Stainless steel

Stainless steels are iron and carbon based alloys containing a minimum of 10.5% Chromium. Stainless steel is often referred to in singular, as if it were just one material. The American Iron and Steel Institute (AISI) recognizes 60 stainless steels as established alloys. Chromium is the alloying element that gives stainless steels their quality of corrosion resistance, since on combining with oxygen it forms a fine transparent protective film of chromium oxide on the surface.

Types of Stainless Steel

There are 4 basic large groups classified according to their metallurgical structure: austenitic, ferritic, martensitic and duplex.

In the swimming pool market, the so-called "austenitic" steels are used; these contain from 17% to 25% Chromium and from 8% to 10% Nickel. They also include several elements to achieve suitable strength properties. These steels are not usually magnetic, not being attracted by a magnet.

Types of Austenitic Steels used in the swimming pool market are:

14301 / AISI 304 / V2A: Cr: 18-20% & Ni: 8-12% Excellent corrosion resistance in freshwater environments with little pollution but not recommended for salt water.

14401 / AISI 316 / V4A: Cr: 16-18% & Ni: 10-14% & Mo: 2-3% The higher percentage of Nickel and the fact it contains Molybdenum make it more resistant to corrosion by chlorides.

14404 / AISI 316 L: The percentage of carbon is reduced by 0.03 to 0.035% This lower percentage of carbon offers better conditions for welding but does not guarantee higher strength.

Austenitic stainless steels provide a good combination of corrosion resistance and manufacturing properties.

Types of corrosion that can be found

The resistance of stainless steel to rusting and corrosion is due to the layer of chromium oxide that forms on the surface on contact with oxygen. When this layer forms, the stainless steel is said to be in a passive or passivated state. Passivation is a protective operation; it is a chemical attack that serves to cause the formation of the protective oxides (chromium oxide layer).

There are several risks to the successful use of stainless steels. If from all of them we choose a given quality, its corrosion will depend of various factors, such as: the site, the medium, the concentration and the temperature.

Many problems can be avoided by taking into account the risks involved and taking the appropriate measures to eliminate them.

EXTERNAL CORROSION:

Galvanic or contact corrosion: This type of corrosion appears when, in presence of an electrode (an acid solution or, ultimately, atmospheric humidity itself), two metallic elements are joined together with electrical continuity to form a true battery. Of these elements, the one which corrodes faster is the more anodic of the two. Stainless steels in passive state are purely cathodic (noble) materials, as shown in the list below.

FROM ANODICA TO CATODICA:

- Magnesium

- Zinc
- Aluminum
- Carbon Steel
- Alloy steel
- Iron foundry
- Martensínicos Stainless Steels (active)
- Ferritic Stainless Steels (active)
- Austentíticos Stainless Steels (active)
- Brass
- Bronze
- Copper
- Cupronickel
- Nickel
- Inconel
- Martensínicos Stainless Steels (passive)
- Ferritic stainless steel (passive)
- Austentíticos Stainless Steels (passive)
- Titanium
- Silver
- Gold
- Platinum

Therefore, when connecting stainless steels with other metallic materials, this fact should always be taken into account in order not to damage the more anodic (less noble) material.

INTERNAL CORROSION:

Concentration and temperature: Whether on the site or in the medium, aggressive elements (certain chemical agents for chlorination) may be present in higher or lower concentration. Acids will be more aggressive when diluted between 40% and 80%.

Temperature also influences corrosion. At higher temperatures, chemical and electrochemical reactions are accelerated and therefore all activity speeding up corrosion increases.

Corrosion by chlorides: On the surface of a stainless steel, pitting appears when the protective passive layer is broken in small isolated points and chlorides are deposited on the surface. The stainless steel, AISI304, supports well the chloride concentrations and other chemical levels recommended in swimming pool water. The material, AISI316, resists corrosion more than AISI304 not in a general way, but especially in the case of pitting corrosion. The element best known to cause this type of corrosion is CHLORINE.

An excess of chlorides or HYPERCHLORINATION can produce a chemical reaction (SODIUM HYPOCHLORITE CL-NA) which causes a very aggressive corrosion phenomenon. To protect stainless steel from the action of chlorides, the element MOLYBDENUM (Mo) is included in the alloy at a proportion of 2% to 3%. Within the stainless steel, the molybdenum forms chemical compounds that protect the material from pitting corrosion. Chromium-nickel-molybdenum steels, which we consider stainless steels, are resistant to certain types of rusting or corrosion, in accordance with their chemical and mechanical features.

Recommended chemical levels of the water

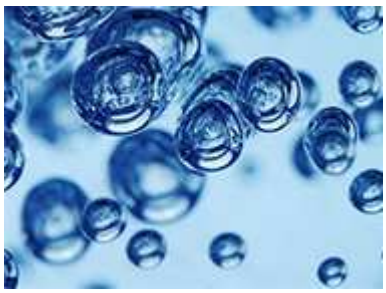
Niveles PH: *7.2 – 7.8 ppm*
Free Chlorine: *1 – 3 ppm*
Calcium Hardness: *200 – 400 ppm*
Alkalinity: *100 – 150 ppm*
Total Dissolved Solids (TDS): *Less than 1,000 ppm*
Bromine: *2.0 – 4.0 ppm*

Cooper: *0 ppm*
Chloride: *Less than 140 ppm*
Langelier Index: *-0,3 – 0,3 ppm*

Recommendations to follow:

- Follow the steps indicated on the instruction sheets and the maintenance instructions which come with each accessory.
- All stainless steel accessories MUST be installed with earth.
- Avoid dosing chemicals or aggressive products near stainless steel elements, to avoid possible corrosion or stains from splashing. Both products which are poured into the water and products used for cleaning/disinfecting the area surrounding the pool. Should this occur, rinse the accessory with water and dry.
- Avoid concentrations of dust, salts, concrete adherences, dirt, and contact with other metallic elements (especially iron), as corrosive processes are favoured by these causes.
- Products used for building are NOT allied to stainless steel. Avoid having stainless steel accessories installed in the same facility during the building / cleaning process, whenever possible installing them when the construction is finished and cleaned. If this is not possible, when the work is finished, rinse the stainless steel parts with water and dry.
- Stainless steel products should be stored properly packaged and in a suitable place, independent and always away from chemical products that may create corrosive environments.
- Accessories must be handled properly during installation; they should not be hit or scratched as this damages the passivation layer of the steel producing incisions liable to cause pitting corrosion.
- Once installed in the swimming pool, accessories should be used exclusively for their purpose (especially the ladders), never as a support for adding chemicals to the pool water. Chemicals must be added to the water as far as possible from the stainless steel parts of the swimming pool.

Chemical Composition



Designation of steel						
AISI USA	Euronorm EN 10088-1	C	Si	Mn	P max	S
AISI-304	1.4301	≤ 0,07	≤ 1	≤ 2	≤ 0,045	≤ 0,015
AISI-316	1.4401	≤ 0,07	≤ 1	≤ 2	≤ 0,045	≤ 0,015

Designation of steel					
AISI USA	Euronorm EN 10088-1	N	Cr	Mo	Ni
AISI-304	1.4301	≤ 0,11	17 a 19,5	-	8 a 10,5
AISI-316	1.4401	≤ 0,11	16,5 a 18,5	2 a 2,5	10 a 13

Cleaners that should NOT be used on stainless steel include:

- Cleaners containing chlorides, especially those containing hydrochloric acid,
- Hypochlorite bleaches should not be used on stainless steels. In the event of accidental use or splashing on the surface of stainless steel, rinse immediately with cold water,
- Silver cleaners should not be used on stainless steel.

To avoid cross contamination by iron particles, ensure cleaning utensils have not previously been used for “normal” steel (e.g. carbon steel). It is desirable to reserve the materials used for cleaning stainless steel and use them only for this purpose.

WE RECOMMEND OUR CLEANING PRODUCT WHICH CAN BE FOUND IN OUR CATALOGUE. ASK YOUR DEALER.

Cleaning and Maintenance

Although stainless steels are inherently corrosion resistant materials that require no additional surface protection to enhance their appearance and durability, it is necessary to perform some regular maintenance and cleaning to ensure stainless steel surfaces remain in good condition and that, in this way, neither their aesthetic appearance nor their corrosion resistance will be compromised.

The purpose of these recommendations is to advise installers and owners how to perform effective and efficient cleaning in order to derive benefits from the anticorrosive properties of stainless steel.

We recommend cleaning the products to remove residues (lime, chlorides…) and other damaging substances that may adhere to stainless steel and cause pitting corrosion.

The frequency of cleaning will vary according to the environmental and atmospheric conditions to which the product is subjected, as well as to the quality of the stainless steel:

Atmosphere	**Frequency**	**Frequency**	**Frequency**
	+ 6 months	*3-6 months*	*1-3 months*
Rural	AISI-304 (1.4301)	-	-
Urban	AISI-316 (1.4401)	AISI-304 (1.4301)	-
Industrial	-	AISI-316 (1.4401)	AISI-304 (1.4301)
Marine	-	AISI-316 (1.4401)	AISI-304 (1.4301)

Clean with recommended products or with phosphoric or nitric acid based stripping pastes, always using nylon brushes (never with iron bristles), and then rinse with clean water. In this way, we conserve the product in perfect conditions and ensure its durability.

AISI-304 (1.4301) quality stainless steel is able to support the variations of different types of water, provided these meet the optimum conditions regarding the concentration of chemicals for disinfection, especially the concentration of residual chlorine (chloramines).

In indoor swimming pools we find more severe environmental conditions due to a higher concentration of corrosive vapours from chemicals, making it very important to clean with greater frequency.

In the most aggressive environments, such as the sea shore or highly industrialized areas, or in swimming pools with salt chlorinators, the use of AISI-316 (1.4401) quality stainless steel products is recommended as they have a higher concentration of nickel and contain molybdenum. (See table).

Stainless Steel & Salt Chlorinators

The percentage of salt in a swimming pool with salt chlorination is from 3.5 g to 5 g / l (seawater contains 50 g/l of salt). This percentage of salt is not damaging to stainless steel, although it is recommended to use A316 quality accessories.

What does damage stainless steel are high concentrations of salt even over short periods of time. The start-up of a salt chlorinator often involves pouring a substantial quantity of salt into the water. If this high concentration of salt is at a point of the pool near a stainless steel accessory, the stainless steel element will be damaged, with the appearance of dirt in a short time, which will first spread over the welded parts and then over the rest of the product.

The best thing to do when starting up a Salt Chlorinator, if possible, is to keep the stainless steel accessory out of the pool and install it once the percentages of salt have reached their optimum working parameters.
ENSURE THE EARTH IS PROPERLY INSTALLED.