How do you remove and prevent flash rust on stainless steel?

One of the problems of stainless steels is that they are susceptible to rust if they do not have correct maintenance. In this article, some common rust problems are dealt with, and it is shown how the rust can be removed by using a simple kit consisting of two liquid agents and a special sponge.

N.W. Buijs – Metallurgist – Innomet b.v.

Flash rust

One of the causes of flash rust, also known as rust film, is when small steel particles fall or swirl down onto a stainless steel surface. When combined with moisture, they quickly dissolve due to the base character of the steel particles (see Fig. 1). There is a relatively large potential difference between stainless steel and carbon steel, which is why this reaction occurs extremely quickly. In practice, the term 'iron particles' is often used, but what is actually meant is 'steel particles'. During dissolution of the steel particles, iron oxides are created that contaminate the surface of the stainless steel. In addition, oxygen is somewhat prevented from entering the area, as a result of which the stain-

Fig. 1. contamination corrosion on stainless steel tubes caused by carbon steel grinding.

less steel surface becomes activated locally. This then leads to contamination corrosion. Examples include steel particles that are the result of wear and tear, such as near to railway tracks, as well as grinding dust and showers of sparks that develop during carbon steel grinding. The latter particles are particularly dangerous because they can burn into the stainless steel surface whilst the core of these particles still contain unburnt steel. In addition, the abrasive movements of carbon steel and stainless steel together can also lead to contamination corrosion in the end. This is why stainless steel needs to be protected from carbon steel and must be processed separately from carbon steel. If the latter is not possible than pickling and passivating stainless steel offers a good option to become free of any undesired steel particles.

Fig. 3. Contamination by a steel object such as the fork of a forklift truck.

Aerosols

Local rust spots can also develop due to aerosols, for example, and this primarily occurs in coastal areas. Aerosols are small droplets of seawater that are carried from the sea by the wind and which evaporate during their flight leading to a further increase in salt and chloride concentrations. This forms a greater corrosive load for stainless steel than normal seawater. The result is local corrosion that can also even lead to pitting corrosion at times. The effect of this action can regularly be seen on stainless steel parts on or near the shore in particular. In Fig. 2 you can see an access gate made from stainless steel 316 that is situated near to the coast. Rust spots, which in this case are also known as tea stains, can clearly be seen.

Another common reason for contamination corrosion is the contact between carbon steel and stainless steel due, for example, to steel forks of forklift trucks, nails on pallets, contact with Stelcon plates, steel tools, steel transport rollers etc. An example of this can be seen in Fig. 3. Corrosion products can clearly be seen seeping out of the 'wound', causing further contamination to the surface. If this damage is not removed then the corrosion will quickly continue in this area until the material is bored through locally as it were. The speed with which it happens is due to the fact that contact occurs between a small anode and a large cathode.

In general it can therefore be said that stainless steel is not particularly maintenance-free. Thanks to an extremely thin and dense oxide film, stainless steel continues to display rust-resistant behaviour because this film remains intact thanks to the oxygen present in the air. If this layer is perforated by steel particles, for example, then this film will be unable to recover automatically. Under the oxide film there is always an active metal and as soon as moisture is added this will start corroding. The passive film should therefore remain intact at all times.

Normally, damage to the stainless steel surface will not produce any problems because the oxygen in the atmosphere will repair the film in that area again; this is why this effect on stainless steel is also known as 'self healing'. This unique property disappears however as soon as the surface becomes contaminated and the rust formation that is initiated will therefore spread until the material is bored through. In other words, these corrosion products may

Fig. 2. RVS 316 access gate corroded by aerosols.

not be left on the surface, which is why a good maintenance plan must be drawn up.
Local rust formation can be removed with pickling liquids or pickling pastes as well as with inorganic chemicals. In some cases this can also be done mechanically with, for example, sandpaper, special scourers or stainless steel brushes. The disadvantages are generally well-known, as scouring damages the surface considerably and, in addition, the scoured area is often less corrosion-resistant. Pickling is harmful to the environment and dangerous for the people working with it. Regular inhalation of the hydrogen fluoride present can even lead to a pulmonary embolism. The use of inorganic acids also has its dangers and is also subject to stringent rules and guidelines. This is why an oxide-dissolving organic agent called Innosoft B570 is now available that gives a very effective and efficient result. In Fig. 4 you can see light fittings made from stainless steel 316 that were only in use in a maritime environment for one and a half years. The top sections still show the severity of this contamination by aerosols. After use of the organic acid Innosoft B570, the surface was quickly restored to its original condition. The bottom fitting has partially been treated with this. And yet one must not lose sight of the fact that small scars may have developed in the surface that could quickly lead to new corrosion as soon as the fittings are put back in place. This is why a basic neutraliser has been developed that also deposits a nanolayer on the surface to provide protection against possible new corrosion. This product will be introduced on the market under the name Innoclean B560. A maintenance protocol will also be needed in this case as all things come to an end. In other words, the surface will need to be cleaned and the nanolayer reapplied periodically.
Various maintenance advice can be found on the Internet regarding stainless steel. Unfortunately, reputable companies sometimes issue advice that is often at odds with what should actually be done. For example, advice is given to clean contaminated stainless steel with steel wool or a scouring sponge. This should particularly be avoided as steel wool is something that contaminates stainless steel and a scouring sponge damages the surface. This is why Innosoft B570 is a product that only dissolves the iron oxides and also has a deep cleansing effect. In other words, it is gentle on stainless steel but tough on oxides and all kinds of dirt. A good example can be seen in Figs. 5 and 6. A stainless steel flange 304 was kept in a plastic bag in which ferruginous water was present. The flange came out the packaging in such a state that it was ready for the scrapheap. This problem was easy to solve with the afore-mentioned organic cleaner and the flange was reconditioned in no time at all.

Fig. 4. Contamination corrosion on 316L light fittings (the bottom fitting has partially been treated with the organic acid Innosoft B570).

Fig. 5. RVS 304 flange contaminated by ferruginous water.

Fig. 6. The same flange as in Figure 5 but cleaned with Innosoft B570 and coated with a nanolayer.

Another example is a seriously contaminated stainless steel tube that was lying at a building site (see Figs. 7 and 8). A section on the left of the bar was the only part treated with this particular organic acid and the result exceeded all expectations.
It would be sensible to mention that corrosion pits will of course remain, but the pits are, however, stripped of the harmful corrosion products. These imperfections do require extra care as they can quickly set the corrosion mechanism in motion again. In that case, the invisible nanolayer also provides some additional protection.

Deep cleansing

Innosoft B570 also has a deep cleansing effect and this is of significant importance as dirt etc. can settle as a deposit, particularly on a somewhat rougher or ground surface. This can lead to 'under deposit attack' which is a form of corrosion that only occurs under these types of depositions. This type of corrosion mainly appears when aeration does not occur evenly across the metal

Fig. 7. Stainless steel 316 tube that was badly contaminated by steel grit on a building site.

Fig. 8. The same tube as in Fig. 7 but cleaned on the left side of the bar.

surface. This can lead to the formation of local corrosion cells. The corrosion that occurs then concentrates on these areas (see Fig. 9). In practice, there is a known case regarding polished AISI 316 tubes on a seaworthy yacht that remained in good condition for years, but when the owner had these replaced with ground 316 tubes, the new tubes started to turn brown after only three months. This is due to the dirt deposits in the ground grooves and especially also to chlorine ions, which in terms of size are significantly smaller than large oxygen molecules. This enables chloride ions (halogens) to do their devastating work, whilst oxygen is scarcely able or unable to reach this particular surface to maintain its passivity. Innosoft B570 penetrates deep down into the pores, however, in order to remove these harmful dirt deposits. This is why this product also acts as a detergent, and dirt and micro-organisms in so-called 'hidden pockets' (that can be found in the surface) are also likely to disappear.

Trial

Many of you will recognise the problems mentioned above and realise that stainless steel does indeed require maintenance. If any readers of this article would like to give these agents a try, there is an opportunity to do so. A test kit has been made available containing two bottles – a 250 ml bottle of Innosoft B570 and a 250 ml bottle of Innoclean B560 plus a special sponge. To request this kit, please contact the author at nwbuijs@hetnet.nl or visit www.inno-soft.nl. ■

ABOUT THE AUTHOR

Ko Buijs is a recognized metallurgical / corrosion specialist on stainless steels as well as special metals. He works as consultant for Van Leeuwen Stainless as well. In addition, Mr Buijs is a lecturer for various organisations such as steel associations, technical high schools and innovation centres. He has published over 130 papers in a number of technical magazines. In close co-operation with Barsukoff Software Mr Buijs has developed the computer programme Corrosion Wizard 2.0. Info www.corrosionwizard.com

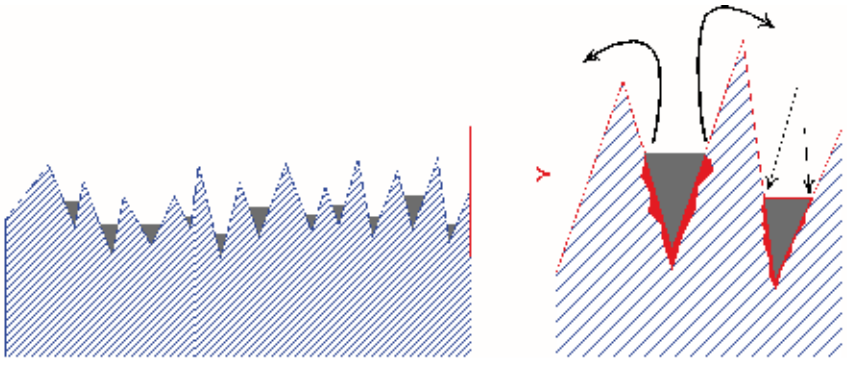

Fig. 9. Ground surface that has been significantly enlarged in the diagram. Dirt and other deposits ensure that chlorine ions, for example, are able to penetrate deeply underneath these depositions leading to local corrosion of the surface. Corrosion products such as rust will then appear.