CLIFFS

410S
STAINLESS STEEL

- **Chemical Processing Equipment**
- **Distillation Towers**
- **Oil Refineries**
- **Trays**

TYPE 410S is a low-carbon, non-hardening ferritic stainless steel. The ability to cool from elevated temperatures without hardening makes Type 410S suited to applications such as annealing boxes, quenching racks, oxidation-resistant partitions and other high-temperature units. This alloy has been widely used in chemical processing, including applications in distillation towers and separators.

Product Description

Type 410S is a non-hardening modification of Type 410. A small aluminum (Al) addition minimizes austenite formation at high temperatures, thereby restricting the alloy's ability to harden. The result is a soft, ductile condition when the material is rapidly cooled from above the critical temperature. This non-hardening characteristic also retards formation of hardening cracks when the steel is welded. The alloy is completely ferritic in the annealed condition.

Composition		(wt %)
Carbon	(C)	0.08 max.
Manganese	(Mn)	1.00 max.
Phosphorus	(P)	0.040 max.
Sulfur	(S)	0.030 max.
Silicon	(Si)	1.0 max.
Chromium	(Cr)	13.5
Titanium	(Ti)	0.20 max.

AVAILABLE FORMS

Type 410S is available in thicknesses from 0.015 – 0.135 in. (0.38 – 3.43 mm) in widths up to 48 in. (1219 mm). For other sizes, contact your Cleveland-Cliffs sales representative.

The values shown in this bulletin were established in U.S. customary units. The metric equivalents of U.S. customary units shown may be approximate.

TABLE 1 – TYPICAL MECHANICAL PROPERTIES

UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)	Rockwell Hardness, B
67 (462)	41 (283)	27	72

Properties

TABLE 2 – PHYSICAL PROPERTIES

Density, lbs/in^3. (g/cm^3)	0.28 (7.73)
Electrical Resistivity, $\mu\Omega$•in. ($\mu\Omega$•cm) 68 °F (21 °C)	 23.7 (60)
Specific Heat, BTU/lbs./°F (kJ/kg•K) 32 – 212 °F (0 – 100 °C	 0.11 (0.46)
Thermal Conductivity, BTU/hr./ft./°F (W/m•K) 212 °F (100 °C	 15.6 (26.9)
Coefficient of Thermal Expansion, in./in./°F (μm/m•K) 32 – 212 °F (0 – 100 °C) 32 – 600 °F (0 – 315 °C) 32 – 1000 °F (0 – 538 °C) 32 – 1200 °F (0 – 649 °C)	 6.0 x 10^6 (10.8) 6.4 x 10^6 (11.5) 6.7 x 10^6 (12.2) 7.5 x 10^6 (13.5)
Modulus of Elasticity, ksi. (MPa)	29.0 x 10^3 (200 x 10^3)
Melting Range, °F (°C)	2700 – 2790 (1482 – 1532)

CORROSION RESISTANCE

The corrosion behavior of Type 410S provides moderate resistance to atmospheric and neutral chloride corrosion. However, is not recommended for applications where surface appearance is critical, as it is prone to localized pitting corrosion. In the as-welded condition, this material may be susceptible to sensitization, which can lead to preferential grain boundary attack in the heat-affected zone. Like most 11 – 14% chromium (Cr) alloys, in highly acidic environments this grade can undergo uniform corrosive attack that will result in high corrosion rates. Caution should be exercised when considering this alloy in environments of such extreme conditions.

OXIDATION RESISTANCE

The oxidation resistance of Type 410S is good. It can be used up to 1300 °F (705 °C) in continuous service. Scaling becomes excessive above about 1500 °F (811 °C) in intermittent service.

FORMABILITY

Type 410S is often used in applications requiring blanking, bending, roll forming and moderate drawing.

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WELDABILITY

This ferritic class of stainless steels is generally considered to be weldable by common fusion and resistance techniques. Special consideration is required to avoid brittle weld fractures during fabrication by minimizing discontinuities, controlling weld heat input and occasionally warming the part somewhat before forming. This particular alloy is generally considered to have slightly poorer weldability than the most common alloy of the stainless class, Type 409, but better than standard non-stabilized Type 410 with higher carbon. A major difference is the addition of aluminum to control hardening, which results in the need for higher heat input to achieve penetration during arc welding. When a weld filler is needed, American Welding Society (AWS) Classification ER/EC430, E430TX-X, ER/EC309L or E309LT0-3 wires may be used.

HEAT TREATMENT

Type 410S is not hardenable by heat treatment. It is annealed in the 1600 – 1650 °F (871 – 899 °C) range and then air cooled, mainly to relieve cold working strains. Care should be exercised to avoid exposure at temperatures of 2000 °F (1093 °C) or above because of possible embrittling effects. If excessively large grains are found after annealing mildly cold-worked material, the annealing temperature should be decreased to the 1200 – 1350 °F (649 – 732 °C) range.

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials and direct reduced iron to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest steel supplier to the automotive industry in North America. Headquartered in Cleveland, Ohio, Cleveland-Cliffs employs approximately 25,000 people across its mining, steel and downstream manufacturing operations in the United States and Canada.

CLIFFS

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May 2021