Technical Bulletin

Testing and measuring procedures for measuring the quality of stainless steel (constructions)

Avoid disputes with your customer, know what you are supplying

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Introduction
We have already written much about stainless steel and corrosion over the years. Vecom is often consulted after a problem has occurred that must be subsequently be solved. Fortunately this can be done in most cases, but who pays the costs? The constructor or the user? This Technical Bulletin outlines which procedures and methods can be used by the manufacturer to implement a clear and unambiguous quality policy, while giving the customer more realistic expectations.

Determining the material used
Because there are countless qualities of stainless steel available we will limit ourselves to the two most common ones here: Stainless steel 304 and 316. The most important basic difference between these alloys is the addition of Molybdenum to 316. This element increases corrosion resistance against aggressive elements (e.g. chlorides). Unfortunately, it is not or barely possible to visually identify with which alloy one is working. In case of doubt a simple test can however give a conclusive answer: In the Moly Drop test, 3 to 4 drops of a liquid applied to the material react with Molybdenum or otherwise. If the drops discolour after several minutes, Molybdenum is present and one has a 316 or higher quality. If the drops remain semi-transparent, the quality is 304 or lower. See the images below.

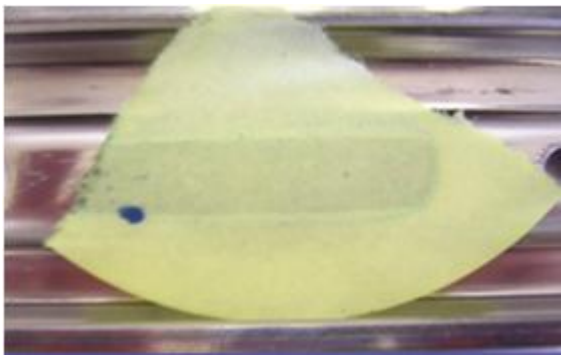
This test costs approx. 1 euro per time for the liquid. Obviously with a mistake the costs could be many times greater (material or corrosion problems so a potential claim from your customer). If you do this test in the presence of the customer (on delivery, for example) there can never be a dispute about the quality supplied.
For demanding users, electrolytic equipment is also available with which one can identify the material type.

Demonstration of the presence of free iron on stainless steel using the Ferroxyl Test
The Ferroxyl Test is to check if austenitic stainless steel must be pickled or if it has already been adequately pickled. If the surface of austenitic stainless steel has been contaminated with metallic iron (free iron) the properties of the stainless steel will be affected.
The presence of free iron in the stainless steel surface affects the chromium oxide skin so corrosion resistance there is lower. If the free iron is not removed, serious (pitting) corrosion can occur.

Principle of the Ferroxyl Test
The test is based on a reaction of potassium ferricyanide with iron in a strongly acid environment. The excessive iron dissolves in this strongly acid environment as a bivalent iron and forms a blue-coloured complex known as Berlin blue. If this blue discolouration occurs when carrying out the

Apply three drops to a clean surface and wait for a maximum of 5 minutes until discolouration occurs. If the drops turn yellow/brown the material contains molybdenum and the quality is at least 316. Caution: the drops can make the surface mat or leave a ring behind!

test, the surface of the stainless steel does not yet have the correct structure and is still insufficiently pickled.
If the blue discolouration does not occur, the structure is restored and this is an indication of an adequately pickled surface. The method is according to ASTM 380A.



blue discolouration indicating the presence of free iron

Passivity control

The corrosion resistance of stainless steel sinks or swims depending on the thickness and quality of the chromium oxide skin. This skin, that builds up due to a natural reaction of the chrome with oxygen in the air, must have a minimum passivation value on delivery of the construction. Passive means that the chrome has practically fully reacted with oxygen, and the chromium oxide skin is sealing and of sufficient thickness. As already described in other documentation, it takes approx. 24-48 hours after the pickling procedure for the stainless steel to become passive. This passivation process can be disturbed by high concentrations of chlorides in the air (salts) or by carbon steel particles (this base material reacts with noble materials such as chrome and nickel). The result is a poorer quality chromium oxide skin and a greater likelihood of corrosion.
Further, the contamination does not necessarily always occur at one's own workplace. If, for example, the material is externally blasted (ceramic or glass beads), the jet or bead grit can “blow” contamination into the surface. It is not uncommon for the original passivation value of stainless steel as on delivery to be lowered by blasting/beading.

Equipment for measuring the passivity/corrosion resistance

The passive value of the chromium oxide skin or the corrosion resistance value is also simple to measure. Two types of appliance are capable to do this; The Corrodium Oxilyser III and the Nitty-Gritty Clinox Test.

OXILISER III - The most important difference between these devices is that the Oxilyser is calibrated beforehand for 304, 316 and Duplex materials. Using 1 pin an LED and LCD display shows the resistance value of the chromium oxide skin, and whether or not this value applies as passive for the measured material or not passive. Accordingly, it can be established with a pickling/passivation process that the processed material is not only passive, but that the corrosion resistance value has also increased from, for example, standard value 65 to value 85 after pickling/passivation.

TEST.CLINOX - With the Nitty Gritty Test.Clinox one measuring pin is supplied for 304 material. Pins for 316 or Duplex must be separately ordered. The Test.Clinox also works with a calibration per measurement. For each measurement calibration must take place on a pure piece of material (not affected by welding, discolouration, grinding, etc.). The critical part is then measured (the welded joint, for example) and the value is compared with value of the pure area. An LED light then indicates if the critical part is passive (green LED) or not passive (red LED). No value is shown. In practice the Test.Clinox is as a result a little more laborious to use. A corrosion resistance value can only be read if a universal voltmeter/ ohmmeter is connected.

The Test.Clinox and Oxilyser III are both exclusively supplied by Vecom in the Benelux.
With a first measurement after grinding/blasting/pickling the passive value can still be too low. This can have a number of causes;

- The material has not yet had time to sufficiently react with oxygen (24-48 hours)
- In the passivation phase the material came into contact with chlorides/free iron
- The material was treated with contaminated tools/ grit

In just about all cases a chemical passivating agent (for example Vecinox Passivating Liquid) can be sprayed to still achieve the minimum passivation value within 3 hours.

Determining the quality supplied

How can determining the corrosion resistance value further help you as a constructor? As mentioned in the introduction to this Technical Bulletin, disputes often originate when a stainless steel construction nevertheless shows signs of corrosion after a short while. The discussion often starts with the question of what the cause is: the condition of the stainless steel on delivery or the circumstances or treatment by the user. Mentioning in the terms of delivery that all stainless steel is delivered with the minimum passive value can make a claim concerning corrosion easier to deal with. You can as a constructor inform the customer that measuring and delivering a minimum passivity is a standard control in your quality system.
You can even go a step further, particularly if you already know that the supplied construction will be subjected to

corrosive conditions. When delivering constructions with, for example, a value of more than
€ 5,000 you fill in a “delivery certificate” in the presence of the customer in which the critical aspects (material type, passive value) are noted. Carrying out measurements in the presence of the customer will also mean there are more realistic expectations of the resistance to corrosion of the construction supplied. You can then proactively conduct an open and honest conversation about how to treat the material. Should corrosion nevertheless originate in a relatively short time, you can then as the constructor, state to have done everything possible to supply the material in an optimal condition. All problems can then be shown to be the consequence of factors beyond your control, and for which you can accept no responsibility.

Aftercare and advice for the user with corrosion problems
To further assist your customer in the case of stainless steel corrosion, it is always wise to explain the limitations of stainless steel beforehand and make clear that stainless steel also requires maintenance. For example, it must be cleaned at regular intervals (in a neutral environment with a mild water-based cleaner, in corrosive conditions with an acid cleaner). The material must always again be given the chance to react with oxygen (passivation), so may not be sealed under a coating or layer of contamination. If corrosion does occur there are a couple of less aggressive products that can simply remove it:

- Vecinox Stainless Steel Gel 4023 – This gel dissolves surface corrosion without mechanical means in 15 – 45 minutes (at a temperature of 20°C) that can then be wiped off with a cloth/sponge or immediately rinsed off with demineralised water. Classified as Corrosive.
- Vecinox Soft (equivalent to the well-known Innosoft B570) – This mild acid cleaning liquid cleans very intensively and deeply while dissolving corrosion with light mechanical means (sponge). Very economical in use. Classified as Irritant.
  There is additionally Vecinox Soft Protect, an agent that condenses the chromium oxide skin with nanoparticles to further increase corrosion resistance. To be applied after the full cleaning of the surface.

This image shows how façade cladding of stainless steel 304 is affected by carbon steel contamination (object is in the vicinity of a railway station). The left part of the panel is briefly treated with a sponge and Vecinox Soft (not yet rinsed).

You can find further advice and tips on the maintenance of stainless steel in previous Technical Bulletins. For more information about the subjects covered in this bulletin you can contact Vecom at: tb@vecom.nl or by telephone on the numbers on the contact page on our website

Author: B.J. Jongenotter, segment manager Metal Industry
www.vecom-group.com