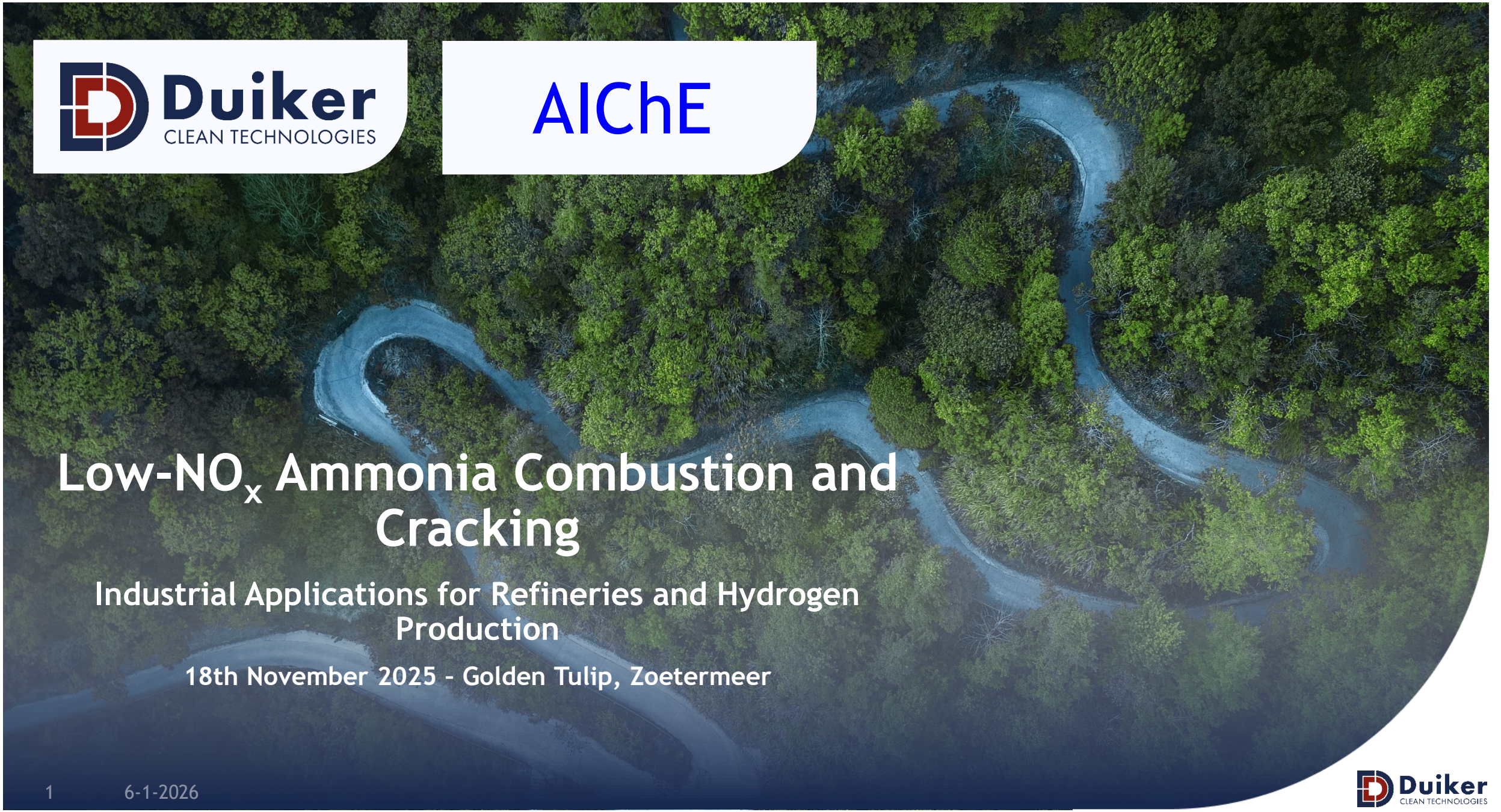


Duiker CLEAN TECHNOLOGIES

AIChE

Low-NO_x Ammonia Combustion and Cracking

Industrial Applications for Refineries and Hydrogen Production

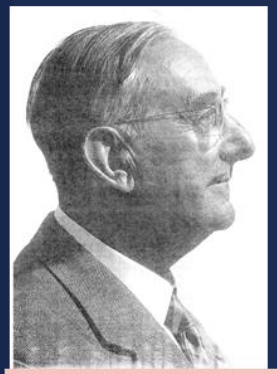
18th November 2025 - Golden Tulip, Zoetermeer

Duiker CLEAN TECHNOLOGIES

Agenda

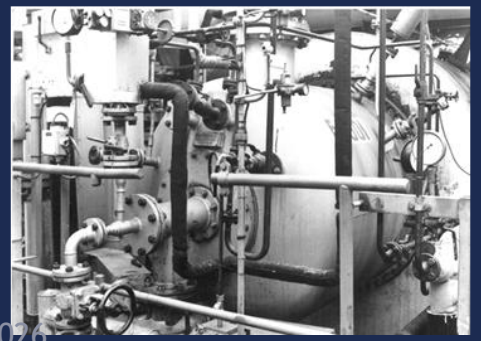
1. Introduction to Duiker
2. Why Ammonia as a hydrogen carrier?
3. Ammonia Cracking Technology
4. Ammonia Combustion Technology
5. Industrial Application:
    A. Refining
    B. Biorefining
    C. Ammonia Cracking
6. Conclusion

Legacy & spirit of innovation



1919 — Technical Office of J. Duiker Founded in The Netherlands

1961 — First Luynet Multiple Vortex burners installed



1978 — Babcock acquires Duiker projects for its expertise

1989 — Duiker is sold to Laidlaw Drew and is renamed as LD Duiker.

2004 — Management buyouts out LD to make Duiker CE.

2009 — Duiker develops and sells first low NO_X ammonia burners.

2022 — Duiker develops and launches ammonia crackers.

2023 — Duiker CE is rebranded as Duiker Clean Technologies.

Thousands of process solutions

You can rely on our experience

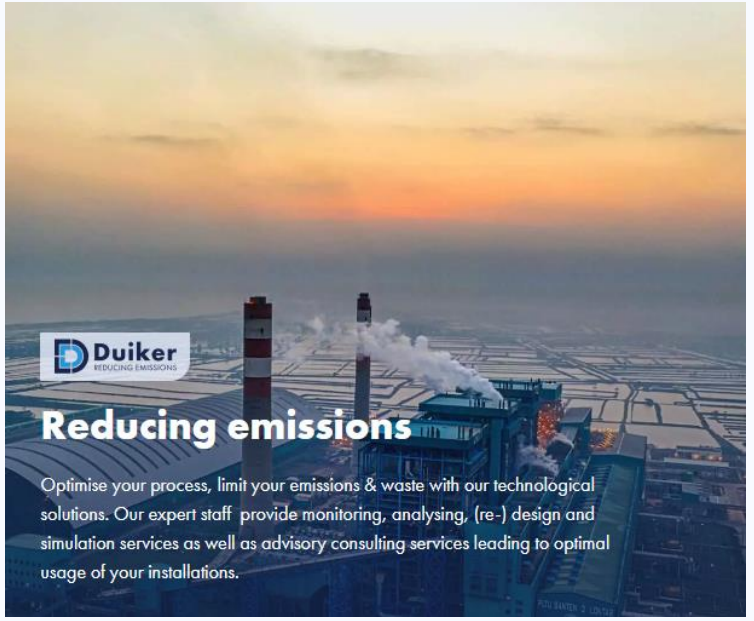
Duiker CLEAN TECHNOLOGIES

Duiker CLEAN TECHNOLOGIES

Focus on clean technologies

Supply of engineering, hardware & serviceing combustion and process equipment

Supply of technology, licensing, process engineering and propretary equipment



Supply of services for site measurements, problem analyssi and CFD supported consutancy

Duiker SULFUR SOLUTIONS

Duiker CLEAN ENERGY

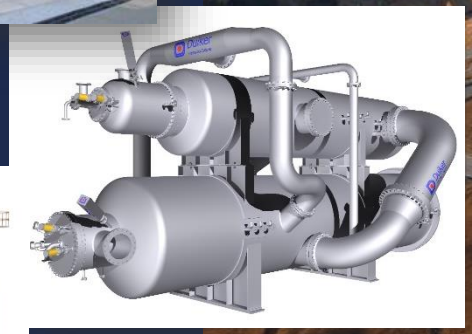
Duiker REDUCING EMISSIONS

Duiker CLEAN TECHNOLOGIES

Technology and engineering partner for realising the ammonia economy

Duiker & partners offer process solutions for midstream and downstream ammonia value chain.

Duiker’s core scope of supply is technology licensor and supply of critical equipment.



Stoichiometry Controlled Oxidation (SCO)
Patented technology

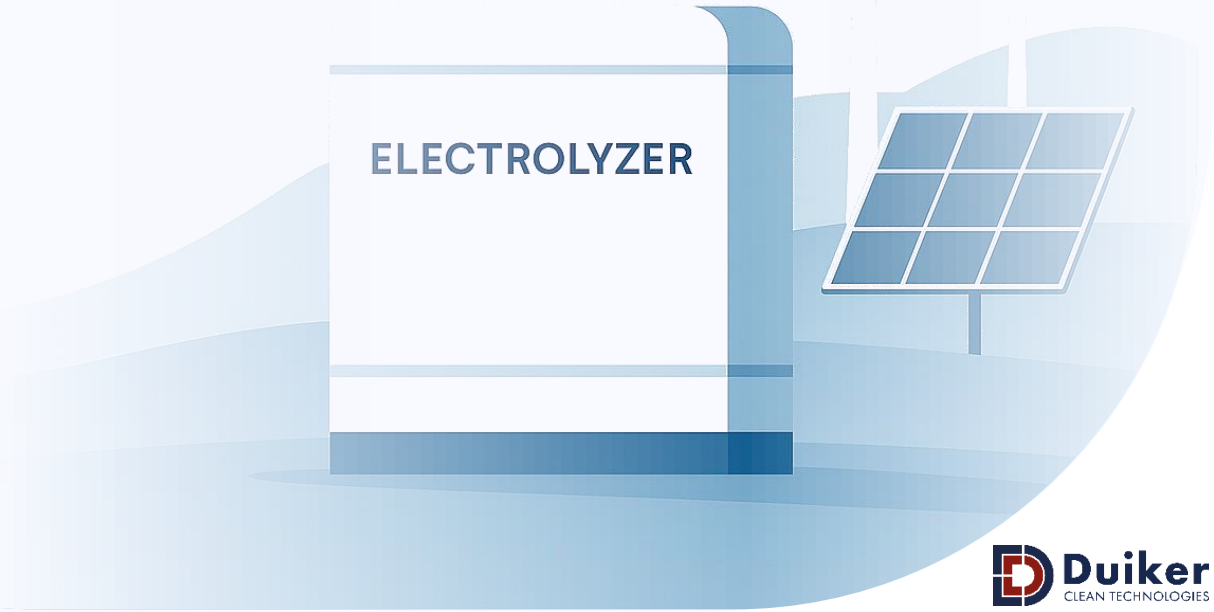
Electrolysis: A Green But Costly Pathway

Limitations

- High electricity demand (50–55 kWh/kg H_2)
- CAPEX-Intensive
- (Often) not competitive without subsidies or very low electricity prices

Strengths

- Zero Direct Emissions
- Flexible deployment
- Renewable Integration



Duiker CLEAN TECHNOLOGIES

Upstream

Captured CO_2

Natural Gas

CCS

Blue Hydrogen Production

Green Hydrogen Production

Green Electricity

Water

H_2

N_2

Ammonia Production

H_2

Midstream

Low-carbon NH_3

Ammonia Storage

Ammonia Cracking

NH_3

Marine Fuel

Containerships

Tankers

Gas Carriers

Bulk Carriers

Heat

Industrial Steam Boiler

Downstream

H_2

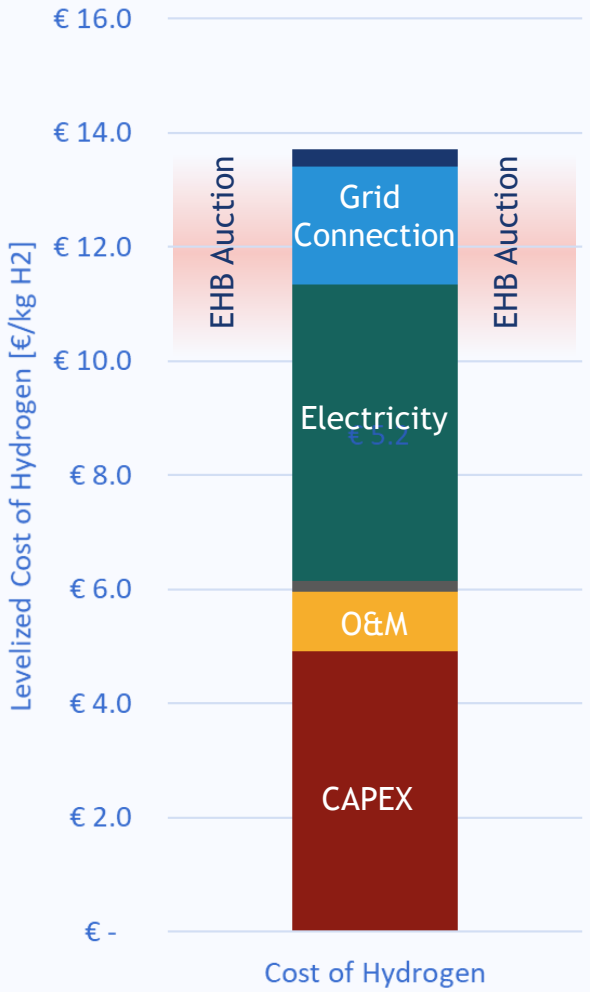
(Inter) National Hydrogen Backbone

Refining & Chemical conversions

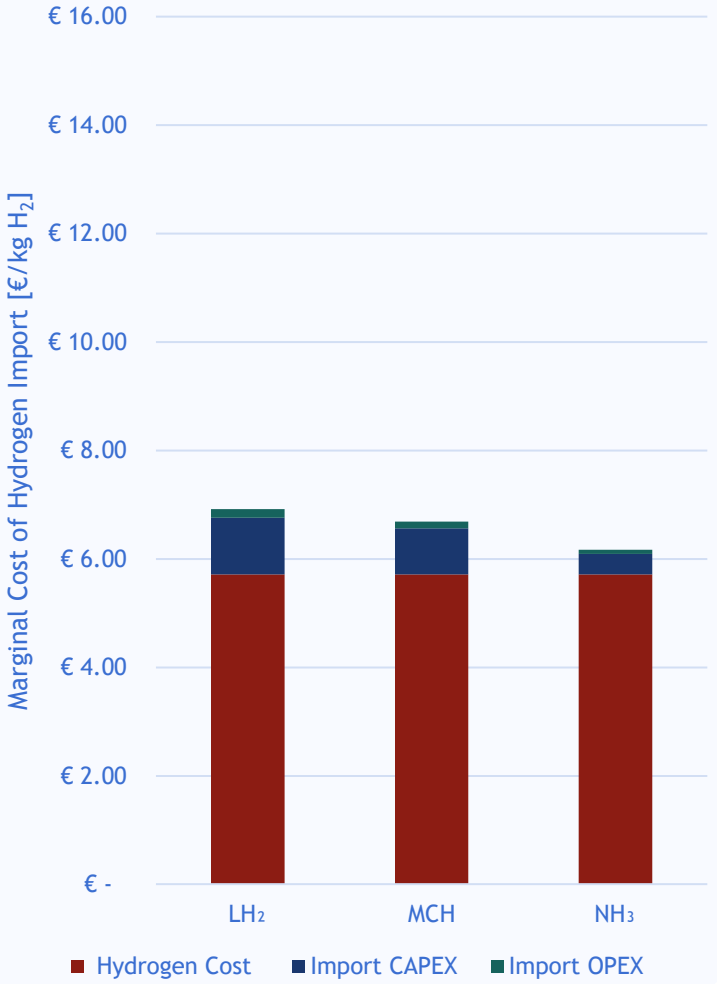
Iron & Steel

Duiker CLEAN TECHNOLOGIES

Cost Comparison: Electrolysis vs Imported Hydrogen



- Locally produced hydrogen cost[1]: 10 - 14 €/kg H2
- Imported hydrogen is 50% cheaper
- Ammonia is the cheapest method to import hydrogen [2]



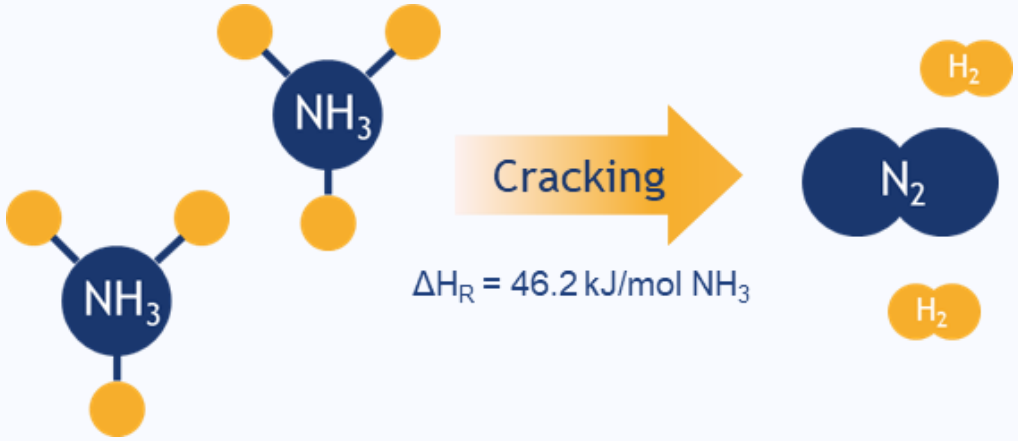
[1] TNO Study & European Hydrogen Bank (EHB) Auction

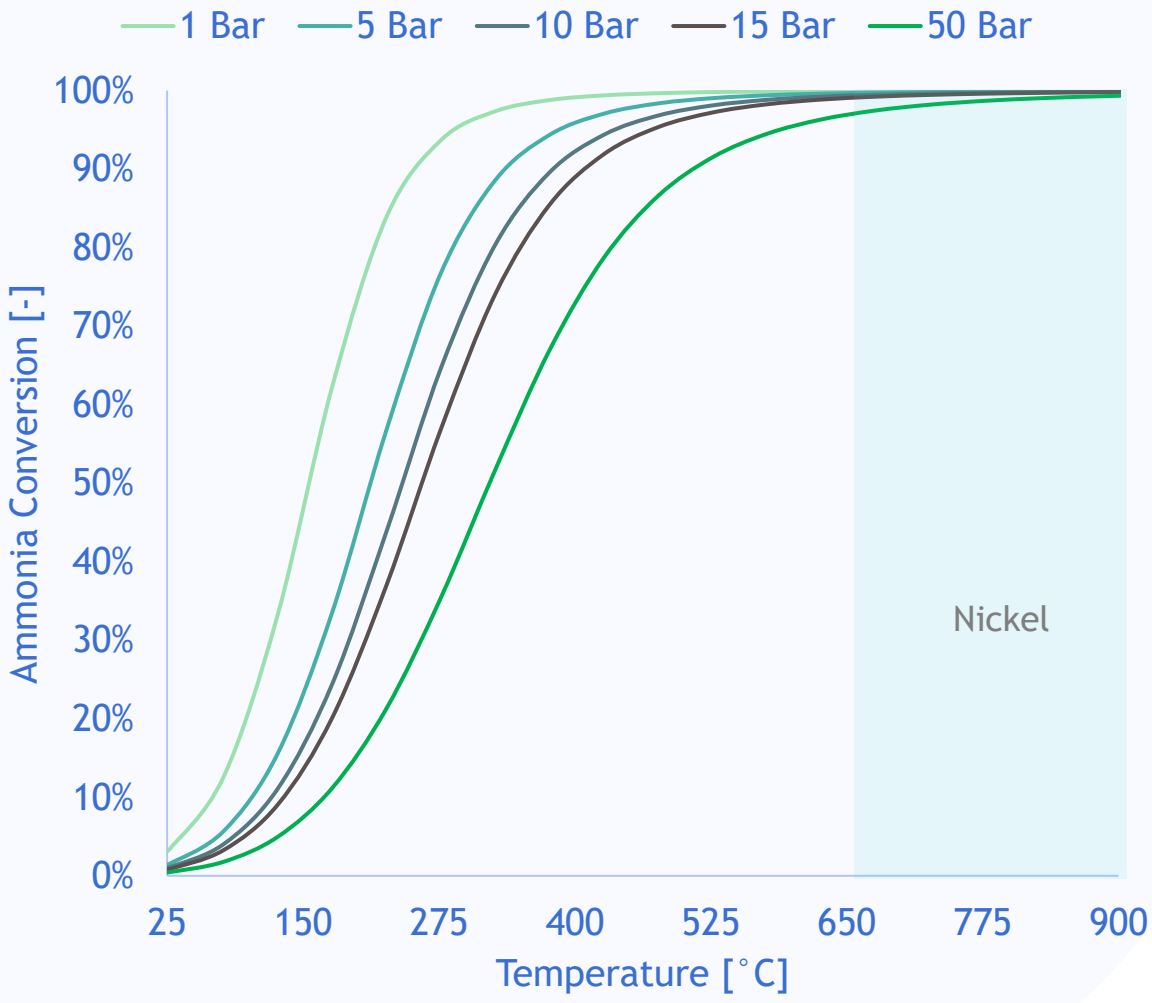
[2] Report by KBR and CATF.
Based on 800€/t NH_3

Duiker CLEAN TECHNOLOGIES

What is Ammonia Cracking?

- Ammonia as a hydrogen carrier: high volumetric density & ease of handling.
- Cracking = Catalytic thermal decomposition





Ammonia Leverages Existing Global Infrastructure

- 2.8 Millon Tonnes of H_2 already transported as NH_3.
- Existing ports, storage tanks, ships (ocean and river going) & rail cars.

$14{,}700\ m^3\ NH_3$

=

$\sim 10{,}000$ tons NH_3

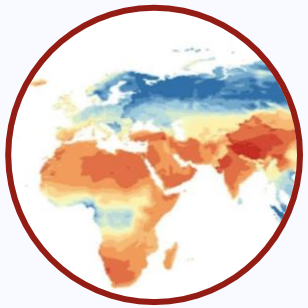
=

~ 1400 tons H_2

- Established technology for large-scale storage.

Duiker CLEAN TECHNOLOGIES

Electrolysis Isn’t the Only Answer



Ammonia cracking complements electrolytic hydrogen, not competes.

It's a pragmatic, scalable, and often cheaper solution for near-term deployment.

The missing piece in enabling this chain is Ammonia Cracking

Duiker CLEAN TECHNOLOGIES

Heat Generation: Duiker SCO Reactor

Proven in industrial applications

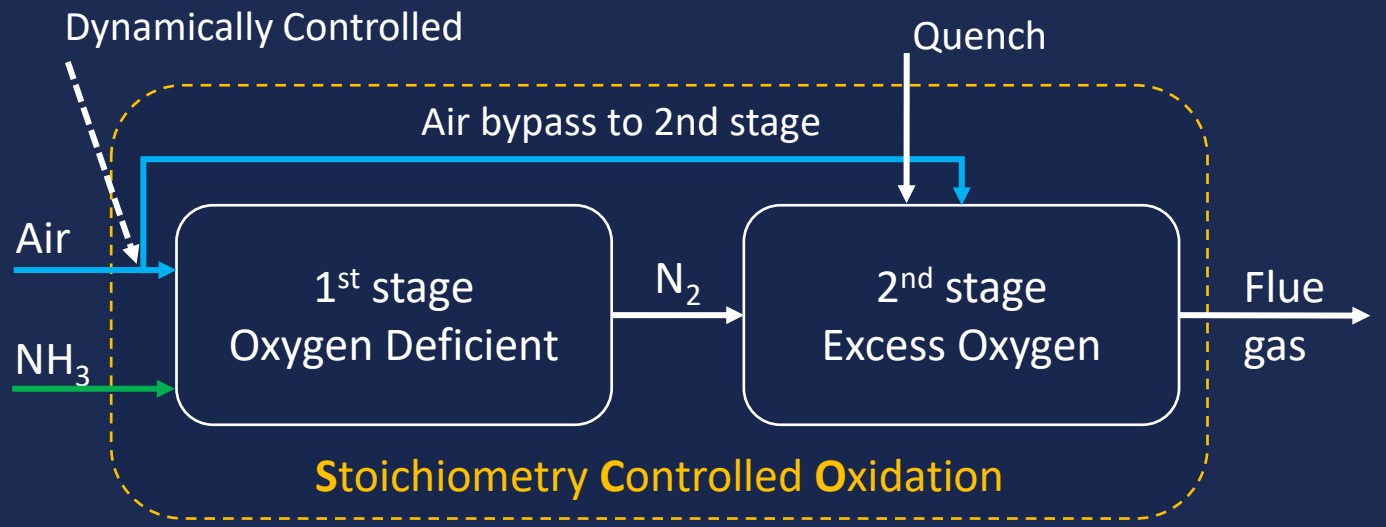
No CO_2 emissions

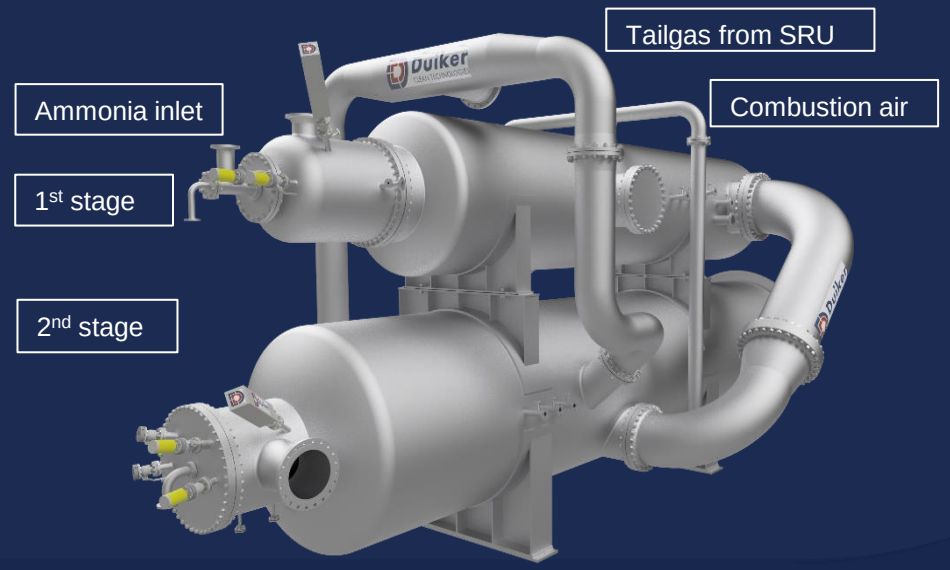
No soot or particulate emissions

Outlet NO_x: 50ppmv @ 3% O_2 dry

Inlet NH_3: up to 100%

Patented Technology





Concept to Execution

Duiker CLEAN TECHNOLOGIES

Stoichiometry Controlled Oxidation (SCO): Proven Technology for Ammonia Combustion

NO_x: 50ppmv @ 3% O_2 dry

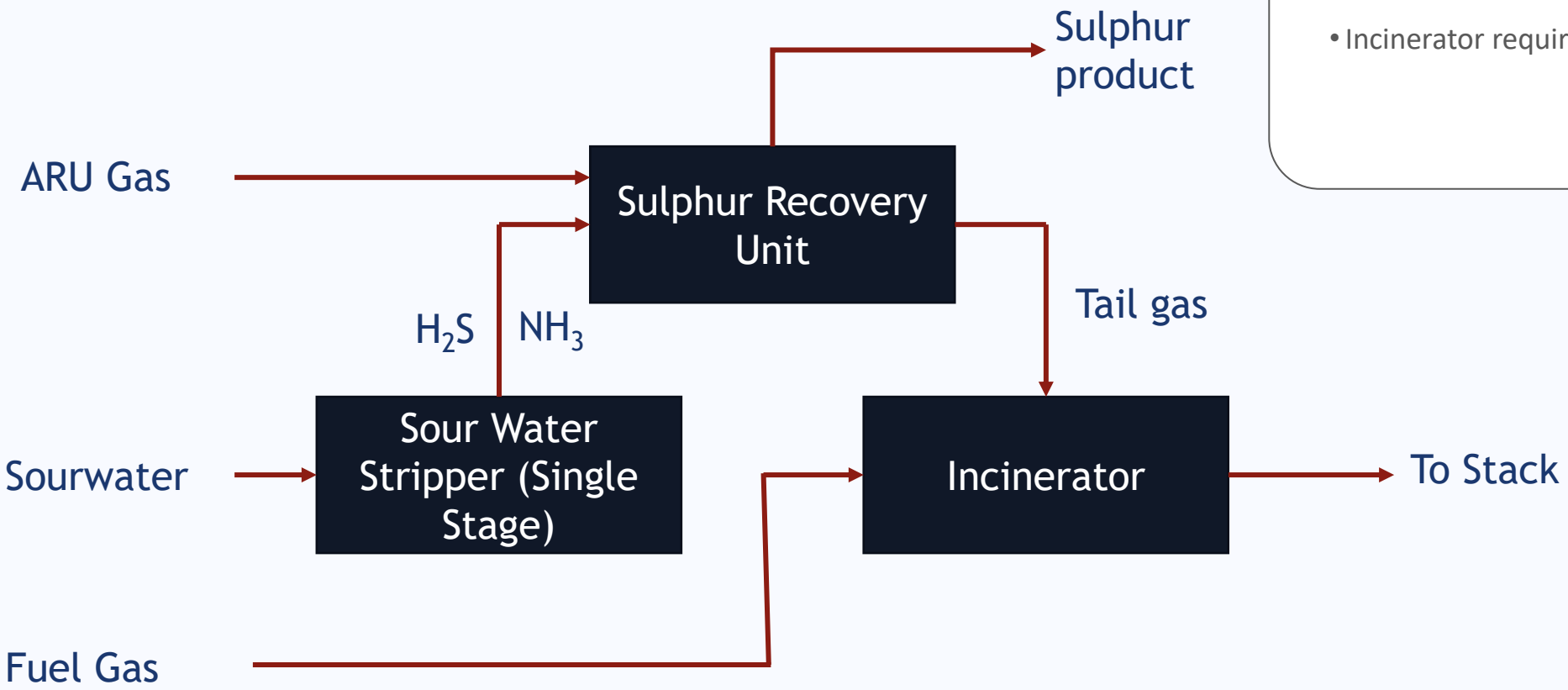
N_2O: Below detectable levels

Proven at commercial scale

Patented Technology

Duiker CLEAN TECHNOLOGIES

SCO Application - Sulphur Recovery Unit
Typical refineries

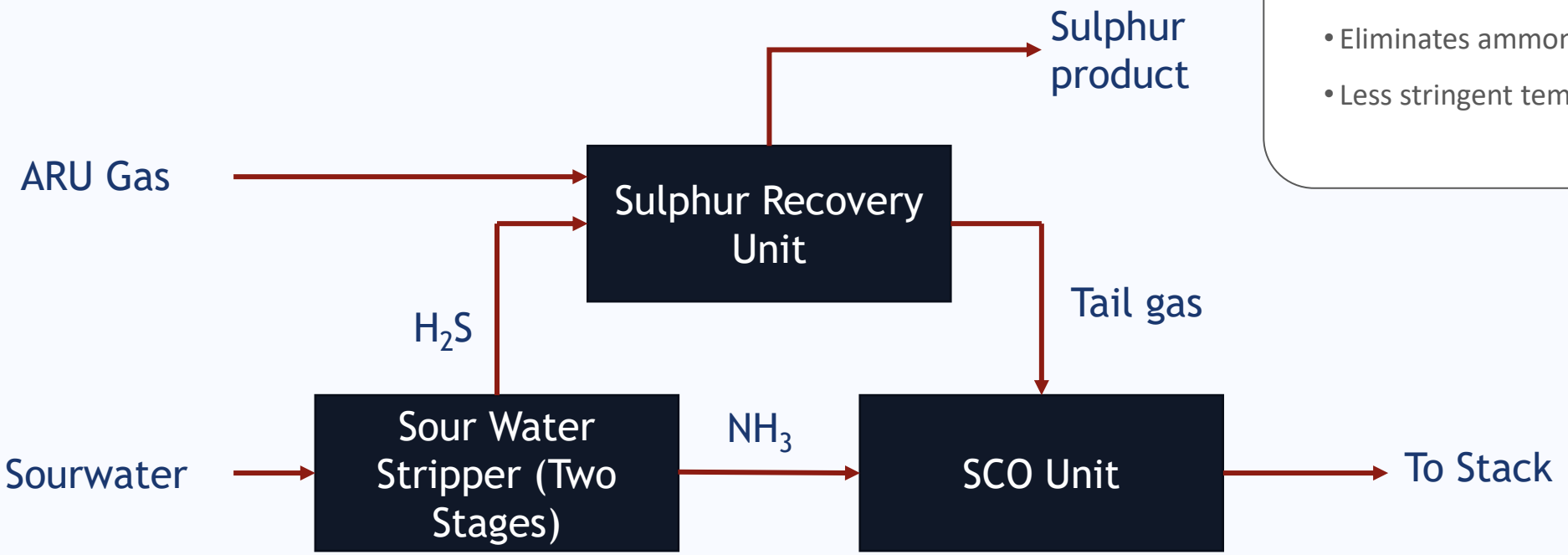


Highlights

- In a typical refinery, ammonia that is produced Ammonia is combusted in the SRU Main Burner
- Complete destruction is critical to prevent ammonia salt formation.
- Incinerator requires fuel gas as fuel

Duiker CLEAN TECHNOLOGIES

SCO Application – Sulphur Recovery Unit
Typical refineries

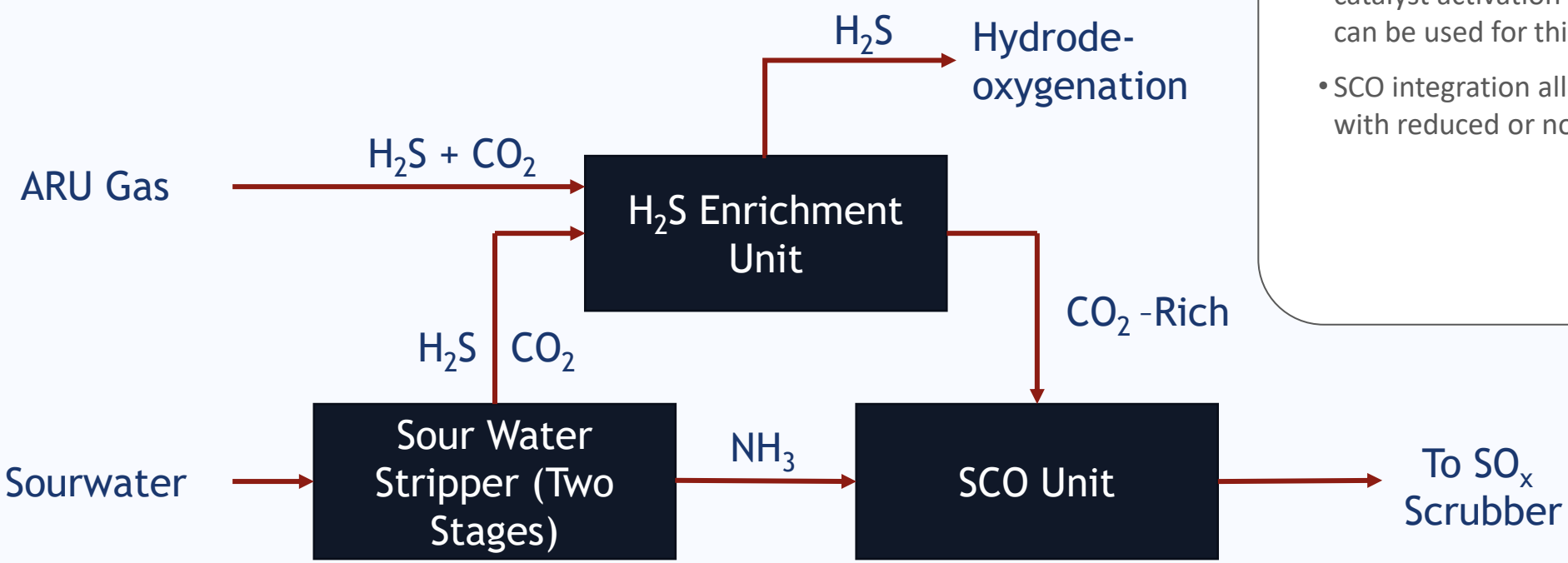


Highlights

- Reduces CAPEX of the SRU (by up to 25% compared to processing of NH_3 through SRU)
- Saves fuel gas consumption of the incinerator by using NH_3 as fuel.
- Eliminates ammonia salt formation in SRU
- Less stringent temperature constraint for the SRU

Duiker CLEAN TECHNOLOGIES

SCO Application – Bio refinery application

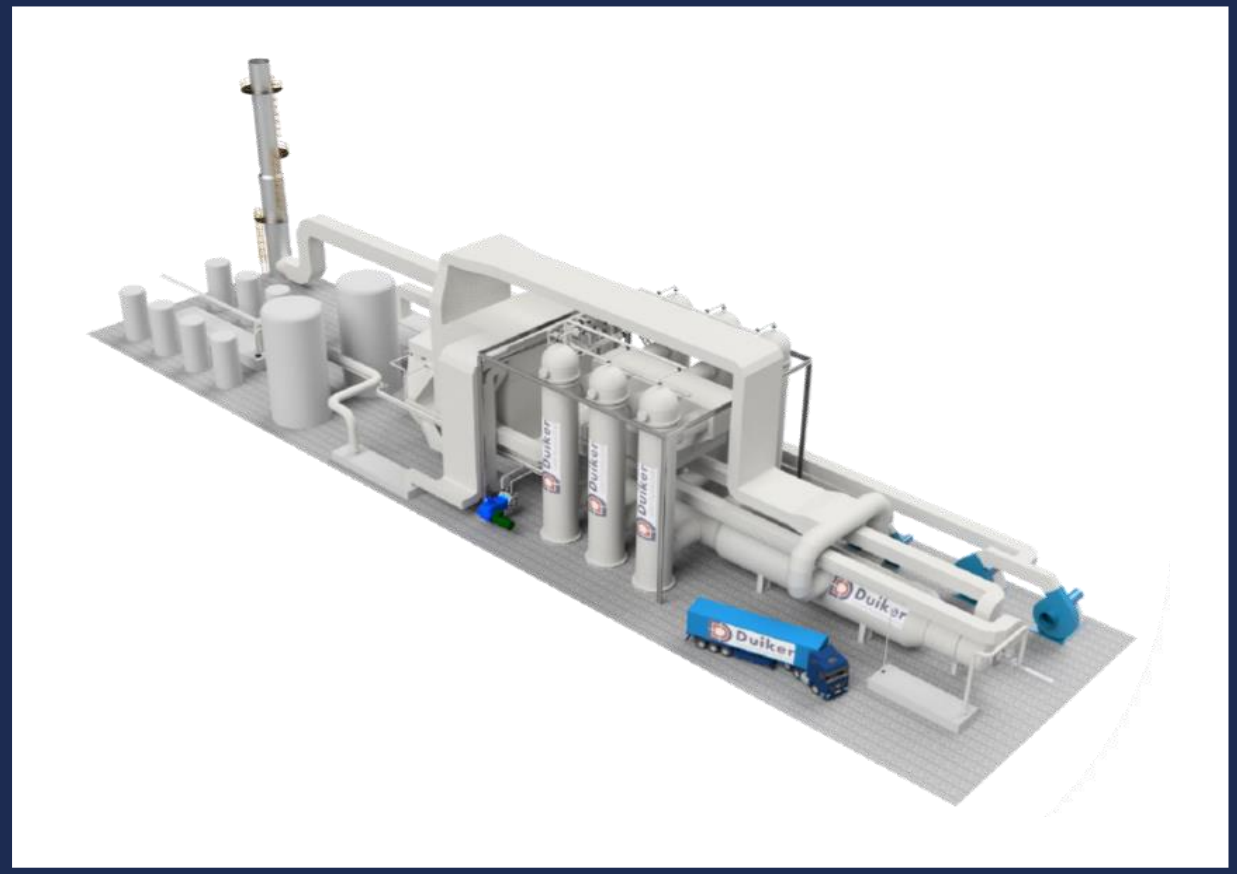


Highlights

- Hydrodeoxygenation (HDO) is critical in biorefining to increase fuel energy density.
- HDO catalyst must remain sulphided for optimal catalyst activation and stabilization. Recovered H_2S can be used for this.
- SCO integration allows the process to be operated with reduced or no fuel gas demand.

Duiker CLEAN TECHNOLOGIES

Duiker Ammonia Hydrogen Converter



Duiker Ammonia to Hydrogen Converter

>90%
Highly efficient conversion of ammonia.

Zero CO_2
No scope 1 CO_2 emissions.

275 TPD H_2
Modular design with single train capacity optimized for cost and performance.

5 ppm NO_x
Low levels of NO_x enabled by patented and industrially proven technology.

99.97% H_2 purity
Able to produce fuel cell grade hydrogen.

No Steam Export
Standalone operation

Duiker CLEAN TECHNOLOGIES

Jebin James

Process Development Lead
james@duiker.com
+31 (0)6 5000 9657

Duiker
CLEAN TECHNOLOGIES

Thank you for your attention

Q&A