

Uhde innovate 2024

Where sustainability meets chemical engineering

New solutions in fertilizer production and emission control | June 5, 2024 | Dr. Klaus Noelker
thyssenkrupp Uhde

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New solutions in fertilizer production and emission control

Agenda

- Part 1: Project update
- Part 2: Advances in technology:
 - Ammonium nitrate neutralization: optimum process for every customer
 - Nitric acid: First installation of MAN NAMAX gearless compressor
 - Urea plants: Emission control
 - Urea plants: New layout for lower CAPEX
 - Urea plants: Energy saving



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Uhde Projects Update

Project update

Brunei Fertilizer Industries, Brunei

Location: Sungai Liang, Brunei Darussalam

Capacity:

- Ammonia: 2,200 mtpd
- Urea melt: 3,900 mtpd (Stamicarbon license)
- Urea granulation: 3,900 mtpd (tkFT license)

Contract: Engineering, procurement, construction, commissioning, lump sum (EPC)

Status:

- engineering start: Oct. 2017
- first ammonia December 2021
- first urea January 2022
- plant in operation



Highlights:

- Low limits on emissions of ammonia and dust.
- Acidic scrubbing of urea granulation exhaust and melt plant vent
- Recovery of spent acid (Ammonia Convert Technology)



Uhde Projects Update

Project update

NCIC

Location: Ain Sokhna, Egypt

Capacity:

Ammonia: 1,200 mtpd

Urea: 1,050 mtpd

Nitric Acid: 500 mtpd

ANS/CAN: 635/826 mtpd

Contract: Engineering, procurement and construction lump sum (in consortium with Petrojet)

Status:

- engineering start: June 2019
- all units in operation since end of 2023

Highlights:

- project execution during COVID restrictions
- Low energy urea melt plant: 0.7 t steam/t urea
- Low limits on ammonia and dust emissions

- Acidic scrubbing of granulation exhaust and melt plant vent
- Recovery of spent acid (Ammonia Convert Technology)



Uhde Projects Update

Project update

Anwil, Włocławek, Poland

Location: Włocławek, Poland

Capacity:

Nitric Acid: 1,265 mtpd

Ammonium Nitrate: 1,200 mtpd

Contract: Engineering, procurement and construction lump sum

Status:

- engineering start: April 2019
- all units in operation

Highlights:

- project execution during COVID restrictions
- CE marking for full assembly achieved
- First commissioning of an MAN NAMAX compressor train



Uhde Projects Update

Project update

Nutrien, Geismar, USA, AN Plant Revamp

Location: Geismar, LA, USA

Capacity:

Ammonium Nitrate: 1,750 stpd

Contract: Engineering and procurement

Status:

- engineering start: August 2021
- in operation since June 2023

Highlights:

- low-pressure urea off-gas feed
- “plug-in” neutralizer replacement
- tailored natural draft circulation process
- hot-commissioning incl. guarantee test run within one week



Uhde Projects Update

Project update

Undisclosed client, North America, Urea Plant Revamp

Location: undisclosed, North America

Capacity:

Urea: Increase to above 2,500 stpd (+58 %)

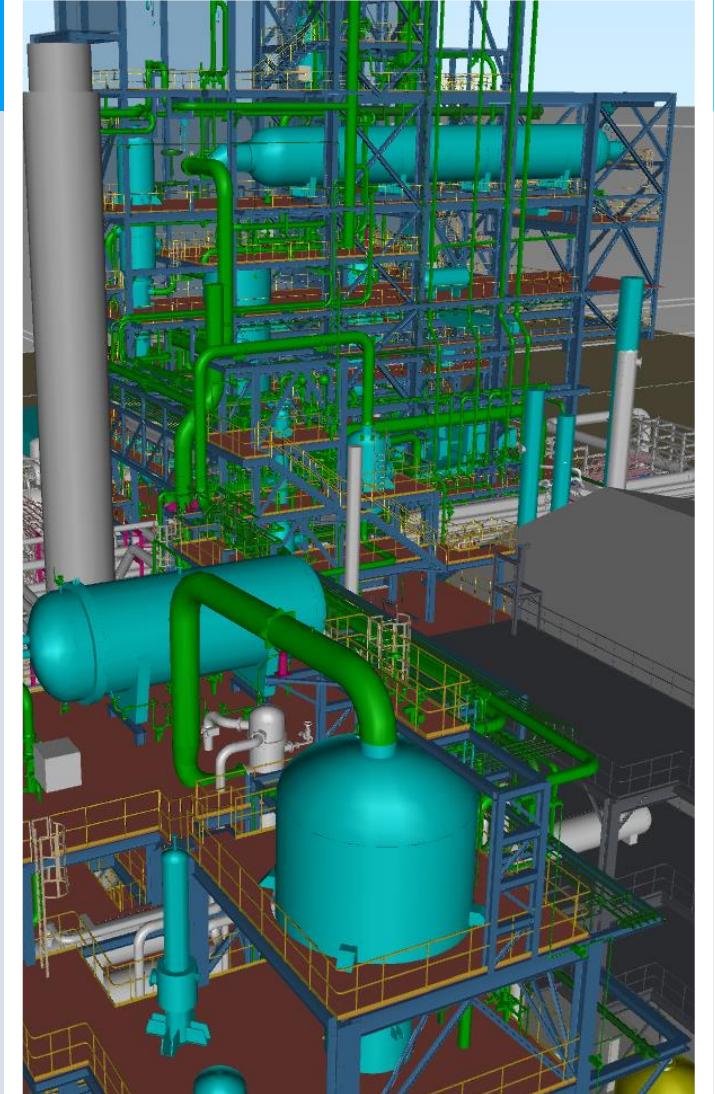
Contract: Basic Engineering incl. HAZOP

Status:

- engineering start: October 2021
- HAZOP finished November 2022
- detail engineering by third company

Highlights:

- revamping total recycle melt plant of licensor Toyo into Stamicarbon low energy process with 0.7 t steam/t urea
- preparation for further capacity increase to +82 %
- melt plant had to be split into two parts due to crossing road



Uhde Projects Update

Project update

MOPCO I, II, III, Egypt, Urea Plant Revamp

Location: Damietta, Egypt

Capacity:

Urea: 1750/1925 mtpd $\Rightarrow$ 2150 mtpd (+23/12 %)

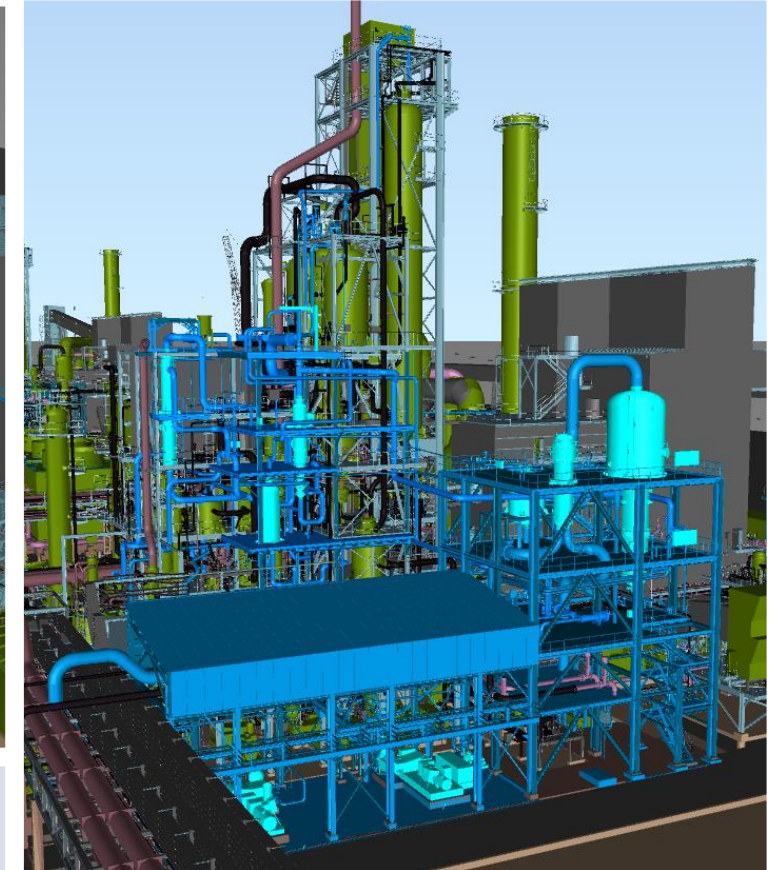
Contract: Basic Engineering incl. HAZOP

Status:

- engineering start: September 2022
- basic engineering finished

Highlights:

- energy saving: 0.95 $\Rightarrow$ 0.60 t steam/ t urea
- emission reduction by acidic scrubbing of melt plant and granulation vent in a common scrubber
- integration of future melamine plant into melt plant I and II prepared



Uhde Projects Update

Project update

Grupa Azoty, Tarnów, Poland

Location: Tarnów, Poland

Capacity:

Ammonium Nitrate: 1,500 mtpd

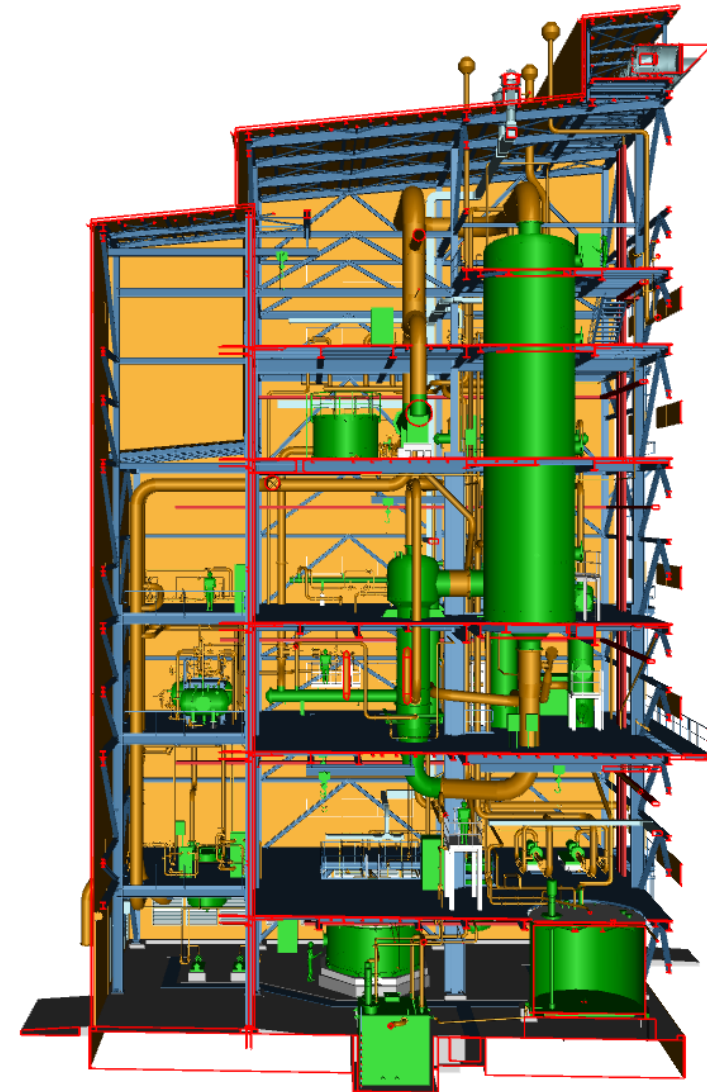
Contract: Engineering and procurement
lump sum

Status:

- engineering start: May 2023
- basic engineering package delivered in time

Highlights:

- two parallel lines for different products
- low-pressure ammonia gas feed
- tailored natural draft circulation process



Uhde Projects Update

Project update

Hu-Chems, Yeosu, South Korea

Location: Yeosu, South Korea

Capacity:

Nitric Acid: 1,150 mtpd

Contract: Basic Engineering, Proprietary equipment

Status:

- engineering start: May 2021
- basic engineering package delivered in time
- start-up in December 2023
- PAC in January 2024

Highlights: 5th plant for same client in a row
3rd “copy” of the 1,150 mtpd azeotropic acid plant



Uhde Projects Update

Project update

Grupa Azoty, Puławy, Poland

Location: Puławy, Poland

Capacity:

Nitric Acid: 1,000 mtpd

Ammonium Nitrate: 1,500 mtpd

Contract: Basic engineering, proprietary equipment

Status:

- engineering start: April 2017 (NA)
July 2017 (AN)
- basic engineering packages delivered in time
- start-up scheduled for 2024

Highlights: Implementation of MAN NAMAX machine train



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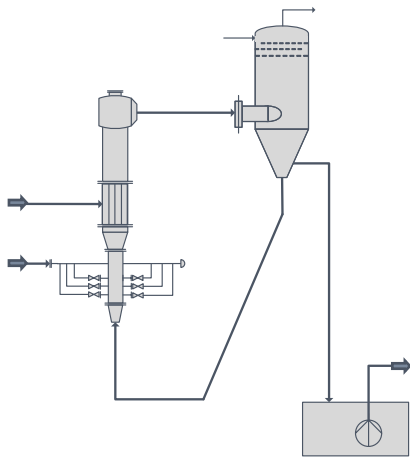


The uhde® ammonium nitrate neutralization technology

Ammonium nitrate neutralization: Optimum process for every customer

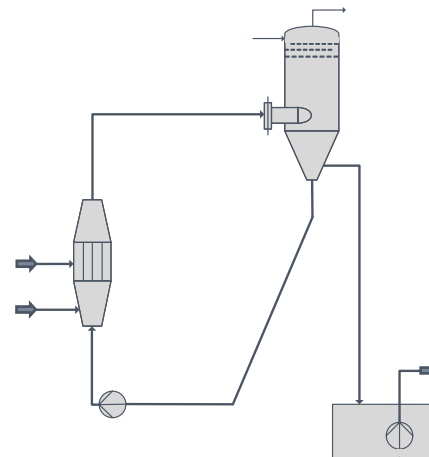
Natural draft neutralization

- Low pressure ammonia gas or urea off-gas feed with high content of non-condensable gases
- Optimized neutralizer design attributes to high reaction rates and low nitrogen losses
- Low reaction temperatures due to high natural circulation rate



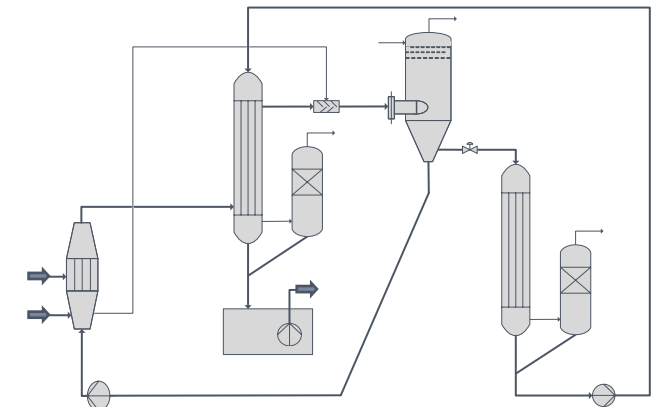
Vacuum neutralization

- Many references with high capacities and low turndown ratios.
- Production of clean process condensate
- Very low reaction temperatures resulting in safe operation and low corrosion rates



Pressure neutralization

- OPEX optimization through heat integration and reduced LP steam consumption
- Plant safety and corrosion mitigation ensured through low operating temperatures and pH control
- Different options available tailored to specific client requirements



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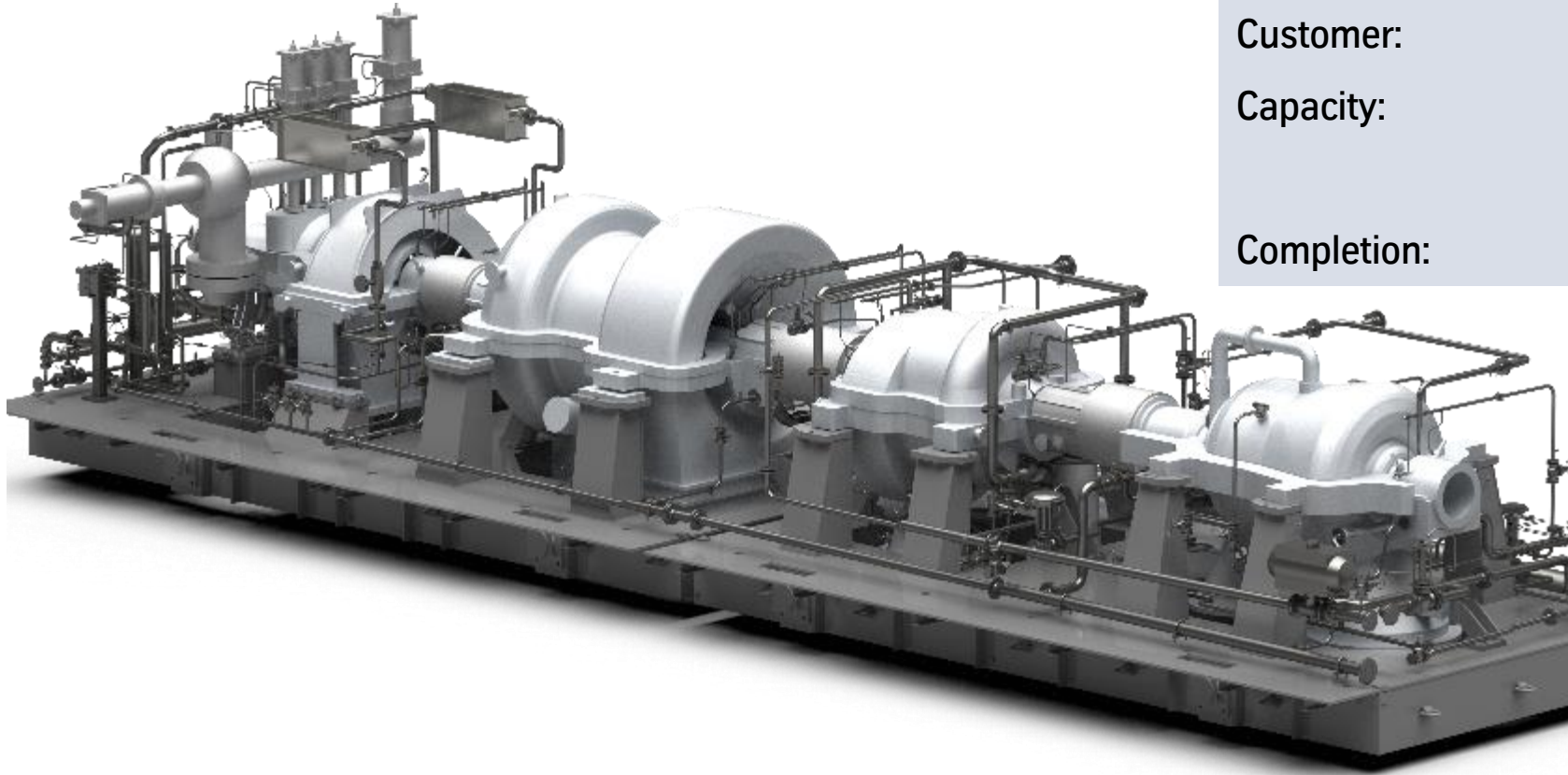
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First NAMAX in operation world-wide

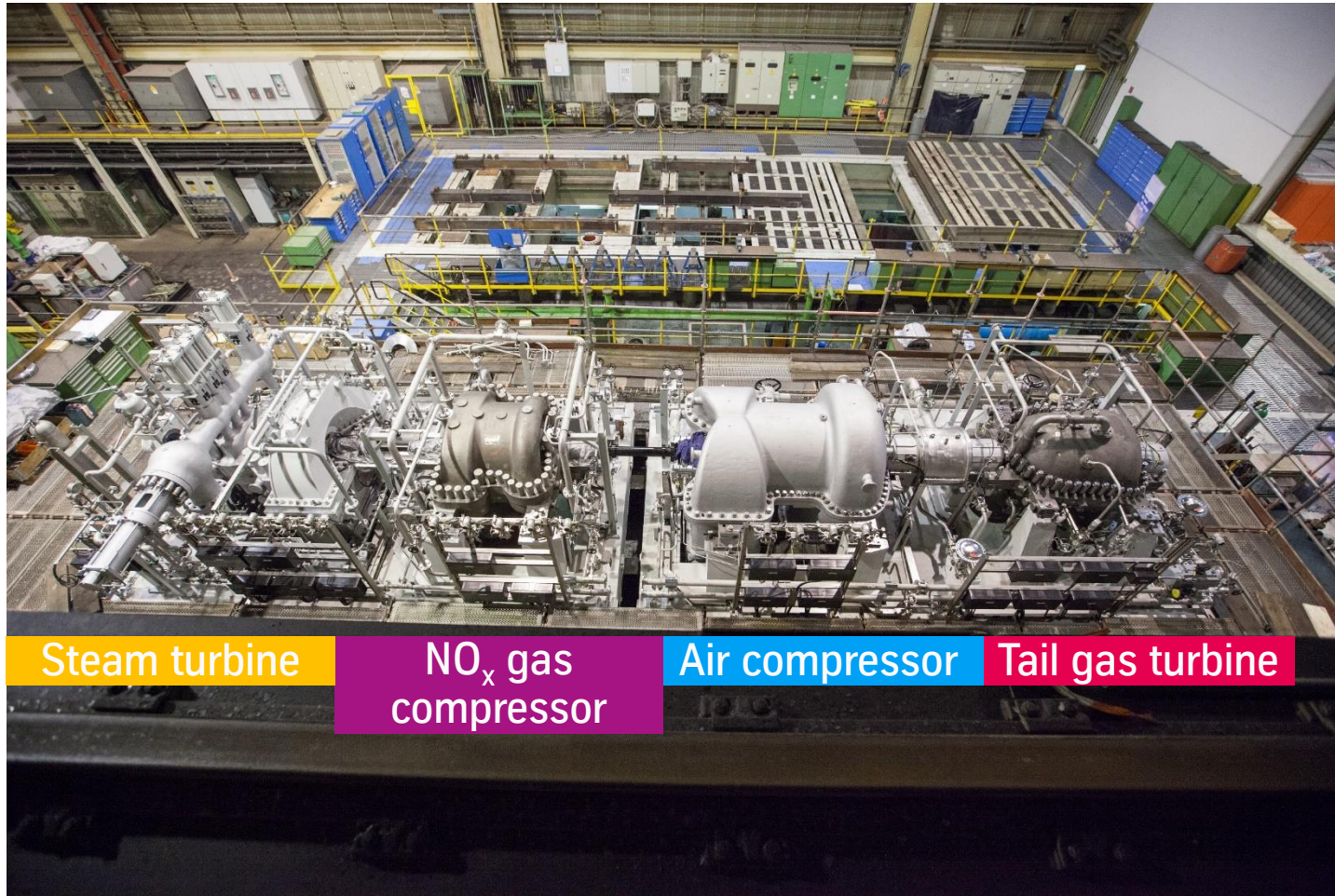
MAN NAMAX machine train for nitric acid plant



Application:	Nitric Acid
Project Location:	Wloclawek, Poland
Customer:	ANWIL S.A.,
Capacity:	1,265 mtpd HNO ₃ uhde® dual pressure process
Completion:	2023



Second NAMAX in operation world-wide soon



uhde® dual pressure process: Poland, 1,000 mtpd

Source: MAN

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- High efficiency
 - No gear → no frictional losses
 - Optimized efficiency of each single machine
- No gear box → no maintenance of the gear box
→ lower investment costs
- Highest robustness of air compressor blades against surging
- The arrangement follows commissioning schedule → reduced commissioning costs



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Superior Emission Control for Granulation Plants

Ensuring Compliance with Advanced Design

Standard	Ammonia	Dust
IFC (World Bank, 2007) ¹⁾	< 50 mg/Nm ³	< 50 mg/Nm ³
Fertilizers Europe (2013) ²⁾	< 50 mg/Nm ³ < 0.25 kg/mt	< 50 mg/Nm ³ < 0.25 kg/mt
EU BREF LVIC (2007) ³⁾	< 3 - 35 mg/Nm ³	< 15 - 55 mg/Nm ³
Louisiana (2012)	< 30 mg/Nm ³	PM10 / PM2.5 < 8.3 mg/Nm ³ < 20 % opacity
Iowa (2012)	BACT ⁴⁾	PM2.5 < 20.96 mg/Nm ³ No visible emissions

1) IFC: International Finance Corporation (World Bank Group)
2) Fertilizers Europe as of 24th April 2013
3) EU BREF LVIC: European Commission, Integrated Pollution Prevention and Control, Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals, August 2007
4) Best available control technology

Achieved in tk Uhde plants using acidic scrubbing:

- Ammonia: 11.1 mg/Nm³ ^{a)}
- Dust (PM_{total}): 0.86 mg/Nm³ ^{b)}



Actual plant performance parameters significantly exceed requirements

a) Using EPA 9 method
b) Using EPA 5 method



Urea plants: Emission control for granulation plants by acidic scrubbing

Production of ammonium salt fertilizer from the scrubber bleed

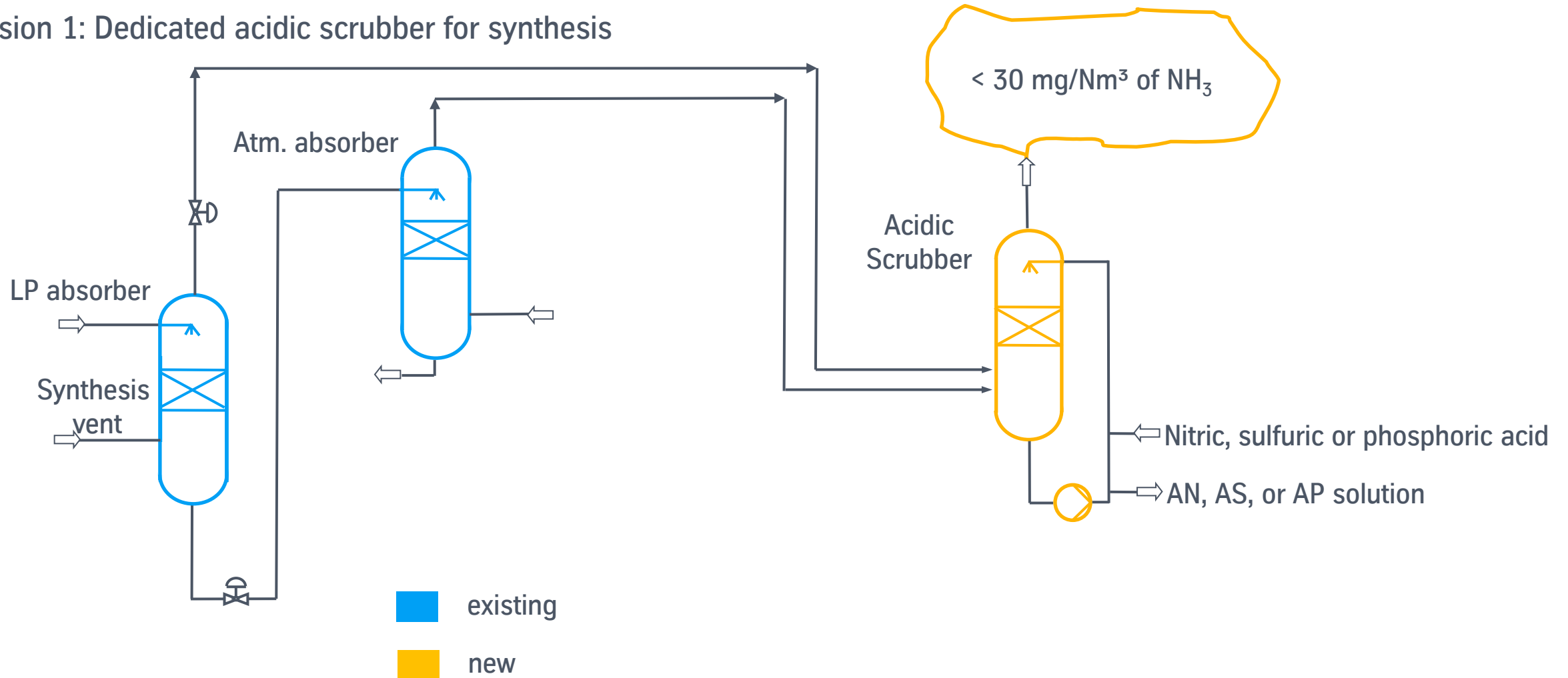
Scrubbing agent	Chemical reaction in scrubber; product	Uhde reference plant
Nitric acid	$\text{HNO}_3 + \text{NH}_3 \rightarrow \text{NH}_4\text{NO}_3$ <pre>graph TD; A["HNO3 + NH3 -> NH4NO3"] --> B["Liquid fertilizer"]; A --> C["UAN solution"]</pre>	IFCo, USA CF Donaldsonville, USA CF Port Neal (all conversion to UAN)
Sulfuric acid	$\text{H}_2\text{SO}_4 + 2 \text{NH}_3 \rightarrow (\text{NH}_4)_2\text{SO}_3$ <pre>graph TD; A["H2SO4 + 2 NH3 -> (NH4)2SO3"] --> B["Liquid fertilizer"]; A --> C["AS crystals or pellets"]; A --> D["Incorporation in urea granules"]</pre>	NCIC, Egypt BFI, Brunei (all incorporation into urea granules)
Phosphoric acid	$\text{H}_3\text{PO}_4 + 3 \text{NH}_3 \rightarrow (\text{NH}_4)_3\text{PO}_4$ <pre>graph TD; A["H3PO4 + 3 NH3 -> (NH4)3PO4"] --> B["Liquid fertilizer"]; A --> C["DAP/MAP crystals or pellets"]; A --> D["Use bleed in DAP/MAP plant"]</pre>	Mopco revamp, Egypt (basic engineering finished)



Urea plants: Emission control

Emission reduction in urea melt plant by acidic scrubbing

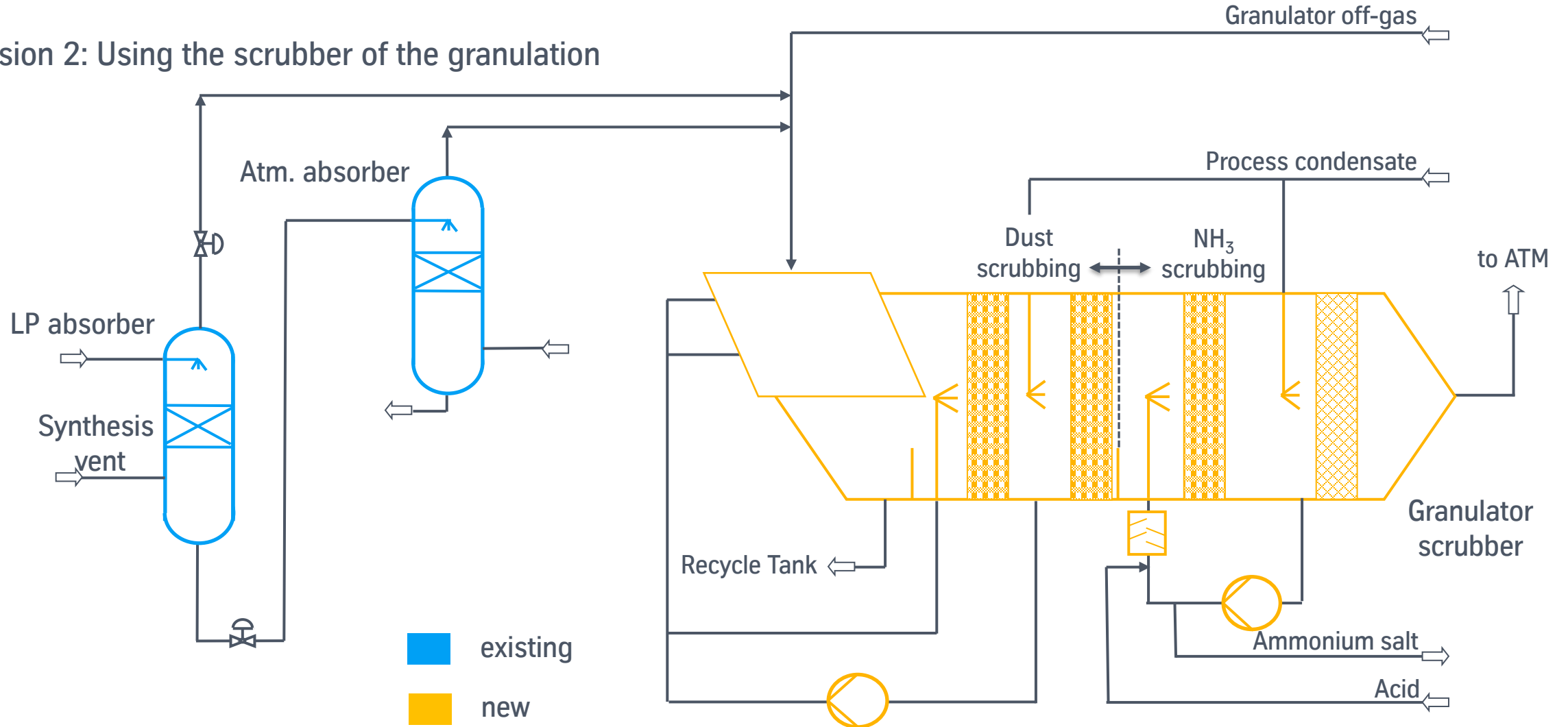
Version 1: Dedicated acidic scrubber for synthesis



Urea plants: Emission control

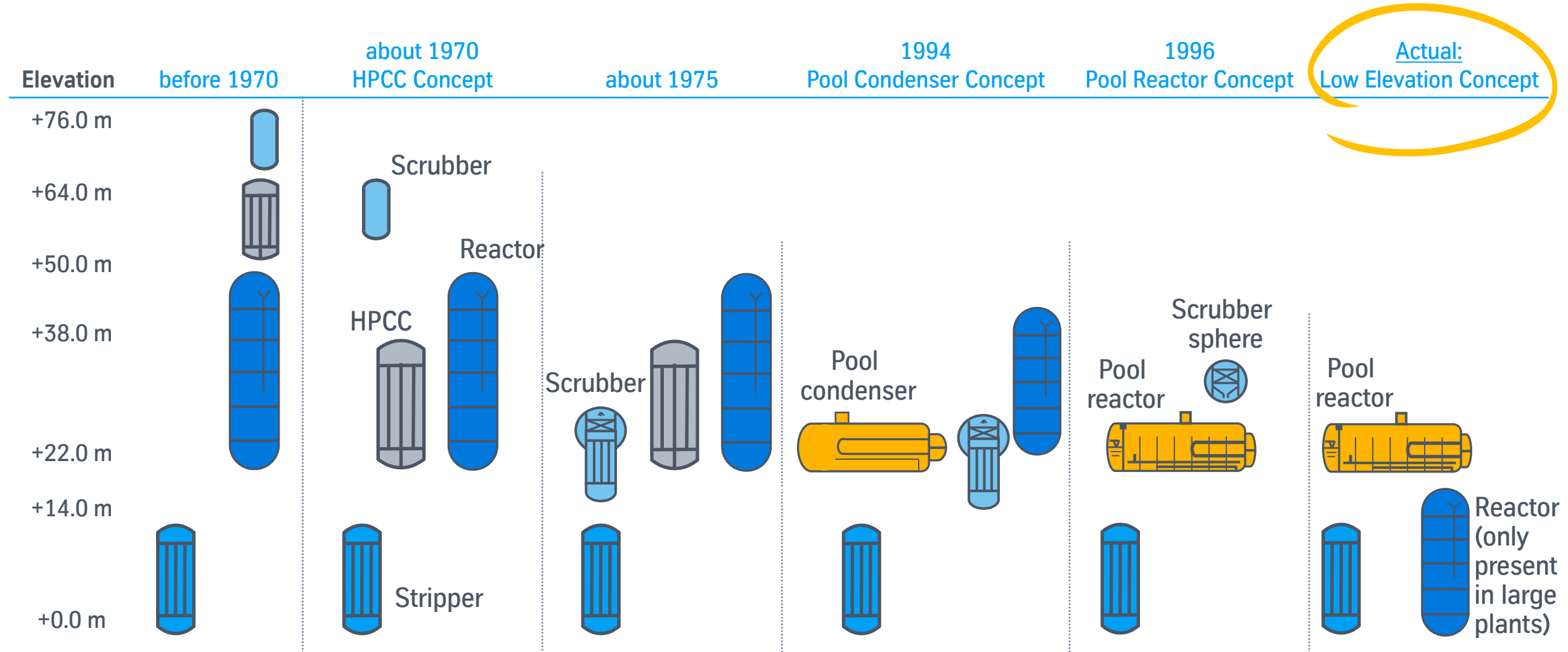
Emission reduction in urea melt plant by acidic scrubbing

Version 2: Using the scrubber of the granulation



Urea plants: Layout development for lower capex

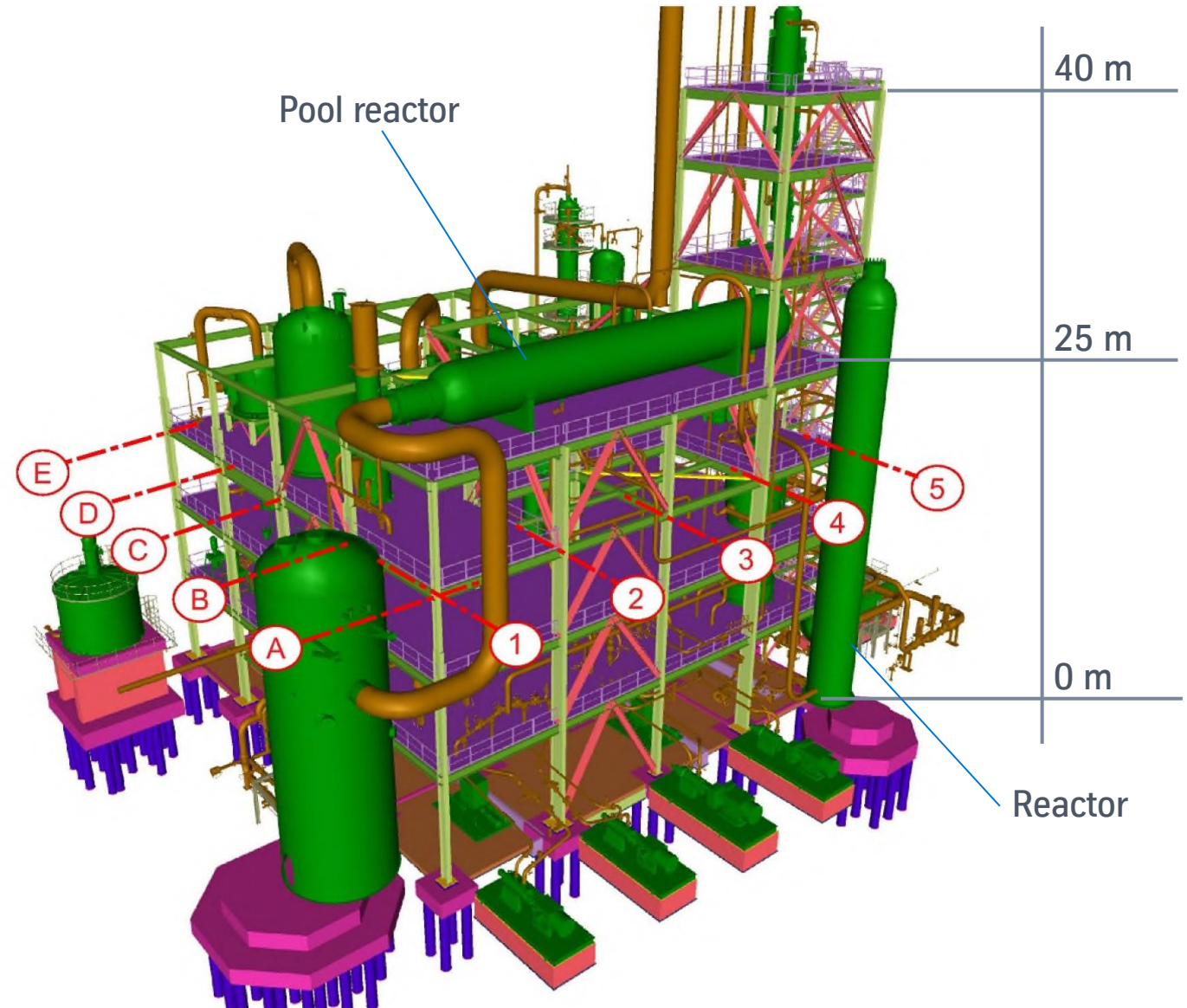
Decreasing the height of the urea structure



Urea plants: Low elevation concept for low capex

3D model of low-elevation plant:

- Capacity: 3,900 mtpd
- Plot area: 32 m x 32 m
- Platform elevation of HP pool reactor: ~25 m
- Platform elevation in the tower shown in the back right, for ammonia inert removal vessel and acidic scrubber: ~40 m



Green urea production by heat integration

Options with green ammonia plant	Steam supply from green ammonia plant	Stand alone
Plant size	3,850 mtpd	
Technology basis	Melt plant: Stamicarbon low energy “MP Flash 2.0” Granulation: tkFT CO ₂ compressor driven by electric motor	
Modification of licensor PDP	Steam import from ammonia plant Steam production in urea plant by use of heat pumps	Steam production in urea plant by use of heat pumps
Steam production compared to steam required	Required amount can be satisfied or exceeded	
Additional electrical power required to provide heat	13 MW	28 MW
Total electricity consumption for urea plant incl. CO ₂ compression, pumps, granulation	28 MW	50 MW
For comparison: electricity consumption for required amount of 2,200 mtpd green ammonia	900 MW	





Thank you for your attention



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