



How to manage Leaks in Urea Plants


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1. Introduction
2. Why leaks in the HP synthesis section are so critical ?
3. What happens when it leaks ?
4. What are critical leaks ?
5. Prevention measures
6. Mitigation measures
7. Conclusions

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Internet platforms to exchange technical information
within the nitrogen fertilizer industry

with the target to improve the Safety and Performance of all nitrogen fertilizer plants



Urea in China
www.ureanet.cn

nitrogen syngas
Published by BCInsight

AmmoniaKnowHow
NH₃ HNO₃ CH₃OH NPK (NH₄)(NO₃)

Partnerships

Company	Urea	Ammonia	Methanol	NPK
Yara	1	1	1	1
CFI	1	1	1	1
OCI	1	1	1	1
Ureac	1	1	1	1
Yara	1	1	1	1
CFI	1	1	1	1
OCI	1	1	1	1
Ureac	1	1	1	1

Round Tables



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all nitrogen fertilizer plants worldwide**

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Where the urea industry meets

November Paper August 2010

Arcadian, Lake Charles Urea HP Reactor explosion
Lesson to be learned

Investigation report
General Report

1. Introduction
The paper is a copy of REPORT ON LAKE CHARLES UREA HP REACTOR EXPLOSION, prepared by ODECO S.p.A. No. 13-0529 available on internet (<http://www.urea.com/urea/urea/2010/130529>) and the main content of this paper is to share lessons to be learned from this accident, together with the target to avoid similar future accidents.

On July 26, 2009, a pressure relief reactor exploded after normal working hours at Arcadian Corporation's "Arcadian" Urea HP Reactor plant in Lake Charles, Louisiana, destroying the facility, killing six workers and injuring 11 others. The explosion was the result of a failure of the HP reactor and not due to the O-2 compressor unit. The main objective of the report is to share lessons to be learned from this accident.

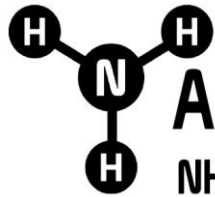
It was concluded that the main accident could have been avoided by:

- 1) Shutting down the reactor upon the pressure indicator of tank in the vessel's being;
- 2) Implementing an adequate program to ensure that the reactor was available system was properly maintained; and
- 3) Ensuring that relief vents were performed according to industry standards and design.

Other lessons to be learned on or less from the incident report are:

- 1) Any reactor / modification should be well described and relevant construction drawings should be updated accordingly;
- 2) When a safety valve or a relief device is not working, the plant should be shut down and the relief device repaired and replaced. When a leak detection line that indicates a leak and does not work, the leak should not occur there in the first place. In the meantime, the leak detection system is designed by reproduction of continuous on/off valve and check valve condition of the reactor when the leak valve leading to catastrophic situation.

**Biweekly a
Technical paper**



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Corrosion challenges

- A urea plant continuously fights against corrosion (due to presence of ammonium carbamate)
- Passive corrosion reduces wall thicknesses continuously
- Several reasons can cause active corrosion with high corrosion rates

Sealing challenges

- Due to the corrosion challenges, only a limited number of special urea grade materials can be applied
- Hardness figures do not always differ a lot
- More attention required to properly seal two parts

Why many leaks in piping systems

- A relative large number of safety incidents occur with high pressure 316L UG carbamate lines and NH_3 and CO_2 carbon steel feed lines
- Many failure modes exist when using standard materials like 316L UG and carbon steel
- Many welds of piping systems are made in the field instead of shop
- Welds in low pressure parts of feed lines are typically considered a lower risk level
- Piping systems are typically difficult to inspect and to reach

- Toxic ammonia gas is released directly and via dissociation of ammonium carbamate.
- Carbamate flashes from high pressure to low pressure, below 60 °C solids occur. When urea is present solids occur more easily
- These solids increase the risk of erosion damages along the leak path and/or cause clogging
- Ammonium carbamate is very corrosive for carbon steel and also for stainless steel when oxygen gets depleted (active corrosion)
- In case leak stops, pressures and temperatures increase leading to higher corrosion rates





Case 1: A leaking HP flange connection



Case 2: A solidified HP flange leak



Case 3: A solidified leak along stuffing box of a HP butterfly valve



Case 4: Cracks in HP gas line



Case 5: A leaking threaded connection of a HP drain valve

- Leaks touching carbon steel (bolts & nuts, tubesheets, loose liners)
- Along threaded connections
- Leaking HP piping accessories
- Cracks
- Be aware of end of lifetime conditions



- Minimise number of flange connections
- Choose a better (crevice free) design
- Apply more corrosion resistant materials (super duplex)
- Make use of high quality and experienced fabricators
- Perform risk based corrosion inspections including HP piping systems
- Pay more attention to flange connections (flange passport, perform soap test)
- Perform regular plant tours looking for leaks
- **Apply Zero Tolerance for leaks**

- Install ammonia leak detection systems
- Shut down the plant
- Perform a risk assessment
- Flush away solids / dilute and monitor
- No clamping on ammonium carbamate and ammonia lines
- Avoid dripping on carbon steel wall of HP vessels



- Detect leaks at an early stage
- Shut down the plant
- Perform a proper Risk Assessment and assure you know all the possible failure modes. Perform all possible NDT inspections. Search for similar cases in the industry
- Never clamp ammonium carbamate and ammonia lines
- In case of a crack or leak along a threaded connection, shut down the plant
- Take all possible preventive measures to avoid leaks
- **Apply Zero Tolerance for leaks**



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Thank You
Any Questions ?