KBR-JM
MeOH+NH_3 Co-production

Johnson Matthey
Inspiring science, enhancing life

KBR

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- KBR + JM Introductions
- Grass Roots Co-Production
- Q&A

Proud history, bright future.

KBR Global Leader in Ammonia

KBR

- US$5.8bn Revenue 2020, 29000 employees, 80+ Countries
- Licensed 244 grassroots ammonia plants since 1944, 44 since 2000
- Half of world's ammonia produced by KBR process
- Every major ammonia technology and scale leap successfully delivered by KBR

Why KBR

World's largest ammonia plant with a single converter 2,890 tpd (currently operating over 3,000 tpd), EuroChem, Russia

World's Most Energy Efficient Ammonia Plant 6.27 Gcal/ton, Chambal, India

World's Most Reliable Plant – 2,162 consecutive days in operation (almost 6 years) at Yara, Netherland

JM Global Leader in Methanol

JM

- £4.2 billion* revenue, 15000 employees worldwide with a global footprint
- Licensed over 100 grassroots methanol plants
- >60 million tpa of methanol licensed using JM technology

Why JM

World's leading technology

Portfolio of methanol technology to meet project requirements

World's leading catalysts

Premier catalyst used globally by the leading methanol producers

World's largest operating methanol plant

6,600 mtpd Baofeng, China

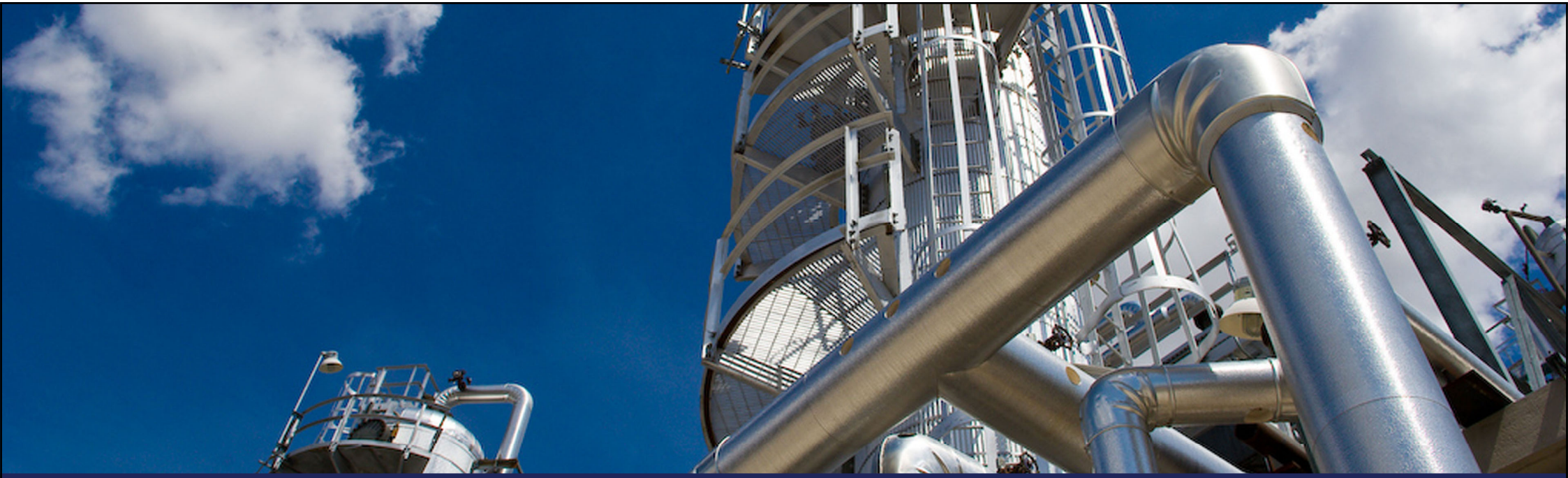
* Excludes precious metal sales

World leaders in their field

KBR and Johnson Matthey (JM) have partnered to combine their respective market-leading ammonia and methanol technologies to offer new ammonia-methanol co-production solutions for new grassroot plants and modification of existing plants.

- The co-production scheme for new grassroot plants is based on
  - **JM SMR methanol** technology and
  - **KBR Purifier™ ammonia** technology
- **Single train** up to 6,800 MTD $MeOH+NH_3$
- Both technologies are industry leaders and **well-proven with highest reliability** in the market:
  - **13 days more online** time per year of KBR Purifier plants
  - **9 days more online** time per year of JM Methanol plants

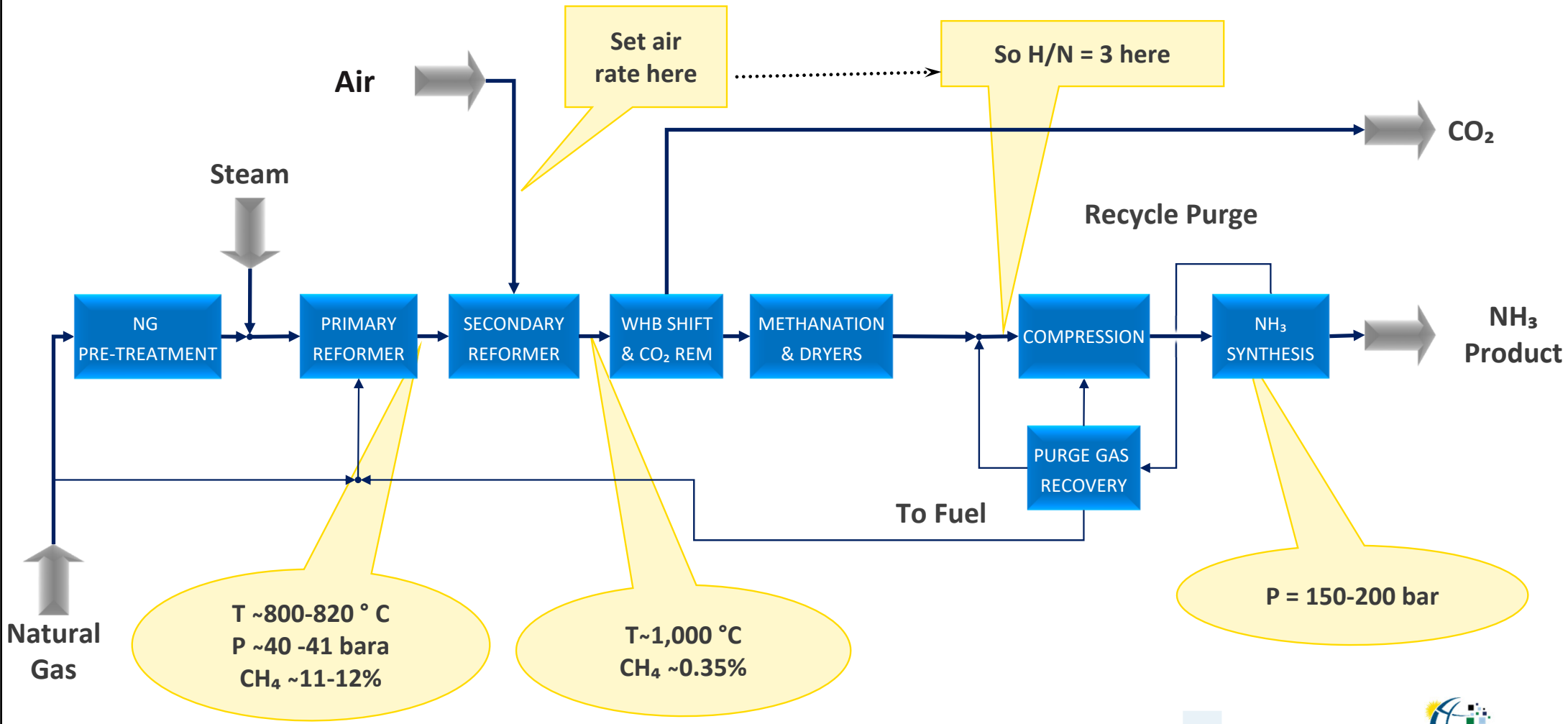
Proud history, bright future.



KBR Ammonia Unit

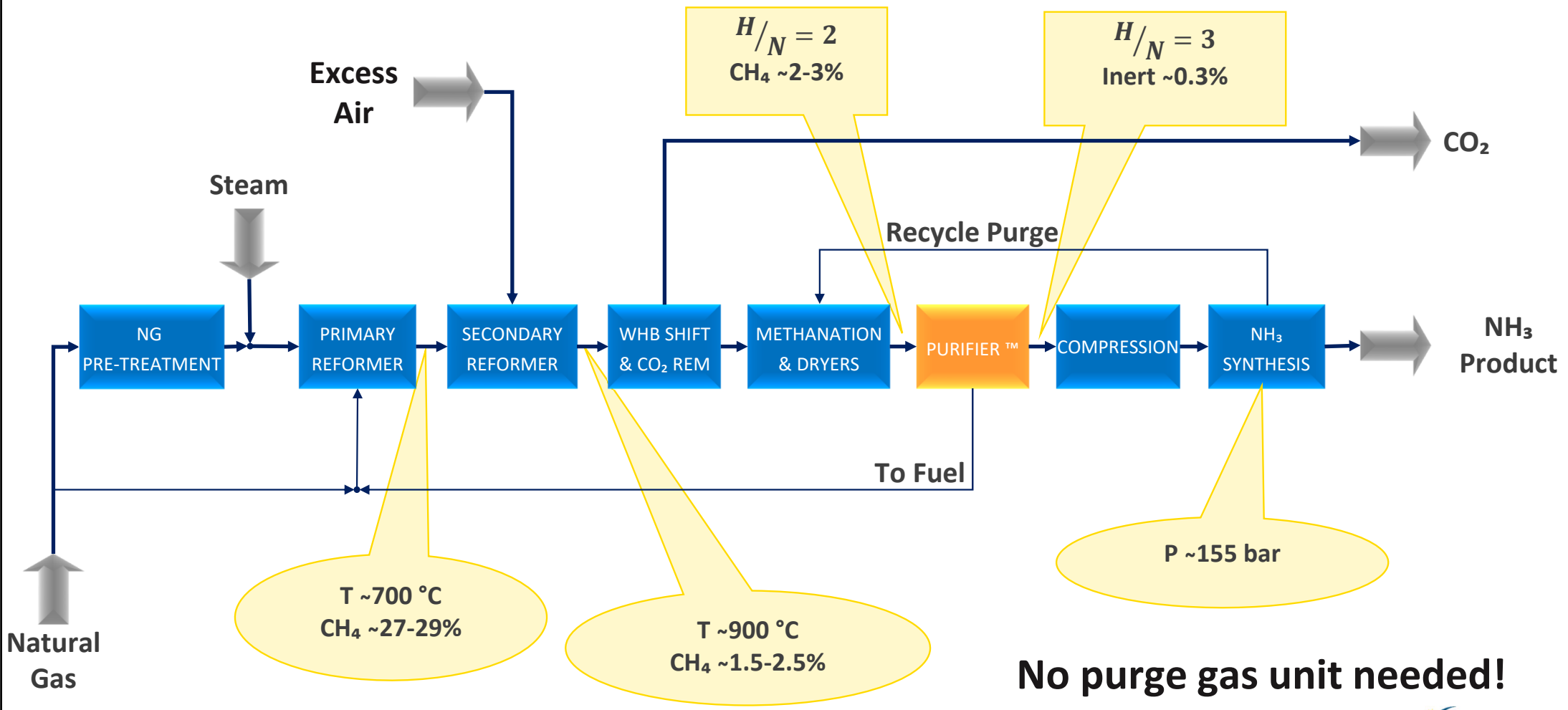
Process Overview and Key Equipment

Conventional Ammonia Process



Proud history, bright future.

KBR Purifier™ Process



No purge gas unit needed!

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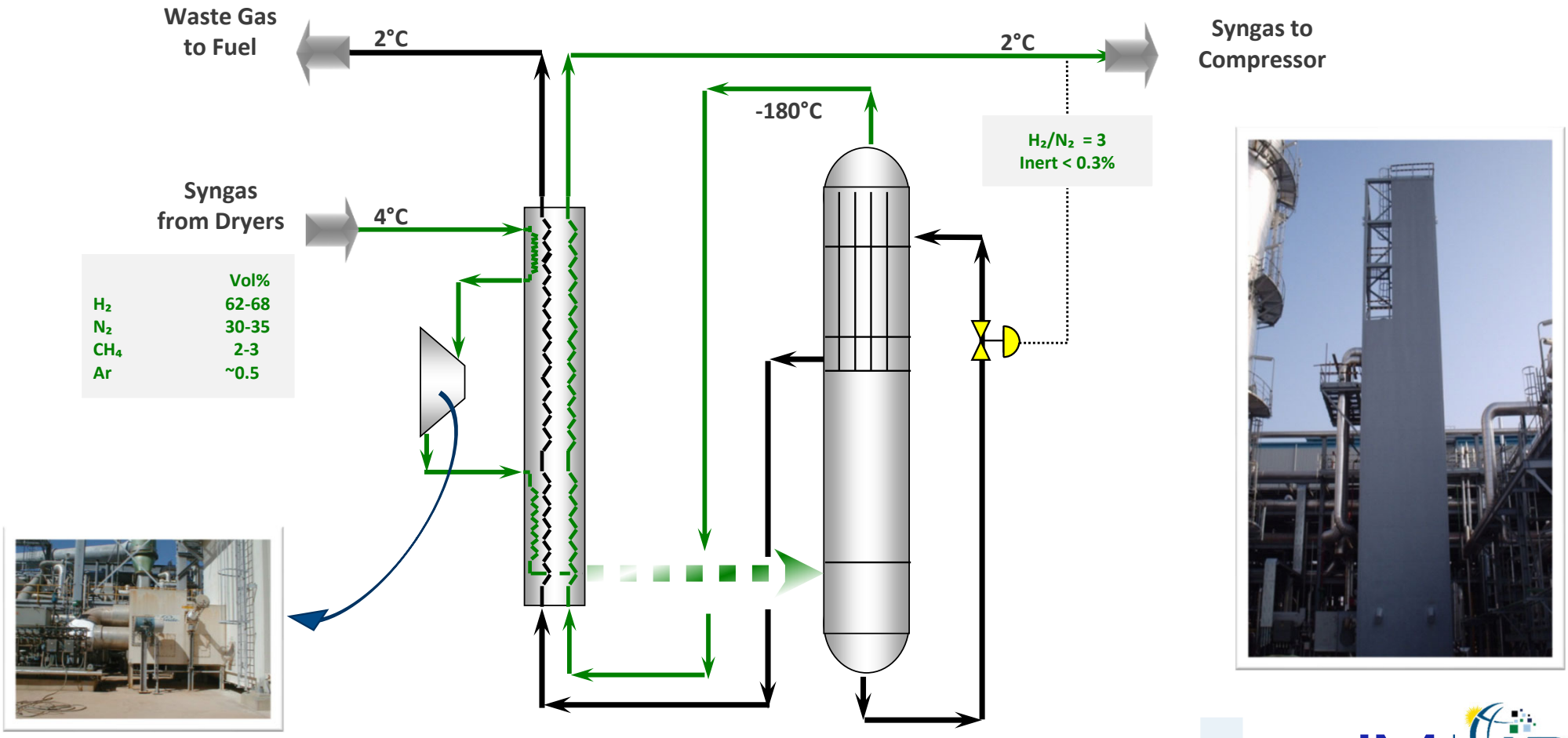
KBR Cryogenic Purifier™



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KBR Purifier™ Ammonia Process - Summary

- It utilises the proven concepts of:
  - Mild (low temperature) Primary Reformer – reduced load and CAPEX
  - Secondary reformer with excess of air and no metallic burner
  - Vertical thermosiphon waste heat boiler
  - CO_2 removal with aMDEA process
  - Cryogenic purification of syngas
  - Reduced equipment count in the SynLoop
  - Cold wall horizontal ammonia converter
- No separate purge gas – hydrogen recovery system not required
- Recent major achievements:
  - CFCL #3 : 2,200 MTD, 6.27 Gcal (LHV)/mt of ammonia (warm), Jan 2019 – new lowest in the world
  - Eurochem Kingisepp: 2,890 MTPD – world's largest single stream in operation, Apr 2019
  - Lukoil Ammonia Plants: 3,300 MTPD with 10% margin (3,630 MTPD), award Aug 2019
  - KBR can now offer 6,000 MTD in one single stream (single cold wall horizontal converter)

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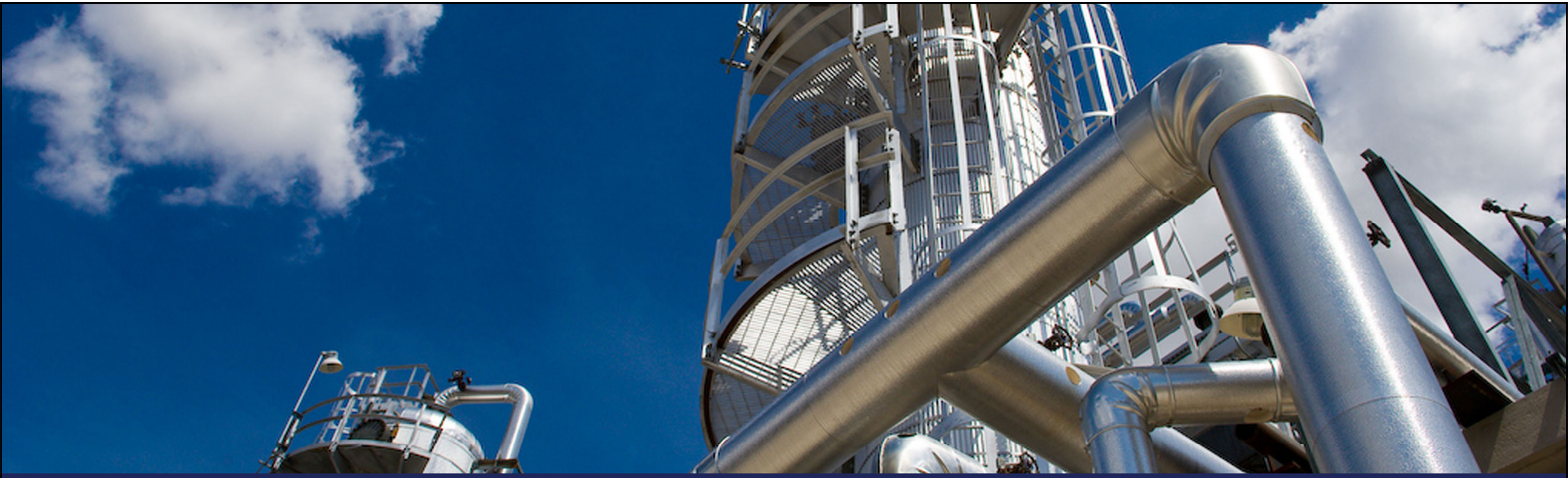
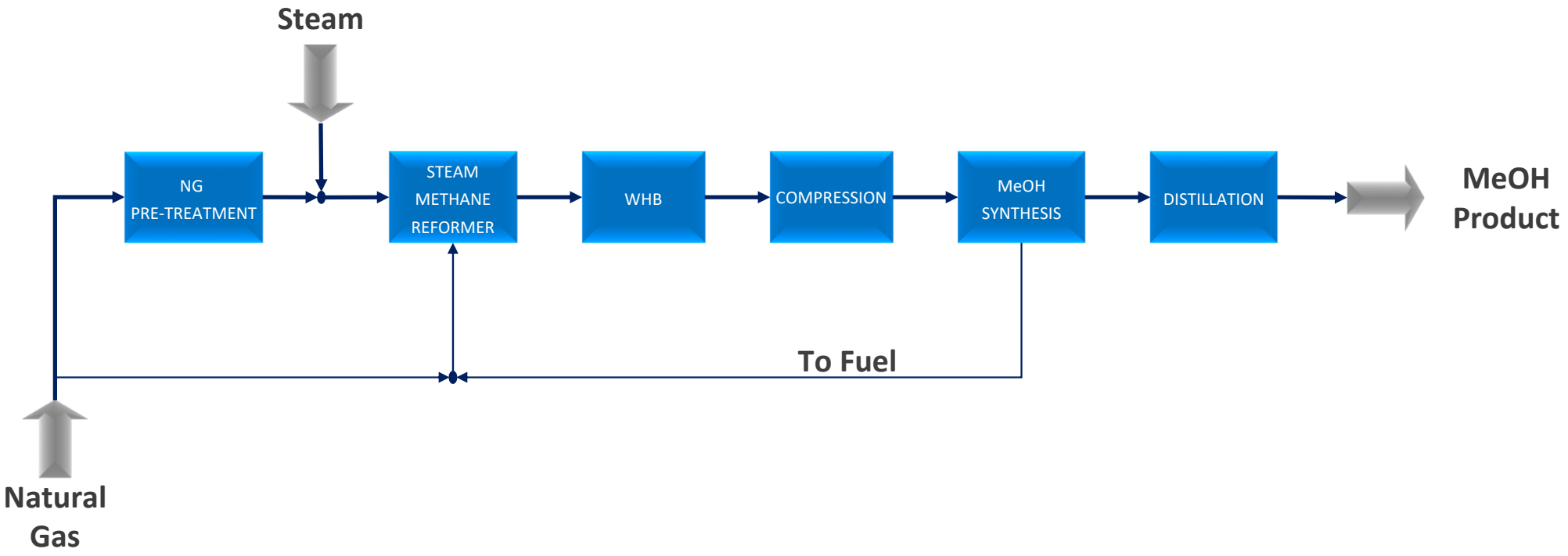


JM SMR Methanol Unit

Process Overview and Key Equipment

JM SMR Methanol Unit



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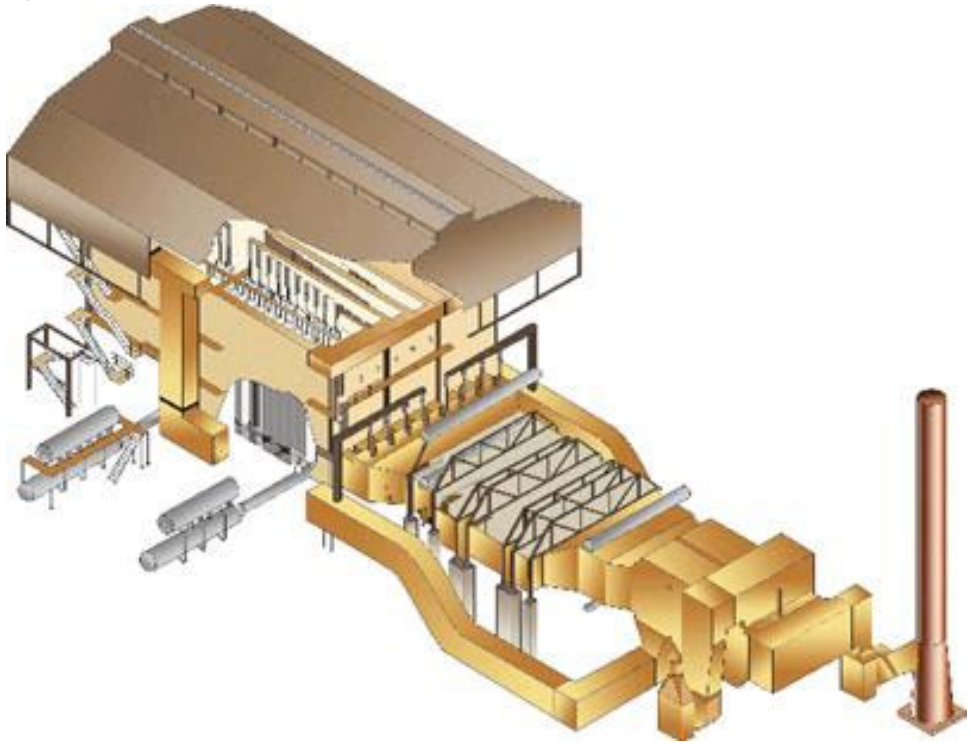
JM Steam Methane Reformer (SMR)

The key features of the **JM** reformer are as follows;

- Down fired down flow reformer
- Tubes supported by spring hangers – low cost reliable method
  - Refractory lined outlet collector
  - Proven reformed gas boiler design
  - Simple horizontal duct – low cost
  - Fixed plate air preheater – proven design
  - Turbine driven combustion air and flue gas fans for maximum reliability



All these feature are built into a single reformer structure which is pictured

JM Methanol Synthesis Loop

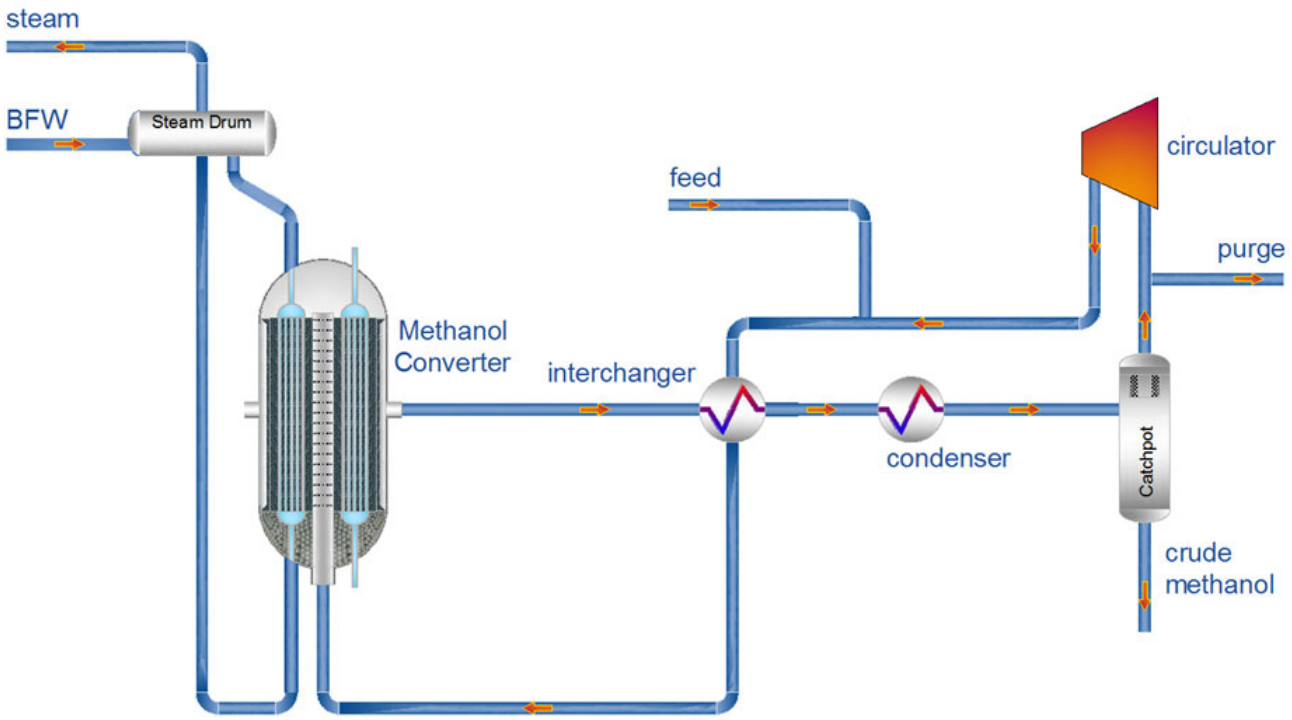
High conversion efficiency

- Consistent Methanol Production between BOL and EOL
- Smaller Reforming Unit

Largest methanol production per single reactor

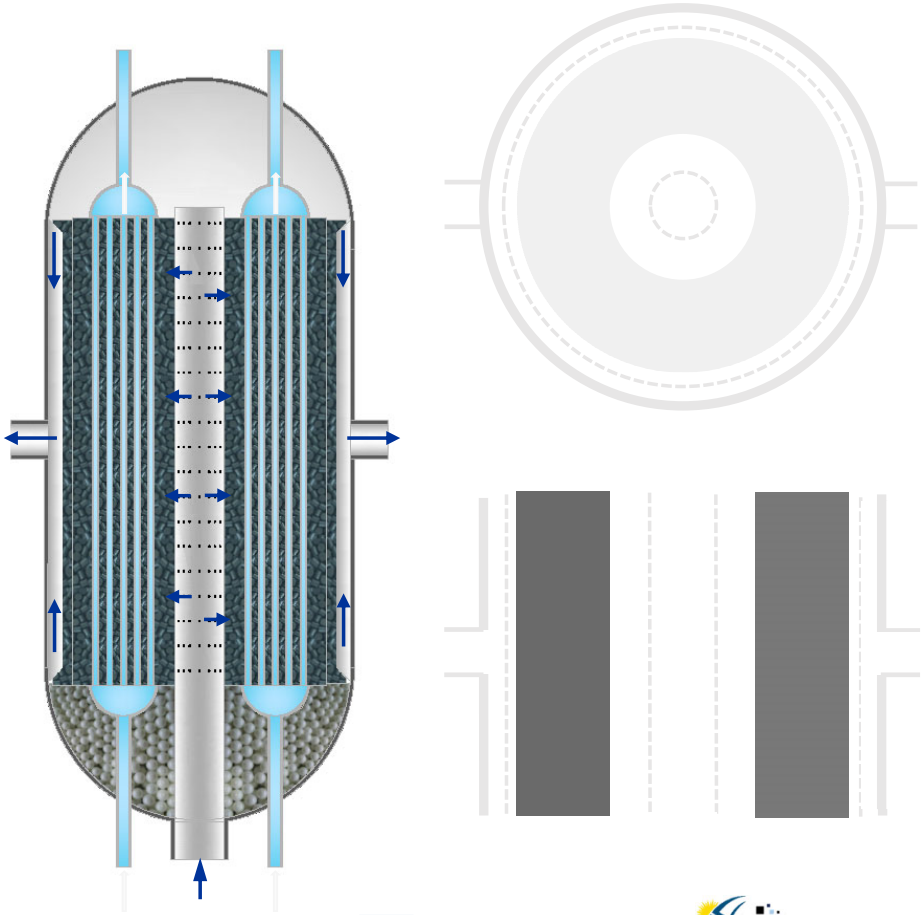
- Minimum number of Reactors – Reduced Capex

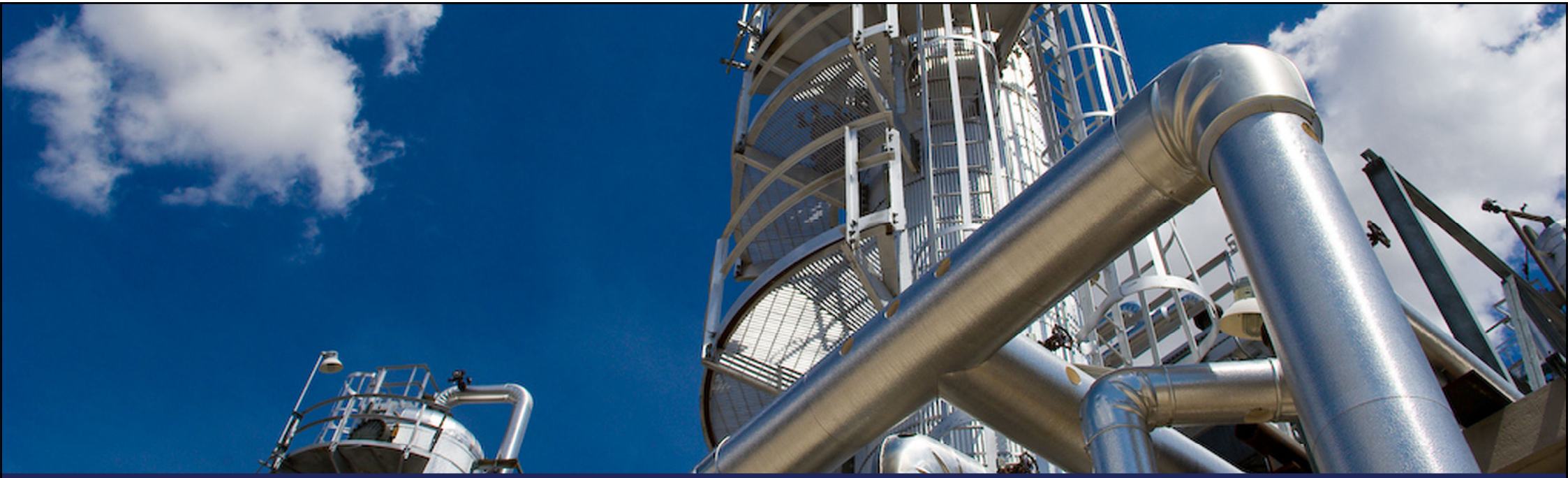
Flexibility to import CO_2 to make more methanol at a reduced ammonia make



JM Radial Steam Raising Converter Features

- Radial flow reactor
  - Gas flows from inside to out
  - Low pressure drop through the bed
- Catalyst on the shell side
  - Higher catalyst capacity and easy loading
  - No tube sheet
  - Less metal – lower cost
- Catalyst bed temperature intimately controlled by controlling steam pressure
  - Near isothermal temperature profile
    - High loop efficiency
    - Long catalyst life
    - Low catalyst cost
- Materials of Construction
  - Typically Low Alloy
  - No requirement for Duplex Stainless Steel

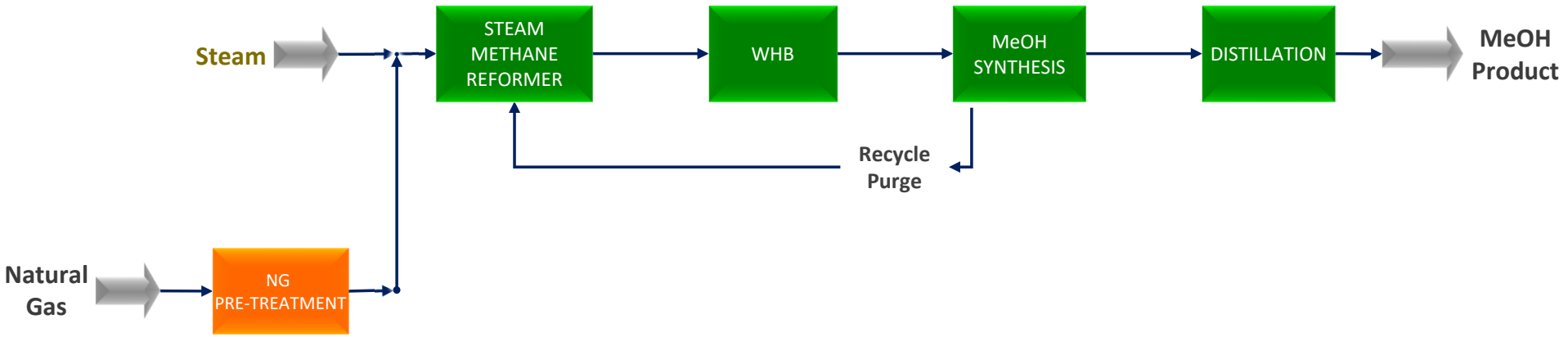




JM-KBR coproduction scheme

Process Overview

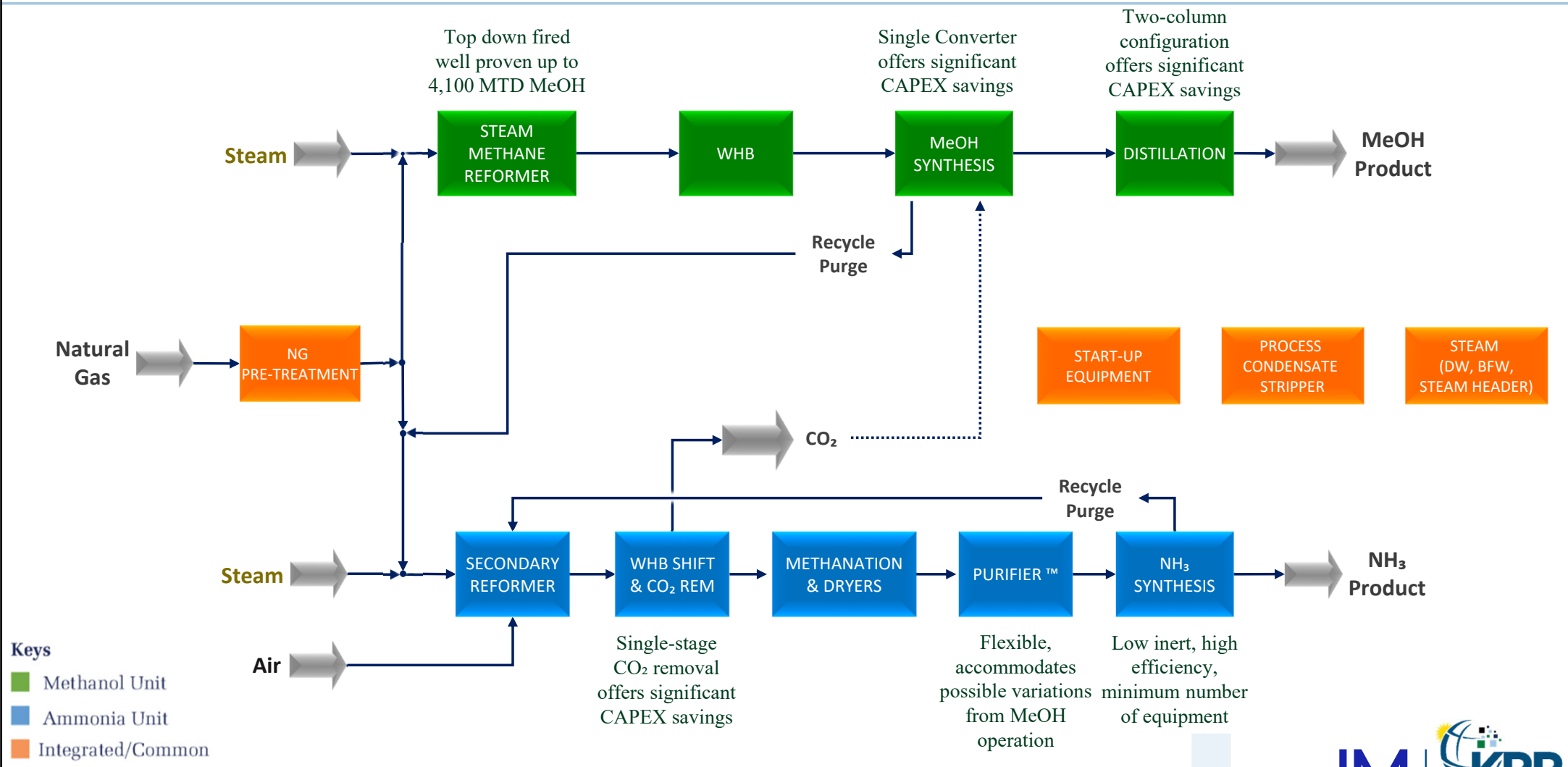
JM-KBR co-production flowsheet



Keys

- Methanol Unit
- Ammonia Unit
- Integrated/Common

JM-KBR co-production flowsheet



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JM-KBR co-production highlights

Single train produces up to 6,800 MTD methanol + ammonia

Capex saving

- JM SMR plant is typically 10% less capital intensive compared to O_2 based plant for the same capacity
- Purifier™ plant is typically 8% less capital intensive than conventional plants and when integrated with the methanol plant is further 25-30% less capital intensive

Bankability

- Combination of two well proven technologies, improving the bankability of the project

Safety

- No oxygen required - handling pure oxygen increases risks in operating the plant

Reliability & Flexibility

- SMR plants typically has half the number of trips compared to O_2 based plants
- Purifier™ plants consistently rank top of the range for longest runs and highest on-stream factor
- Flexibility in methanol/ammonia ratio – can be optimised in the design to allow a range of production capacities

Turndown

- SMR plant can operate down to 60% of the design capacity
- Purifier™ plant can operate down to 45% of the design capacity

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Johnson Matthey ProcessWise Webinars

Methanol ammonia co-production

Questions and Answers

Please submit your questions, feedback and suggestions for future webinar topics through the Team Live Events Q&A panel on the right of your screen