Case histories of

ATMOSPHERIC CORROSION

In Ammonia & Urea Plants

NTT Consultancy
Giel Notten
Senior Corrosion Engineer

Summary

One main condition for atmospheric corrosion or corrosion under insulation to take place is moisture. Moisture which penetrates the insulation may originate from:

- Rain water
- Vapour resulting from "breathing" due to cyclic temperature changes, followed by dew formation
- Increased water exposure resulting from:
  - nearby cooling towers
  - water-jetting of heat exchangers
  - fire-fighting drills
  - sprinkler installations
  - leaking trace lines
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Atmospheric corrosion or corrosion under insulation can have the following forms:

- Overall corrosion (crater-like attack at critical area's)
- Stress Corrosion Cracking
  - carbon steel: NO_3^- - ions
  - austenitic SS: Cl^- - ions
  - copper alloys: NH_3

In the UreaKnowHow.com Mechanical Paper of December 2009, an example of Nitrate Stress Corrosion Cracking has been discussed. This Paper discussed two examples of overall corrosion, which in fact is a crater-like attack at critical area's such as at the lower elbow of a vertical line or under behind a clamp.

It is strongly recommended to always coat not-insulated equipment in unalloyed and low alloy steel.

Case 1: Rupture of carbon steel HP CO_2 line in Urea plant

Incident

After an on stream time of about 25 years a high-pressure CO_2 line (140 bar, 70 °C) in a urea plant ruptured at the lower elbow of a vertical line.

Photo 1 shows the ruptured high pressure carbon steel pipe. Rupture was caused by severe external overall corrosion and crater type attack. At process (CO_2 gas) side no corrosion was observed. The insulated pipeline was not coated.

Photo 1: Atmospheric corrosion in HP CO_2 pipeline from urea plant.

Photo 2: Crater-like attack

Conclusion

Rupture of the carbon steel HP CO_2 line was due to corrosion under insulation.

Recommendation

Insulated carbon steel at concerning temperatures of 70 °C has to be protected by a coating system.

Case 2: Serious external (crevice) corrosion behind clamp in carbon steel HP ammonia spill back line

Incident

During a life time extension study in a urea and ammonia plant with on stream time of 21 years serious external (crevice) corrosion was observed at a carbon steel high pressure (140 bar) NH_3 spill back line transporting ammonia from the ammonia plant to the urea plant.

The corrosion occurred in a crevice between a clamp and the carbon steel high pressure line at location of a run through a concrete floor.

To investigate the severity of the attack it was necessary to remove the concrete around the pipeline.

Due to the severe crevice corrosion the wall thickness was decreased from original thickness of 11 mm to locally 6 mm. The thickness required for strength was already trespassed; probably rupture did not yet occur as a result of presence of the clamp around the pipeline.

The severe crevice corrosion could occur due to flush water used for flushing the concrete floor.

Photo 's 3 and 4 show the severity of attack.

Photo 3: Crevice corrosion at carbon steel ammonia spill back line

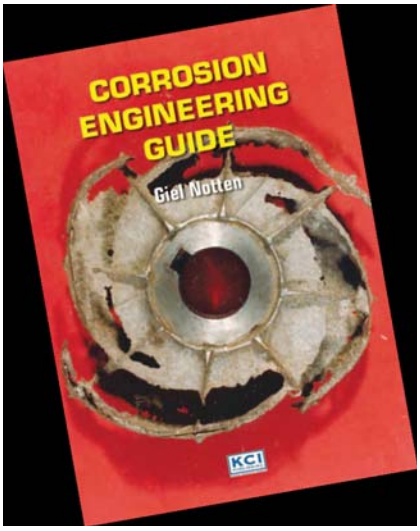
Photo 4: Severity of external corrosion at carbon steel ammonia pipeline

Conclusions

- The severe decrease in wall thickness of the ammonia is due to crevice corrosion in the area of the clamp; at this location no protective coating was applied.
- The corrosion occurred as a result of wetting during flushing the floor.

Recommendations

- Apply a protective coating system on the pipeline also in the area of the clamp
- Apply a glass fibre tape between the pipeline and the clamp
- Avoid wetting of the pipeline during flushing the floor.



Giel has written the Corrosion Engineering Guide, a valuable asset for any engineer working in a urea plant.

This guide is available via:
http://www.stainless-steel-world. com/
Please find the Table of Content of this Corrosion Engineering Guide herebelow.

About Giel Notten

Giel is a true materials and corrosion expert who, before his retirement in 2004, spent thirtyeight years working with DSM in The Netherlands. After gaining his Engineering degree at the Higher Technical School of Heerlen, The Netherlands, he joined DSM's central laboratory.
He was to remain with the company for the rest of his career and held several positions as a materials and corrosion expert there. For the last twenty years before he retired, Giel worked in the Corrosion Department as Managing Senior Corrosion Engineer. He has further participated in numerous conferences spreading the word about his broad experiences as a corrosion and materials specialist in chemical process plants.
For Stamicarbon, a subsidiary company of DSM, and licensing DSM's know-how, he set up programmes for lifetime extension studies in urea and ammonia plants and supervised them.
He was also involved in the development of Safurex®, the super-duplex stainless steel grade (developed by Sandvik in cooperation with Stamicarbon) for application in Stamicarbon urea plants.
Giel has always enjoyed teaching so, after only five years working in the field at DSM, he already began to develop a Corrosion Engineering course. Since then he has taught many young engineers from both inside and outside DSM about the ins and outs of corrosion control in chemical plants. He was also a board member of NACE Benelux and a member of the Contact Group Corrosion of the Dutch Chemical Process Industry and the Studiekern Corrosion of the Dutch Corrosion Society (NCC).
Since his retirement from DSM, Giel Notten has remained active as a corrosion engineering consultant. He has devoted much of his time to passing on his extensive knowledge and experience on the complicated topic of corrosion engineering to a new generation of engineers.
He has done this in the form of numerous corrosion courses and workshops.
Alongside his professional career, Giel has been very active in local societies and has been a Rabobank board member for about thirty-five years, twenty-five years of which as Chairman of the Board. Furthermore, he is an active cyclist. Together with his wife, Lianne, he has made trips up to 2500 km by bicycle to Santiago de Compostela, Spain and Rome, Italy.

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