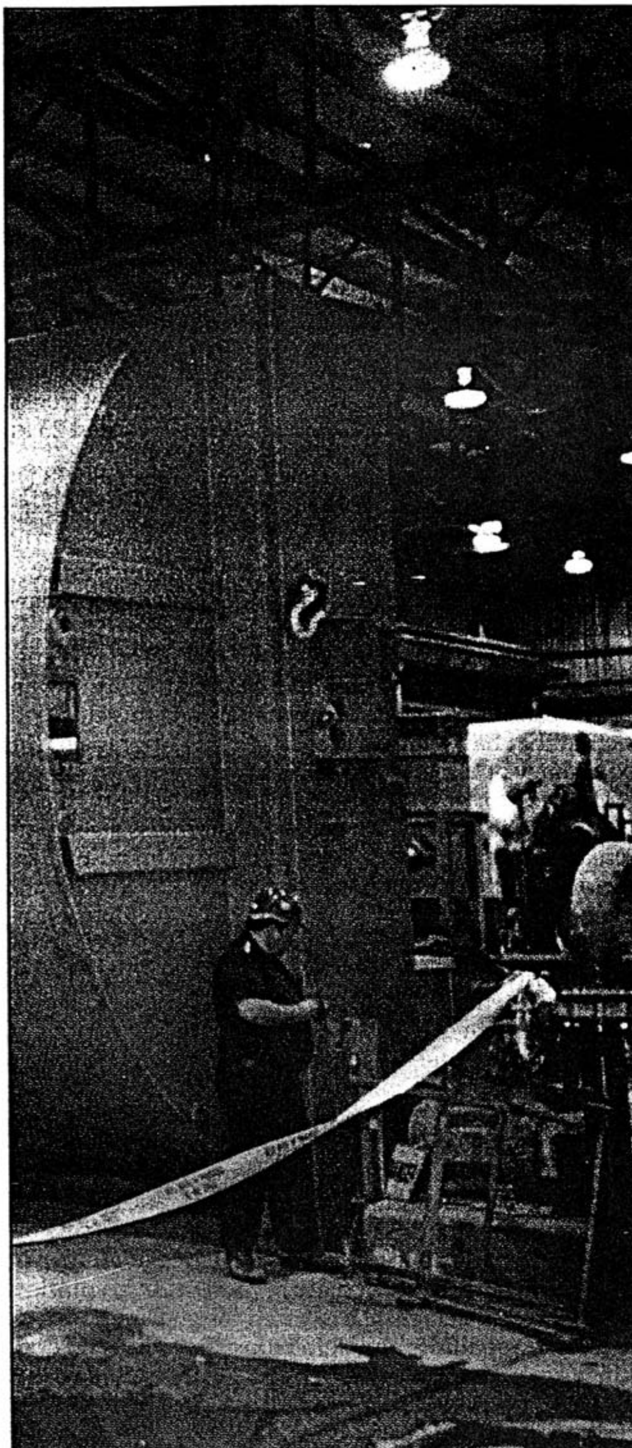
Seven years ago, Avesta Research established a program to develop an austenitic stainless steel having corrosion resistance superior to that of the 9% molybdenum nickel-base alloy 625. Alloy 654 SMO (composition 24Cr - 22Ni - 7.3Mo - 0.5N) has chloride resistance comparable to that of the 15% molybdenum nickel-base alloy C-276.

Critical crevice corrosion temperatures

Alloy	Temperature, °C		
254 SMO	37.5	42.5	37.5
654 SMO	>60	>67.5	>60
Alloy 625	>20	>27.5	>20
Alloy C-276	60	65	55
Solution	ASTM G48 6% $FeCl_3$	11% H_2SO_4 1.2% HCl 1.0% $FeCl_3$ 1.0% $CuCl_2$	4% NaCl 0.1% $Fe_2(SO_4)_3$ 0.01M HCl

The 654 SMO steel is already covered in ASTM specifications for flat-rolled products, with specifications for other product forms to follow soon. The company is moving to establish availability from inventory for a full range of product forms, along with intensive technical support for users. The application for ASME Code case is proceeding. Five 70-ton heats have been produced by continuous casting in each case. In addition, Avesta Welding has developed appropriate filler materials and procedures for several welding processes.

For more information: Gregg Clark, Avesta Sheffield, Woodfield Corporate Center, 425 Martingale Rd., Suite 2000, Schaumburg, IL 60173; tel: 708/517-4050; fax: 708/517-2950.



Alloy 654 SMO washer vat being installed at the Weyerhaeuser plant in Grande Prairie, Alberta.

Allegheny Ludlum develops superferritic stainless steels

The superferritic stainless steel AL 29-4C alloy shows excellent resistance to chloride ion pitting, crevice corrosion, and stress corrosion cracking (SCC). This high corrosion resistance makes it suitable for use in a wide variety of corrosive environments. At the same time, it is economical because of its low alloy content (compared with other high-performance alloys) and conventional melting method.

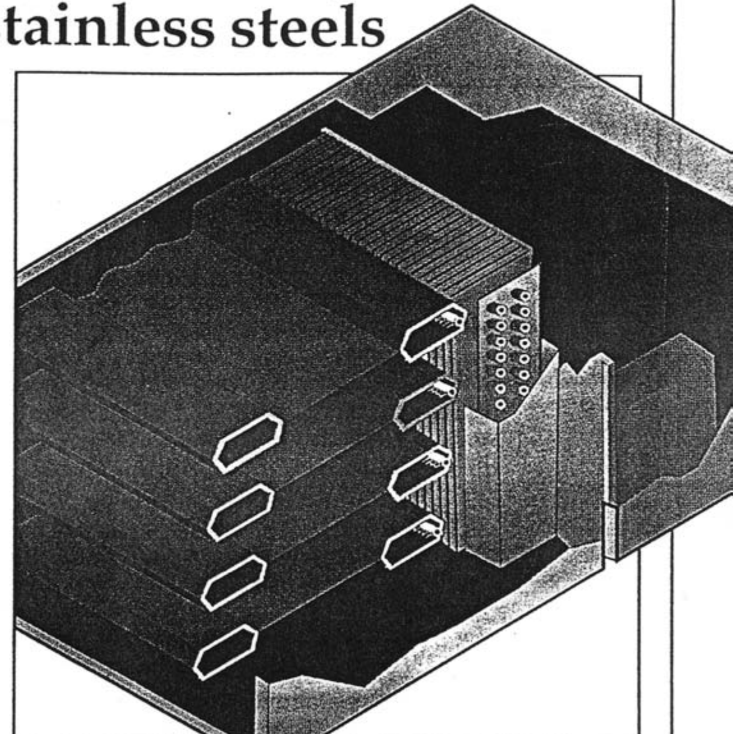
Fe-Cr-Mo alloys with 29% chromium have excellent resistance to chloride pitting and crevice corrosion. They were developed in the 1970s by Dr. Michael Streicher of DuPont and commercialized by Allegheny Ludlum. Both AL 29-4 and AL 29-4-2 (UNS S44700 and S44800) are highly resistant to corrosion in a variety of oxidizing environments. The nickel-containing AL 29-4-2 alloy also has good resistance to corrosion in dilute reducing acid environments.

Both alloys possess fully ferritic structures. Ferritic stainless steels exhibit a transition from ductile to brittle impact behavior as the test temperature is reduced, and increasing test-section thickness raises the temperature for this transition. The AL 29-4 and 29-4-2 alloys were designed to mitigate this effect through restriction of carbon and nitrogen levels to extremely low levels, which could only be attained through the use of high-purity raw materials and vacuum melting, making these alloys expensive to produce.

AL 29-4C alloy (UNS S44735), a conventionally melted alloy designed by Allegheny Ludlum, maintains the high level of chloride pitting and crevice corrosion resistance of the vacuum-melted alloys at lower cost. The stabilized composition allows production using conventional argon-oxygen decarburization (AOD) refining of standard raw materials. However, this economy is achieved at the cost of reduced toughness.

Although light-gage AL 29-4C has good toughness, material thicker than about 2.5 mm (0.1 in.) may have a Charpy V-notch ductile-to-brittle transition temperature as high as room temperature. Consequently, this alloy is not offered for sale at thicknesses greater than about 1.5 mm (0.06 in.). The majority of applications have been in welded products at thicknesses ~ 1.2 mm (0.05 in.).

The 29Cr-4Mo alloys are very resistant to chloride pitting and crevice corrosion. One test for corrosion resistance in high chloride environments is the ASTM G-48 Practice B ferric chloride test. In this test, inert polytetrafluoroethylene (PTFE) crevice forming blocks are held against the sample, which is then immersed in a 10% solution of ferric chloride hexahydrate (equivalent to 6% anhydrous ferric chloride). After immersion, the alloy sample is removed, weighed, and examined for evidence of corrosion attack. In order to rank the materials according to temperature, the test is repeated at successively higher temperatures until crevice corrosion attack of the sample is observed.



This high-efficiency furnace uses AL 29-4C in its secondary heat exchanger and flue-gas vent pipe.

The highest temperature at which no attack is observed is called the "critical crevice corrosion temperature" (CCCT). Experience has shown that stainless alloys that exhibit ferric chloride CCCTs above room temperature (25°C, 75°F) are usually resistant to crevice corrosion in sea water. The 29Cr-4Mo alloys, with CCCT of 50°C (122°F), would thus not be expected to be attacked in this environment. In addition, the low nickel contents of these alloys gives them high resistance to chloride stress corrosion cracking .

Some of the high chloride environments in which AL 29-4C alloy has been successfully used include both sea-water-cooled and brackish water-cooled surface condensers in electrical utility power plants, where over 3155 km (1960 mi) of welded tubing have been used. Other AL 29-4C heat exchangers operate in geothermal brine, which is among the most corrosive of the high-chloride environments. The alloy has also been used in a range of petroleum refining applications because of its resistance to chloride-induced pitting, crevice corrosion, and stress-corrosion cracking.

For more information: John Grubb is an engineer at Allegheny Ludlum Corp. Tech Center, Alabama & Pacific Avenues, Brackenridge, PA 15014-1597; tel: 412/226-6230; fax: 412/226-5067.

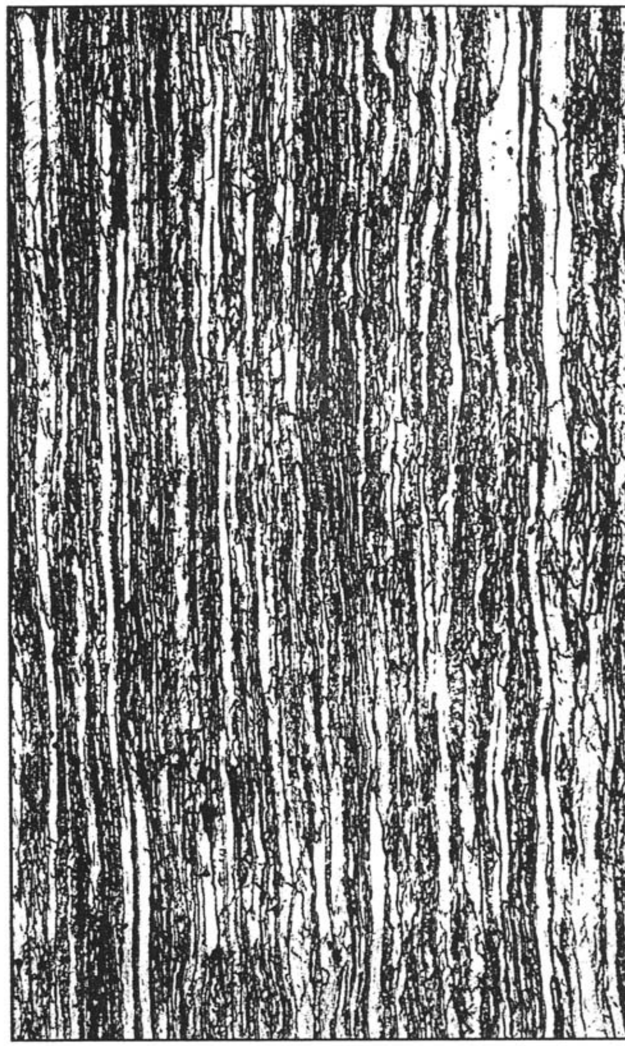
Washington Steel introduces dual-phase alloy

Duracorr is a new steel based on the familiar cold rolled ferritic grade Type 409, and the common martensitic plate grade Type 410. Developed by Washington Steel, it exhibits a combination of hardness, strength, toughness, weldability, and formability with the corrosion resistance of a nominally 12% Cr stainless.

The beneficial mechanical properties of the alloy are derived from a microstructure that is a dual-phase mixture of ferrite and martensite. The attached figure illustrates the microstructure of a 6 mm (0.25 in.) thick plate. At reheating temperatures (for rolling), the balanced composition of the steel provides for an approximately equal mixture of ferrite and austenite. During plate rolling, the microstructure is refined to grain sizes of ASTM No. 9 and finer. Hardenability of the austenite is controlled by the composition to provide for transformation to martensite during cooling to room temperature. Subsequent tempering of the plate provides minimum mechanical properties of 275 MPa (40 ksi) yield strength and 455 MPa (66 ksi) tensile strength with room-temperature Charpy values typically greater than 36 J (50 ft-lb). The dual-phase microstructure permits the steel to be welded without the severe grain coarsening common with ferritic stainless. As a result, welded fabrications have excellent toughness.

Dual-phase steels were first developed in the 1970s for automotive hot-rolled sheet applications requiring severe forming of high-strength steel. Duracorr combines this mature technology with the corrosion resistance of Type 409 and other 12% Cr stainless steels. It is available in hot rolled plate from 4.8 to 30 mm (0.2 to 1.25 in.) thick and in widths up to 2500 mm (100 inches.) Hot rolled sheet is also available from 3.4 to 4.8 mm (0.135 to 0.187 in.) thick and in widths up to 1220 mm (48 in.)

The combination of manufacturing efficiencies and low life cycle cost makes it an economical steel for many applications. Users consider the steel to bridge the price/performance gap between structural carbon/alloy steels and austenitic stainless steels.



Microstructure of 6 mm (0.25 in.) Duracorr plate showing mixture of ferrite and martensite. Vilella's Reagent Etch. 200X.

Washington Steel Corporation metallurgists expect the alloy to replace carbon steel plate and sheet in many applications where low maintenance and longer performance life are beneficial. Similar grades developed in the eastern hemisphere are widely employed in mining machinery and equipment, especially where corrosion and abrasion are problems with traditional carbon steel components. Some specific applications include linings, chutes and bins for coal, ores and agricultural products; railroad hopper cars and containers; transmission towers and catenary units; water treatment equipment; and transportation equipment frames.

For more information: Fred B. Fletcher, Washington Steel/Lukens Inc., P.O. Box 3001, Coatesville, PA 19320-0911; tel: 610/383-3106; fax: 610/383-2674.

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