



RECONNECT

SYMPOSIUM 2022

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Operational Experiences with the Ultra-low Energy Plant Design

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18 May 2022

Jaarbeurs, Utrecht

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- Ultra-low energy plants in operation and under construction
- Process description
- Operation experiences and key performance parameters
- Considerations for pool reactor design
- Operational experiences of pool reactor
- Conclusions

Introduction and background

1.1 The Ultra-Low Energy (ULE) design has been launched in 'Stamicarbon symposium 2012'

- OPEX: Drastic reduction in steam consumption from 870 kg/ton in traditional Launch melt pool condenser process (former Urea2000plus™) process to 567 kg/ton (23 bara, 330 °C) for ULE
- CAPEX: Equivalent CAPEX as in traditional Launch melt pool condenser process.

Introduction and background

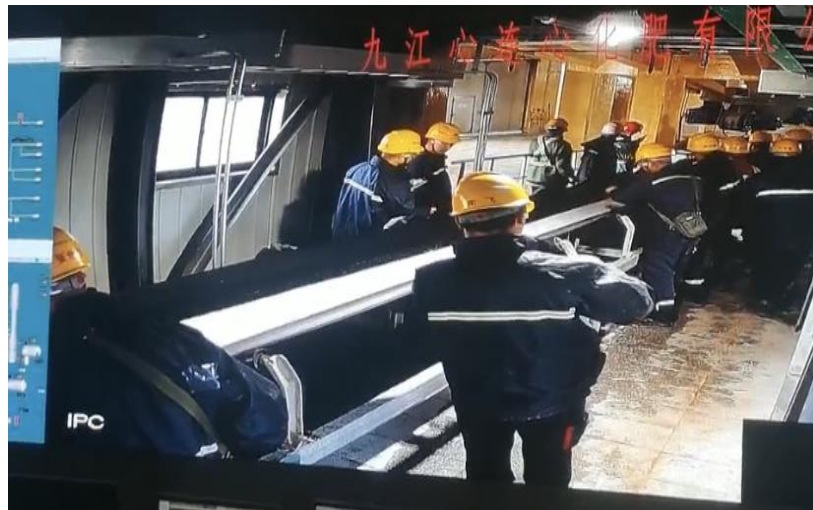
1.2 Main elements of the Ultra-Low Energy™ (ULE) design in operation and in construction;

- CO₂ stripping process
- Pool condensation
- Limited high-pressure equipment's
 - Only 2 pieces (pool reactor and stripper),
- Process-process heat exchange between 'synthesis' and 'medium pressure section'

Ultra-Low Energy plants in operation and under construction

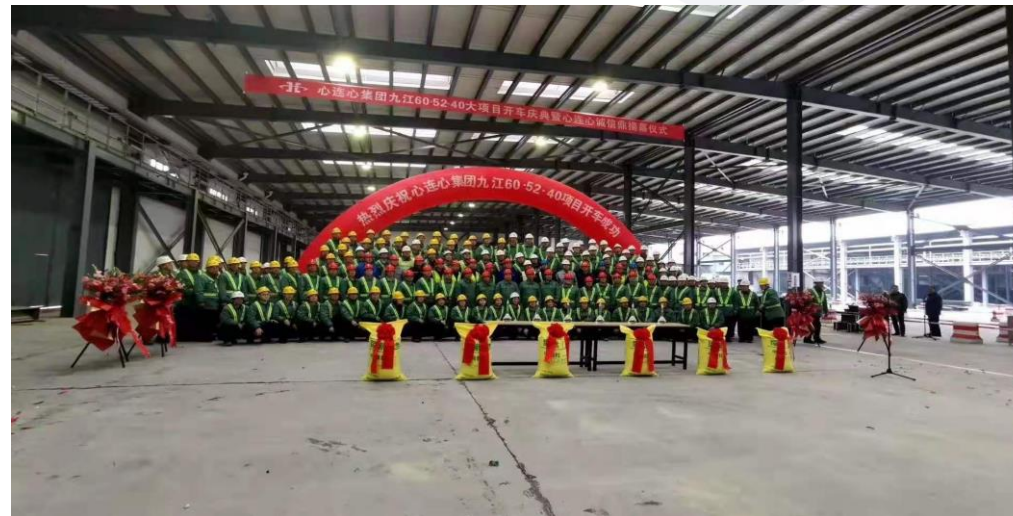
Jiujiang XinLianXin Fertilizer Co. Ltd (XLX)

- Synthesis: **Pool reactor + Stripper**
- Capacity: 2334 mtpd
- Project phase: **In operation since Feb. 2021**



Hubei Sanning Chemical Industrial Co. Ltd.

- Synthesis: **Pool reactor + Stripper**
- Capacity: 2334 mtpd
- Project phase: **In operation since April 2021**



Two Ultra-Low Energy plants in operation since beginning 2021

Ultra-Low Energy plants in operation and under construction

Xinxiang XinLianXin Fertilizer Co. Ltd (XLX)

- Synthesis: **Pool reactor + Stripper**
- Capacity: 2334 mtpd
- Project phase: under construction
- Start-up expected: 2023

Gemlik Gubre, Turkey

- Synthesis: **Pool reactor + Stripper**
- Capacity: 1640 mtpd
- Project phase: under construction
- Start-up expected: 2023

Confidential client, China

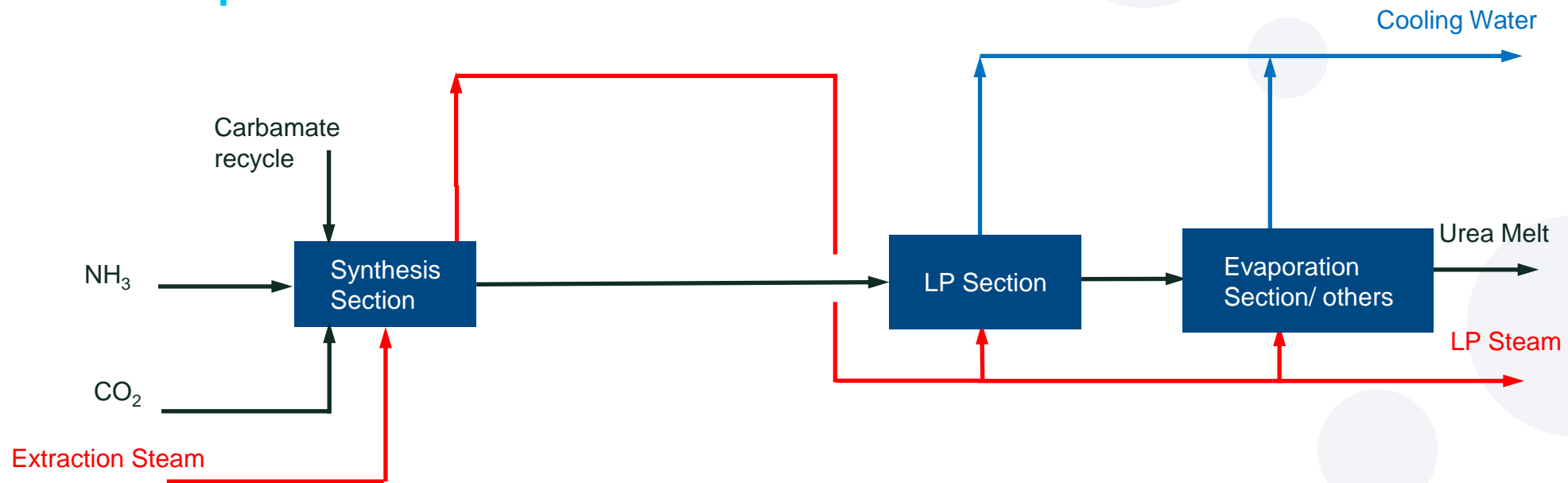
- Synthesis: **Pool reactor + Stripper**
- Capacity: 2 x 2334 mtpd (two units)
- Project phase: in engineering phase
- Start-up expected: 2024

- in total 6 Ultra-Low Energy (ULE) plants are licensed
 - 2 plants in operation

Process description

Energy flow diagram of traditional process launch melt pool condenser process (former urea 2000plus™)

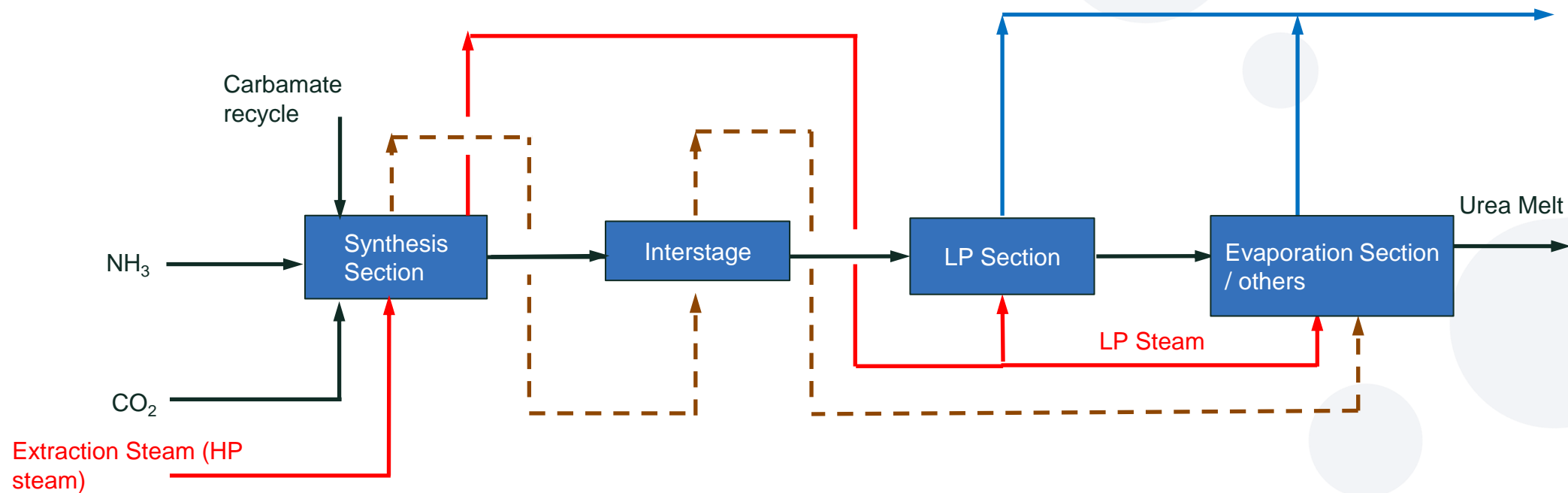
The “N = 2” process



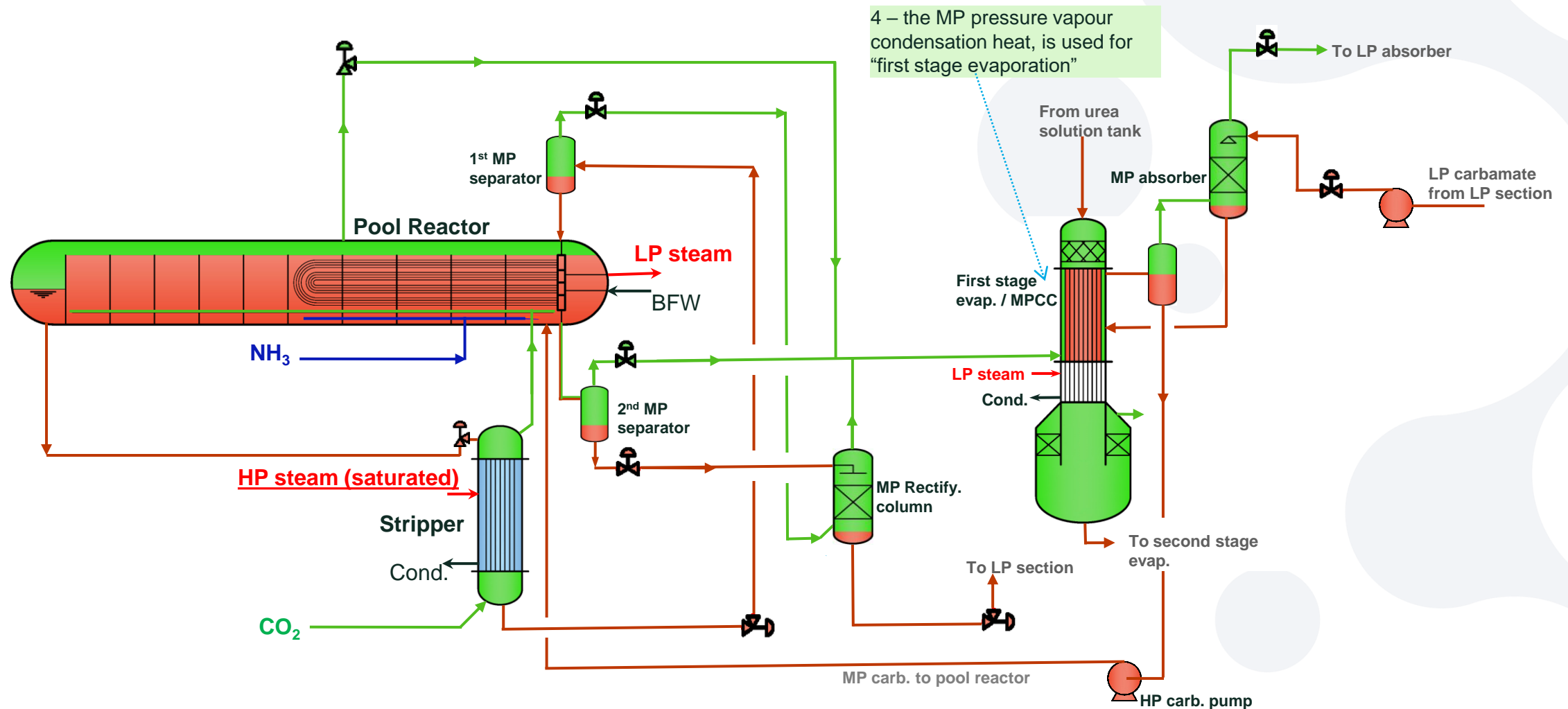
Process description

Energy flow diagram in Ultra-Low Energy design

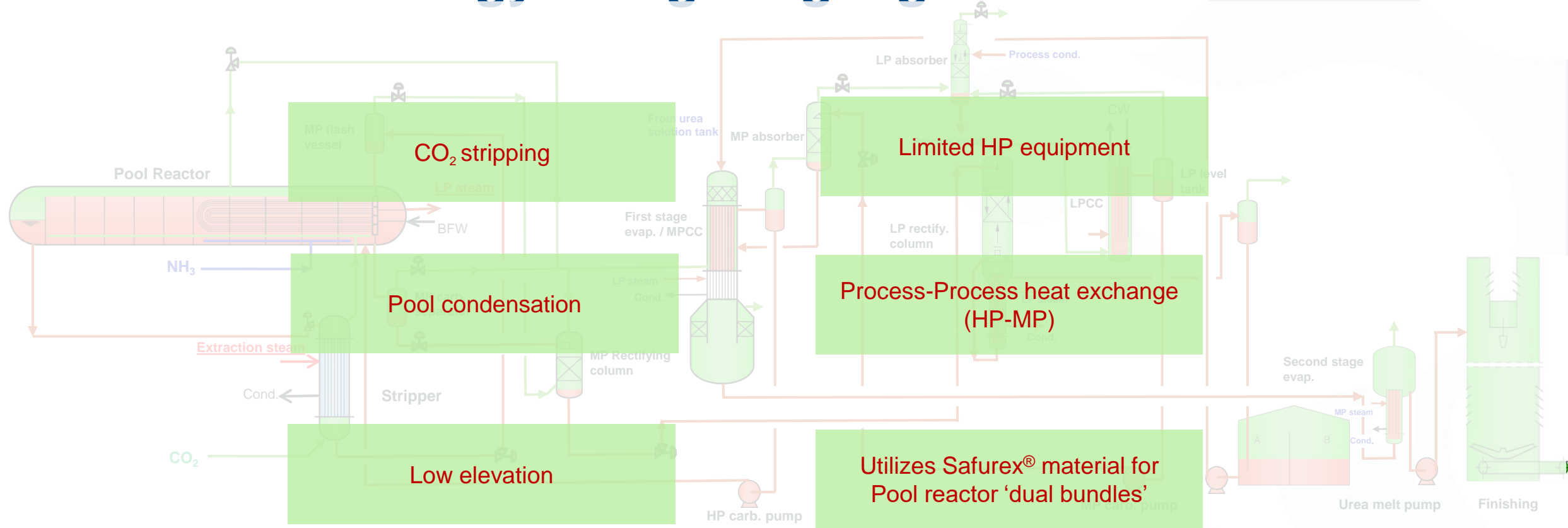
The “N = 3” process



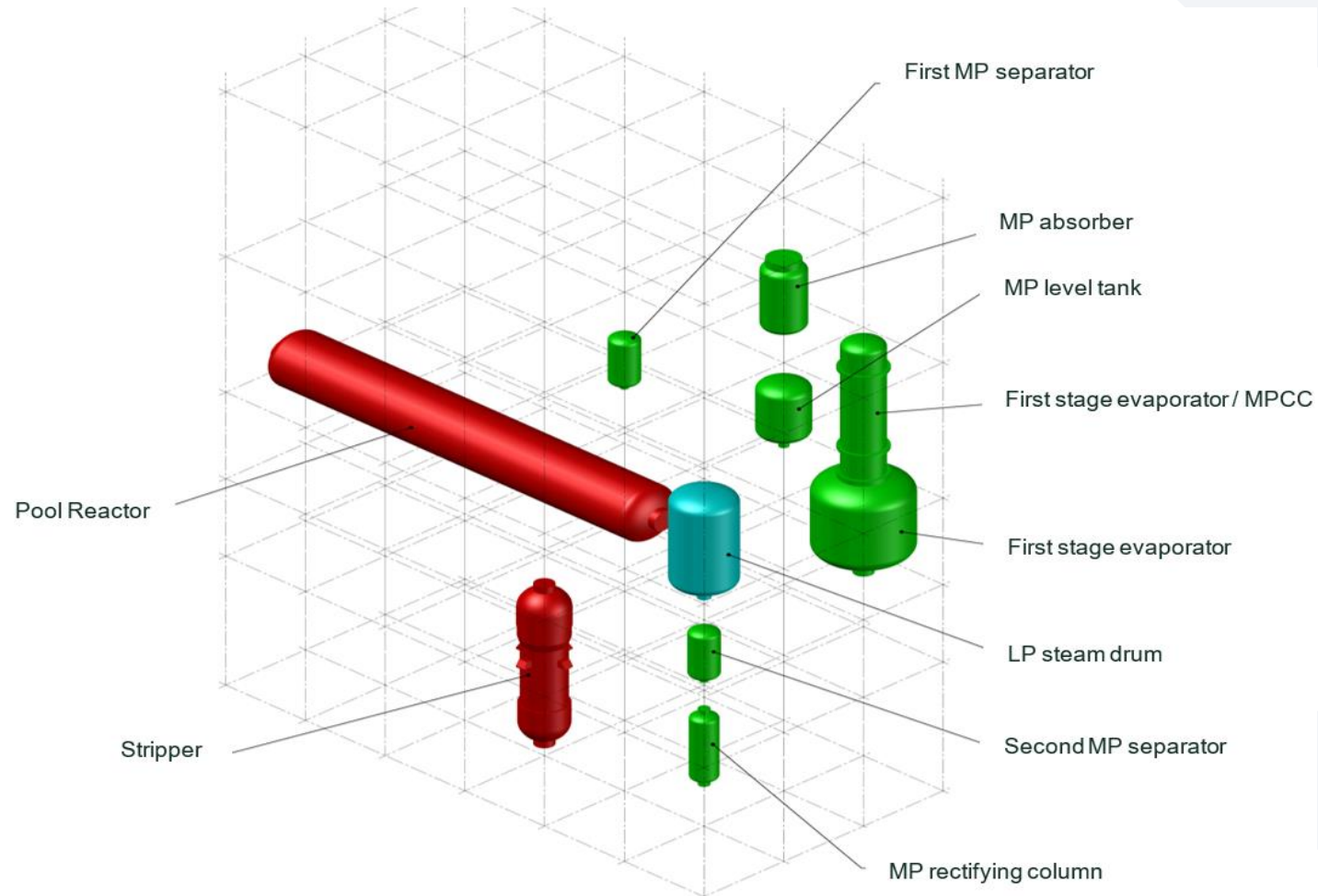
Process description “XLX / Sanning Plant Design”



Ultra-Low Energy Design Highlights



Typical layout of synthesis and medium pressure (MP) recirculation section



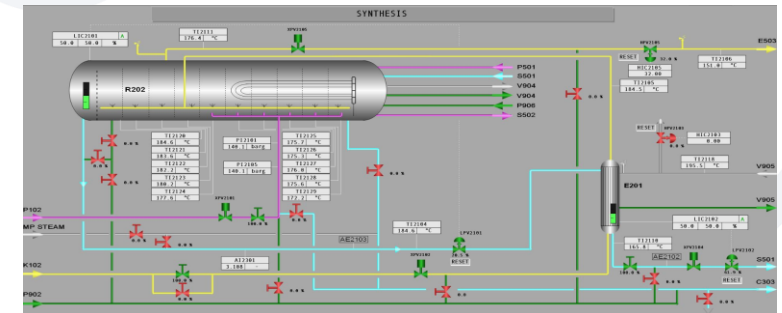
Operational experiences and key performance parameters

Simulation of operational window and start-up procedures with the Stami Digital Process Simulator:

- To get deeper understanding of the dynamics
- Train the operators for Ultra-Low Energy design.

Main observations:

- Relatively more stable synthesis and low-pressure operation due to “dual bundle” in synthesis.
- Operating correctly the Medium pressure section is the key element for maximizing the energy gains.



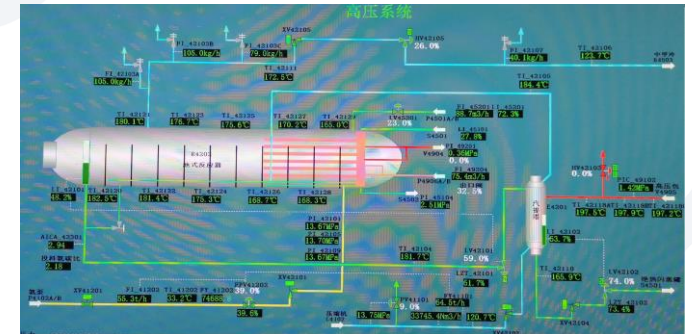
Operational experiences and key performance parameters

In Feb. 2021, Jiujiang XLX Ultra-Low Energy plant started-up

- The startup of the plant went very smooth without any issues.
- Initially operated at turndown capacity, the capacity increased to about 100% within a week.

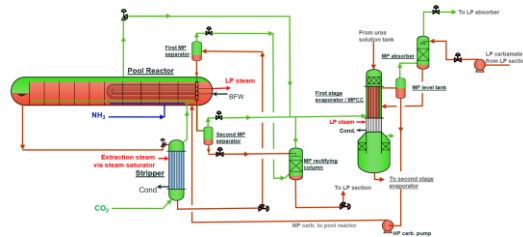
Main observation from operations:

- Relatively simpler and stable operation of the plant.
- Lower-energy consumption
- Milder stripper conditions due lower steam side pressures.
 - Provides a longer life-time of the stripper
 - Lower biuret formation at stripper



Operational experiences and key performance parameters

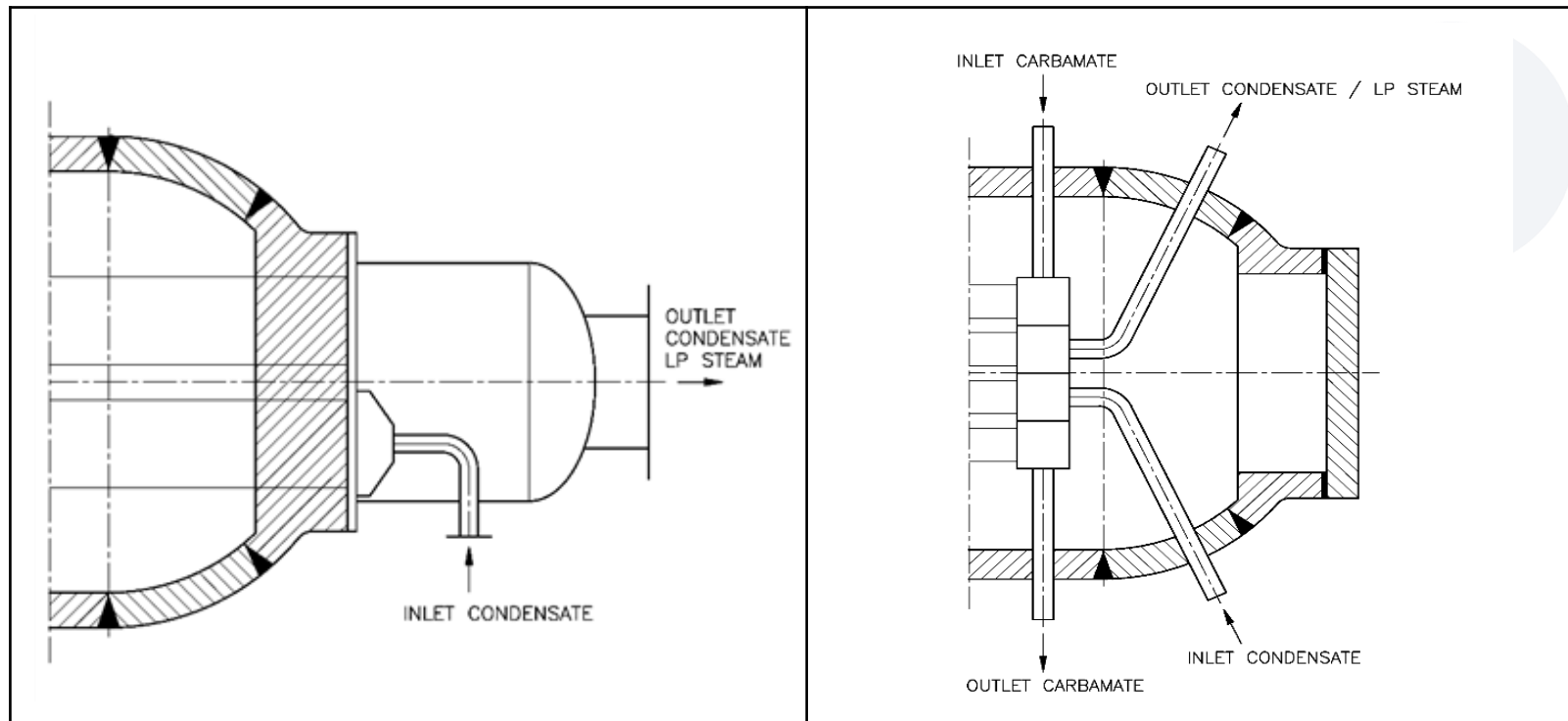
Key performance parameters (based on Jiujiang XLX performance)		Units	Expected values during design phase	Actual plant performance during the performance test. (average 5 days, XLX Jiujiang)
Production capacity		tons/day	2334	2387
Cooling water		tons/ton _{urea}	61 ($\Delta T = 10\text{ }^{\circ}\text{C}$)	61 ($\Delta T = < 10\text{ }^{\circ}\text{C}$)
High pressure Steam	Extraction steam 23 bara, 330 °C <u>(equivalent)</u>	kg/ton _{urea}	577	567
Product quality	Total nitrogen	wt%	46.5	46.6
	Biuret	wt%	0.85	< 0.80



Considerations for pool reactor design

- Dual bundle is integrated in pool reactor
- Design allows corrosive media on shell side and tube side
- Tube sheet and distribution channel are built inside the vessel
- Much thinner tube sheet compared to a conventional pool reactor or pool condenser
- Superior resistant properties of Safurex[®] Infinity steel against corrosion steel fully utilized

Considerations for pool reactor design

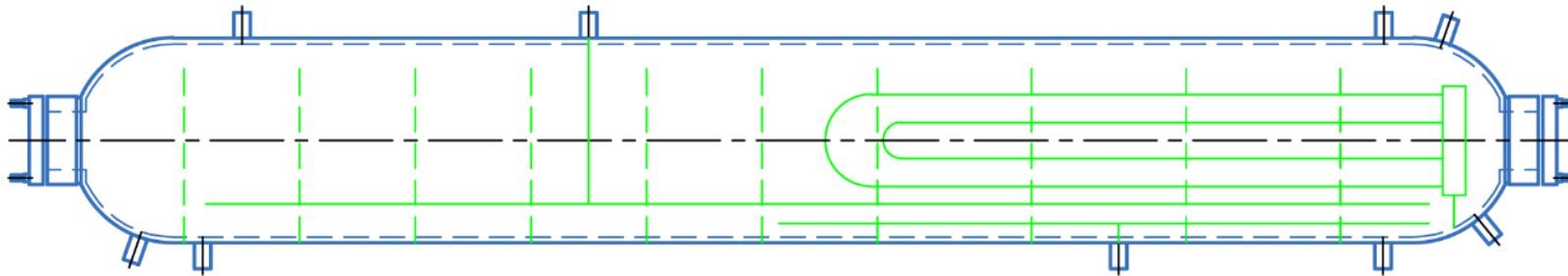


Conventional pool reactor or pool condenser

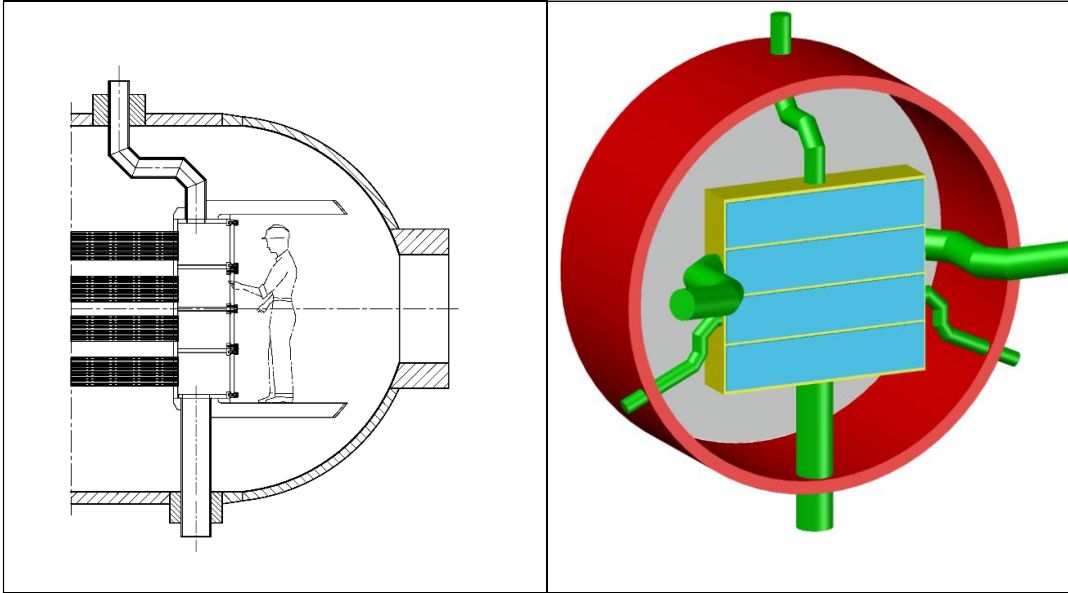
Ultra-Low Energy pool reactor

Considerations for pool reactor design

- All internal components of pool reactor are made from Safurex[®] Infinity steel
- Standard practice for tube-to-tube sheet weld like stripper
- Conceptual lay-out of pool reactor

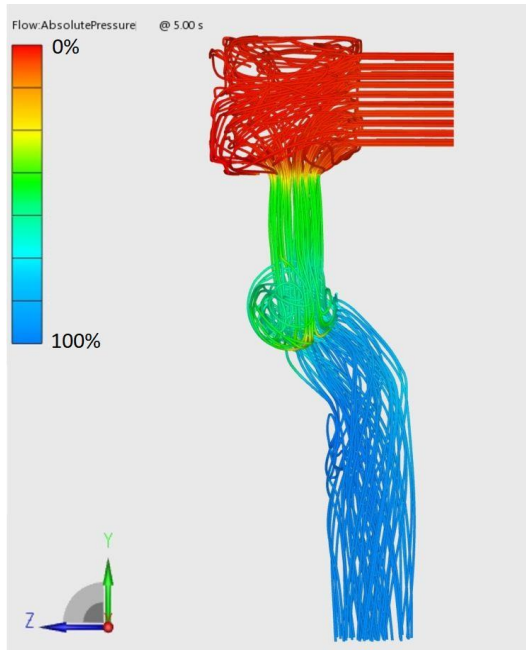


Considerations for pool reactor design



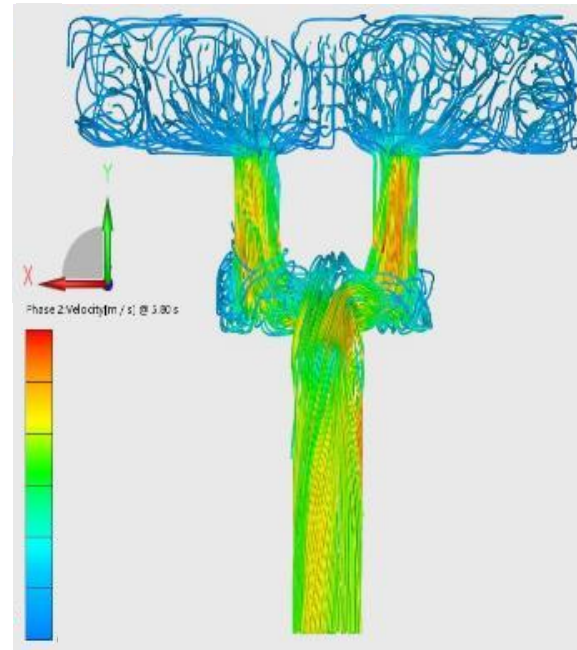
- Internal parts are accessible through manhole by opening internal covers
- Special sealing system on internal covers
- Piping elbows:
 - Bended pipes
 - Segments

Considerations for pool reactor design



Profile for change in pressure

Blue is the lowest value



Relative fluid velocity profile

Blue is lowest value

- Design by rules as per code
- Finite Element Analysis for internal components
- Computational Fluid Dynamics for medium pressure outlet flow

Operational experiences of pool reactor

- Two grass-root plants in China in operation since beginning 2021
- Plants are running stable
- Plant operational staff trained during the pre-commissioning period of the plant
- Risk based inspection program advised for first plant shutdown
- One grass-root plants in China and one in Turkey in manufacturing phase



Operational experiences of pool reactor

First manufactured pool reactor with
dual bundle ready for transport

Conclusions

- Two grass-root Ultra-Low Energy™ plants in China are successfully in operation since beginning 2021
- Actual steam consumption is 567 kg/ton urea and meets the targeted energy savings
- Cooling water consumption is 61 kg/ton urea meets initial requirement
- Lower biuret in the final product compared to traditional process
- Milder stripper operating condition, resulting in longer lifetime
- The Ultra-Low Energy™ process design is fully optimized and requires two synthesis equipment only, for plant capacity up to 2500 MTPD
- Mechanical design of pool reactor is validated by stable operation
- Design fully employs the superior resistant properties of Safurex® Infinity steel against corrosion
- Internal parts like tubes and distribution box are easily accessible for maintenance and inspection

Statement Mr Weipeng

What is your most important benefit of ULE?

1. Lower Steam consumption
2. Lower cooling water consumption
3. Milder stripper operation / longer stripper life time
4. Lower Biuret
5. Operational flexibility

Thank you!