CLEANING OF RUST ON STAINLESS STEEL

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Prepared by

Pipe Fabrication Institute Engineering Committee



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CLEANING RUST ON STAINLESS STEEL

1. Scope

1.1 This Technical Bulletin discusses rust on Stainless Steel, and describes recommended methods for properly cleaning stainless steel, and ways of testing to assure that surfaces are clean and do not contain "Free Iron."

2. Definitions

2.1 **FREE IRON**: A thin layer of carbon steel that has transferred to the surface of stainless steel when carbon steel comes into contact with stainless steel.

3. Reference Standards/Documents

3.1 ASTM A-380

3.2 "Rust on Stainless Steel" by Sperko Engineering Services, Inc. December, 2014.

4. General Comments

4.1 Rust is formed on the surface of stainless steel when a condition develops in which the metal molecules at the surface are not sufficiently alloyed with chromium to create or maintain the required oxide layer. Contrary to popular opinion, surface rusting does not occur when stainless steel is "sensitized" since the bulk of the metal has adequate chromium to prevent surface rusting; sensitized stainless steel only corrodes along the grain boundaries. Rusting phenomenon discussed in this Technical Bulletin is a surface phenomenon only.

4.2 The simplest condition under which rusting can occur on stainless steel is when a piece of ordinary carbon or low-alloy steel is rubbed against the surface of an otherwise corrosion-resistant piece of stainless steel. The iron from the ordinary steel will rub off onto the stainless steel surface as a film of unalloyed steel, and, after exposure to moisture in the atmosphere for a few days that unalloyed steel film will form unsightly rust. This happens because the unalloyed steel film on the stainless steel has little or no chromium, so the film transforms to ordinary "red rust". Once the shallow film of iron that has "contaminated" the stainless steel surface has oxidized, corrosion stops, provided the stainless steel surface remains exposed to the atmosphere and is not wetted on a nearly continuous basis. The rusted surface looks bad, but, the chromium in the stainless steel under the rust film forms a suitable corrosion-resistant oxide layer, and further corrosion does not continue once that film of unalloyed steel turns to rust.

4.3 Methods for how cleaning Stainless Steel surfaces are going to be cleaned should be agreed upon with the Owner before fabrication starts.

5. Housekeeping

5.1 Good fabrication practice avoids allowing stainless steels to come in contact with ordinary iron or steel, such as work tables, lifting tools, storage racks, steel turning rolls, steel truck beds and chains, steel forklifts, etc. Iron and steel dust, such as may be created by grinding, cutting, blast cleaning, etc., should be kept away from areas where stainless steel is being fabricated, since that dust may settle on otherwise non-contaminating surfaces potentially contacting the stainless steel.

5.2 Cleaning and grinding tools, such as grinding wheels and wire brushes that have been used on carbon or low alloy steel should not be used subsequently on stainless steels. Only stainless steel wire brushes should be used on stainless steel.

6. Chemical Cleaning

6.1 Chemical cleaning agents that will successfully remove free iron and most other contaminants are commercially available. These cleaning agents are acids which typically remove a little of the material (about 0.001 inches) from the surface to which they are applied. They need to be left on the surface long enough to remove any free iron and any visible oxides. Most contain nitric and hydrofluoric acids, so they must be handled using rubber gloves and other personal protective equipment, and they must be thoroughly rinsed off the surface, and the rinse water may need to be neutralized with baking soda, baking powder, limestone or other basic material. Generally chemical cleaning should be done following an approved procedure.

7. Mechanical/Hand Cleaning

7.1 Mechanical cleaning should only be done using grinding wheels, flapper wheels, and stainless steel wire brushes which have not been previously used on carbon or low alloy steel. *Final cleaning by power wire brushing is not recommended*; wire brushes – even stainless steel wire brushes – will microscopically deform the surface, drive contaminants into the surface, smear the metal and form crevices – none of which are particularly good for the corrosion resistance of stainless steel. Wire brushing between weld passes to remove slag is acceptable since the brushed surface will be remelted during subsequent welding. If wire brushing is used for finish cleaning, it should either be by hand brushing or the powered bristles should be soft and flexible and the pressure light.

7.2 Free iron that has already rusted cannot be successfully removed using grinders or wire brushes. Also, wire brushes will not remove free iron that has deposited as a vapor such as that formed on the heat-affected zone during GTAW welding. If cleaning with grinder or wire brush is attempted in these cases, the rust and free iron are dehydrated by the heat generated during cleaning, turning the oxide white, blending in with the base material. The oxides are then smeared over the stainless steel surfaces that were not previously rusted, and, although the rust will have appeared to have been vanquished, after exposure to moisture in the atmosphere for a period of time, those previously rusted surfaces and any new surfaces on which the oxide has been smeared will turn red as the oxides rehydrate.

8. Testing

8.1 The presence of free iron on stainless steel is readily detected by spraying the steel with water and letting it set overnight. This test is described in ASTM A-380, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.* Spraying should be done in the shade and it should be done late in the day to maximize the time that the surfaces stay wet. The surface should wet completely without breaks in the water film; breaks in the film indicate surface contamination, and further cleaning is required. Any areas of free iron will rust overnight, staining the surface. In humid or rainy weather, stainless steel may simply be exposed outdoors for a day and any free iron will turn to rust. Only those areas exhibiting rust need to be cleaned as described above.

8.2 A quicker way of identifying free iron is to brush (not spray) the ferroxyl solution as described below over the stainless steel to be checked. Personal protective clothing is required for this procedure since the solution is acidic and contains cyanides. Iron contaminated areas will turn blue within a few minutes; if the solution is left on the surface too long, the entire surface will eventually turn blue even if no free iron is present (stainless steel is, after all, mostly iron.). This solution should be removed after a few more minutes using water, and the rinse solution may need to be neutralized. A baking soda solution is acceptable for this purpose.

Ferroxyl Solution for Finding Free Iron on Stainless Steel

Distilled Water: 1 liter
Nitric Acid: 30 milliliters
Potassium Ferrocyanide: 30 grams