NEXTCHEM

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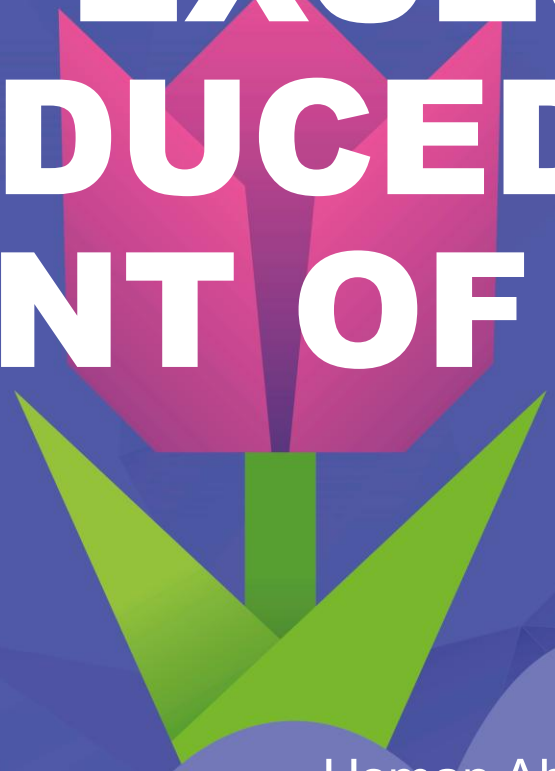
15TH SYMPOSIUM 2026

VALORIZATION OF EXCESS LP STEAM FOR REDUCED CARBON FOOTPRINT OF UREA PLANTS



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AGENDA

01	INTRODUCTION AND INTEGRATION BETWEEN NEXTCHEM AND TECNIMONT
02	UNDERSTANDING LP STEAM BALANCE IN STAMICARBON UREA PLANTS
03	COMMON PRACTICES FOR RE-UTILIZATION OF EXCESS LP STEAM
04	MECHANICAL VAPOR RECOMPRESSION (MVR) OF LP STEAM
05	CONCLUSIONS

01

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INTRODUCTION AND INTEGRATION BETWEEN NEXTCHEM AND TECNIMONT

WE MAKE ENERGY TRANSITION HAPPEN

COMBINING TECHNOLOGICAL LEADERSHIP WITH EXECUTION EXCELLENCE

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NEXTCHEM
MAIRE Sustainable Technology Solutions

Unique portfolio of low-carbon and circular technologies

We enable

TECNIMONT
MAIRE Integrated E&C Solutions

KT
MAIRE Integrated E&C Solutions

Superior execution track record in the downstream segment

We deliver

MAIRE INTEGRATED SERVICES TO CREATE VALUE

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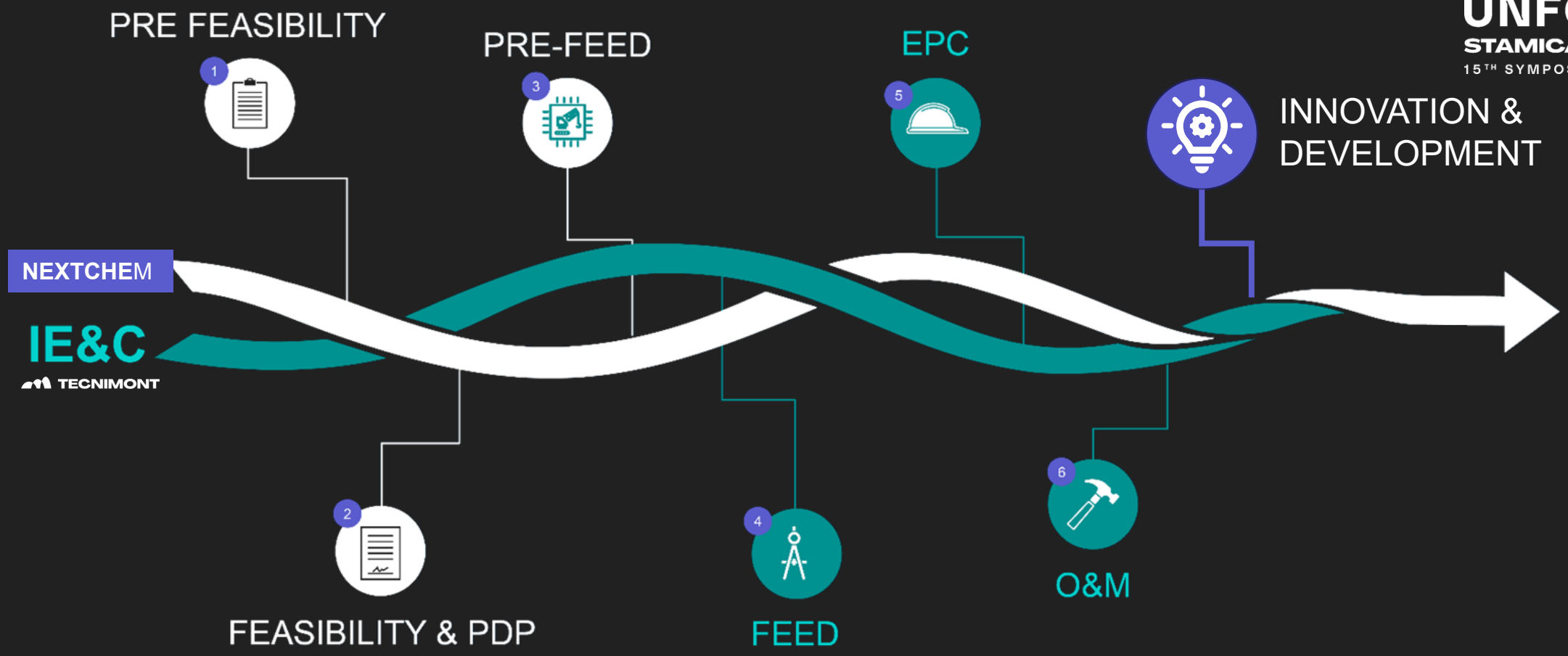

STAMICARBON

INTEGRATION

TECNIMONT

STAMICARBON – TECNIMONT INTEGRATION

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Country: EGYPT
Client: KIMA
Capacity: 1,575 MTPD Urea
Completion: 2019

Country: RUSSIA
Client: VOLGAFERT
Capacity: 1,500 MTPD Urea
Completion: 2022

Country: TURKEY
Client: GEMLIK GÜBRE SAS - YILDIRIM HOLDING
Capacity: 1,640 MTPD Urea & 500 MTPD UAN

Completed -Started up December 2025

02

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UNDERSTANDING LP STEAM BALANCE IN STAMICARBON UREA PLANTS

STEAM BALANCE IN STAMICARBON UREA PLANT

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"High pressure" steam (15 to 25 bar)

High pressure synthesis section

$2\ NH_3 + CO_2 \longleftrightarrow$ Carbamate (Fast and exothermic)

Carbamate $\longleftrightarrow$ Urea + H_2O (Slow and endothermic)

Overall exothermic

Release energy in form of Low pressure (LP) steam (4 to 6.5 bar)

EXCESS LP STEAM??

LP section

Evaporation

Water treatment, ejectors, tracing

EXCESS

WHAT TO DO WITH EXCESS LP STEAM

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- The excess LP steam represents available energy.
- Translates to relatively low temperature steam with temperatures less than 150 °C.
- Due to the low temperatures, plants typically face challenges in utilization of this steam.
- Sometimes condensed against cooling water or vented to the atmosphere.
- Valorize the excess LP steam?

	Pressure	Temperature (saturation)	Specific D enthalpy (1)
Lower value:	4 bar	144 °C	2319 kJ/kg
Normal operation:	4.5 bar	148 °C	2325 kJ/kg
Higher value:	6.5 bar	162 °C	2341 kJ/kg

(1): Δ enthalpy is the difference between the enthalpy of saturated steam and the enthalpy of condensate at 100 °C

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COMMON PRACTICES FOR RE-UTILIZATION OF EXCESS LP STEAM

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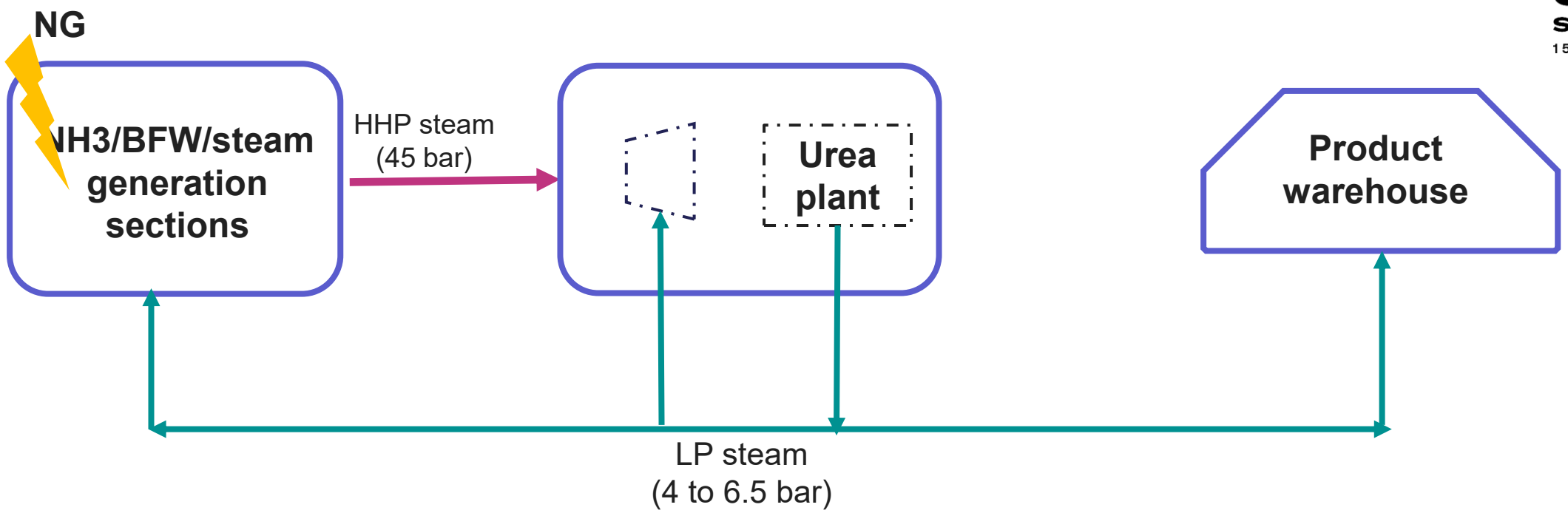

LP Steam to convert thermal energy from steam into mechanical work

- Injection of LP steam into compressor turbine as motive fluid.

LP Steam as Heating Medium for Offsite users

- Evacuation of dissolved oxygen from boiler feed water (de-aerator).
- Heating System for Urea Warehouse.
- Cooling fluidization air of granulation unit

INJECTION OF LP STEAM INTO COMPRESSOR TURBINE AS MOTIVE FLUID

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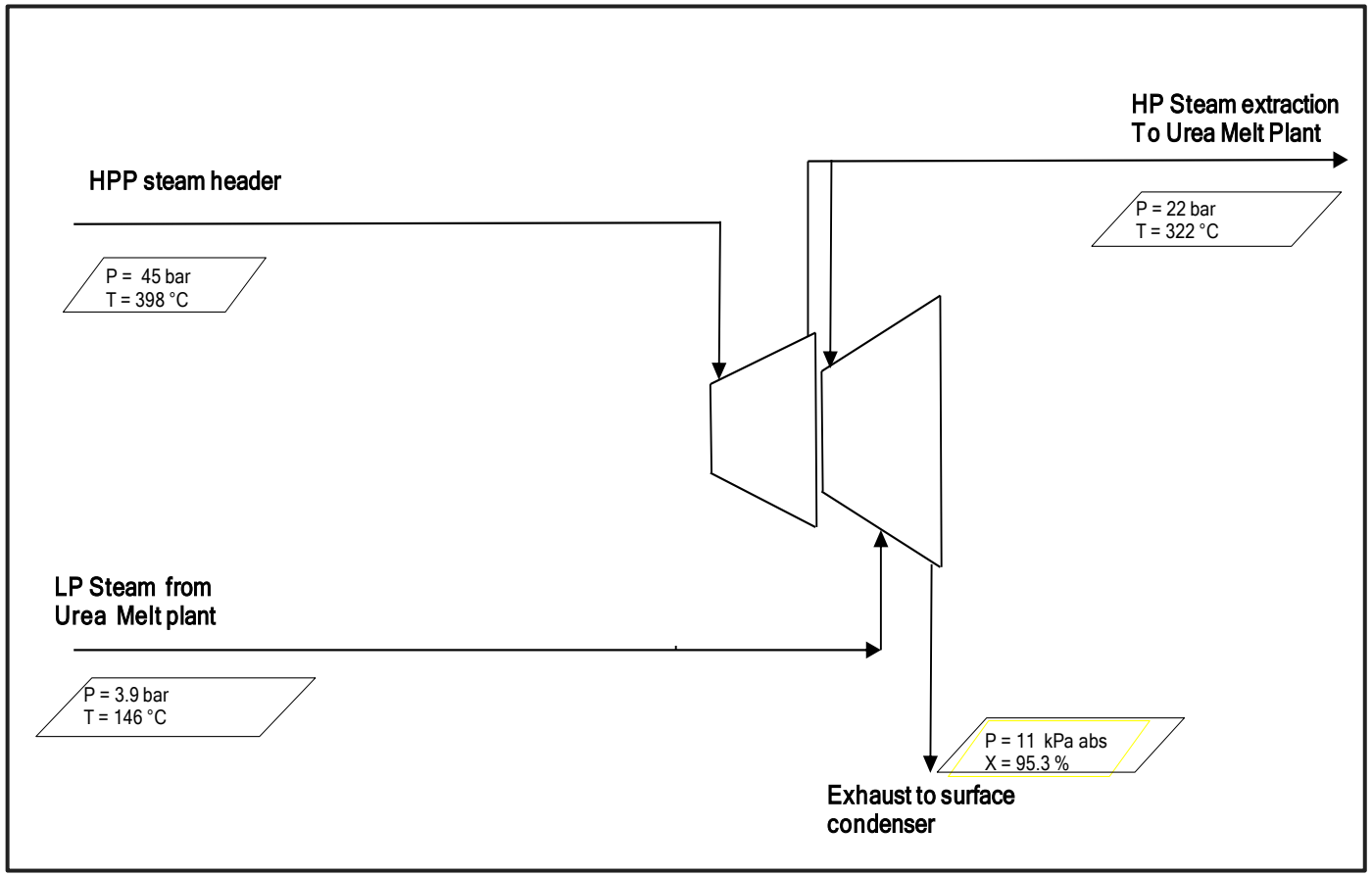
- CO_2 Compressor Driving System
- Driven by extraction-admission-condensing steam turbine.
- HHP steam from ammonia plant at 45 bar and 398 °C.
- HP extraction steam at 22 bar for urea stripping process.
- Excess LP steam at 3.9 bar introduced at lower pressure stage.
- Exhaust steam condensed in water-cooled condenser at 0.11 bar.

Kima Plant



INJECTION OF LP STEAM INTO COMPRESSOR TURBINE AS MOTIVE FLUID

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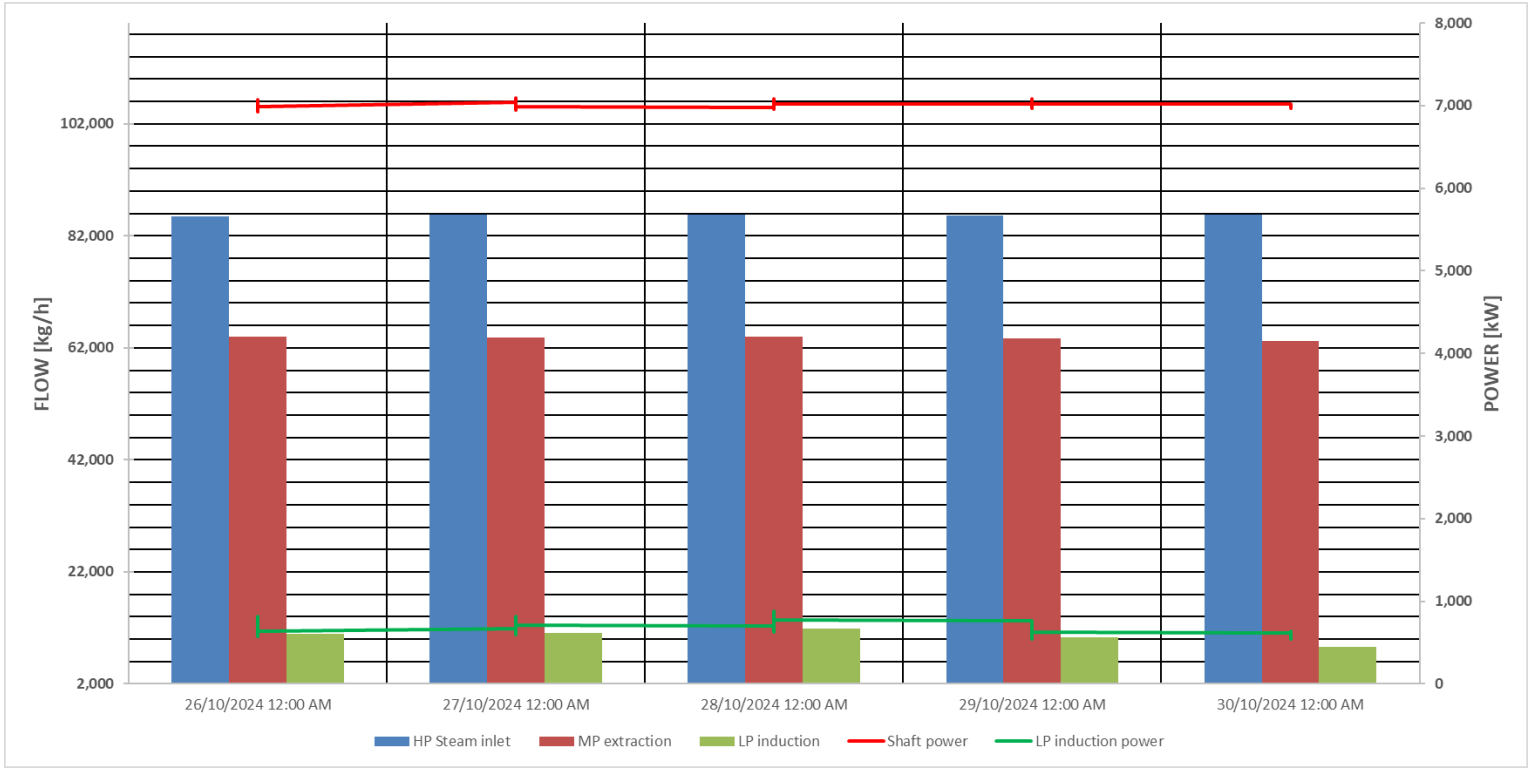
DEMONSTRATION RUN RESULTS

- Four-day trial with 1670 MTPD of urea production
- Power obtained by LP steam injection: 705 kW
- HHP steam inlet reduction (-3.5 t/h)
- Energy saving ~ -0.04 Gcal/t of urea
- Corresponding to ~ -4% overall energy consumption (*)



(*) assuming 0.94 Gcal/t for a conventional Stamicarbon CO_2 stripping

EXCESS LP STEAM CAN BE USED TO SUPPLY HEAT FOR UREA WAREHOUSE

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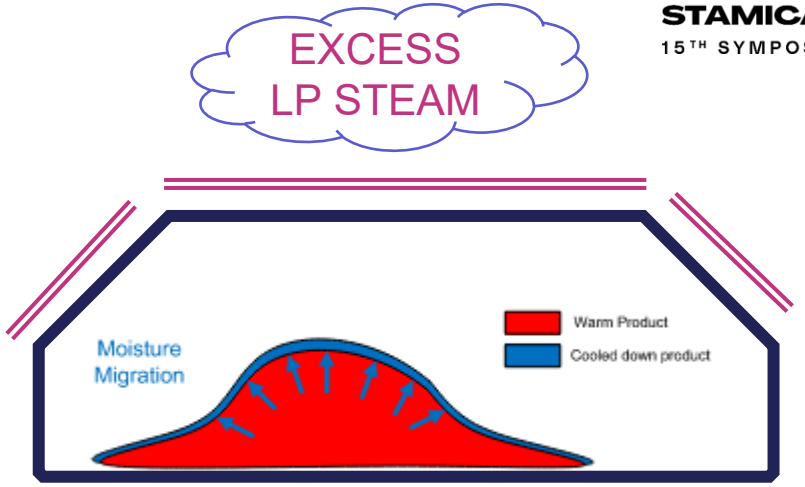
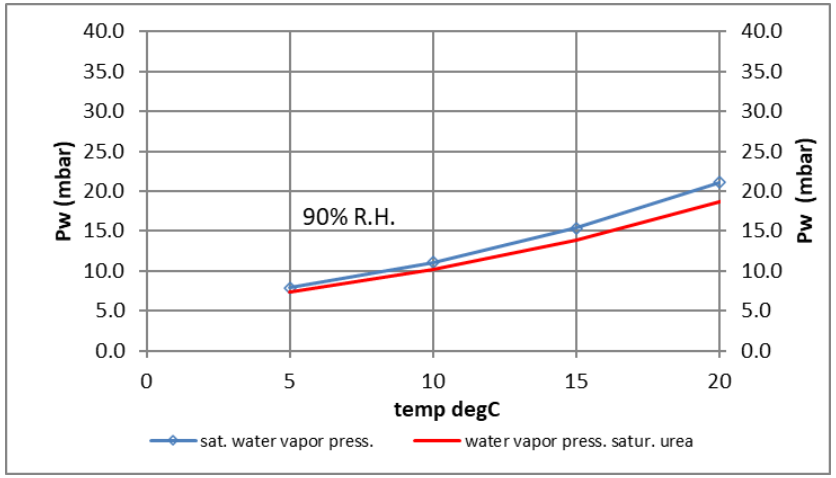
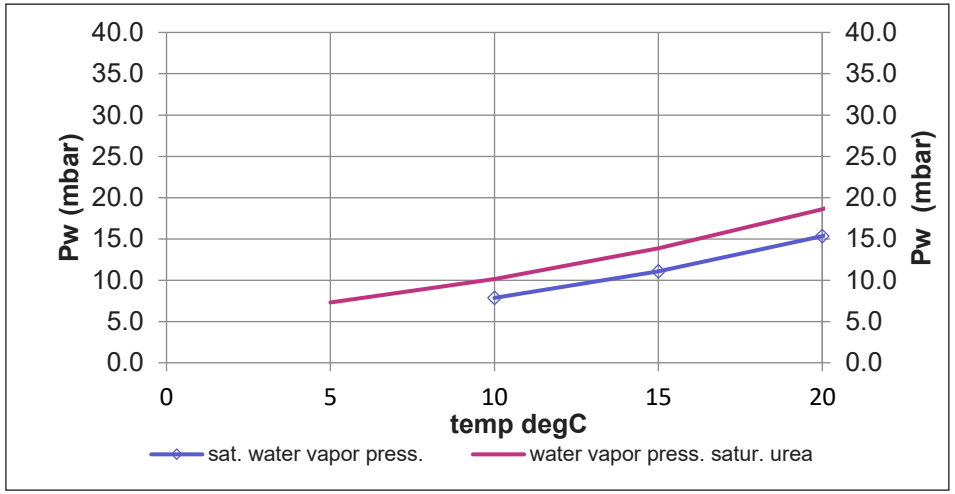
- Normally there is a positive driving force (DPw) favoring water desorption from the warm urea stockpile into the surrounding
- However, in relatively humid or cold conditions, the outer surface of the stockpile is very close to equilibrium, with alternance of sorption/desorption cycles.
- **Heated** environment: Ambient air heated more than 5°C prevents bridge formation.
- Example: **Unheated** environment with 90% humidity and 10°C temperature, conditions close to equilibrium.







EXCESS LP STEAM CAN BE USED TO COOL GRANULATION AIR IN SUMMER

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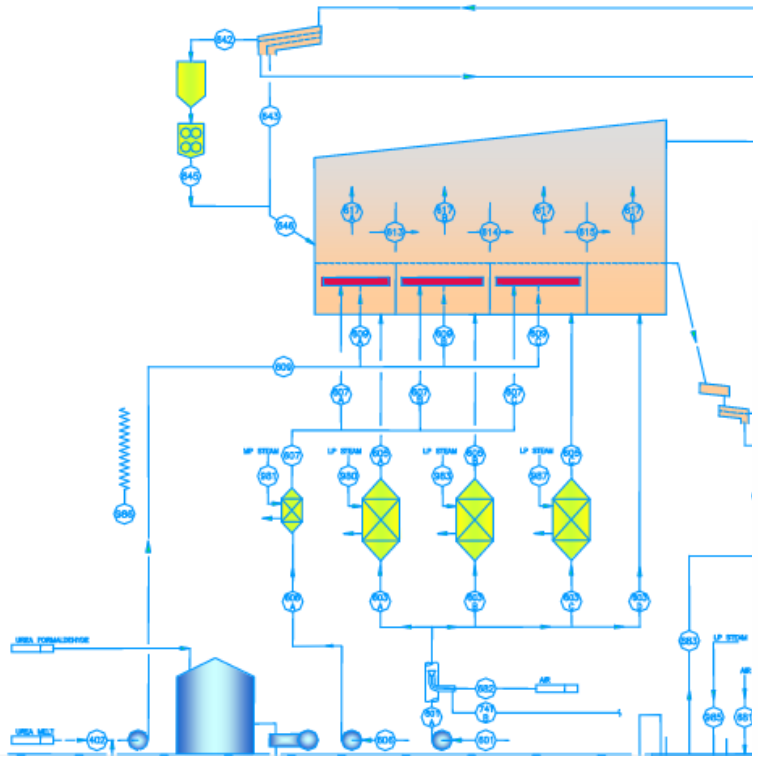
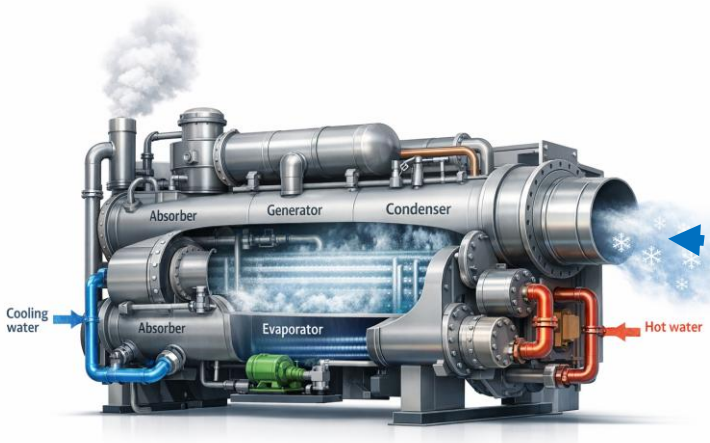
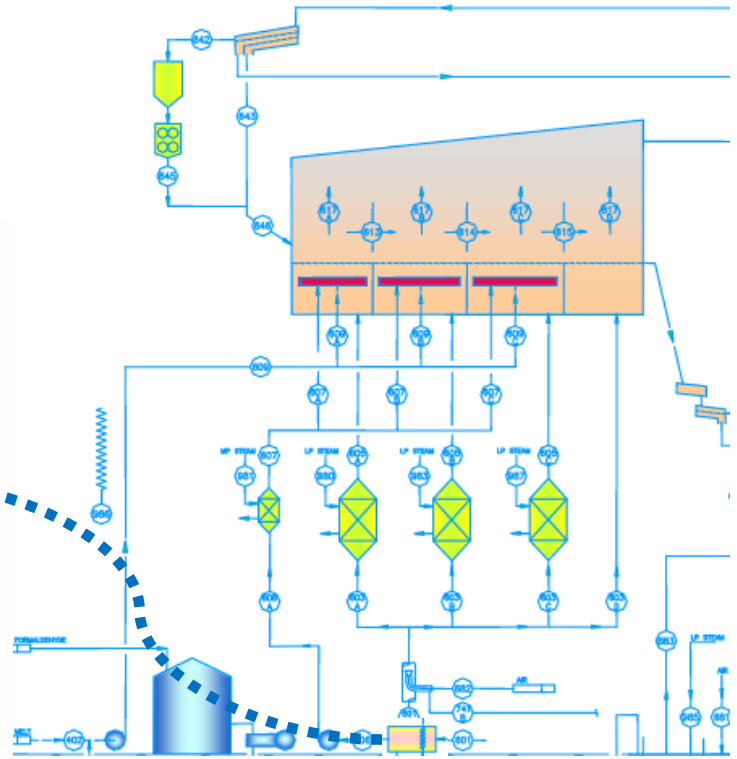
Availability of LP steam in summer season, when there is no need to preheat the granulation air, can be used via adsorption chiller for cooling the granulation air, either to increase capacity or to extend the Granulator running time removing humidity.



EXCESS LP STEAM





MECHANICAL VAPOR RECOMPRESSION (MVR) OF LP STEAM

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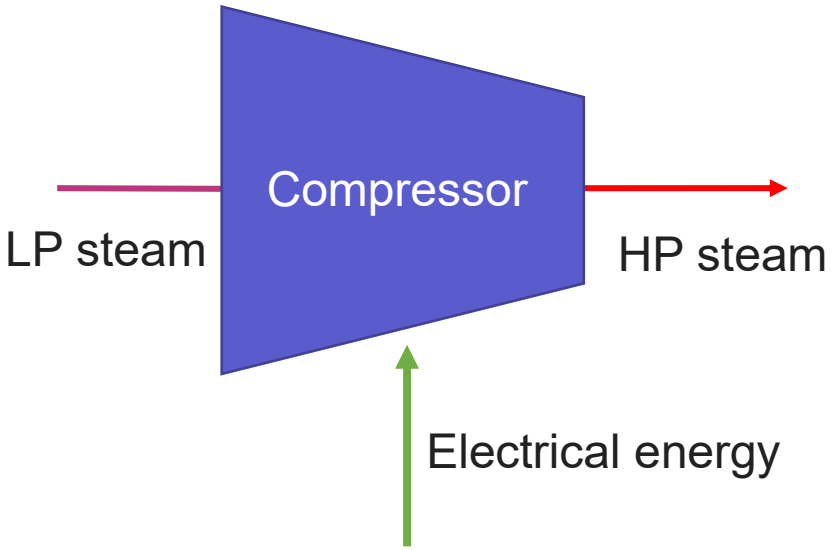


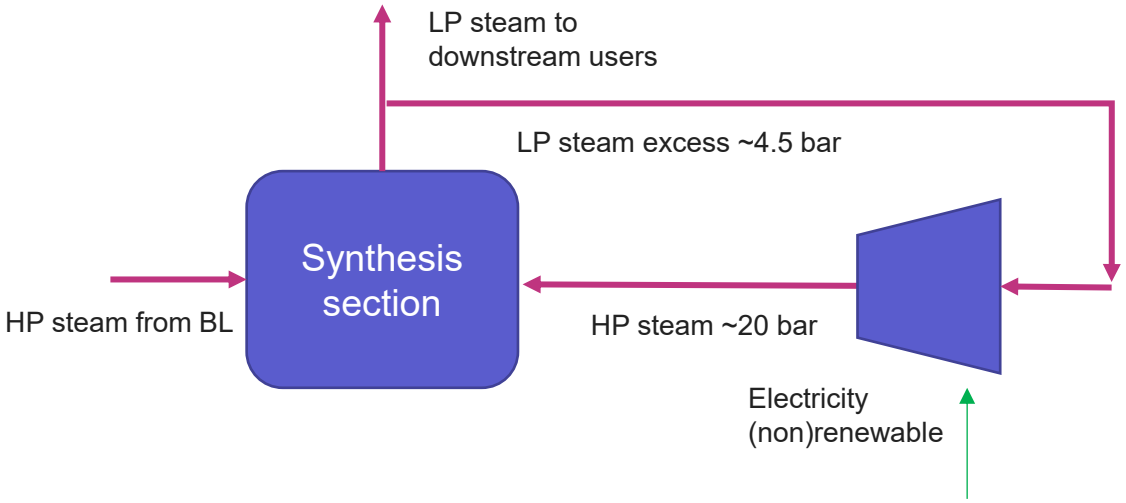
- Adding energy to low pressure vapor by compressing it to a higher pressure.
- Residual heat of LP steam is upgraded by compressing to higher pressures.
- Increased availability of renewable electricity.
- Increased proven technologies from compressor vendors.
- Application in industrial processes such as paper [1], food[2] and petrochemicals[3].

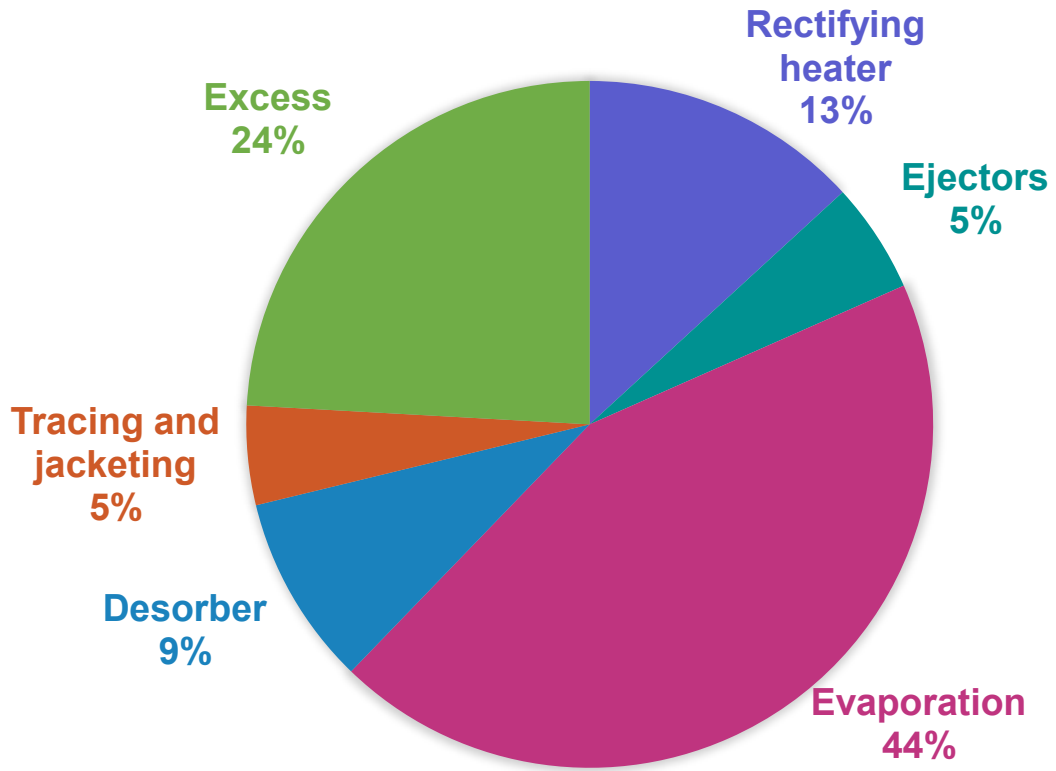
[1] “Steam compressor for steam recycling at pulp drying with pressurized superheated steam dryer (PSSD)”, www.heatpumpingtechnologies.org/annex58/

[2] “MVR (Mechanical Vapour Recompression) Systems for Evaporation, Distillation and Drying”, Energy efficiency and conservation authority.

[3] “Breakthrough in steam recycling”, PortNews 2020 Issue 2

MVR IN TRADITIONAL STAMICARBON CO_2 STRIPPING PLANT





MVR IN TRADITIONAL STAMICARBON CO_2 STRIPPING PLANT

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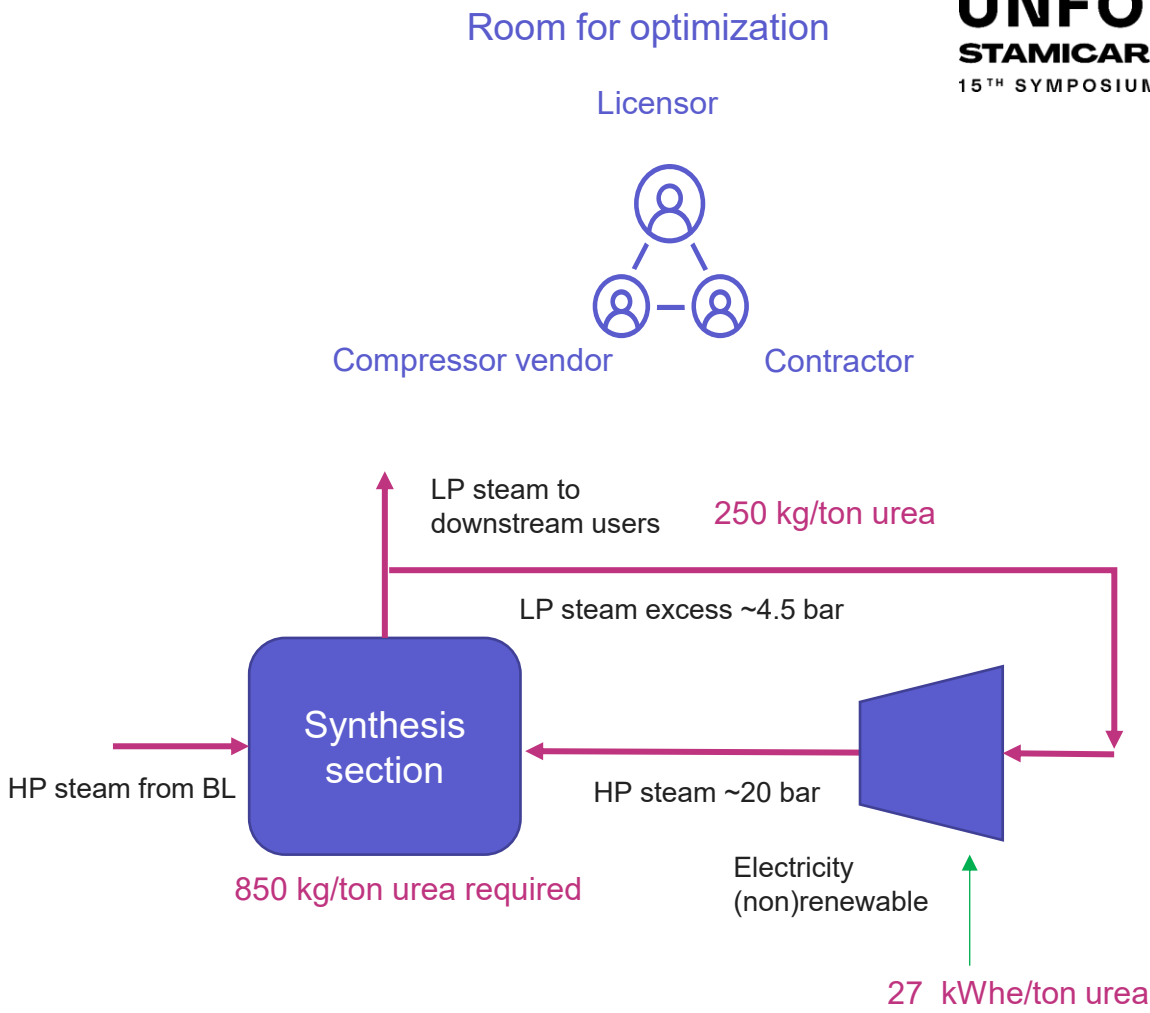
FOR A 2000 MTPD UREA PLANT

- Most plants in the world are traditional plants (without new generation energy integrations).
- Equivalent HP steam requirement (kg/ton urea) reduction.
- Represents an energy saving of almost 10% for a traditional Stamicarbon CO_2 stripping urea plant (including CO_2 compressor).



POTENTIAL OF MVR IN UREA PLANTS

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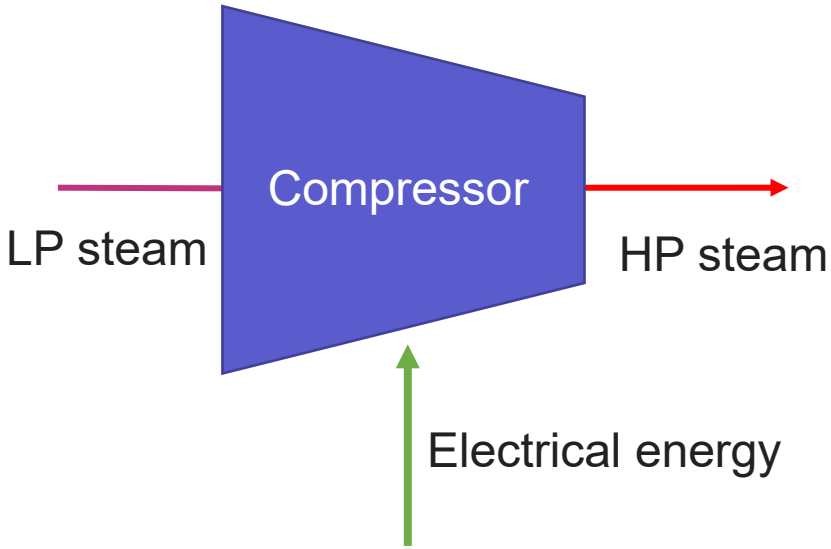
- Enhanced usability of LP steam
- Reduced need for HP steam import
- Minimized consumption of carbon-based fuels
- Solving HP steam bottlenecks in steam deficient urea complexes
- Use cases in sites with CO_2 capture/recovery technology and ammonia from modular sources/green ammonia



POTENTIAL OF MVR IN UREA PLANTS

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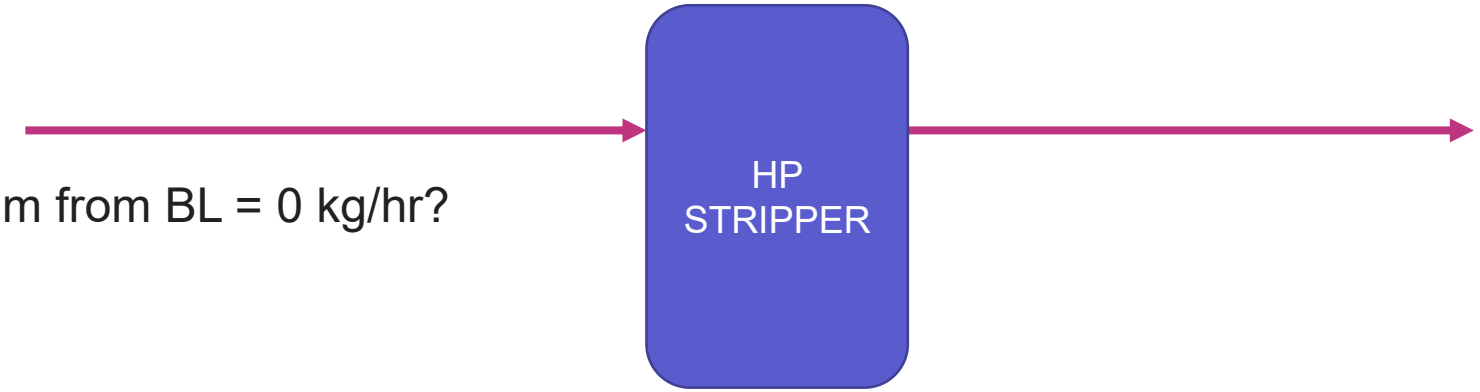
QUESTION ?

- Does the urea process produce enough LP steam to fully satisfy the stripper consumption?



- ULE process with low concentration urea product such as DEF.
  - YES with some modifications.

EVALUATION

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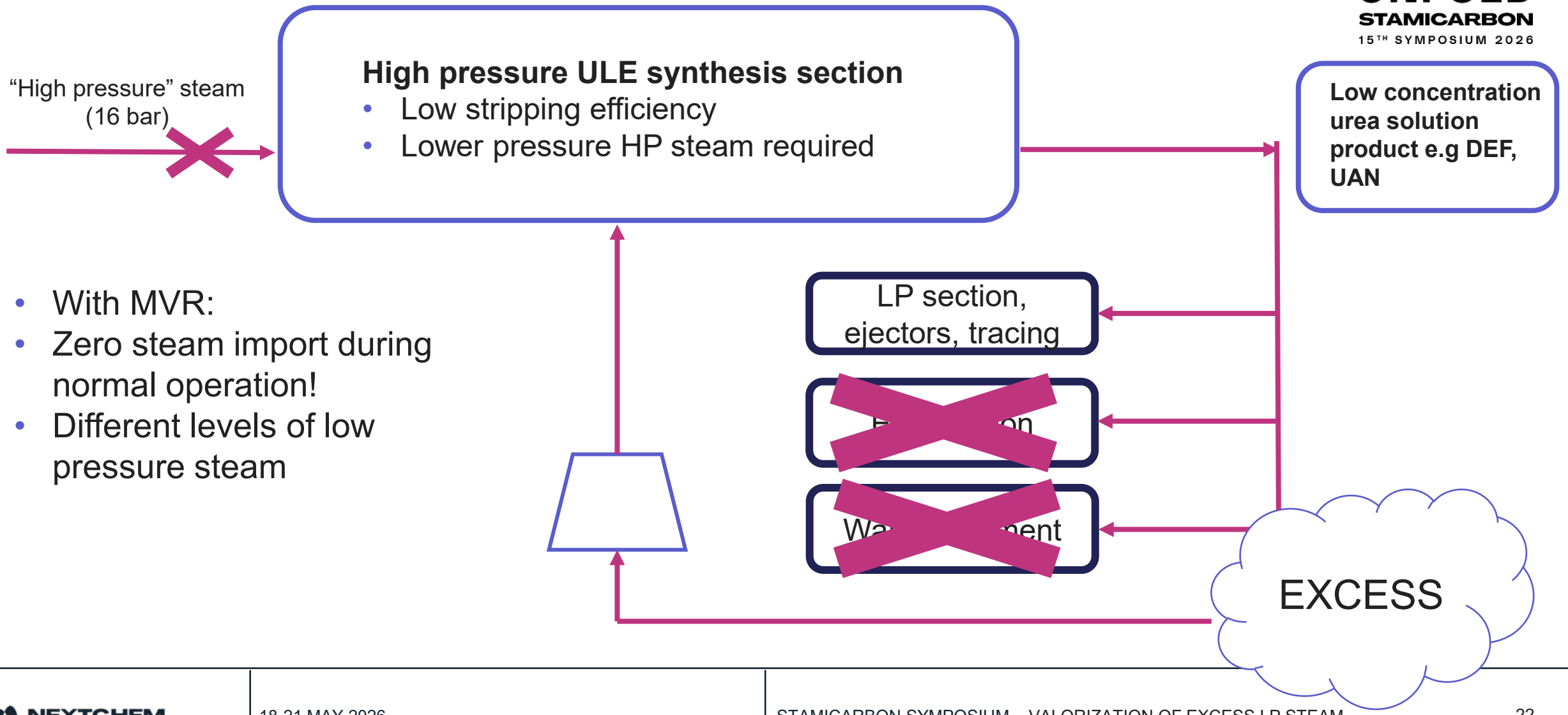

- With MVR:
- Zero steam import during normal operation!
- Different levels of low pressure steam

PROCESS DESCRIPTION ULE DESIGN

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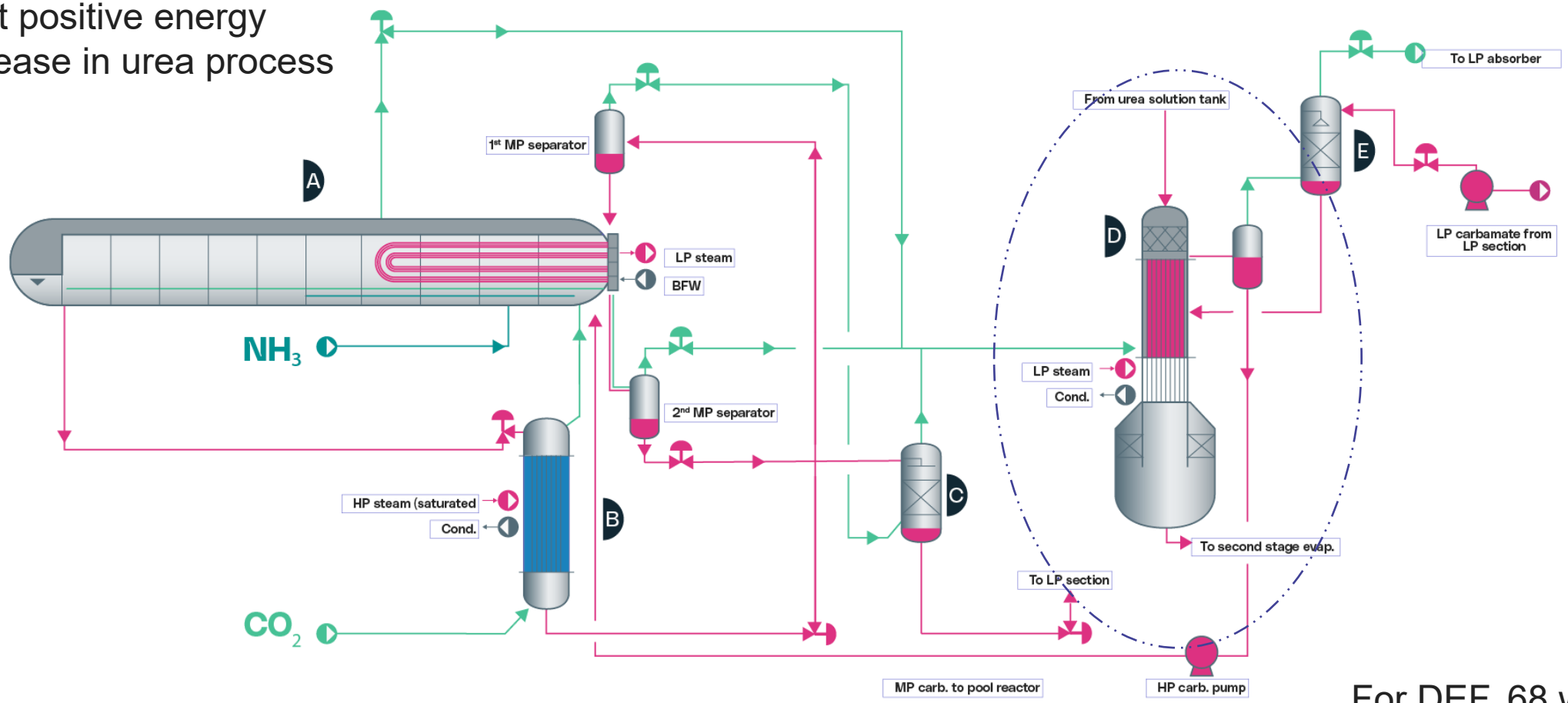
Net positive energy release in urea process



- A | Pool Reactor
- B | Stripper
- C | MP rectifying column
- D | First stage evap. / MPCC
- E | MP absorber

For DEF, 68 wt% urea solution sufficient

PROCESS DESCRIPTION ULE DESIGN

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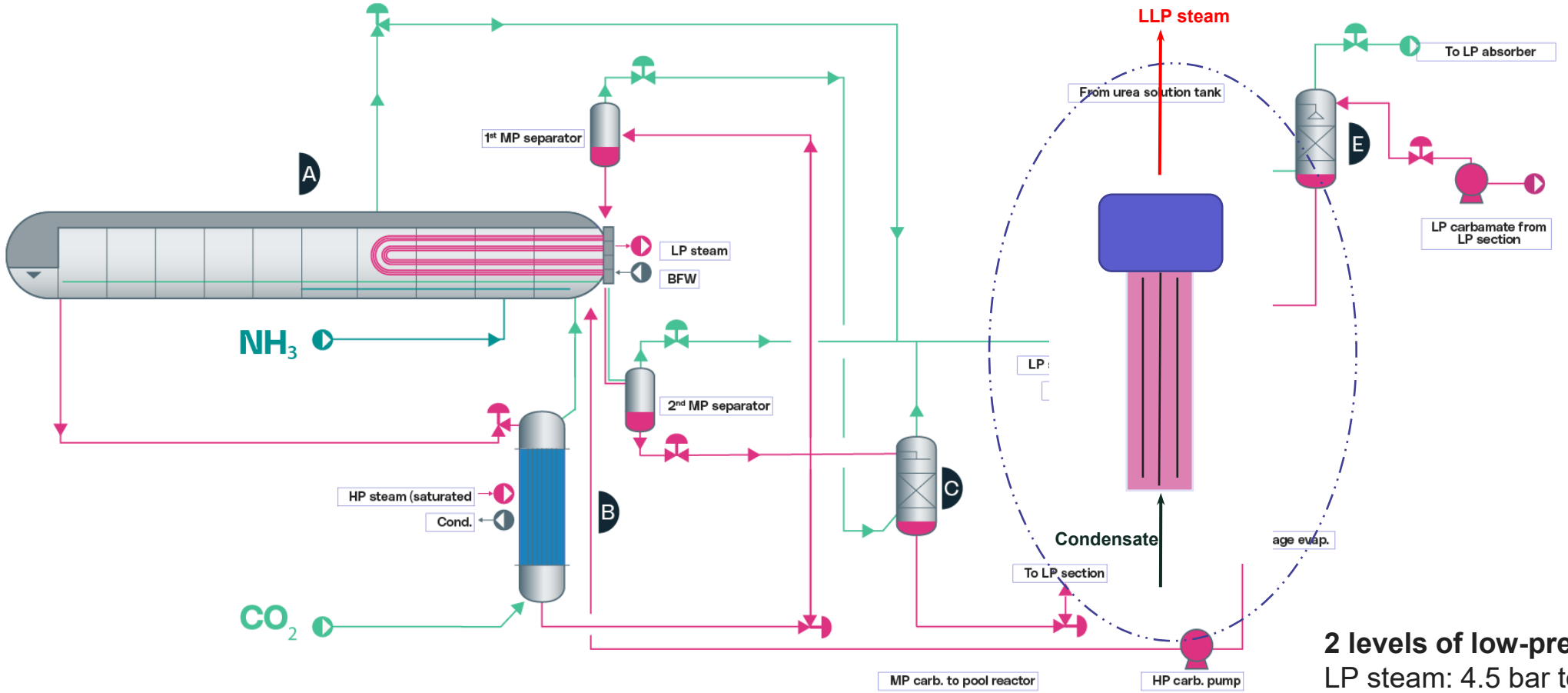
MP carbamate is condensed against steam condensate to generate LLP steam (~1.7 – 2 bar)!



- A | Pool Reactor
- B | Stripper
- C | MP rectifying column
- D | First stage evap. / MPCC
- E | MP absorber

2 levels of low-pressure steam:
LP steam: 4.5 bar to users
LLP steam: (1.7 – 2 bar) to MVR

CASE STUDY 1500 MTPD UREA:

STEAM SYSTEM

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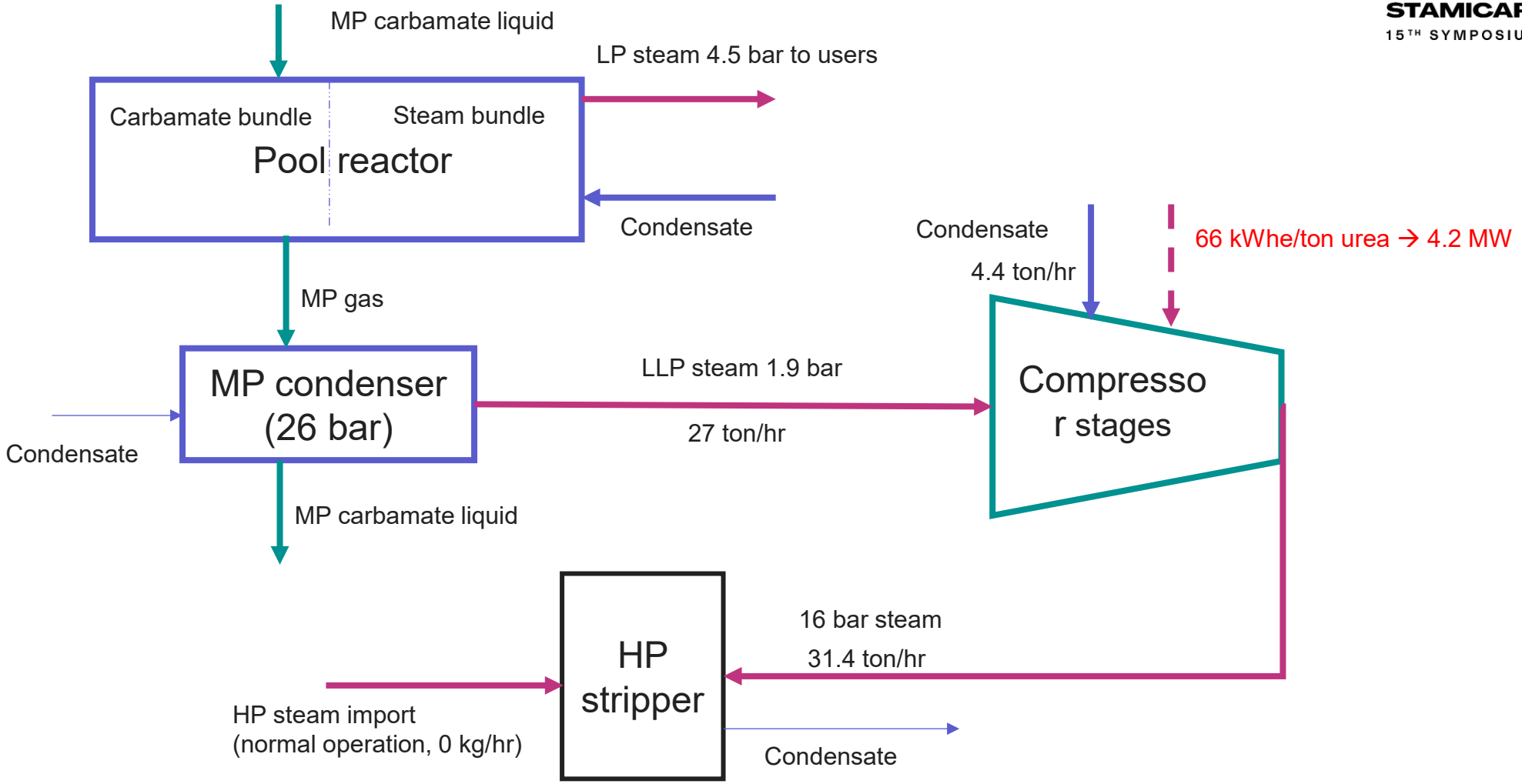

SOME DESIGN CONSIDERATIONS

ULE PROCESS WITH DEF PRODUCT

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- **Minimize LP steam users:** Eliminate wastewater section and evaporation section. Low concentration urea solution product (DEF).
- **Minimize stripper steam consumption:** Lower stripping efficiency (60%)
- **Optimize pressure of LLP steam generated in MPCC (1.7 - 2 bar).** Higher MP section pressure (26 - 30 bar).
- **Multistage electrical compression.** Steam compression technology is available at vendors.

SOME NUMBERS

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Most applicable to countries in demand of DEF, with high HP steam price, low (green) electricity price, and high carbon tax

Rough Calculation.	Cost (Typical)	Cost ($/Hour)	Savings ($/Yr)
Electrical steam compression	60$ per MWh	250	
Boiler (low case)	4$ per million Btu (1 Gcal = 4 million Btu) → 16$ per Gcal	-304	**432,000**
Boiler (high case)	8$ per million Btu (1 Gcal = 4 million Btu) → 32$ per Gcal	-608	**2,864,000**

Steam compressor power consumption per ton urea product:

66 kWh/ton urea

(80% polytropic efficiency)

Total power consumed by the steam compressor about

4.16 MW

Compared to a natural gas fired boiler for equivalent HP steam amount:

19 Gcal/

KEY BENEFITS

BY ELIMINATING HP STEAM IMPORT DURING UREA PLANT OPERATION, IT IS POSSIBLE TO:

- Reduce the carbon footprint of the urea plant by applying renewable electricity.
- An alternative way to produce DEF. Can be further optimized for a solid urea product
- Integrate a urea plant to a green ammonia complex with CO_2 from a grid or carbon capture unit.
- Reduce the operating costs of the urea plant depending on the costs of (renewable) electricity in the area.

05

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CONCLUSIONS

CONCLUSIONS

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- Excess LP steam = value. Enhanced energy efficiency.
- LP steam as motive fluid for turbine drivers has demonstrated substantial energy savings (-4%).
- LP steam for heating application, de-aerators, warehouse heating, granulator air cooling.
- MVR enhances LP steam usability and reduces need for additional HP steam generation in traditional CO_2 stripping plant (energy savings up to 10%).
- MVR application can allow for zero HP steam import from battery limit during normal operation for solution-based product such as DEF.
- MVR facilitates reduction on the reliance on carbon-based steam boilers and enables the transition to renewable electricity sources.
- This hints a potential for a broader application of steam MVR in the fertilizer industry.
- Urea plants can contribute to more sustainable and environmentally friendly operation.

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THANK YOU

QUESTIONS?