Emission control in urea plants in normal operation and upset cases – why so many different solutions?

Martina Schmitz – Athens, 20 – 23 February 2012
Introduction

Emissions during normal operation

Emissions from tank vents and safety valves

Emergency releases

Case studies

Résumé
Emissions during Normal Operation
International Requirements for Ammonia Emissions

IFC – International Finance Corporation (World Bank Group)

<table>
<thead>
<tr>
<th>Granulation Unit</th>
<th>Prilling Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mg/Nm³</td>
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</table>

EFMA – European Fertilizer Manufacturer Association

<table>
<thead>
<tr>
<th>Granulation Unit</th>
<th>Prilling Unit</th>
<th>Vents</th>
</tr>
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<tbody>
<tr>
<td>50 mg/Nm³</td>
<td>50 mg/Nm³</td>
<td>4 kg/h</td>
</tr>
<tr>
<td>0.25 kg/t</td>
<td>0.5 kg/t</td>
<td>0.06 kg/t</td>
</tr>
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</table>
Emissions during Normal Operation

Emission Points

**Total:**
- 4 - 6 kg/h NH₃

**Atm Absorber**
- Off gas from evaporation
- Process water
- Bleed to evaporation
- Air from granulator

**LP Absorber**
- Steam condensate
- Process water
- Synthesis off-gas

**UREA SYNTHESIS VENTS**

**UREA GRANULATION VENT**

**Granulator Scrubber**
- 80 – 90 kg/h NH₃

**Ventilation**
- Air from granulator
- Bleed to evaporation
- Process water

Nitrogen + Syngas, M. Schmitz
Emissions during Normal Operation
Acidic Scrubbing in Granulation Plant

Granulator Scrubber

Acidic Part
Nitric or sulphuric acid
AN- or AS-solution

Dust Part
Process water
Air from granulator
Weak urea solution

Emission control in urea plants
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Emissions during Normal Operation
Acidic Scrubbing -> Purge Solution

**Nitric acid** + **NH₃** -> **Ammonium nitrate (AN) solution**

- **Liquid Fertilizer**
- **UAN solution**

**Sulphuric acid** + **NH₃** -> **Ammonium sulphate (AS) solution**

- **Liquid Fertilizer**
- **AS crystals or pellets**
- **Incorporation in granules**
Emissions during Normal Operation
Acidic Scrubbing in Granulation Plant - Requirements

Granulator Scrubber

Acidic part

Dust part

Acid Tank
Solution Tank

Solution purge
Emissions during Normal Operation
Acidic Scrubbing for Synthesis Vents

Atm Absorber

LP Absorber

Acidic Scrubber

Nitric or sulphuric acid

AN- / AS-solution
Emissions during Normal Operation
Flaring for Synthesis Vents

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Atm Absorber
LP Absorber
Nitrogen purge
Nitrogen purge
NOx
Flare
Support gas
Emissions during Normal Operation
Flaring for Synthesis Vents - Consequences

NOx compared to NH₃ has a negative environmental balance:

- Global warming potential
- Tropospheric ozone-forming potential
- Ozone-depletion
Emissions from Tank Vents and Safety Valves
International Requirements

IFC – International Finance Corporation (World Bank Group)

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- This requirement only applies to 95% of the time that the plant is operating.

EFMA – European Fertilizer Manufacturer Association

- Connection of tank vents to the plant main stack or other safe location.
- Connection of ammonia pump safety relief valves to a flare.
Emissions from Tank Vents and Safety Valves
Mitigating the Consequences

Vents from tanks
- Vent stack
- Acidic scrubbing
- Flaring

Safety valves ammonia pump
- Flaring

Safety valves carbamate
- Avoidance of PSV (design)
Emissions from Tank Vents and Safety Valves
Main Safety Valves in Urea Plant

- Reactor
- Pool Condenser
- Stripper
- HP Scrubber
- Rectifying column

NH₃ →

CO₂ →
Emissions from Tank Vents and Safety Valves

Main Safety Valves in Urea Plant

- Reactor
- Pool Condenser
- Stripper
- HP Scrubber
- Rectifying column

NH₃

CO₂

Emission control in urea plants
20-23 Febr 2012
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Emissions from Tank Vents and Safety Valves
Overview Mitigating the Consequences

Vents from tanks
- Vent stack
- Acidic scrubbing
- Flaring 😞

Safety valves ammonia pump
- Flaring

Safety valves carbamate
- Avoidance of PSV (design)
- Avoidance of blowing (pressure switches)
- Vent stack
- Flaring
**Emergency Release**

No international standards available, but

- neighbouring inhabitants?
- areas with frequent emissions?

→ local authority requirements or company policy limits

Event rare, but impact serious -> Risk evaluation
Emergency Release
Risk – Definition and Ranking

Risk = Frequency x Consequence

Risk Ranking by

⇒ Risk Matrix
⇒ LOPA (Layer Of Protection Analysis)
Emergency Release
Tube Rupture - Separator System

HP Scrubber
Pool Condenser
Stripper
Collection Tank

Emergency Separator

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Emergency Release
Tube Rupture - Absorber System

HP Scrubber

Pool Condenser

Stripper

Collection Tank

Emergency Absorber

water
Case Studies

‘Zero Emission‘ Flaring System installed in Fertil Plant, Abu Dhabi

LP Absorber Flare
- Support gas
- Process water
- N₂

Emergency Flare
- Support gas
- Process water
- PSVs, RD
- Buffer tanks
- N₂

Vent Flare
- Support gas
- Process water
- N₂
- Tank vents

Ammonia Flare
- Support gas
- N₂
- NH₃
- Steam
- Condensate

Collection tank
- Process water
- Emergency Flare
- Vent Flare
- Ammonia Flare
Case Studies
Acidic Scrubbing installed in Yara Plant, The Netherlands

Atm Absorber
LP Absorber
Acidic Scrubber

< 30 mg/Nm³

Nitric acid
AN solution
Case Studies
Emergency System installed in Yara Plant, The Netherlands
Case Studies
Emergency System installed in Safco 4 Plant, Saudi Arabia
Any questions?