Tri-Canada

What Makes Stainless Steel Corrosion Resistant?

This article from Tri-Canada provides some background on why stainless steel is the ideal choice for almost all sanitary fluid handling components and processing equipment.

Let's start with a brief history on stainless steel. In the early 1900's, metallurgists observed that chromium had a better draw to oxygen than iron did, so they added the element chromium to steel. Studies have proven that when a minimum of 10% chromium was added, the chrome joined with oxygen would form a tight transparent layer over the steel surface that prevented rusting by stopping further oxidation. The transparent layer is self-healing when injured by scratches or denting.

Stainless steels are materials of long term beauty. These steels also tolerate the corrosive attack of various acids, they retain strength and toughness at both ends of the temperature scale, yet can be fabricated into complex shapes for numerous uses. It is because of this exceptional versatility, that stainless steel warrants careful consideration for any product where one of these six key requirements are involved.

- Corrosion Resistance
- Strength at Elevated Temperatures
- Strength and Ductility at Cryogenic Temperatures
- Oxidation Resistance at High Temperatures
- Appearance
- Abrasion Resistance

Here is a brief look at the elements found in stainless steel and what their functions contribute to the non-corrosion feature of stainless steel.

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- **Chromium:** Forms a surface film of a rough, adherent, invisible, corrosion resisting chromium oxide film on the steel surface for corrosion resistance and increases scaling resistance at extreme temperatures. The chromium substance allows the formation of a self-healing film if harmed mechanically or chemically. This film is self-healing, if oxygen is present. The corrosion resistance and other effective properties of stainless steel are enriched by raised chromium content and the addition of other elements such as molybdenum, nickel and nitrogen, as introduced below.

- **Nickel:** Steadies the austenitic structure and builds up ductility making the stainless steel easier to form. It also raises high temperature strength and corrosion resistance mostly in industrial and marine environments, chemical, food and textile processing industries.

- **Silicon:** Raises scaling resistance by creating a tight initial scale which will tolerate cyclic temperature changes. Small amounts of silicon are added to all grades of stainless for deoxidizing.

- **Manganese:** Promotes the stability of austenite at or near room temperature and improves hot working properties.

- **Molybdenum:** Increases corrosion resistance, strength at high temperatures, increases the range of passivity and lessens the susceptibility to pitting, especially in chloride environments.

- **Aluminum:** Lowers the hardenability and improves scaling resistance.

- **Carbon:** Strengthens and promotes the expansion of precipitates harmful to corrosion resistance.

- **Columbium:** Together with Carbon reduces susceptibility to intergranular corrosion. It performs as a grain refiner and raises the formation of ferrite.

- **Copper:** Added to stainless steel to increase resistance to certain corrosive environments. It also decreases susceptibility to stress corrosion, cracking and provides age-hardening effects

- **Titanium:** Combines with carbon to reduce susceptibility to intergranular corrosion and also acts as a grain refiner. Like Columbium, Titanium also promotes the formation of ferrite.

The many remarkable values offered by stainless steel make it a strong contender in materials selection. Engineers and designers often under-estimate or overlook these values because of what is observed as the higher initial cost of stainless steel. However, over the total life of a project, stainless is most often the best value option. Stainless steel's resistance to corrosion, staining, low maintenance and well-known shine make it a perfect base material for a variety of applications. Stainless steel is 100% recyclable. Over 50% of new stainless steel is made from re-melted scrap metal, characterizing it as a rather eco-friendly material.

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There are more than 60 grades of stainless steel. The bulk of the products that Tri-Canada sells are either grade 304 or 316L. Sanitary fittings and tubing are offered in both grades, 304 primarily for dairy and many food applications, 316L in biopharmaceutical applications and any other applications where products are more aggressive (primarily higher chloride products i.e. sports drinks, barbeque sauce, etc.) Most sanitary pumps and valves are offered in type 316L only. Sanitary heat exchangers, mixers and instrumentation are normally offered in 316L as well.

There are some process fluids in the food, beverage and biopharmaceutical industries that, because of a combination of high temperature and high chlorides content, require the use of an even more corrosion-resistant alloy than 316L stainless steel. In those cases, either AL6XN, Titanium or Hastelloy materials are required. While more limited in selection, there are sanitary pumps, valves tubing and fittings available in these materials, although there are very expensive.

If you have any questions on which grade of stainless steel is the best choice for your process application, please call your Sales Representative at **905-677-9000** or emailing **sales@tricanada.com**.

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