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Stainless Steel - Stainless Steel in Coastal Environments

Last Updated **18 July 2019**

The main purpose of this Datasheet is to advise on the choice of stainless steel for use outside in coastal areas in terms of the correct choice of grade and finish.

It has been shown after many years of stainless steel usage in coastal environments that grade 316 or 316L is the optimal choice of stainless steel grade with mirror polished being the best finish choice for long life and maintenance of good appearance. If a matt finish is required then finishing by use of bead-blasting using fine glass beads to give a smooth surface may be an option, although this is NOT recommended and will require more regular cleaning - If using this method, it is critical that the glass beads must be clean and free from any iron/mild steel contamination and that a rigorous pickling & passivation treatment is carried out after blasting.

This correct choice of mirror polished grade 316 should also be combined with a cleaning regime that will keep the stainless steel and its finish looking great for many years. After fabrication and/or upon installation the stainless steel should be thoroughly cleaned to remove any surface contamination, dirt, etc.

For both initial cleaning and on-going cleaning, care must be taken to use soft, non-abrasive cleaning cloths that are clean and not contaminated in any way with iron or mild steel.

Equally, any cleaning products used must not affect the polished finish and, if likely to damage the passive surface layer must be followed by a repassivation treatment.

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 millimetre 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.

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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. Places not exposed to rain are particularly susceptible to under-deposit corrosion.

Above is detail of a canopy above a stainless steel revolving door after four years in service in the vicinity of sea water. You can see all kinds of rusty spots also known as tea stains. This 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. In this case, 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 PROBLEM

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.

THE SOLUTION

So to repeat, it is vital that stainless steel products and fabrications are:

- Clean when they go into service an, in particular weld areas must be free from discolouration and contamination plus any mild steel contamination that may have occurred during fabrication must be completely removed.
- Kept clean whilst in service.
- The surface finish of the stainless steel is also a key factor and will have a major effect on the corrosion resistance of the stainless steel.

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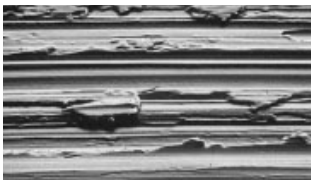
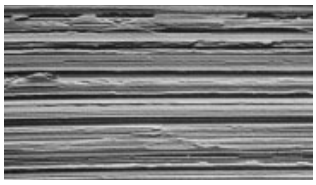
SURFACE FINISH

Many 'polished' finishes that are applied to stainless steel are highly directional ground (scratched) finishes applied using dry abrasives. These perform very poorly in terms of both corrosion resistance and cleanability. The reason for this can be explained by microscopic examination of the surface.

These images show two typical 'polished' (dry-ground) finishes

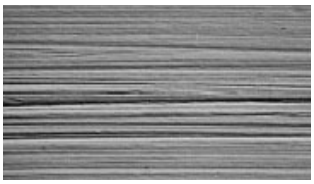


Ra > 1 Micron



Ra approx. 0.5 Micron

A good quality wet-cut finish with an Ra of 0.2 microns as shown below is a much better alternative but compared to mirror polished could hardly be called 'smooth'.



Clearly surfaces of this nature have the propensity to trap dirt and contaminants whilst their roughness hinders proper cleaning as well as an even formation of the passive layer.

Equally, it can be seen that orientation of the finish in service will also have an effect with vertical orientation of the 'scratches' being preferred.

CLEANING PRODUCTS

Stainless steel is easy to clean. Washing with soap or a mild detergent and warm water, followed by a clear water rinse, is usually quite adequate for domestic and architectural equipment. An enhanced aesthetic appearance will be achieved if the cleaned surface is wiped dry.

Where stainless steel has become extremely dirty with signs of surface discolouration or tea staining, (perhaps following a period of neglect or misuse) then a more aggressive cleaning regime will be required. In this case the choice of cleaning products will depend to some degree upon the surface finish since some cleaning chemicals may spoil a mirror polished finish.

As already stated:
- Any cleaning products used must not affect the polished finish and, if likely to damage the passive surface layer must be followed by a re-passivation treatment.
- For both initial cleaning and on-going cleaning, care must be taken to use soft, non-abrasive cleaning cloths that are clean and not contaminated in any way with iron or mild steel.

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SURFACE FINISHES TO EN 10088-2 / 10028-7

Special Finishes*				
EN Finish	**Old BS Finish**	**Description**	**Typical Grit**	**Typical R_a**
1G or 2G	**-**	Ground grit	120	2.5 to 2.0 µ
1J or 2J	**3B**	Brushed - unidirectional	180	1.2 to 1.0 µ
1J or 2J	**4**	Dull Polished - unidirectional	240	0.6 µ
1K or 2K	**5**	Satin polished - unidirectional	320	0.5 Max
1P or 2P	**7**	Bright polished - non-directional with a high degree of image clarity	600	0.1 µ
1P or 2P	**8**	Mirror finish - non-directional with a very high degree of image clarity	800	0.05 µ

***Note:** Special finishes indicate hot rolled (1) and cold rolled (2) sheets, e.g.: Ground polished hot rolled sheets = 1G / Ground polished cold rolled sheets = 2G

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