

Equipment Staining – Causes and Removal

Are you aware that surface staining can still occur on stainless steel? Stainless steels owe their stain resistant nature to a passive oxide film of chromium oxide, nickel oxide, and molybdenum oxide. The passive nature of this film also gives stainless steels their unique corrosion resistance. This film is formed naturally on exposure of the stainless steel surface to oxygen in the air.

Listed below are some causes of equipment staining.

1. **Iron Staining:** Iron staining can occur from high levels of iron present in the plant's water supply. Levels of iron exceeding 0.2-0.3 ppm can produce reddish to black stain on stainless steel over time. The same is true for high levels of manganese in the water supply or a combination of iron and manganese. Iron staining is amplified by addition of oxidizers, such as chlorine bleach, to the alkaline wash solutions.



2. **Metal Oxidation:** Metal oxidation occurs when a hot caustic solution, that does not contain chelators to bind the iron, is circulated for long periods of time or is allowed to dry on to the surface of stainless steel. Metal oxidation staining is commonly observed on processing equipment that requires cleaning solutions containing high concentrations of caustic and high wash temperatures, that are circulated for long periods of time. Metal oxidation is similar to “bluing” of gun barrels. It can start out as a light golden color and slowly, with time, become darker and darker until it is nearly black in color.



3. **Galvanic Corrosion:** When two different metals are immersed in a corrosive solution, each will develop a corrosion potential. If the corrosion potential of the two metals is significantly different and they are in direct contact and immersed in an electrolyte, the more noble metal will become the cathode and the more active metal will become the anode. A measurable current may flow between the anode and cathode. The corrosion rate of the anode will be increased, and the cathode decreased. The increased corrosion rate of the anode is called “galvanic corrosion.” This corrosion or metal ion transfer can be prevented by making sure dissimilar metals are insulated from one another.



4. **Stray Voltage:** Stray voltage is another form of galvanic corrosion where electrons are transferred from one surface to another via a low voltage electric current. The low voltage current is typically the result of poor grounding of an electrical device (ie..pump motor) that is located in the system. Stray voltage is defined and described as a small voltage, less than 10 volts (V), that can be measured between two possible contact points.

Are You Aware...?

- Heat Stain:** The surface discoloration on stainless steel after grinding or welding is surface oxidation. At elevated temperatures, the metal comprising the stainless steel will combine with oxygen to form an oxide layer on the metal surface. The color of the “stain” is a function of the layer thickness.
- Rouging:** A phenomenon that is most observed in the pharmaceutical industry but can also be observed in the food industry at times. Rouging is a reddish-brown film of iron oxides and hydroxides and is found usually in ultra-pure water systems. The rouging film mainly contains iron (ferric) oxides, but also can contain chromium and nickel compounds which can give different colors to the stain (rouge).
- White Rust:** This is a form of corrosion of galvanized steel and is typically found in cooling towers of various food plants.



This is an example of rouging stain which is a corrosion product.



New Galvanized

Steel White Rust Corrosion

Passivated Galvanized Steel

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