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DESIGN AND LAY-OUT FOR CORROSION PREVENTION

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Corrosion can manifest itself in countless forms and via various mechanisms. There are also numerous methods used to protect against this corrosion. These can be summarised as follows:

- Good design and layout
- Optimal selection of construction materials
- Altering the corrosive environment; using inhibitors
- Application of protective coatings
- Changing the electrode potential

The optimal selection must be made from these various techniques of preventing corrosion or limiting it to a minimum. Relevant issues are safety, availability of the equipment and of course life-cycle costs. The various corrosion-engineering approaches to preventing or minimising corrosion are shown schematically in figure 1.

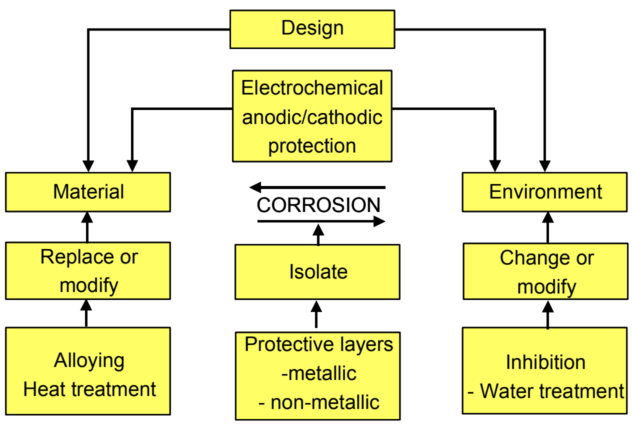

Figure 1: Corrosion engineering approaches for fighting corrosion

In addition to the already mentioned methods, cleaning, pickling and passivation of stainless steel types in particular play an important role in the prevention of corrosion.

Importance of optimal design and layout
Important savings in the operational costs of process installations are possible if corrosion problems are anticipated in advance. This anticipation must take place during the process installation design phase. Pressure vessels, heat exchangers, tanks, etc are important equipment in the chemical industry. Reactions, distillation, separation of products, heating, cooling and storage take place in these types of equipment. Designing this equipment so that corrosion is avoided as far as possible lowers maintenance costs and raises the availability of the process installation and consequentially also profit levels.

Much corrosion damage can be traced back to shortcomings during the design phase of the plant and/or equipment.
In general the design of high-pressure equipment as well as storage vessels is regulated by local codes and standards. The requirements in these codes tend to relate mainly to the construction/strength aspects and not to the corrosion resistance of the materials used.
It is important that corrosion prevention and control is kept in mind during the entire design process and not just at the end when the design phase has really been completed.
Correct design will only be achieved using a multidisciplinary approach through close cooperation between designers (process and structural engineers), equipment fabricators, welding specialists and material and corrosion engineers.

Relevant factors relating to design and layout
The following issues are among those that are important in a multidisciplinary approach to design:

- Layout and/or location of the equipment - prevailing wind direction in relation to contamination such as chlorides and nitrates (corrosion under insulation).
- Structures without crevices - welded joints are preferable to bolted and riveted joints.
- The design must allow for efficient inspection and maintenance at relatively low cost levels (life-cycle costs).
- The equipment and piping must be designed in such a way that tapping, cleaning and/or pickling can be carried out easily.
- Components where corrosion or cavitation is expected must be designed in such a way that they are easy to replace.
- Contacts between two different types of construction materials must be avoided to prevent galvanic corrosion.
- To prevent cavitation - avoid sharp bends and narrowing in piping; install impingement and/or sacrificial plates where acquired.
- Avoid high levels of mechanical stress.
- Avoid contact with extremely aggressive and hot media, e.g. by using refractory masonry.
- Design so that the effective application of waterproof cladding over insulation is possible.
  Use tracing techniques where required to prevent corrosion being caused by condensation.
- Design in such a manner that all types of inhomogeneity are avoided - local stress concentrations, temperature differences, locations where moisture and dirt can gather, etc.

Crevice corrosion, galvanic corrosion, cavitation and stress corrosion are the forms of corrosion that require the most attention during the correct design of process equipment. Specific procedures and situations such as welding and drainage (tapping) can also be optimised by careful design.

During the design of heat exchanges for example is important to consider how these can be cleaned once they are in service if contamination is a possibility. Thus it is usual to design heat exchangers so that the cooling water runs through the tubes, particularly if this cooling water may cause deposits and/or scale formation. Figure 2 shows an example of a heat exchanger with the cooling water on the shell side. Cooling water conditioning using phosphates causes serious contamination by a combination of calcium phosphate deposits and biological slime. Cleaning this type of contaminated tube bundle requires a specialist approach.

Deposits on heat exchanger tubes bundles can lead to pitting and crevice corrosion (corrosion under deposits), as shown in figure 3. Here pitting has occurred on stainless steel (X3CrNiMoN17-13-5; ASN5W) heating spirals of separators in a VCM recovery section of a PVC plant due to sedimentation on the pipes. Regular cleaning of these pipes could greatly increase their service life.

Figure 2: Contamination of a heat exchanger with the cooling water on the shell side

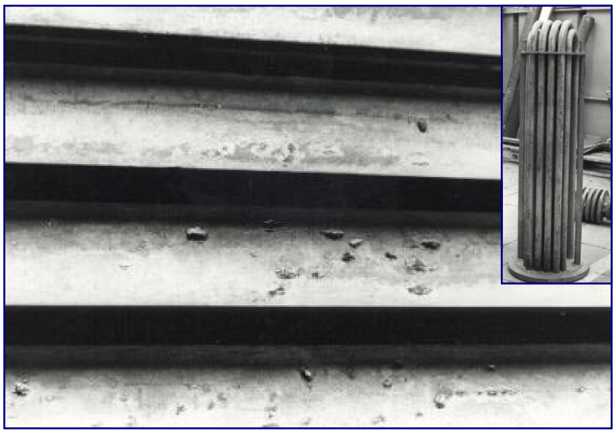

Figure 3: Pitting in X3CrNiMoN17-13-5 heating spiral of separator in a MVC recycling section of a PVC plant

Author: Mr. G. Notten (Senior Corrosion Engineer)
Reactions and/or questions: e-mail: tb@vecom.nl