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## STAINLESS STEEL IN ARCHITECTURAL CONSTRUCTIONS, BEAUTIFUL BUT DELICATE

### Introduction

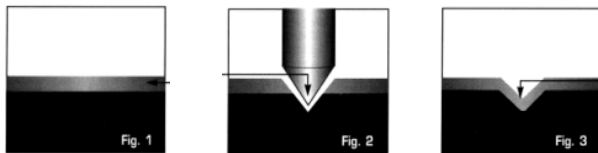
The enormous price increase of stainless steel over the last years has not resulted in a reduction of architectural appliance of the material. In the contrary, stainless steel is applied more then ever. From the conventional letterbox cover plates and "doorbell panels" to fancy facades, fences and art objects. The choice for stainless steel seems simple, it has an exclusive and solid appearance and the general idea is that it is maintenance friendly. But is it?

### Application, cleaning and maintenance of stainless steel

The result of all this stainless steel being applied in and around buildings confronts conventional cleaning companies with cleaning and maintenance problems. On one hand because of the volume they often have to clean nowadays, on the other hand sometimes because the wrong type of stainless steel was applied in a specific environment.

To emphasize on this last remark, a bit of explanation on the stainless properties of stainless steel is required. The reason that stainless steel is better resistant to corrosion then "normal" steel has to do with the presence of chromium in the alloy. This percentage has to be at least 12% for the alloy to earn the word "stainless". The chromium present in the alloy forms a chromium oxide layer at the surface of the stainless steel. This layer is what protects the steel against corrosion up to a certain extent. The chromium oxide layer is "self healing". By this we mean that if the layer is damaged (scratches, it is only a few microns thick) the underlying steel is exposed and vulnerable to corrosion, but a new layer of chromium oxide will be formed in the damaged area in up to 24 hours. If chlorides or other contamination like foreign steel particles attach to the damaged part of the stainless steel, it will corrode. In figure 1, 2 and 3 this is explained graphically.

Fig. 1: The gray layer is the chromium oxide layer, the black layer is the stainless steel. Fig. 2: The chromium oxide layer is only a few microns thick and is easily



damaged. Fig. 3: Several hours after the stainless steel surface has been damaged, a new layer of chromium oxide will appear

Not only scratches will damage the chromium oxide layer. Also chlorides (salts), foreign steel particles (carbon steel) and heat (for instance by welding) can damage the chromium oxide layer to such extent that it no longer has its protective properties. In the worst case this means stainless steel will show corrosion. Most common applied stainless steel qualities in construction are from the "300" or austenitic steel series. The lowest applied grade is called "304" and the higher grade is "316", the last two numbers say something about the present percentage of chromium, molybdenum and other elements that increase the resistance to corrosion. This means that 304 is much less resistant to corrosion then 316. In Table 1 you can see the exact alloys of most common types of stainless steel.

| Comm. name | DIN                | C %   | Cr %  | Ni % | Mo % | Cu % | N %   | PREn (%) |
|------------|--------------------|-------|-------|------|------|------|-------|----------|
| 304L       | X2CrNi18.9         | 0,021 | 18,2  | 10,1 |      |      |       | 18,2     |
| 316L       | X2CrNi18.10        | 0,021 | 17,0  | 10,1 | 2,06 |      |       | 23,8     |
| 1.4439     | X2CrNiMoN17.13.5   | 0,027 | 17,2  | 12,8 | 4,3  |      | 0,132 | 33,4     |
| UNS N08028 | X1NiCrMoCu31.27.4  | 0,015 | 26,6  | 30,4 | 3,3  | 1,0  |       | 37,6     |
| 1.4462     | X2CrNiMo23.5.3     | 0,016 | 22,0  | 5,7  | 3,1  |      | 0,16  | 34,8     |
| 1.4539     | X2NiCrMoCu25.20.5  | 0,016 | 20,2  | 24,9 | 4,5  | 1,4  | 0,7   | 36,0     |
| UNS S32760 | Superduplex        | 0,016 | 25,06 | 6,44 | 3,46 | 0,58 | 0,23  | 40,2     |
| UNS S31254 | X2CrNiMoCuN20.18.6 | 0,16  | 19,9  | 18,0 | 6,14 | 0,8  | 0,19  | 43,2     |

In this technical bulletin we will give you two examples where stainless steel was applied on the outside of a building and directly or after some time started to show corrosion (rust).

### Example 1:

#### Apartment complex Beach Road, Hook of Holland

This apartment complex consist of 3 equal blocks and was finished in the course of 2006 and the beginning of 2007. It is situated on a few hundred meters away from the sea. Air measurements have shown that sea air contains high concentrations of chlorides which are transported by wind up to 35 miles land inwards. This concentration is in general already high enough to penetrate through the chromium oxide layer of stainless quality 304. In other words, stainless quality 304 applied in coastal areas will start to "rust" within weeks if it is not maintained properly. Also 316 quality will eventually start to rust in these areas, but it will take substantially longer than with the 304 quality.



The apartments at the Beach Road had stainless steel letterboxes on the outside of the entry. Within 6 months however, they started to show corrosion. The active committee of house owners asked their facility maintenance company, Van Holstein, to solve the problem.

Dennis van Holstein, owner of this company explained us: "We really did not know what to do about it at first. Regular cleaning products don't remove rust. Also we did not have a clue whether the products we tried made the situation any better or worse. I know there are products on the market to remove rust, but in general these are highly acid products that I wouldn't like my people to work with!" Therefore Van Holstein searched for a user friendly solution to solve the corrosion problem at the apartments on Beach Road, that now also spread to some poles meant to support parked bicycles. There search lead to one of the other customers of Van Holstein: Vecom.



Dennis van Holstein continues his story: "At Vecom they understood immediately what was going on and also understood that I was not planning to use heavy chemicals as part of my daily routine cleaning buildings. Besides that, an online search showed me that such chemicals were sold per 10 or 25 liter drum, much more than I need for a few letterboxes and poles." Fortunately we just developed a kit for



maintenance of stainless steel called "Enviro-Shield". This kit not only provides the 3 products to maintain and protect stainless steel, it also clearly explains the principle of stainless steel. The user is educated in a clear and understandable way why he should always follow certain steps to keep his stainless steel in tact, even when slight corrosion is already showing

(tea staining). Via the Vecom website and through many customers, mostly stainless steel construction companies, we received numerous comparable questions on how to solve these issues with stainless steel. We were used to sell heavy pickling chemicals per 25 liter but could not offer these products to end users who have a "consumer" like knowledge of stainless steel. Therefore Vecom decided to create a consumer friendly kit with mild, ready to use chemicals in a consumer packaging. Of course the chemicals should not be dangerous to both user and it's environment. Van Holstein was happy to try this package and tested it on the letterboxes. And with a fine result. The already formed corrosion was removed and the letterboxes achieved their original appearance. From now on Van Holstein cleans the letterboxes weekly with the Vecinox Protect spray that was present in the Enviro-Shield kit or even a mild cleaner. Vecom advised to use the R2U stainless steel cleaner 3 to 4 times a year to remove possible corrosion that might not even be visible yet. For the poles that support the bicycles it is too late. Unfortunately, it seems that the used quality of stainless steel is too poor (304) and the corrosion that appeared up to now is to severe to remove it with the R2U version of the stainless steel cleaner. A specialized stainless steel surface treatment company will have to remove this corrosion with heavy chemicals and protect the underlying ground from these chemicals. Also the chemical waste after the treatment will have to be processed in a responsible way.



The last example of corrosion at these apartments was found on the inside of the letterboxes, where you can see that on the spots where it was welded together, corrosion also started to kick in. This can only be removed by using highly acid pickling paste which contains HF (hydrofluoric acid), the only type of acid that can remove corrosion on stainless steel extensively. The presence of this acid unfortunately also means that many precautions must be taken when working with pickling paste. The user must wear complete facial and breath protection, gloves and an acid proof overall. When the paste has done it's job, the surface has to be rinsed with demineralized water and by preference also chemically passivated. This kind of treatment can also only be done by a metal surface treatment company.



## Example 2: Stainless steel Duct at the entry of Vector, Rotterdam

At Vector in Rotterdam, Van Holstein also experienced a maintenance problem with a stainless steel construction. The duct hanging over the entry of the Vector building showed corrosion. The type of stainless steel that was used for the construction is of good quality (316 or higher grade) and was fitted in 2005. After one-and-a-half year it started to show a modest corrosion on the surface. Roland Borst of



the Vector Facility Management explains: "We tried to solve the problem ourselves with these silver/blue spray cans "stainless steel polish". They made the uncontaminated parts shine really well but it didn't stop the corrosion." At Vecom we are familiar with those kind of products. The Vecinox Protect spray that comes in the Enviro-Shield kit is a similar product. In general these products are harmless as long as you realize what you are doing. An uncontaminated surface will indeed shine and even be "protected" with such a product, but when you apply it to a surface that already is showing corrosion you can make the problem worse. You can lock elements like chlorides and foreign steel particles under a layer of the product (Protect spray or similar products), shutting the stainless steel surface from oxygen. This means the chromium oxide layer has no chance repairing itself. The chlorides or other contamination will "eat" their way through the surface, creating "pit corrosion". Since Van Holstein had good experience with the Enviro-Shield kit, they also applied it to the stainless steel duct at Vector. And here also it proved to be the right solution. As can be seen on the recent image, the duct shines again and there are no signs of corrosion any more. Still the question remains why in this situation a good quality stainless steel started to "rust". The answer is quite simple, if you know what to look for. The street on which the Vector Building is situated crosses with a railway track just a few hundred yards away. Carbon steel particles coming from the tracks and the train wheels are transported by the wind and attach to the stainless steel duct. Once enough particles have attached themselves to the surface, even this stainless steel quality is not resistant any more and corrosion will occur.

## Conclusion

Applying stainless steel in architectural ways in the open air does not have to be a problem, as long as you are aware of the need for maintenance and treatment of stainless steel. In coastal areas and in areas where plenty of tracks (trains, subways etc) can be found, the 304 quality of stainless steel is not sufficient. It is advised to use at least quality 316. Clean the stainless steel on a regular basis with a mild daily cleaner product. If after some time corrosion still starts to show, immediately apply a mild acid product like Vecinox Stainless Steel Cleaner R2U. Rinse properly, preferably with demineralized water, because tap water contains chlorides that can damage the chromium oxide layer. Once the surface is clean from chlorides or foreign steel particles, a "protective" spray such as Vecinox Protect can be applied. If used on a regular basis, this should keep your stainless steel in perfect condition.

Vecom can also provide you with a "MolyDrop" tester. This easy drop test tells you whether the stainless steel applied is of 304 or 316 or higher quality.