FERTILIZER ACADEMY

Course title:

High-Temperature (HT) Failure Modes in Ammonia Plants

Introduction:

This course will present in separate modules the most important high-temperature failure modes like metal dusting, HTHA, nitriding, creep and DMW occurring in ammonia plants. The parameters influencing these high-temperature failure modes are elaborated. It is explained how to mitigate the failure modes by correct choice of the materials of construction and equipment design.

In an additional module a survey is given of other, may be less well known, failure modes like graphitization, SRC, hydrogen embrittlement, temper embrittlement, brittle fracture, fatigue and oxidation.

Duration 8 hours

Course outline:

Module 1: Metal Dusting

1. Introduction.
2. Mechanism of metal dusting.
3. Parameters influencing metal dusting:
   a. Parameters regarding metallurgy of materials of Construction.
   b. Process parameters.
4. Measures to mitigate metal dusting.
5. Experiences with metal dusting.
6. Inspection on metal dusting.
7. Case histories of metal dusting.
8. Conclusions and recommendations.

Author(s) / Trainer(s):

Giel Notten

Materials & Corrosion Engineer,

Giel Notten is a materials and corrosion expert who, spent thirty-eight years working with DSM in The Netherlands. After gaining his Chemical Engineering degree he joined DSM's Materials and Corrosion Department and was heading this Department as Managing Senior Corrosion Engineer. In this job he was involved in a broad range of consultancy activities for numerous (petro-)chemical plants. For Stamicarbon, a previous subsidiary company of DSM, and licensing DSM's know-how, he set up programs for lifetime assessment studies, based on RBI philosophy, in numerous urea and ammonia plants and supervised these studies. Giel 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.
He was a board member of NACE Benelux and a member of the Contact Group Corrosion of the Dutch Chemical Process Industry.

Since his retirement from DSM, Giel started his own company NTT Consultancy in 2006 and has remained active as a materials and corrosion engineering consultant for many companies all over the world. He has devoted much of his time to passing on his knowledge and experience on the topic of corrosion engineering to a new generation of engineers in corrosion courses and trainings; numerous trainings have been presented. In cooperation with UreaKnowHow (in-house) training sessions have been organized and presented to more than 1000 urea engineers, managers, (shift-) supervisors and operators from all over the world. Several workshops have been presented in cooperation with UreaKnowHow for CRU in Nitrogen & Syngas Conferences.

Giel published many technical papers in reputable industry magazines and collected his knowledge and experience, illustrated with numerous cases of corrosion, in a book entitled Corrosion Engineering Guide.

Module 2: High Temperature Hydrogen Attack (HTHA); Nelson

1. Introduction.
2. Mechanism and parameters influencing HTHA.
    a. Nelson curves.
3. Measures to mitigate HTHA.
4. Inspection (techniques) on HTHA.
5. Conclusions and recommendations.
6. Case history: Catastrophic failure of a carbon steel heat exchanger in Naphta Hydrotreater (NHT) due to HTHA.

Module 3: Nitriding

1. Introduction.
2. Mechanism and parameters influencing nitriding.
3. Measures to mitigate nitriding.
4. Inspection on nitriding.
5. Case histories of nitriding.
6. Conclusions and recommendations.

Module 4: Creep

1. Introduction.
2. Mechanism of creep.
3. Parameters influencing creep rate.
4. Calculation of used life-fraction.
5. Inspection (techniques) for creep damage in reformer tubes.
6. Typical locations of creep in ammonia plants.
7. Measures to mitigate creep.
8. Case histories of creep.
9. Conclusions and recommendations.

Module 5: Dissimilar Metal Weld (DMW) failures and the influence of hydrogen

1. Introduction.
2. Mechanism of DMW-failures.
3. Parameters influencing DMW-failures.
4. The influence of hydrogen on DMW-failures.

Author(s) / Trainer(s):

Rob Gommans

Materials & Corrosion Engineer,

Rob Gommans is a materials and corrosion expert and has been working in the field of metal's behaviour since his graduation (M.Sc.) in 1987 at Delft Technical University in The Netherlands. Until 2000 he worked at DSM's Materials and Corrosion Department. Since 2000 Rob has worked as an independent consultant for many companies all over the world. These companies mainly include ammonia/methanol/syngas plants, ethylene plants and power/steam-generation.

He is specialised in the structural integrity of plants and equipment. This includes the mechanical and corrosion behaviour of metals in their environment and loading, defining and predicting of failure and degradation mechanisms, failure investigations, trouble shooting, welding & repair advice, problem solving, fitness for service and remaining life assessments.

Rob is active as convenor of the WG-Materials for the Rules for Boiler and Pressure Vessels in The Netherlands. He is also convenor of the Dutch Creep Committee and member of the European Collaborative Creep Committee.

Rob has published a number of technical papers and also provides training courses illustrated with failure cases.

5. Typical locations of DMW’s in ammonia plants.
6. Inspection (techniques) of DMW’s.
7. Case history of DMW-failures.
8. Conclusions and recommendations.

Module 6: Survey of other types of HT failure modes occurring in NH3 plants

1. Introduction.
2. Survey of failure modes; mechanisms and parameters influencing these failure modes:
    a. Graphitization.
    b. Stress relaxation cracking (SRC).
    c. Hydrogen embrittlement.
    d. Temper embrittlement.
    e. Fatigue.
    f. Oxidation.
    g. Brittle fracture (is basically a LT failure mode).
3. Indication of the locations of the failure modes in PFD’s.
4. Measures to mitigate these failure modes.
5. Inspection (techniques) on these failure modes.
6. Case histories.
7. Conclusions and recommendations.

Learning outcomes:

By the end of this training course, you will understand:

- The mechanisms of the several High-Temperature failure modes occurring in ammonia plants.
- The parameters which influence these High-Temperature failure modes
- How to mitigate these failure modes by correct choice of material of construction and equipment design.
- How to inspect these failure modes in Turnarounds and during operation.

Who will benefit:

Employees who are responsible or share responsibility with respect to the mechanical integrity and safe operation of ammonia plants: process, mechanical, maintenance, corrosion and inspection engineers employed in ammonia plants.

Course materials:

- Hand out presentation slides in PDF format

Price:

€ 800

Discounts:

- 2 places – 10% discount
- 3 places – 15% discount
- 4 or more places – 20% discount.

In-company training:

This course is also available as an in-company course (face-to-face or online) where content can be customised to meet your organisation's specific needs and delivered on a date/location that suits your requirements.

Contact us for more information.

Training code: MAT07

On request the electronic (recently revised) version of the Corrosion Engineering Guide (> 800 pages) is available for additional costs of **€95.00**