

REDUCING THE N_2O FOOTPRINT OF YOUR NITRIC ACID PLANT



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AGENDA

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02 N₂O ABATEMENT SYSTEMS

03 TYPES OF ABATEMENT
SCHEMES

04 REACTOR DESIGNS

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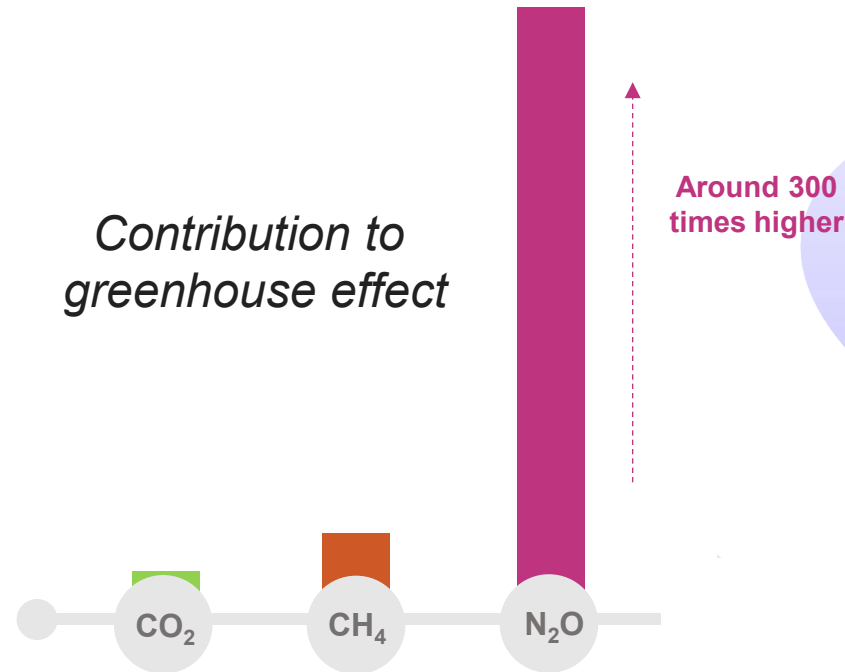


INTRODUCTION

INTRODUCTION

GHG EMISSIONS

- N_2O is potent greenhouse gas (GHG)
- Contributes to carbon emissions



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INTRODUCTION

ETS MARKET

- To regulate emissions, Emissions Trading System (ETS) has been implemented
- Market based approach by providing economic incentives to reduce emissions
- A cap is set on the total amount of certain greenhouse gas emissions
- The cap is reduced over time to ensure overall reduction in emissions
- Companies receive or buy emission allowances, which can be traded

INTRODUCTION

ADDITIONAL EFFORTS

- NACAG (Nitric Acid Climate Action Group) initiative by German government
- Drive a global shift to promoting installation of N₂O abatement technologies in nitric acid and caprolactam plants world-wide
- CBAM (Carbon Border Adjustment Mechanism) initiative by the EU
- Impose carbon levy on imported goods to the EU, like fertilizers and hydrogen
- Global efforts to reduce GHG emissions



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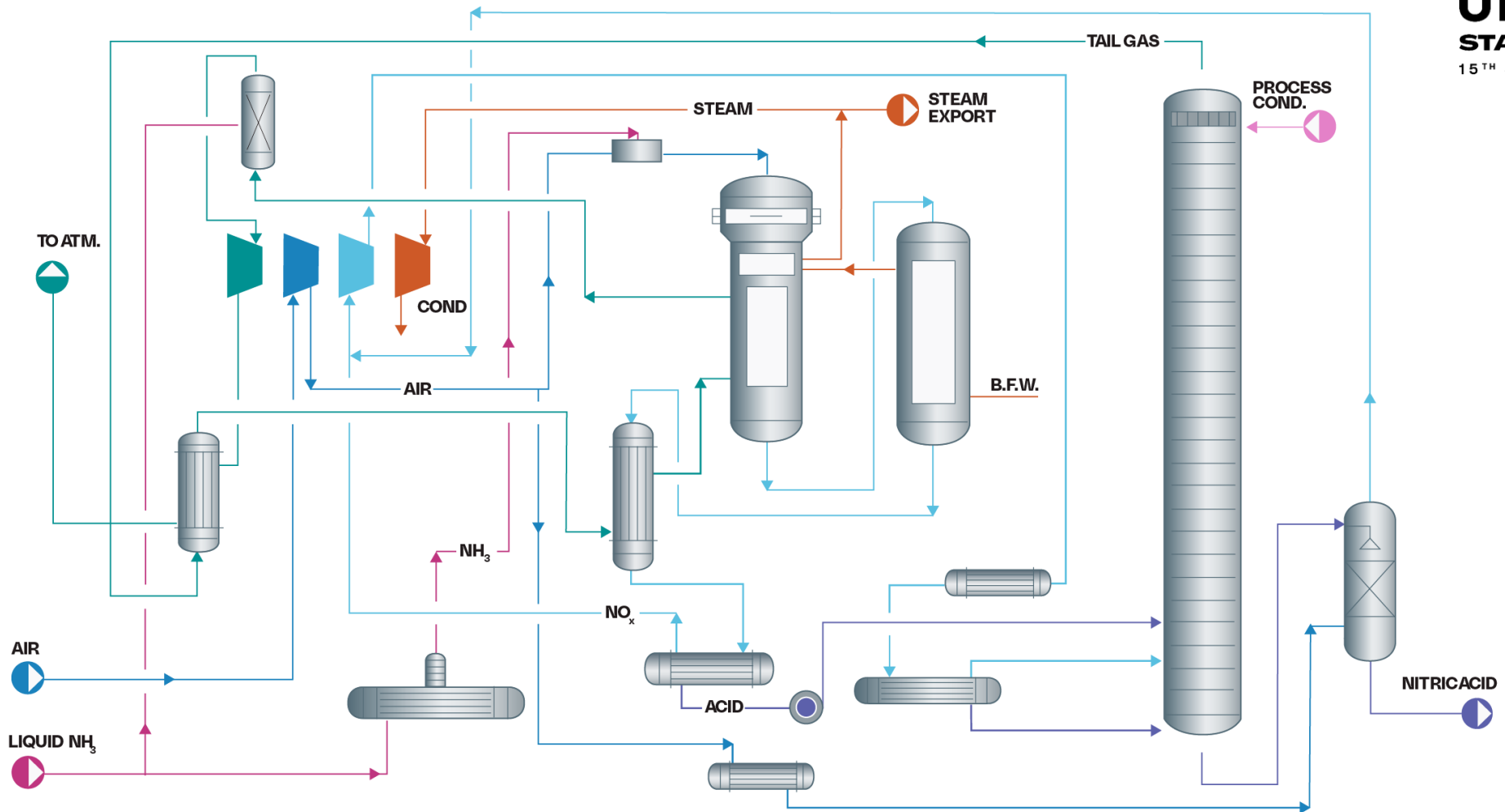


N₂O ABATEMENT SYSTEMS

N₂O ABATEMENT SYSTEMS



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N₂O ABATEMENT SYSTEMS

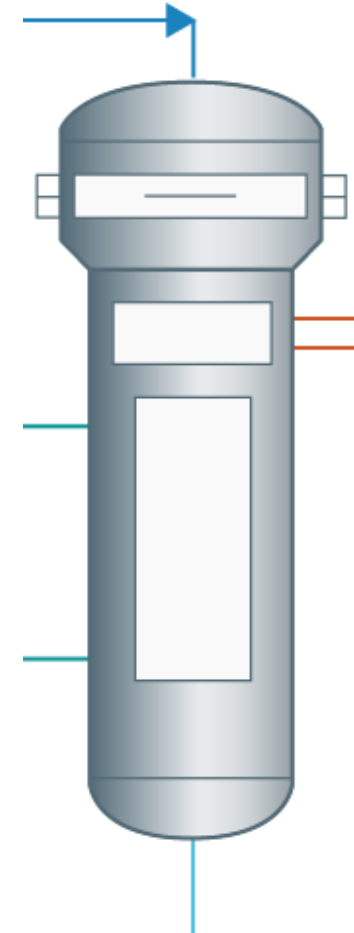


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- Reaction in ammonia burner
 - $\text{NH}_3 + \text{O}_2 \rightarrow \text{NO} + \text{H}_2\text{O}$
 - $\text{NH}_3 + \text{O}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$
 - $\text{NH}_3 + \text{O}_2 \rightarrow \text{N}_2\text{O} + \text{H}_2\text{O}$
- According to IPCC,

Low-pressure plants	5 kg N ₂ O/ton of 100% nitric acid
Medium-pressure plants	7 kg N ₂ O/ton of 100% nitric acid
High-pressure plants	9 kg N ₂ O/ton of 100% nitric acid

- N₂O is DOES NOT react anywhere else in the process



03



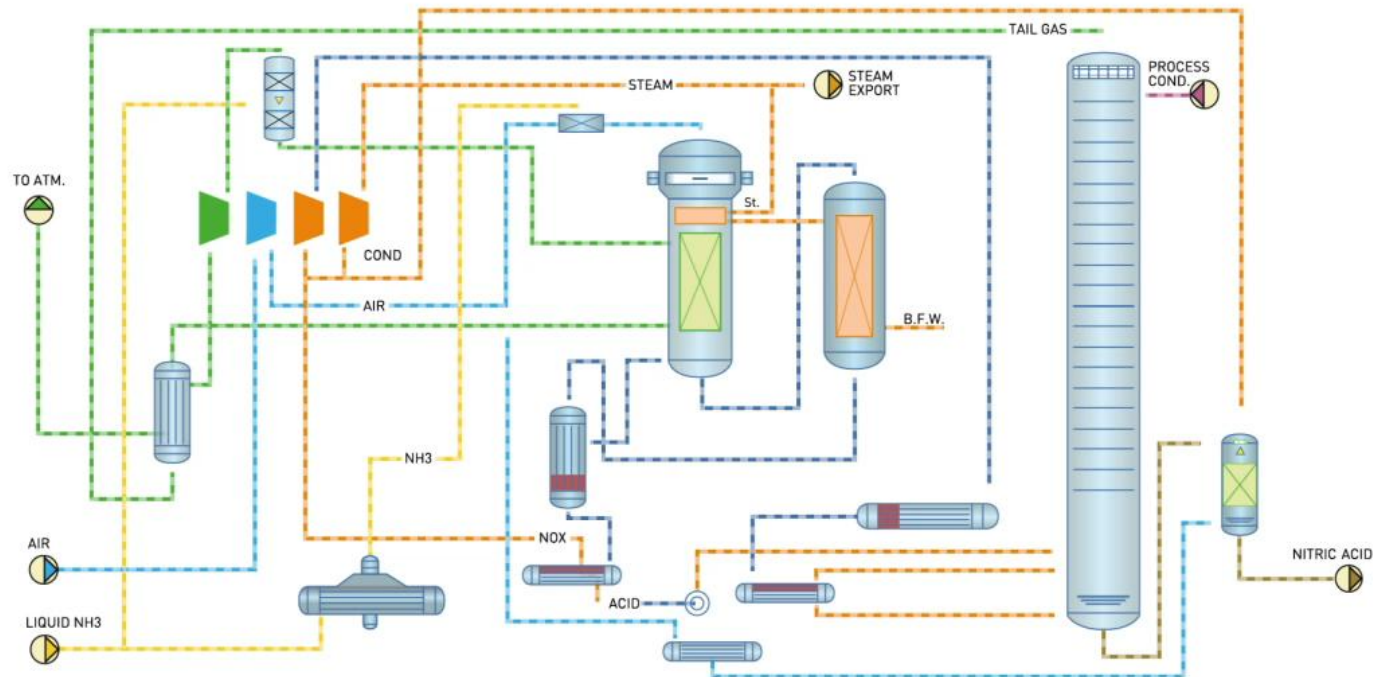
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TYPES OF ABATEMENT SCHEMES

PRIMARY ABATEMENT



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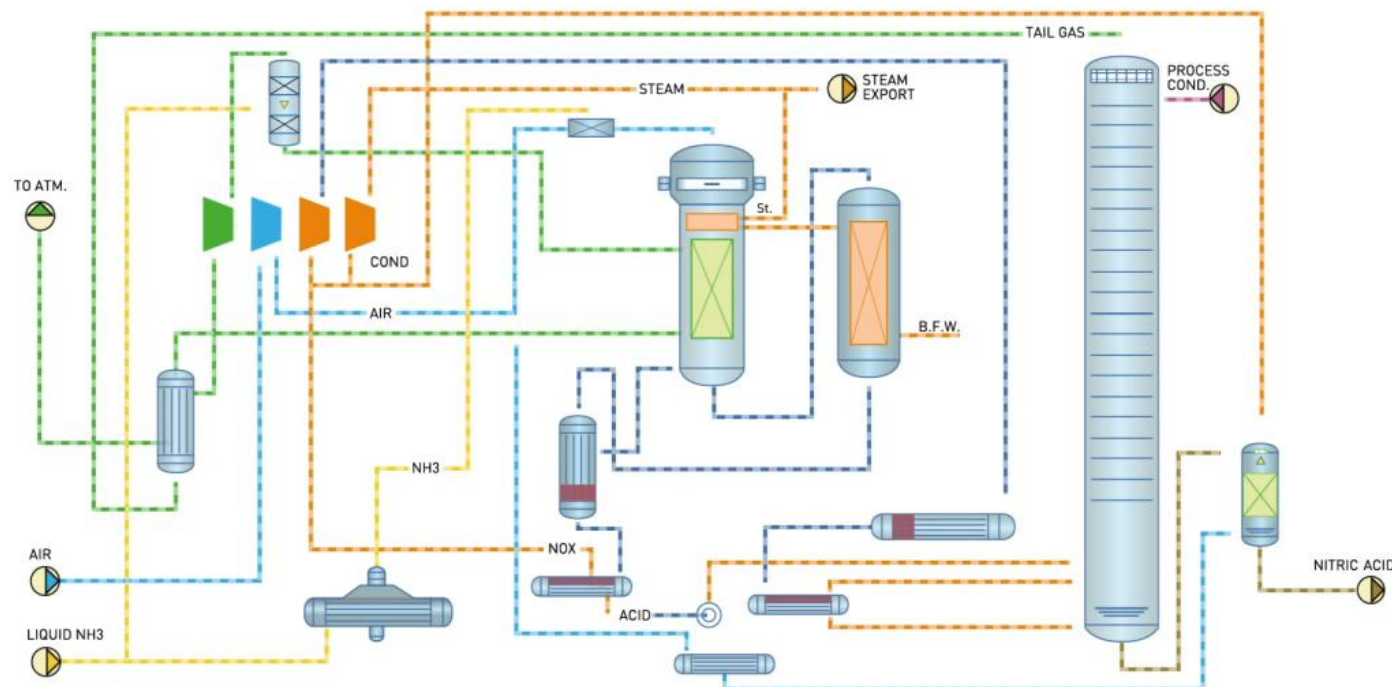


- Targets reduction of N_2O at the Platinum gauzes
- Gauze typically driven by plant specific operation goals
- N_2O abatement is limited

SECONDARY ABATEMENT



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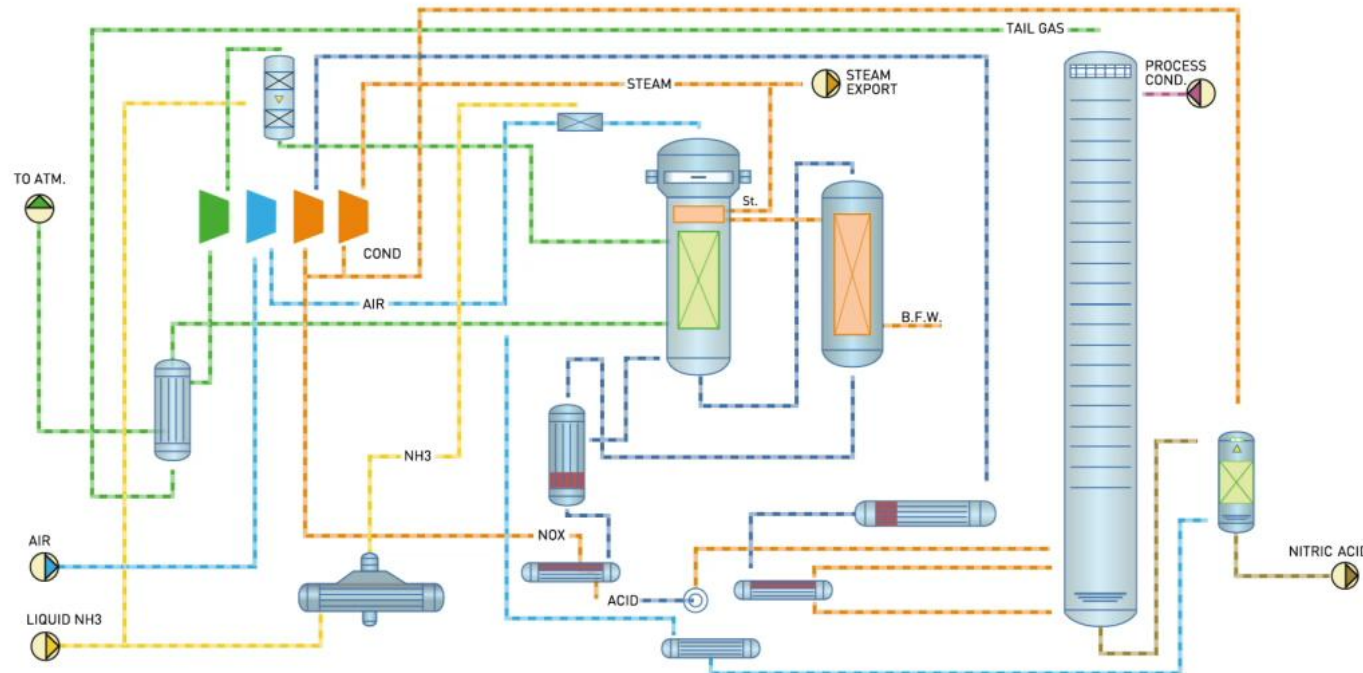


- Remove N_2O formed immediately after the gauzes and before absorption column
- Bed of catalyst, typically metal oxides, placed directly after the gauzes in a basket
- Easy to install
- Additional pressure drop

TERTIARY ABATEMENT



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- Remove N_2O after the absorption column and before expander
- Named as the best available technology for N_2O removal
- “Almost” end of pipe type of solution
- NO_x and N_2O removed in same vessel typically
- Unlike other two, various ways to remove N_2O due to different process in the market

SECONDARY ABATEMENT – EXISTING PLANTS



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Pros

No new equipment or piping is typically needed

Reasonable abatement (80-90%)

Limitations

Additional pressure drop

Increased load can compromise mechanical stability of the burner

Limited catalyst → Limited space abatement



Secondary abatement

Comprehensive study and inspection of existing plant



A new burner is needed, frequently



Can become more expensive than initially expected



Combine revamp with catalyst installation



ROI of around 3 years*



Tertiary abatement

Around 99% abatement, possible



No burner change is needed



Dedicated structure without affecting core plant



ROI of around 1 year*

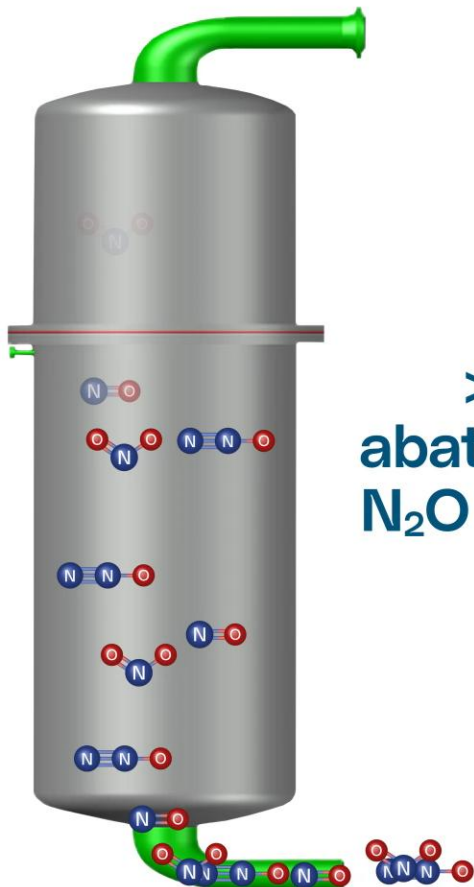


* Based on a monopressure plant with 550 MPTD nameplate capacity

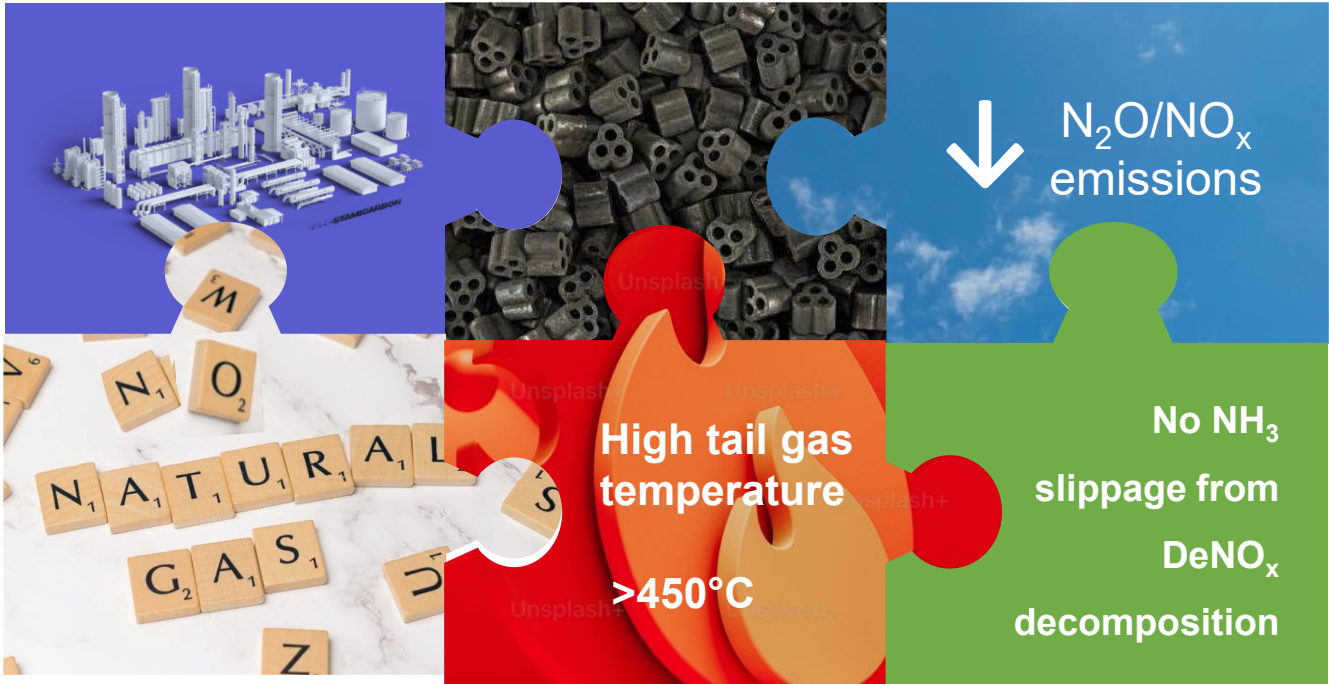
STAMICARBON-GRASSROOT N₂O ABATEMENT



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**>99%
abatement of
N₂O and NO_x**



TERTIARY ABATEMENT – EXISTING PLANTS



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>550°C

- Optimized energy recovery
- Combine N₂O and NO_x removal in one vessel
- N₂O is abated without any agent
- NO_x is abated using NH₃ with no slippage
- Reactor type depending on plant and tail gas conditions

350°C –
550°C

- Combine N₂O and NO_x removal in one vessel with one or two bed solution
- NH₃ or NH₃-Natural gas is needed for NO_x and N₂O abatement (between 350-450°C)
- Reactor type depending on plant and tail gas conditions

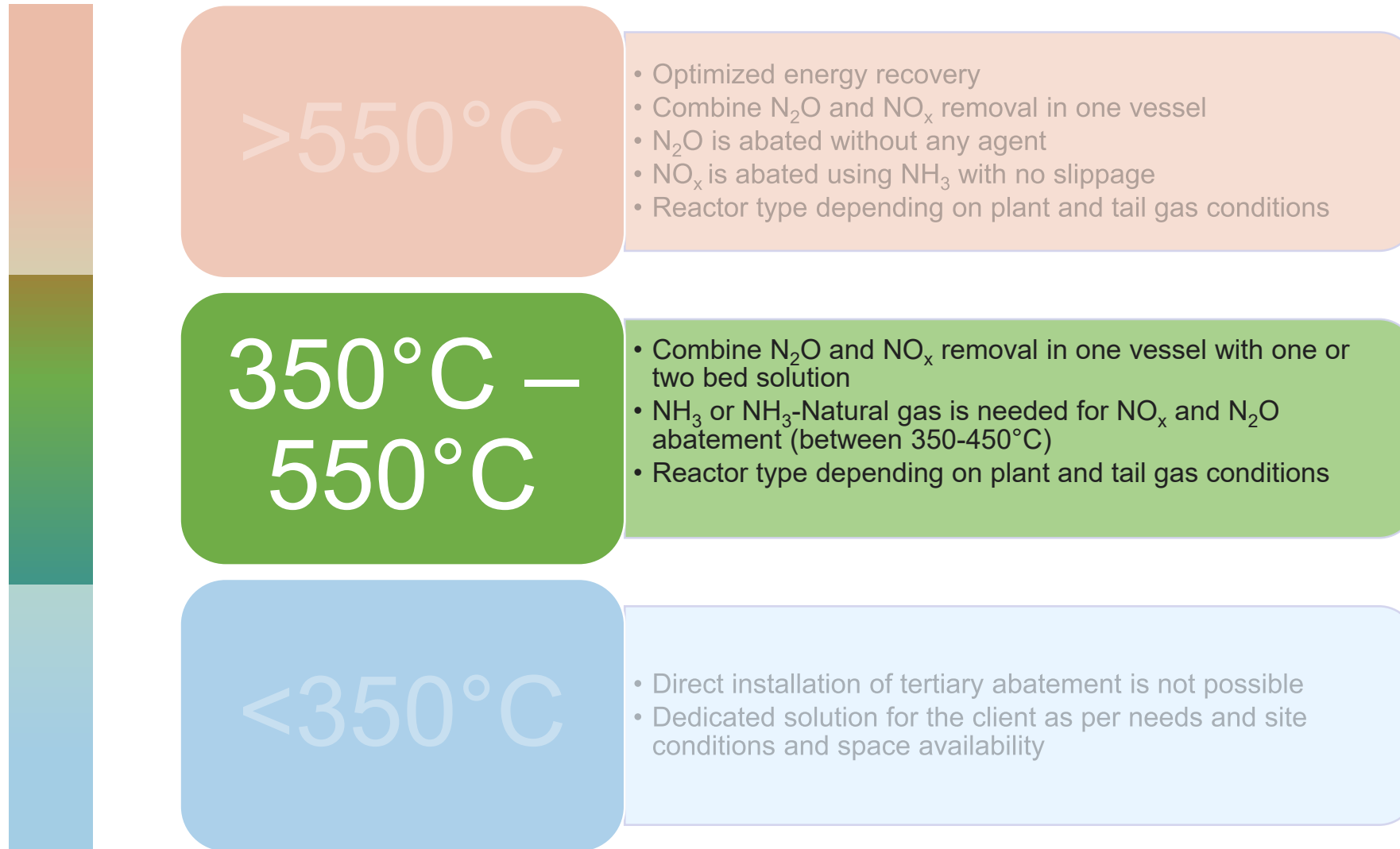
<350°C

- Direct installation of tertiary abatement is not possible
- Dedicated solution for the client as per needs and site conditions and space availability

TERTIARY ABATEMENT – EXISTING PLANTS



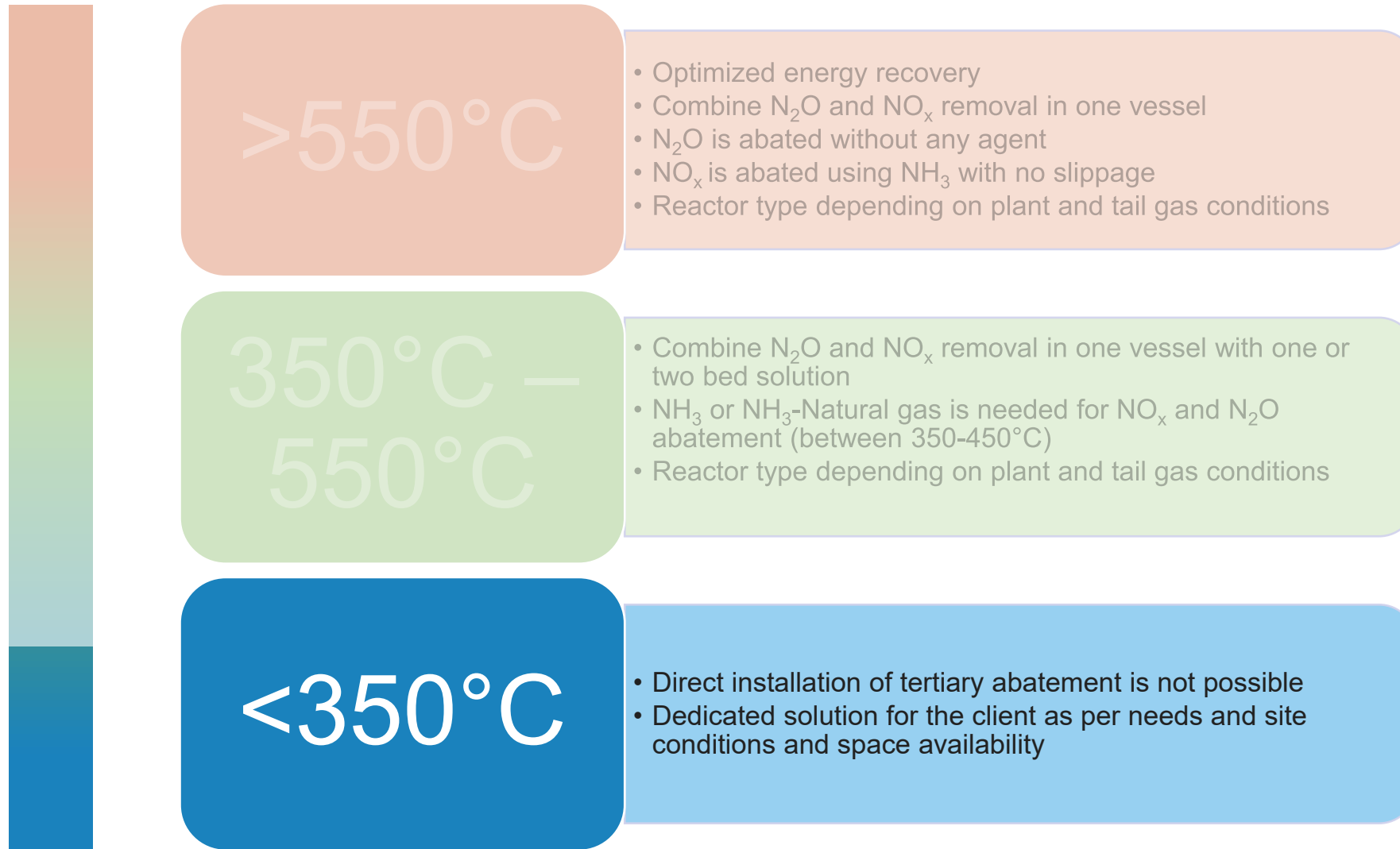
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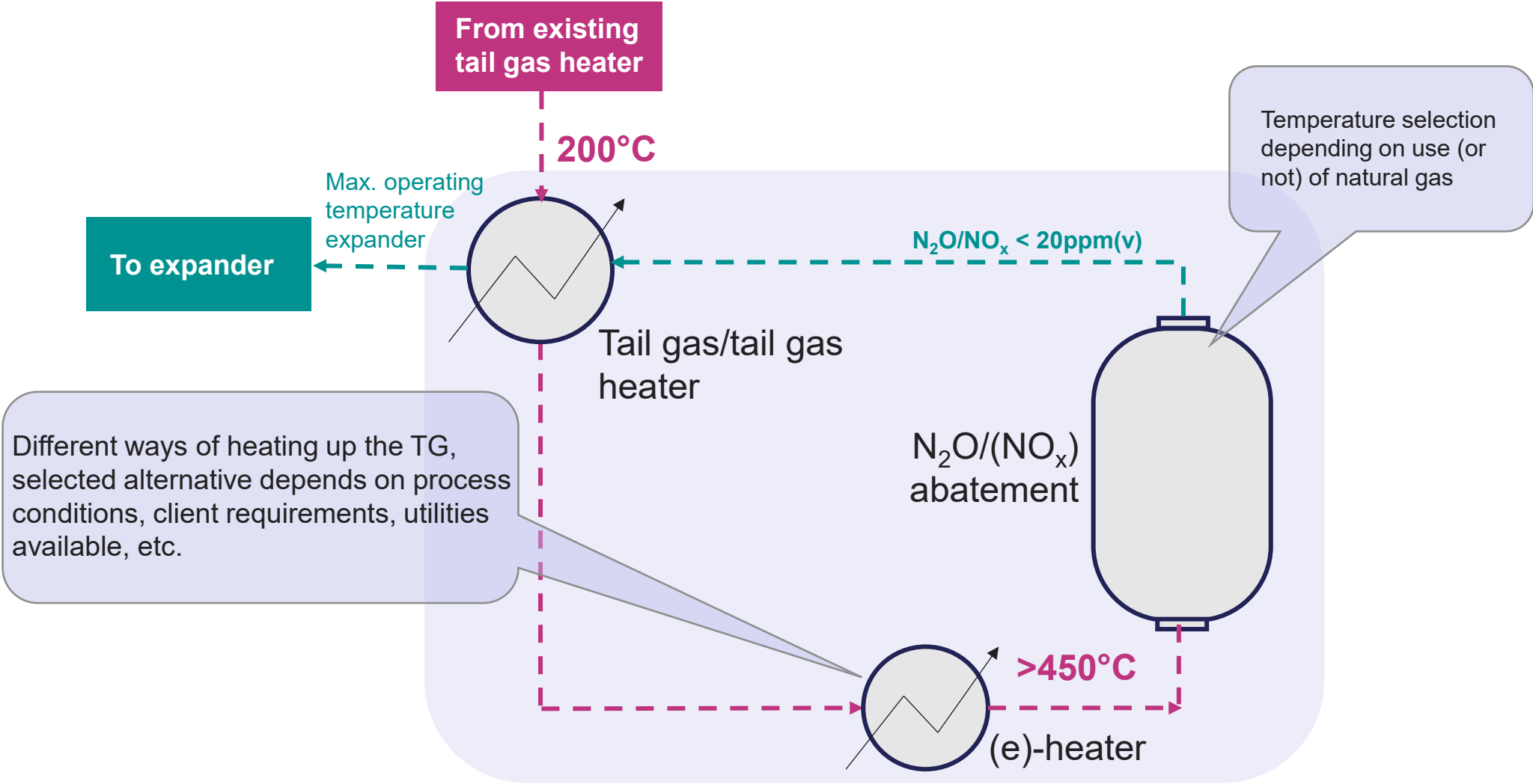
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TERTIARY ABATEMENT – LOW TEMPERATURES



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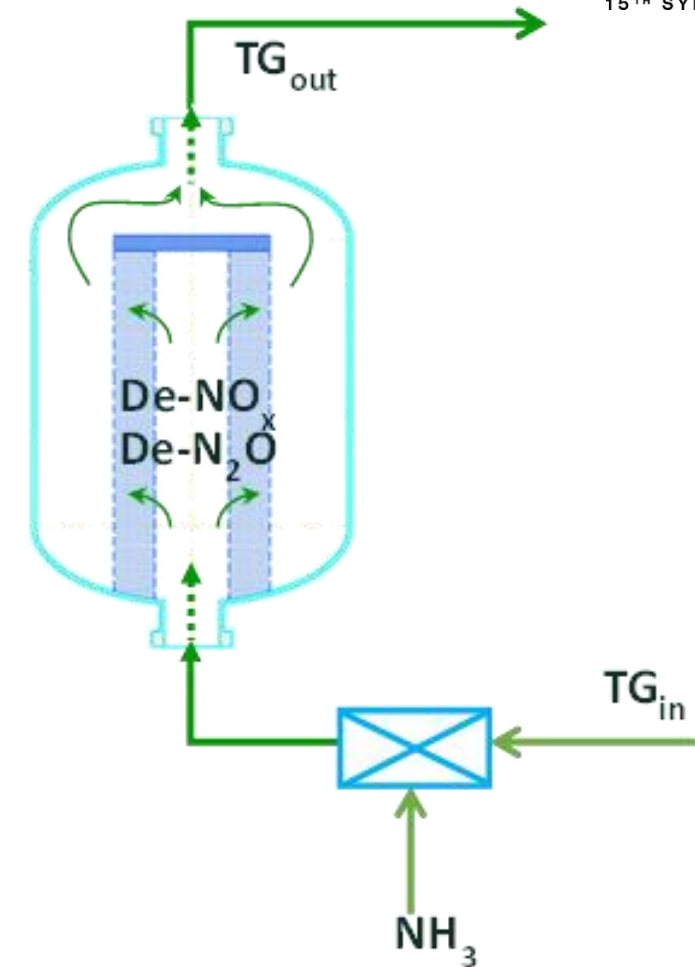


REACTOR DESIGNS

REACTORS FOR EXISTING PLANTS

SINGLE BED RADIAL

- Ammonia is added for NO_x removal and also for N_2O depending on tail gas temperature
- Static mixer for uniform mixing of NH_3 and tail gas
- Extruded catalyst used typically
- Have typically demonstrated high performance with quite some running references



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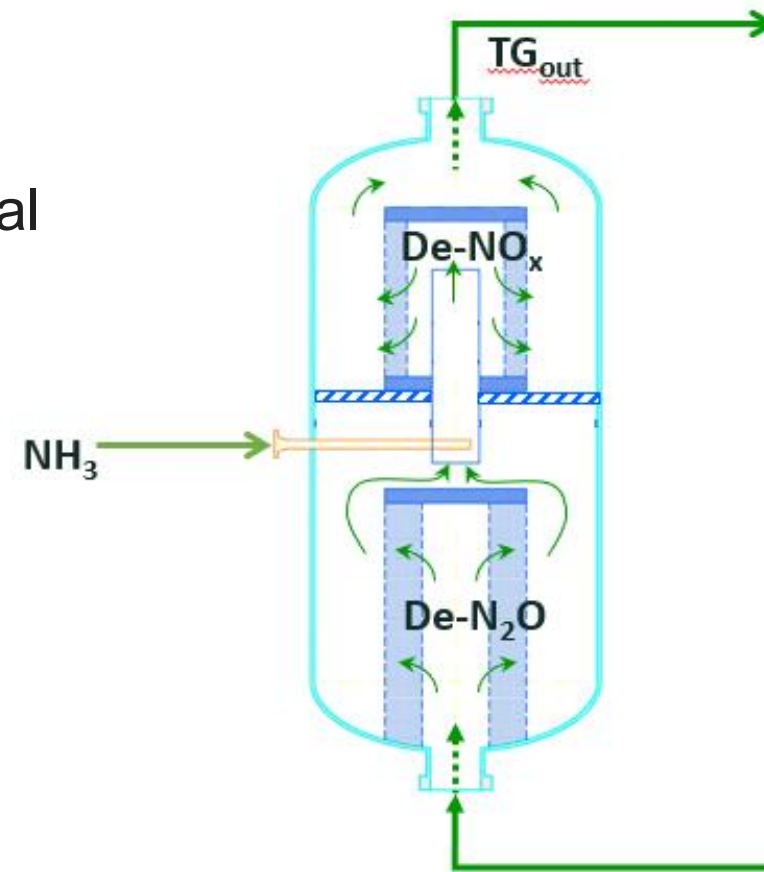
REACTORS FOR EXISTING PLANTS



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DOUBLE BED RADIAL

- Typically for high tail gas temperatures
- NO_x acts as co-catalyst for the N_2O removal
- NH_3 is added through a sparger for NO_x removal
- Quite effective when NO_x content is high
- Extruded catalyst are used



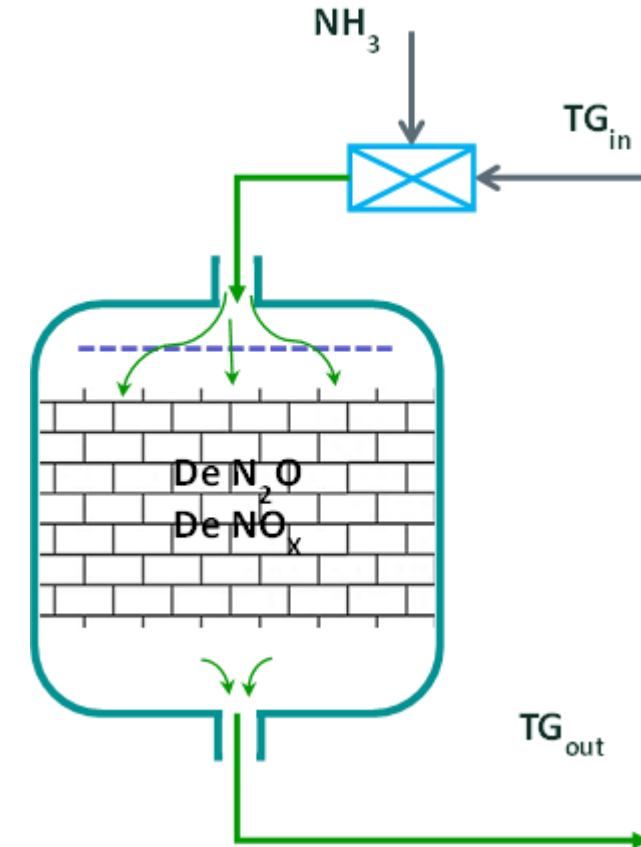
REACTORS FOR EXISTING PLANTS



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AXIAL BED

- N_2O and NO_x removed in single bed with NH_3
- Minimal footprint and lower pressure drops
- Monolith catalysts are used
- Easy to maintain and smaller volumes
- Relatively new in the market



05



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CONCLUSION

CONCLUSION

- It is important to reduce N_2O emissions along with NO_x
- Stamicarbon has solutions for grassroot plants
- For existing plants,
 - Stamicarbon can evaluate secondary vs tertiary abatement
 - Feasibility studies covering catalyst and impact on critical equipment
 - Tailored made solution for your unique plant
- We offer unique reactor design and catalyst to best fit your plant needs
- A tertiary reactor is to be installed, with NACAG, in Mexico.

THANK YOU

