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Stainless Steel - Is Stainless Steel Really Maintenance Free

Last Updated **05 January 2020**

INTRODUCTION

Many people believe that stainless steel can't get rusty and that stainless steel is completely rust-proof. In fact, although stainless steel is an alloy that contains chromium and other elements offering a certain amount of resistance to corrosion the base material is virtually as active as ordinary carbon steel.

The noble nature of stainless is due to an ultra-thin passive Chromium Oxide layer on the surface, but in the absence of this layer the material is rapidly corroded. So good care should be taken of this oxide layer to ensure stainless steel will last a lifetime. In other words, stainless steel is not at all maintenance-free. It can, however, be said to be low maintenance. A component made from stainless steel can be compared to a healthy apple that keeps for a long time thanks to its peel, which is less than a tenth of a millimeter thick, but no substances are able to escape or enter - until a worm eats its way through the peel, triggering the rotting process. The flesh of the apple will also oxidize quickly when the apple is cut in half. The 'skin' on stainless steel is much thinner than apple peel yet also provides complete enclosure, which is why, normally speaking, no metal ions can escape and no foreign substances can enter. However, if this skin is exposed to an excessive chemical load, it will break down, leading to corrosion. The biggest difference from the apple is the ability of stainless steel to repair its oxide layer by itself. This is particularly applicable when the layer is damaged mechanically and the chromium oxide layer disappears in local areas. Thanks to the oxygen in the air, passivation of the material will occur spontaneously in those areas through the formation of a new layer of chromium oxide. This is known as the 'self healing effect' although this mechanism can be badly disrupted in the presence of chlorides.

THE SOLUTION

It is vital that stainless steel products and fabrications are clean when they go into service and kept clean whilst in service. In particular weld areas must be free from discolourisation and contamination plus any mild steel contamination that may have occurred during fabrication must be completely removed.

The following pages detail products that are proven to be the best available for cleaning and protecting stainless steel as well as maintaining its attractive appearance.

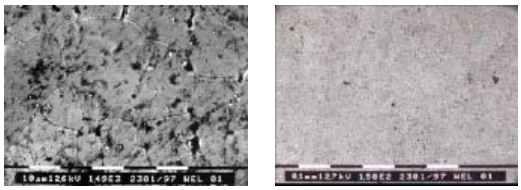
The subsequent pages provide a more detaled technical explanation of the situation.

DIRT DEPOSITS

Stainless steel must be able to 'breathe' as it exists thanks to oxygen. Although oxygen serves to maintain the thickness of the oxide layer, Oxygen is a relatively large molecule however and must be in contact with the surface. This is obviously not a problem when the surface is clean. Those places not exposed to rain are particularly susceptible to under deposit corrosion.

Above is a revolving door that was put into service four years ago. It incorporates a reasonably large amount of stainless steel and is located in the vicinity of sea water. At first sight, there is nothing wrong with it until you take a closer look at the arch above the door. You then see all kinds of rusty spots also known as tea stains. As this revolving door is located near sea water, we can be certain that this destruction is the work of aerosols, together with dirt deposits. Aerosols are small droplets of sea water which evaporate when airborne, increasing their concentrations of salts and chlorides.

These settle on the stainless steel surface and the chlorides push their way under the dirt deposits in the pores, where they attack the material. If nothing is done, this corrosion will slowly spread further. Above you can also see that the stainless steel under the porch has suffered far greater corrosion than the section exposed to rain. The reason for this is that rain water washes away most of these salt residues, which means that the material experiences less corrosion. If the stainless steel arch had been cleaned regularly, these 'tea stains' would not have developed. The cause is therefore the dirt deposits in the pores. As stated earlier, the surface of stainless steel contains a considerable amount of dirt, which can easily be seen using a microscopic image.



A magnification of 1500x shows a significant amount of dirt in the pores on the surface and this, in itself, should not be considered an exception. In fact, this is more the rule than an exception.

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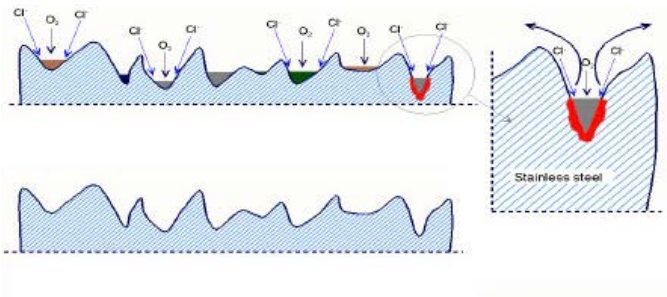

Above is a diagrammatic representation of a stainless steel surface that has greatly been magnified. The pores are filled with all kinds of dirt deposits, under which chlorides will find it easy to move. This will be much easier for small chlorine ions than for relatively large oxygen molecules and that is precisely the problem. Chlorine, just like fluorine, iodine and bromine, is a member of the halogen family, which are known as salt formers. Chlorine ions will therefore be inclined to combine with metals to form metal chlorides and this is certainly the case when oxygen is prevented from reaching the oxide layer to keep it in good condition. This layer will then break down, inevitably resulting in under-deposit corrosion. Once this surface is cleaned right down to the pores, oxygen will be able to do its job to sufficiently guarantee passivity.

Surface tension

Every liquid has a specific surface tension. This can clearly be seen with drops of mercury that form globules on a sheet of glass.

Water forms droplets that look more like toadstools. Mercury will not moisten the glass sheet like water does. The reason for this is that liquid mercury has a very high surface tension and water a relatively low one. Adding soap to the water will reduce this even more. Substances that lower or break the surface tension are also called tensides. These can be either ionic or anionic. The lower the surface tension, the deeper the agent will penetrate into the pores.

This image illustrates this form of corrosion. It shows a switchboard cabinet made from AISI316 that is situated in the open air near to the coast. It is thought that a seawater resistant stainless steel should be chosen in this case. It is mainly aerosols that attack this surface under the dirt deposits. If this surface had been cleaned regularly, then this form of corrosion would not have occurred. As the entrance gate in question is covered, it is very difficult for rain water to reach the object to clean it. Once again, a mistake was made here in thinking that stainless steel was maintenance-free. The corrosion shown is no reason to replace this part as the corrosion can still be removed. It will be necessary, however, to apply extra protection after cleaning as minute blemishes have developed that could quickly lead to new corrosion.

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