1 b - Evaluation of Risks Related to the Transport of Anhydrous Ammonia and Their Mitigation by Localized Small Scale Production

Dennis G. Lippmann – *Uhde Corporation of America*

Q: Dorothy J. Shaffer, Baker Risk
The paper references a report that identifies a very large footprint for a danger zone related to an ammonia railcar rupture. However, the referenced report appears to apply to the worst case for a TIH such as chlorine or ammonia. Were you able to verify the footprint reference applies to NH_3 and not the much more toxic chlorine?

A: Dennis Lippmann
The referenced report estimated the following danger zones for a sudden release from a 90 ton railcar based on dispersion models:

	ERPG-2 level	Urban accident site	Rural accident site
Chlorine	3 ppm	14 miles	>25 miles
Ammonia	150 ppm	4.9 miles	7.8 miles

1 c - Multi-Layered Secondary Urea Reactor Failure

Marc Gilbertson – *CVR Energy*
Daniel J. Benac, P.E. – *BakerRisk*

Q: Ken Lamb, Linde Engineering
The lack of "buttering" was a root cause. Was this a failure of engineering (i.e. weld procedures without buttering were approved) or manufacturing (i.e. weld procedures not followed)?

A: Marc Gilbertson
Initially we thought that the buttering procedure had not been followed by the manufacturer because of the large discrepancies in hardness numbers around the heat affected zone. After much investigation into the procedure there is some evidence that buttering may not have been the correct procedure for treating this type of weld system. Unfortunately documentation from the manufacturer was missing and the metallurgical analysis did not definitively give an answer to this question.

When the repair was executed on the reactor a buttering procedure was followed according to ASME Section VIII but there were some problems associated with the initial results.

There was also some information that came out after our investigation about a similar problem with a reactor that did follow the buttering procedure.

My personal opinion is that there seems to be an issue with the choice of SA-508 alloy steel for the forged head and bottom section.

2 a - High Emissivity Ceramic Coating of Furnace Walls in Tubular Reformers – Theory and Practice

Q: Ahmed Attyub, Fauji Fertilizer, Bin Qasim (Ltd)
What is the impact of flame impingement on life of coating as it is a common problem in a terrace wall furnace?

A: John Bacon
Flame impingement has little effect on the stability of the coating, or the bond to the refractory. However, the reducing conditions in the flame will cause a change in the color of the coating and that may result in a reduction of emissivity. Cetek recommends an overcoat once the emissivity has fallen to less than 0.8, so that the performance can be maintained.

Q: Mike Antony, Proplant, Inc.
What is your experience on top-fired furnaces in ammonia and methanol plants?

A: John Bacon
We have treated several top-fired reformers, with successful results. The benefit is not so pronounced as with floor-fired or wall-fired reformers with single row of tubes, but it is still very worthwhile with a rapid return on investment.

Q: Mike Antony
We could not hold coating on burner tiles. What is your experience?

A: John Bacon
This is not a problem, but there could be some discoloration caused by flame impingement/reducing conditions in the flame. This may result in a reduction of emissivity. Cetek recommends an overcoat once the emissivity has fallen to less than 0.8, so that the performance can be maintained.

A: Venkat Pattabathula
In our case, the coating was applied both on brick and ceramic fiber and everything was fine.

Q: VK Arora, PE, Kinetics Process Improvements
As is well known that radiant wall effects inside a fired reformer is much more prominent than top-fired reformers, what is your assessment to relative savings in top-fired reformers?

A: John Bacon
We have treated several top-fired reformers, with successful results. The benefit is not so pronounced as with bottom-fired or wall-fired reformers with single row of tubes, but it is still very worthwhile with a rapid return on investment.

Q: VK Arora, PE
Typically NO_x is a function of adiabatic flame temperature. How do you explain 20-30% reduction in NO_x while there is no change in adiabatic flame temperature?

A: John Bacon
NO_x emissions from a furnace are related to flame temperature and flue gas temperature. An effect of high emissivity coatings on the refractory surfaces is to change the nature of the radiation emitted from the refractory to close to black body radiation. In this form, the radiation is not readily re-absorbed by the flue gases, or the flame, which are therefore at a lower temperature. Additionally, an increase in radiant heat transfer efficiency allows for more radiant absorbed duty per energy employed, again leading to lower flue gas temperatures.

Q: VK Arora, PE
Please clarify if radiant tubes were replaced at the same time while ceramic coating was implemented.

A: Venkat Pattabathula
Yes, radiant tubes were also replaced at the same time.

Q: Reinaldo Caldera V, Petroquimica de Venezuela
Could you explain if there is any limitation for using the ceramic coating?

A: John Bacon
The refractory surface temperature must be at least 550^{o}C, so that radiation is the major form of heat transfer and a benefit may be derived from the high emissivity property. The ceramic coatings are suitable for refractory surface temperatures up to 1600^{o}C. Any refractory material may be coated – different coating systems are used for different refractory/ceramic fiber types.

A: Venkat Pattabathula
We didn't see any limitations.

Q: Reinaldo Caldera V
How much does it cost USD/square meter?

A: John Bacon
Cetek would be happy to provide a quotation for a specific case.

A: Venkat Pattabathula
Costs are confidential.

2b - Failure of Weld of F-11 Flange with Micro Alloy Catalyst Tubes of Primary Reformer

Anwar Mahmood Shahid – *Fauji Fertilizer Bin Qasim Limited*

Q: D.H. Timbres, D. & E. Consulting Inc.:
Was any dissimilar weld failure with HK-40 and CS flange set up?

A: Anwar Mahmood Shahid
There was no weld failure with HK-40 and CS flange set up; only slight grooving was observed after 5-6 years of operation with these catalyst tubes.

Q: D.H. Timbres
Have there been any issues at top flange area?

A: Anwar Mahmood Shahid
There has been no issue at the top flange area because:
The furnace tube is in vertical position and at higher temperature as compared to lower flange due which there is no condensate collection in the top flange area which can react with CO2 and make Carbonic Acid which will cause corrosion and grooving as it has been done in the bottom flange area.

2 c - Implementation of the API RP 584 Integrity Operating Windows Methodology at the Gibson Island Ammonia Manufacturing Plant

Luke Bateman – *Incitec Pivot*
James Widrig – *Quest Integrity*

Q: Tom Barth, Agrium
How did you implement these operating windows effectively? How did you get operator "buy-in"?

A: Luke Bateman and James Widrig
This was among the most difficult part of the IOW implementation. As you may well know, taking the approach of marching into a plant and telling everyone that "this is the new way of doing things whether you like it or not" will often result in instant rejection.

What we did to assure buy-in was to give a 2 hour presentation on what IOWs are and how it affects the plant, plus a question and answer session. The general consensus after this presentation was that the IOW was not a tool for reducing production capacity, but rather a tool for learning where your Achilles heel was in the plant and therefore was more of an opportunity for improvement.

When the IOW was complete, any limit changes were input or changed in the DCS as alarm or trip point modifications, so the transfer of results to operations was seamless. Remember the "Tree of Controls" for safety? i.e.: elimination or engineering out risks is highly preferred to procedural changes or PPE. Well that's the route we took with IOW changes; they had to be hard-wired into the system.

In saying that we gave a close-out presentation before changes were made so the operators would not see the new set-points and bridge them out or defeat alarms, because the set-point was different for no reason.

Q: John Mason, Agrium
The remaining creep life was determined through modeling. Was any validation of the model results done through destructive or non-destructive testing?

A: Luke Bateman and James Widrig
Yes. Creep life was determined by a combination of factors including past destructive tests of tubes, continual diameter measurements by both the Laser Optic Tube Inspection System, LOTIS® and direct diameter tape measurements, plus material data and tests supplied by the vendor. When we call for creep rupture testing in our new reformer tube spec we ask for longer test times (e.g. 200+ hrs per heat #) at lower temperatures and lower induced stresses, because the usual short-term stress rupture tests are done at abnormally high temperatures and stresses to artificially produce a failure in a shorter time frame. This, therefore, may introduce a different failure mode to the long term low stress creep failures we are trying to emulate for more accurate creep life data. Hence our vendor curves for min mean and max creep data are more valid, and this has been confirmed by destructive testing old tubes.

Q: Ken Lamb, Linde Engineering
Is the use of the IOW approach considered supplemental to Risk-Based Inspection (RBI) or as a replacement for/alternative to RBI?

A: Luke Bateman and James Widrig
IOW supplements RBI. No changes are generally made to our RBI based on IOW results, but the plant's RBI is a good starting point for an IOW study. Remember that IOW assesses the most likely mode of failure for a given item of equipment, then assigns limits based on desired lifespan, to the process variable that drives the failure mode. Therefore, RBI is a good starting point for IOW because the failure modes have already been risk assessed.

2 d - Steam Reformer Pigtail Failures

Charles Ormsbee – *Agrium Inc.*

Q: Kang Xu, Praxair
Did you notice a change in pressure drop when the outlet pigtail changed from sch. 160 to sch. 80?

A: Charles Ormsbee
The line size changed from 1" to 1 ¼" as well the schedule change. There is no record of us measuring the pressure drop in this portion of the inlet piping. A reasonable conclusion is the pressure drop did decrease since the cross section area of the inlet pigtail did increase.

Q: John Turon, Orica
Did the management of change process apply to the new design?

A: Charles Ormsbee
MOC process did apply to this project but the reviews were at a high level, reviewed at approval stage only. Detailed drawing reviews were all completed by project engineering personnel.

Q: John Turon
Did it force external design verification by experts?

A: Charles Ormsbee
The MOC process at Agrium does not force an external review in the majority of design reviews. It would only force a review of a major project (>25 M$) only if there were risks identified in the project such as new unproven technology or other unproven design features.

Q: Ahmed Attyub, Fauji Fertilizer, Bin Qasim (Ltd)

Was the design considered for other installations and was there any requirement for changing the schedule from 160 to 80?

A: Charles Ormsbee
This is the only reformer with this type of inlet pigtail system in Agrium and the only consideration for the size increase was to allow future increase in design flow rates. At the current flow rates there was no requirement to increase the size of the inlet pigtail.

2 e - Combining New Synthesis Loop Revamp Technology with KRES™ Increases Ammonia Plant Capacity & Energy Efficiency

Shashi Singh – *KBR Inc.*

Q: Ahmed Attyub, Fauji Fertilizer, Bin Qasim (Ltd)
What is the impact on energy efficiency? Please comment regarding the situation when the addition of motors may not be possible.

A: Shashi Singh
Combining these two technologies improves total energy efficiency of the ISBL ammonia plant due to synergistic nature of these technologies. The syn-loop upgrade technology adds high value by producing high pressure steam in all the vintage plants, yet keeps the old ammonia converter in use. These benefits are achieved even if motors cannot be added.

Q: VK Arora, Kinetics Process Improvements (KPI)
How do you maintain or increase HP steam superheat temperature for 130% capacity when most of convection section is space constraint?

A: Shashi Singh
KBR uses our proven revamp technology for upgrading furnace, for example by using special finned coils.

Q: VK Arora
What about increasing process air preheat for 130% plant load?

A: Shashi Singh
KBR uses our proven revamp technology for upgrading furnace to preheat increased flow of process air stream, for example by using special finned coils.

Q: VK Arora
What about upgrade of ammonia converter for higher conversion and/or associated 105-J modification, if any, for 130% plant load?

A: Shashi Singh
Depending upon the project objectives and cost of energy involved, KBR may provide add-on radial converter or revamp the existing internals which will reduce power of 105-J. Energy savings from such measures will be additional on the top of what is discussed in this paper.

2 f - Is Hot Restart Jeopardizing Plant Safety?

Niels Kristian Nielsen – *Haldor Topsoe A/S*

Q: Venkat Pattabathula, Incitec Pivot
Do you feel that trip system (SIS) could prevent reformer tube damages?

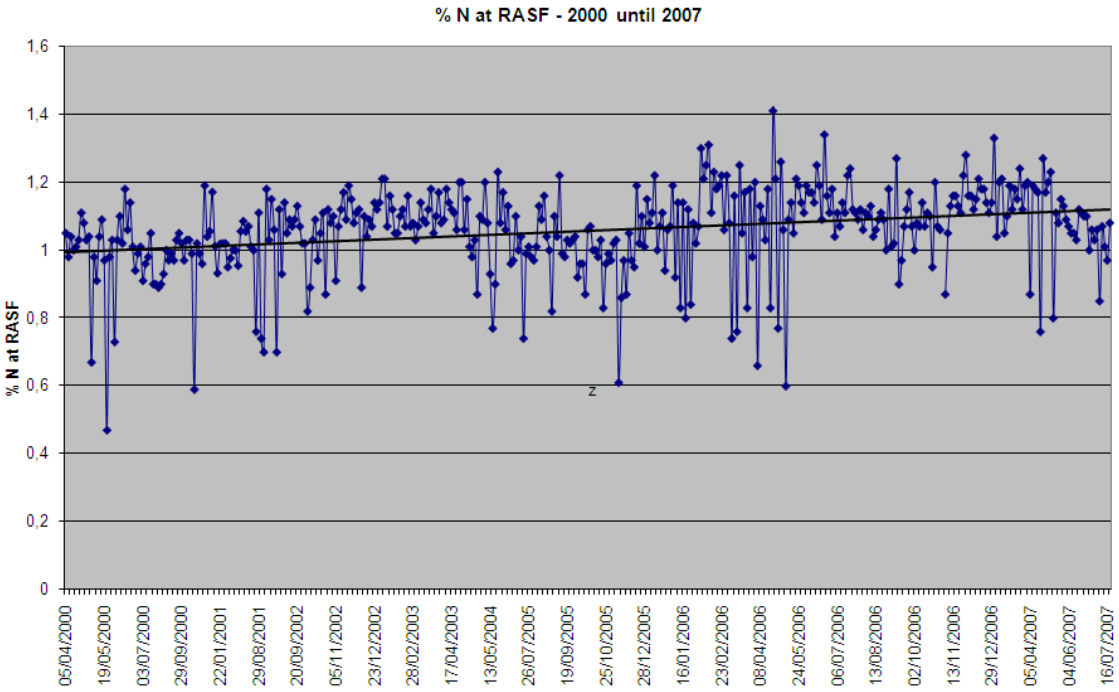
A: Niels Kristian Nielsen
No, I doubt that a trip system will be able to prevent overheating the reformer tubes during start-up & shut down. The problem lies in that it is not possible to have a direct continuous temperature measurement of the reformer tube skin temperature.

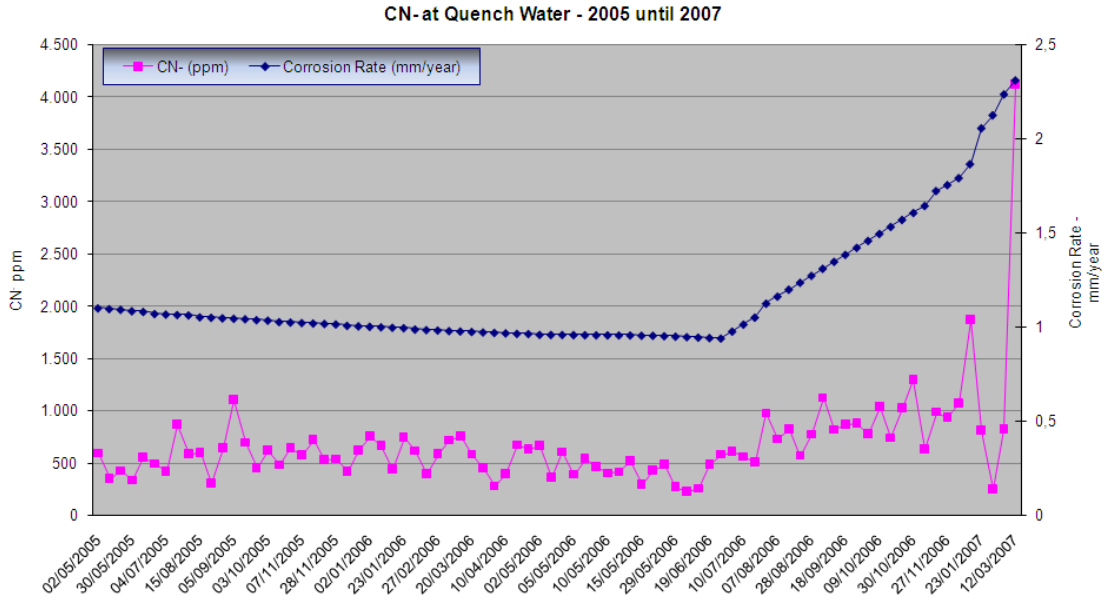
3 a - Carbon Scrubber Hydrogen Attack and Gasification Unit Corrosion

Ruben Wageck – *Vale Fertilizantes*

Q: VK Arora, PE, Kinetics Process Improvements
Any idea of HCN levels—before and after the change in feed composition with high N2?

A: Nestor Reis Neto
The feedstock used in Vale Fertilizantes Araucária depends strongly on the petroleum processed by the refinery. As we can see in picture above, when the levels of N at RASF and CN^- at quench water increased, the corrosion rate increases too.





Q: VK Arora, PE
Did you review the options to remove HCN?

A: Nestor Reis Neto
Unfortunately, the feedstock composition can´t be changed because it depends on the petroleum used at the refinery to produce the RASF, and we didn´t find an attractive option to remove the HCN produced during the process.

Q: Ken Lamb, Linde Engineering
The paper noted erosion and corrosion at the inlet to the POx Reactor WHB. What counter measures were taken for corrosion? What about erosion?

A: Nestor Reis Neto
As mentioned in paper, we didn't take preventive measures to mitigate the corrosion and erosion at the gas inlet because we had to change all equipment before the development and qualification of the procedures to perform the welding of a protective layer (overlay) at the gas inlet.
Unfortunately, the feedstock composition can´t be changed because it depends on the petroleum used at the refinery to produce the RASF.

3 b - Metal Dusting in 1.25 Cr 0.5 Mo and SS304H Feed Gas Coil after Installation of DeSulfurization Unit Upstream of Primary Reformer

Ahmed Attyub – *Fauji Fertilizer Bin Qasim Limited*

Q: VK Arora, PE, Kinetics Process Improvements
Why was metal dusting not elsewhere?

A: Ahmed Attyub
As described in presentation, "**When equilibrium temperature decreases below metal temperature, thermodynamically metal dusting cannot occur**. Since such conditions only prevailed in Feed Gas Coil in our plant, therefore, the phenomena of metal dusting occurred in Feed Gas Coil only. We have checked the complete front end for metal dusting and such conditions were not found. Regarding use of method for calculating the risk was same as presented by Grabke in his book.
In our other plant operating at low steam to carbon ratio we do faced metal dusting in waste heat boilers.

Q: Ken Lamb, Linde Engineering
The author noted that flame was observed in the convection section (as a result of the leak). How specifically was this observed? (E.g. peep doors, flame out of stack)

A: Ahmed Attyub
1. As informed, the first indication was detection of methane 1.2 % in flue gas from stack
2. The second major indication was increase in air preheat coil temperature
3. In Foster Wheeler design Terrace wall furnace, peep doors are available, and using those peep doors, flame impingement on Air preheat coil was observed. However, it was a small flame and did not come out of stack.

Q: John Mason, Agrium
Please comment on the reason why this HDS unit resulted in metal dusting of feed gas coil—HDS reactors with CO_2 in feed gas are extremely common, yet this installation is the first known case where the reverse water gas shift reaction in HDS caused metal dusting.

A: Ahmed Attyub
The HDS unit or the catalyst has not resulted in formation of components required for metal dusting. In our specific gas we have high organic sulfur content varying between (6-8 ppmv). In order to convert this organic sulfur to inorganic sulfur (to be chemisorbed by Zinc Oxide Catalyst), a certain amount of hydrogen needs to be introduced. This hydrogen has to be kept in excess.
We have used synthesis gas as source of hydrogen. Therefore, hydrogen from syn-loop and carbon dioxide from natural gas feed was available. This resulted in initiation of metal dusting as described in our presentation.

Q: Ken Wohlgeschaffen, Chevron
What were the H_2S concentrations upstream and downstream the hydrodesulfurizers in a) the old system, and b) the new system?

A: Ahmed Attyub
The H_2S Concentration in the feed gas varies from 10-16 ppmv for both old and new desulphurization system. With old system, once the bed was saturated approx the total sulfur at the inlet passes to the outlet. However, with new system the sulfur at the outlet remained not detectable. However, when top bed exhausted, sulfur started from 20 ppb to 700 ppb at the outlet of first bed with no slippage from second bed.

Q: Ken Wohlgeschaffen
Why did you keep the compressor aftercooler and add a heater downstream, why not remove the aftercooler to get more preheat and reduce the size of the downstream heater? This seems like it would've been a more efficient design and less costly.

A: Ahmed Attyub
There were following main reasons:

- HDS was installed first before installation of new compressor, K-1003. Initially gas was available at low temperature and high pressure. We have a booster compressor to increase the pressure by 50 psig from 350 to 400 psig. This compressor was operated on requirement basis. Accordingly, the piping installed to the reformer was limited to design temperature of **110 Deg C**. This piping was very long routed due to layout issues
- With new compressor ,we have to put this after cooler in service in any case as this was also used to cool the gas to required temperature for recycling back to suction at low load or to avoid surge
- Temperature cross was accepted in Gas Exchangers, E-1001 A/B, if a gas of 160 Deg C is admitted at the existing inlet of these exchangers. Therefore, we limited gas temperature to reformer to 105 Deg C
- The requirement of steam at the coil inlet also arises, which became more cumbersome. Presently, it is introduced at the inlet of second pass of feed gas coil

Q: John Mason, Agrim
Is CO, reverse shift always occurring in HDS?

A: Ahmed Attyub
No, please refer above

3 c - Successful Management of a 102C Waste Heat Boiler Leak by Close and Effective Collaboration between Operator and Water Treatment Supplier

Douglas Dewitt-Dick, Lancey Knebel – *Champion Technologies*

Q: Sabry El-Sanadedy, EBIC
How long were you able to continue with leaking tube without impairing HT shift catalyst?

A: Douglas Dewitt-Dick and Lancey Knebel
Once a leak was detected, Plant Operations maintained production for 4-6 months until an outage was necessary to repair/plug tubes in order to continue safe and efficient operations.

Q: Reinhard Michel, Thyssenkrupp Uhde
Was there any insight on the cause of the leak because reducing the boiler blowdown might be detrimental for the further development of the leak?

A: Douglas Dewitt-Dick and Lancey Knebel
The cause of the leakages was suspected to be related to the age of the vessel, which had been in operation for over 30 years. Since the vessel was scheduled to be replaced at the next turnaround, no root cause analysis was performed.

Q: Khurram Saleem, Fauji Fertilizer Company Ltd.
After these leakages in WHB, did you experience any increase in pressure drop of HTS?
A: Douglas Dewitt-Dick and Lancey Knebel
The catalyst supplier reported that the HTS activity was equal to its performance prior to the leakages.
Q: Bode Agagu, Notore
What is the history of leakage of the equipment: Number of tubes plugged? The failure mechanism? And how the plant differentiated between leaks from 102-C and 101 CA|CB?
A: Douglas Dewitt-Dick and Lancey Knebel
The 102-C was over 30 years old and due for replacement at the next scheduled turnaround.
Plant Operations' attention to changes in plant operational conditions allowed them to pinpoint which vessel was leaking prior to taking an outage. This question would be best directed to Plant Operations.
Q: Ray Titsing, GE Water & Process Technologies
Why are the boiler cycles under normal operation so low?
A: Douglas Dewitt-Dick and Lancey Knebel
The boiler cycles under normal operation are not low, but are predicated upon steam purity limits for both sodium and silica. Based on steam chemistry analysis, operating at higher cycles could result in deposition in steam turbines. This would also contribute to increased loading on the condensate polishers resulting in increased chemical costs for regeneration.
Q: Ray Titsing
Are there any boiler feedwater pretreatment issues?
A: Douglas Dewitt-Dick and Lancey Knebel
During this time there were no issues with the feedwater pretreatment.
Q: Ken Wohlgeschaffen, Chevron
What impact did the leaks have on the downstream HTS in terms of activity (approach to equilibrium), pressure drop, and life?
A: Douglas Dewitt-Dick and Lancey Knebel
The catalyst supplier reported that the HTS activity was equal to its performance prior to the leakages.
Q: Ken Wohlgeschaffen
What was the root cause of the leaks in the WHB?
A: Douglas Dewitt-Dick and Lancey Knebel
The cause of the leakages was suspected to be related to the age of the vessel, which had been in operation for over 30 years. Since the vessel was scheduled to be replaced at the next turnaround, no root cause analysis was performed.

3 d - Case Study of Weld Cracking in 2.25Cr-1Mo-0.25V (22V) Heavy Wall Ammonia Converter (TACC 105-D)

John Li – *KBR Inc.*

Q: Khurram Saleem, Fauji Fertilizer Company Ltd.
FFC faced a similar weld crack problem at Plant II (commissioned in 1993). What other tests do you recommend other than hardness index to verify the integrity of weld for future operation?
A: John Li
Examination techniques to verify integrity of the weld could include TOFT, WFMT and Hardness Testing
Q: Khurram Saleem
What should be the frequency of TOFD testing?
A: John Li
Common test frequency for TOFT examinations are 2.25 to 15 MHz.
Q: Kang Xu, Praxair
Please clarify if the crack originated from OD or ID.

A: John Li
The metallurgical evaluation was not able to determine the point of origin for the fracture. Half of the core sample was kept by the owner. We believe that the point of origin was in that sample.

Q: Kang Xu
What was the hardness measurement on the sample?

A: John Li
A maximum hardness of 38 HRC was measured in the weld metal adjacent to the fracture.

Q: Kang Xu
Comment: This material requires production hardness test.

A: John Li
Correct. For this kind of closing seam, KBR now recommends the hardness measurement should be taken every 3 linear feet of the welding length, at the location on the weld, the HAZ, and the base metal.

Q: D.H. Timbres, D. & E. Consulting Inc.
Was joint locally post weld heat treated (PWHT) initially?

A: John Li
The failure occurred in a closure weld which was locally PWHTed.

Q: D.H. Timbres
What is the cracking mechanism?

A: John Li
The brittle fracture was caused by high stresses in a low toughness material.

Q: D.H. Timbres
Was any hardness taken initially at OD & ID?

A: John Li
Hardness testing was required by the vessel mechanical specification. Only one hardness testing was done in the failure area.

Q: Mukul Srivastava – IFFCO Phulpur, India
What were the indications available in control room to confirm this leak? Or was it based on the operator feedback about leakage as it may have been leaking for quite some time?

A: John Li
There was no indication in the control room that there was a leak. The leak was detected by the smell of ammonia as well and whistling sound at the vessel site.

Q: Mukul Srivastava
Was any pressure test carried out after the repairs to confirm the integrity of the repair?

A: John Li
No pressure test was performed after the repair.

Q: Mukul Srivastava
What are the short term and long term plans to make it a reliable equipment?

A: John Li
The short term plan was to make the repair and perform NDE to verify the quality of the repair. The long term reliability will be verified by performing inspections of the repair area during all future outages.

Q: Gustavo Matute, Pequiven
When you repair the ammonia converter nozzle, do you change the ammonia catalyst or repair the nozzle with catalyst installed?

A: John Li
The repair was made without removing the catalyst and the basket from the leaking converter. The catalyst basket was protected by N2 purging during the repairing period.

3 e - What can a Plant Owner do when Operating a Plant in an Environment with Limited Gas Supply?
Md. Ali Akkas Mazumder – *Karnaphuli Fertilizer Company Limited*

Q: Umesh Ranchhodji Desai, QAFCO
For ongoing projects "Installation of an off gas compressor", have you checked the capacity in absorber/regenerator for additional load of off gases?
A: Md. Ali Akkas Mazumder
We have checked the capacity in absorber/regenerator for additional load of off gases.
Q: Umesh Ranchhodji Desai
What checks were done?
A: Md. Ali Akkas Mazumder
In TA-2006, we installed high efficient packing & internals in the absorber/regenerator which enhances the performance of CO_2 removal unit significantly. We can operate CO_2 removal unit at 112%+ load without any trouble against load of other units in Ammonia Plant at 110% on sustainable basis provided the availability of adequate NG supply.
Q: Mukul Srivastava, IFFCO
At your normal load of 1228 MTPD, were anti-surge values of PAC, SGC, and RGC open because only then you will get steam savings in reducing their set points?
A: Md. Ali Akkas Mazumder
The name plate capacity of Ammonia Plant is 1500 MTPD. At 82% (1228MTPD) load of Ammonia plant, the anti-surge valves of PAC, SGC, and RGC were open.
Q: Mukul Srivastava
Was the LNG pressure control valve fully open or in throttled condition, so as to reduce discharge pressure of LNG compressor?
A: Md. Ali Akkas Mazumder
We have no facility for utilization of LNG. We use NG as our 1RF feedstock. The normal NG supply to the suction of NGC is 8.6 Kgf/cm^2G and we maintained the final discharge pressure set point of NGC around 40.6 Kgf/cm^2G. At lower load of Ammonia Plant, there is a scope to reduce the final discharge pressure of NGC since PNG control valve opening is lower and hence on November 02, 2010, we first adjusted the discharge pressure for saving of steam. We are now in practice to optimize the final pressure of NGC.
Q: Mukul Srivastava
What was the total steam savings obtained from the various optimizations and how much was the total LNG savings in auxiliary boiler?
A: Md. Ali Akkas Mazumder
The total steam savings obtained from the various optimizations was 12.5 MT/H and the saving of NG in Auxiliary Boilers was 880 MSCFD.

3 f - Impact Minimization of Cooling Tower Failure and Replacement
Travis Kunnemann – *Agrium U.S. Inc.*

Q: Hal K. Cain, PE, Cain & Associates
Was there a load resisting support for lateral loads at the top of the tower on the 36" return line?
A: Travis Kunnemann
No, there were smaller lateral resisting supports lower on the return line, but not at the top of the tower.
Q: Hal K. Cain, PE
Stainless steel hardware is better to use than galvanized. Please comment.
A: Travis Kunnemann
While it is a subjective statement, stainless steel hardware generally will provide lower maintenance requirements than galvanized hardware on a wooden cooling tower. As galvanized hardware is worn and the

carbon steel is exposed, the hardware must be replaced to prevent rot on the wooden members. Stainless steel hardware will not require such a continuous upkeep.

Q: VK Arora, PE, Kinetics Process Improvements
What is the process performance of cooling tower in terms of approach temperature and range?
A: Travis Kunnemann
The new tower was designed for a 13 degree F approach to wet bulb temperature.
Q: VK Arora, PE
Assume fills are splash pipes (of PVC); how are they supported?
A: Travis Kunnemann
The fill is supported at the bottom of each cell by a number of support columns that are anchored to the basin floor.
Q: Ahmed Attyub, Fauji Fertilizer, Bin Qasim (Ltd)
Was equal size risers installed at the outlet of cooling water return line?
A: Travis Kunnemann
Yes, however butterfly valves are used to control the proper distribution of flow to each cell.
Q: Ahmed Attyub
What measures are taken to avoid failures?
A: Travis Kunnemann
Several areas of failure were engineered out of the new tower by design as referenced in the paper. The structure of the tower is inspected routinely like other concrete support structures throughout the plant.

4 a - To Minimize Risks of Catastrophic Failure in Urea Plant Process Lines Requires RBI Methodologies
Alex Scheerder – *Stamicarbon BV*

Q: Stuart Ford, Methanex
What are the effects of applying steam tracing directly onto process pipework? You mentioned this affects the corrosion rate? Steam tracing is usually located directly on pipework?
A: Alex Scheerder
Tracing should be installed unto spacers to avoid direct contact with the pipeline. This will reduce the risk for contact corrosion at the outside. In the described case history, the issue was that the tracing most probably did not heat the pipe uniformly, but only at one side. This resulted in the corrosion presented.
Q: Reinaldo Caldera V, Petroquimica de Venezuela
Regarding the specific failure shown in Case 3 “Failure weld-o-let”, how can we inspect weld-o-let in HP pipe? What are your recommendations?
A: Alex Scheerder
We advise to do a spot check with so-called on-stream radiography. By using this method any severe corrosion can be detected. Also one can use PMI to check on the chemical composition of the Weld-o-let as well as the weld material.
Q: John Mason, Agrium
Please clarify if an atmospheric risk with carbon steel pipelines is nitride SCC (in paper) or nitrate SCC (in presentation).
A: Alex Scheerder
Carbon steel is vulnerable for nitrate SCC only.
Q: John Mason
What is source of nitrate or nitrite in the urea plant that can cause atmospheric SCC?

A: Alex Scheerder
Several sources can be present in the industrial area of the urea plant. But also presence of urea in the atmosphere can cause nitrate SCC under insulation.

Q: Sabry El-Sanadedy, EBIC
What was the root cause of gas line failure?
A: Alex Scheerder
The root cause is not clear yet. However the failure started at the process side and did not start from the outside (CUI). We feel that the damage is related to up-set conditions which happened in this particular case.
Q: Ruben Wageck - Vale Fertilizantes
What do you know about authorities requiring periodic inspections of piping in other parts of the world? In Brazil, the government asks only to inspect equipment items.
A: Alex Scheerder
We know that in European countries for instance, authorities also include piping in inspection programs.

4 b - Reliable Design of Ammonia and Urea Plants
Sergio Panza, Andrea Scotto – *Casale Group*

Q: VK Arora, PE, Kinetics Process Improvements
Why would you use two ID fans in parallel while world-scale reformers have reliably used single ID fan for several decades?
A: For new plants (Ammonia and Methanol) the usual CASALE approach is to design reformers having only one ID-fan; however for existing plant revamping it is pretty common to find (especially for plants located in the former USSR and in other formerly socialistic countries) reformers working with two or even three ID fans; in case reforming section modification (for instance during a complete plant revamping) one of the usual check performed by CASALE is the fluid-dynamic suitability check of the ID fans ducts.

4 d - Failure of Waste Heat Boiler in a Kellogg Design Ammonia Plant (Failure Analysis and Repair Methodology)
Mohd. Masood Ahmad, Mukul Srivastava – *Indian Farmers Fertiliser Cooperative Limited – Phulpur Unit*

Q: D. H. Timbres – D. & E. Consulting Inc.
What has happened to the twisted tube design which eliminates the bayonet and scabbard design?
A: We have no experience of twisted tube design; therefore we cannot make any comment on this.
Q: Ray Titsing, GE Water & Process Technologies
Was there evidence of under-deposit corrosion with these failures?
A: Yes, there was evidence of under-deposit rust products which had blocked the 35 mm gap available between the bottom of inner tube and the outer tube. This was also confirmed during the Borescopic inspection as its probe could not reach up to the bottom of the tubes.
Q: Ray Titsing
Was the boiler water treatment program running in control?
A: The water treatment program for these boilers is running excellent. Typically we are maintaining in boiler blow down pH of 9- 9.5, Phosphate 2-5 ppm and Silica 0.3-0.5 ppm and conductivity of 40-50 micro mhos/cm. For the HP steam generated in the boiler, the quality is pH 9-9.5, Silica 0.02 ppm and conductivity of <10 micro mhos/cm.
Q: VK Arora, PE, Kinetics Process Improvements
Did you consider any improved tube bundle design with a larger gap between inner and outer tube at the bottom?
A: No, because increasing the gap will reduce the efficiency of this boiler.

4 e - LTS Safe & Proven Recovery Strategies
Ken Chlapik – *Johnson Matthey*

Q: VK Arora, PE, Kinetics Process Improvements
Any impact on the downstream catalyst, especially methanator catalyst as a result of excessive CO slip from LTS upset?
A: Ken Chlapik
The plant tripped on a low level steam drum indicator. While the feed water pump ran for about an hour after the trip, the water was contained to the LTS. No downstream impacts were noted following this event.

Q: Craig Hooper, GrowHow UK Limited
Did the wetting and subsequent drying process have any impact on the low methanol production properties expected of the charge of KATALCO 83-3x
A: Ken Chlapik
The charge was already maintaining very low methanol levels exit the LTS and there had been no changes in methanol or methanol related impurities to the CO2 removal and condensate systems noted following the continued operation of the Katalco 83-3X charge.

Q: Venkat Pattabathula, Incitec Pivot
What was the backpressure kept during catalyst dry-out?
A: Ken Chlapik
The back pressure of the initial N2 circulation dry out was maintained at the lowest practical level of around 1-2bar (15-30psi) to keep the dewpoint of the nitrogen very low, enabling the vaporization of the bulk of the liquid water within the structure of the LTS catalyst.
Q: Mukul Srivastava, IFFCO Phulpur, India
I understand that LTS skimming and subsequent reloading with fresh catalyst is carried out under nitrogen atmosphere. Is this skimming done under vacuum because if it is done manually using proper PPE's, the catalyst layer below the skimmed portion would get crushed and have an impact on delta P subsequently?
A: Ken Chlapik
In most of the skims experienced by Johnson Matthey on LTS beds, less than 30% of the bed is removed and reloaded. The LTS catalysts can be removed under inert atmosphere by vacuum through the upper entry point of the LTS vessel without physical entry into the vessel. Fresh catalyst can be reloaded through this entry point as well and properly leveled from outside the entry point.
If inert entry is required to better view the situation or aid in leveling the fresh catalyst loaded into the bed, boards are placed onto the existing catalyst bed to distribute the weight over the reduced catalyst pellets. The reduced catalyst strength of Katalco 83-Series LTS catalyst is robust enough to support this distributed load. Access to any open vessel under inert atmosphere should be performed under proper protocol and PPE.
Q: Mukul Srivastava
How reliable is the LTS catalyst activity recovery after a wetting incident and how long does it take to dry out a catalyst bed so that activity and delta P is regained?
A: Ken Chlapik
As highlighted in the paper and presentation, any response to an upset condition on an LTS unit needs to have a unique assessment of the LTS recovery potential. The assessment needs to consider where the charge is at in its intended lifecycle, what is the value of lost production; for skims - what is the risk profile of inert entry, what is the overhaul schedule, and overall what is the confidence factor of recovery.
For the dry out case study reviewed, the bed took about 32 hours to cool off and upon starting up; it took about 24 hours to slowly remove the water from the LTS catalyst. As long as the dry out is not accelerated such that the driving force or temperature difference of the nitrogen or process gas and the LTS catalyst is growing and

potentially stressing the LTS pellets with vaporized water, the recovery of the LTS allows performance to be regained as presented in the case study.

Q: Malika Nait Oukhedou, B.Sc., Protomation
Did the recovery of the LTS catalyst have an impact on the lifetime of the catalyst? And by how much did it shorten?

A: Ken Chlapik
For the LTS skim profiled, the charge was able to meet the next scheduled overhaul minimizing the financial impact of the LTS upset. For the LTS dry out profiled, the LTS charge continues to operate to initial projected performance and is scheduled for change out at the overhaul that the LTS was originally scheduled upon initial installation.

4 f - Failure of Low Pressure (LP) Flash Drum Packing Bed Support

Geoff Blewett, Umesh R. Desai – Qatar Fertiliser Company

Q: Zaheer Anwar, Fauji Fertilizer Company Ltd.
Thank you for an open and candid sharing of experience. We at FFC also experienced damage due to steam hammering caused by level rise above steam inlet. In upset condition, the operators should be cautioned if the level becomes steady below 100% mark. Density decrease due to dilution indicates less than actual level on ΔP and LI and any further build up is not shown as level beyond top nozzle ΔP does not change. Please comment.

A: Geoff Blewett and Umesh Desai
Density difference between the water and semilean solution is very low. Also dilution of solution will be uniform, so not expecting any major difference between actual level and LI indication due to density difference.
At QAFCO, level in the column was actually high as witnessed by the suction pressure of the semi-lean solution pump. Also due to steam injection during high level in column caused a very high turbulence in the LP flash drum bottom. Level indication stuck at 95% due to float sticking which has misled the operator about the actual level in the column. But the actual level in the column was high and well above the vapor inlet nozzle from stripper.
Therefore if level indication in column increases above 90%, closely observe the changes and try to confirm the actual level by some other means like suction pressure of the pumps.

5 a - An Innovative Safety Solution for Overpressure Protection in the Urea Synthesis Section

Andreas Caldonazzi – *Leser Germany*
Mark Brouwer – *UreaKnowHow.com*

Q: Mike Antony, Proplant Inc.
Does this modified SLS type relief valve conform to ASME/API codes?

A: Andreas Caldonazzi
The SLS type is not defined in ASME or API standards. It is only possible to have this type approved by code case definition. LESER is evaluating how to do this.

Q: Mike Antony
If SLS fails, will this RV perform like conventional spring loaded RV?

A: Andreas Caldonazzi
Yes.

Q: David L. Steed, GrowHow UK Limited
Does the supplementary loading head have a mechanical break free function to allow the valve to operate independently (delatch) if there is a problem with either the air supply from the control unit or the loading head? If not, then the valve would have to overcome the spring load and the air pressure to open.

A: Andreas Caldonazzi
No, this is not necessary according to the design definition of the ISO 4126-5.
In ISO 4126-5 it is defined that "Each individual control system shall be so designed that the relevant main valve will operate reliably incase of failure of the other individual control systems." Therefore, all three control lines have to fail to generate the case of the above question. The probability for that incident is rather low.

5 b - Back-to-Basics: Maximizing Plant Performance through a Better Understanding of the Basics in Catalytic Reactor Operation and Problem Avoidance
Michelle Anderson, Scott Osborne – *Sud Chemie Inc.*

Q: Mohammad Azam, Agrium
What could cause localized sintering of the HTS catalyst?

A: Michelle Anderson & Scott Osborne
In the example in the paper, a plant upset caused air introduction into the downstream HTS reactor. Localized overheating of the catalyst occurred as a result of the exotherm caused by oxidation of the pyrophoric reduced catalyst. The temperatures were high enough to cause catalyst shrinkage and fusion in certain areas of the bed.

5 c - Water Wash of Pre-Reformer Catalyst
Nikhil Das – *Yara Belle Plaine Inc.*

Q: VK Arora, PE, Kinetics Process Improvements
Experience sharing about Benfield carry over from the CO_2 absorbers of two 1850 MTPD ammonia plants in Trinidad:
The problem was quite severe as the plants had to be shut down every 3 to 4 months for cleaning of downstream exchanger (114-C) resulting in reduced MUG suction pressure by 10 PSI and reduced ammonia production. KPI studied and recommended changes of internals which were installed in March and September 2009 in two plants. The carry over problem has been completely resolved based on the performance of nearly 3 years since installation. Please comment.

A: Nikhil Das
We have experienced flooding of the packing in the top of the absorber and believe it's not a simple function of liquid and vapor flow but also has a component related to foaming characteristic of the solution. We monitor dP across the absorber and can anticipate when we go past the upper loading limit so no longer react after carryover commences but before.

Q: John Mason, Agrium
It seems that you were on your own when designing the water-wash and dry-out procedure. Would you please comment on the support that you received in designing the procedure and precautions to take?

A: Nikhil Das
We did have some expert advice not to attempt this wash but believed there was no significant risk and a lot to gain so went ahead and did the wash. The vendor did supply supporting ideas on how to proceed and we found these ideas very similar to our own.

Q: Mukul Srivastava
Would you consider installing a separator at the top of the PC stripper outlet so that the entrained liquid is at least knocked out before entering into the mixed feed coil (MFC) at least after this washing of the pre-reformer catalyst?

A: Nikhil Das
We've not pursued that option but it would have prevented in the incident in question.
Q: Venkat Pattabathula, Incitec Pivot
Did you have a high level trip system on process condensate stripper?
A: Nikhil Das
No, we did not. However, since this incident we've made a combination of high level PLUS cool temperature at the mixed feed coil to initiate a stop of stripping steam but have not yet required this trip to come into play.

5 d - Ammonia Plant Capacity Increase by Autothermal Reforming and Dual Pressure Synthesis
Dr. Klaus Noelker – *Uhde GmbH*

Q: Sachchida Nand, Fertilizer Association of India
What was the energy consumption of base case?
A: Dr. Klaus Noelker
The consumption figures of the revamp cases are shown in Table 2 of the paper. The consumption figure of the original plant is 37.5 GJ/t. This is similar to case 1. In fact, case 1 is more or less just an increase in size of the reformer and thus feed and fuel steam from waste heat all go up by about the same factor of 1.3 for the 30 % increase. Of course further improvements are possible by replacing inefficient machinery by better one or by reducing stack temperature, but that was not the target of the study and it would be about the same for all three process concepts compared. Thus the figures in Table 2 shall not be mistaken for energy consumptions of these processes. The important information is in the differences between their numbers.
Q: Sachchida Nand
If the capacity increase is limited to about 20%, will the relative economics of the three options change?
A: Dr. Klaus Noelker
Yes, it will change. Both the parallel autothermal reformer and the dual pressure synthesis are deliberately designed for large capacity increases. For a lower increase, it would probably be more economical to enlarge the reformer (process concept 1) and accommodate additional ammonia synthesis catalyst volume in the synthesis loop. The idea of the once-through synthesis as shown in Figure 6 of the paper is to leave the loop untouched and install the additional capacity outside of it. For a small capacity increase, the number of additional items in the once-through synthesis would be the same. They would only be smaller which gives only a little cost saving. But for a small capacity increase it is possible to have only a few modifications in the loop, maybe just a booster converter and additional chiller.

5 e - Mechanical Tube Plug Technology for High Pressure Heat Exchangers in Ammonia and Urea Plants
A.G.C.M. (Ron) de Rijk – *EST Group BV*

Q: Ruben Wageck, Vale Fertilizantes
Please comment whether it is acceptable to plug in pool condenser and pool reactor, but not to 316L LIG or 25-22-2 tubing material?
A: Ron de Rijk
The current design as presented is specifically developed for Ammonia Service in ASTM A-182 F22 Class 3 material. EST Group has started the development of a Pop-A-Plug for Urea service which may involve special Urea grade materials for pool condenser and pool reactor.
Q: Dallas Robinson, LSB Chemical Corp.
Are tubes plugged on both ends?
A: Ron de Rijk
Yes, tubes are always plugged on both sides.
Q: Dallas Robinson
Is removal possible without causing damage?

A: Ron de Rijk
Yes, plugs can be removed without damage to the tube by means of a Removal Tool, allowing the unit to be easily re-tubed when possible.

Q: Stuart Ford, Methanex
What is the maximum pressure the plugs can withstand and is this from both shell and tube side pressures?

A: Ron de Rijk
The maximum pressure varies with the diameter of the plug installed, the two sizes specifically developed were 1) P2-630-CR-SP-0611 Range 0.631" to 0.650" (16.03 – 16.51 mm) Max 413.6 BarG @ 537.8°C (6000 PSIG/1000°F) and 2) P2-790-CR-SP-0611 Range 0.791" to 0.810" (20.09 to 20.57 mm) Max 344.8 BarG (5000 PsiG). The pressures and temperatures listed are independent if pressure is from shell or tube side, and EST Group maintains an internal 1.5 safety ratio, so acceptance criteria for testing must be a minimum of 1.5 x higher as specified above.

Q: Stuart Ford
Are the plugs only useful to one side max pressure?

A: Ron de Rijk
As stated before, the pressures and temperatures listed are independent if pressure is from shell or tube side, and EST Group maintains an internal 1.5 safety ratio so acceptance criteria for testing must be a minimum of 1.5 x higher as specified above.