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Nitrogen & Syngas Conference 2019

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Burner Revamp to Increase Primary Reformer Efficiency & Lower Emissions


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Presentation Outline

- Application overview
- Zeeco Single Jet ultra-low NO_x emissions burner
- CFD study
- Combustion testing
- Burner installation
- Conclusion

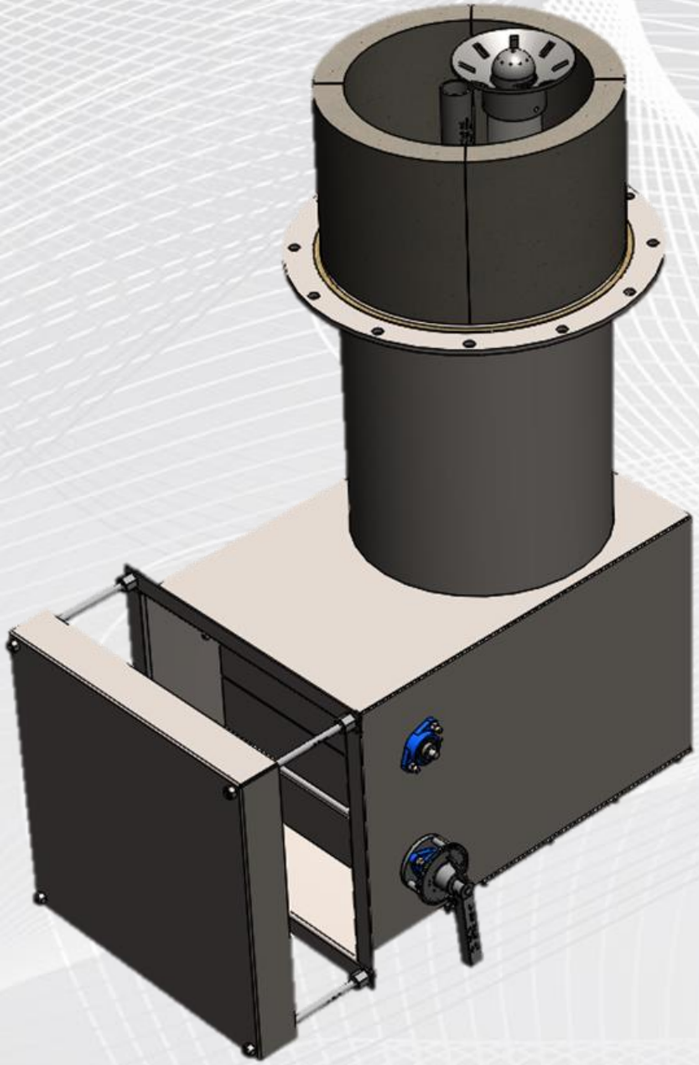
Application Overview

- Downfired primary reformer furnace
- European ammonia production facility
- 105 downfired burners > 40 years old
- NO_x emissions in range of 250-300 mg/Nm^3
- Customer wanted to reuse burner windbox and damper

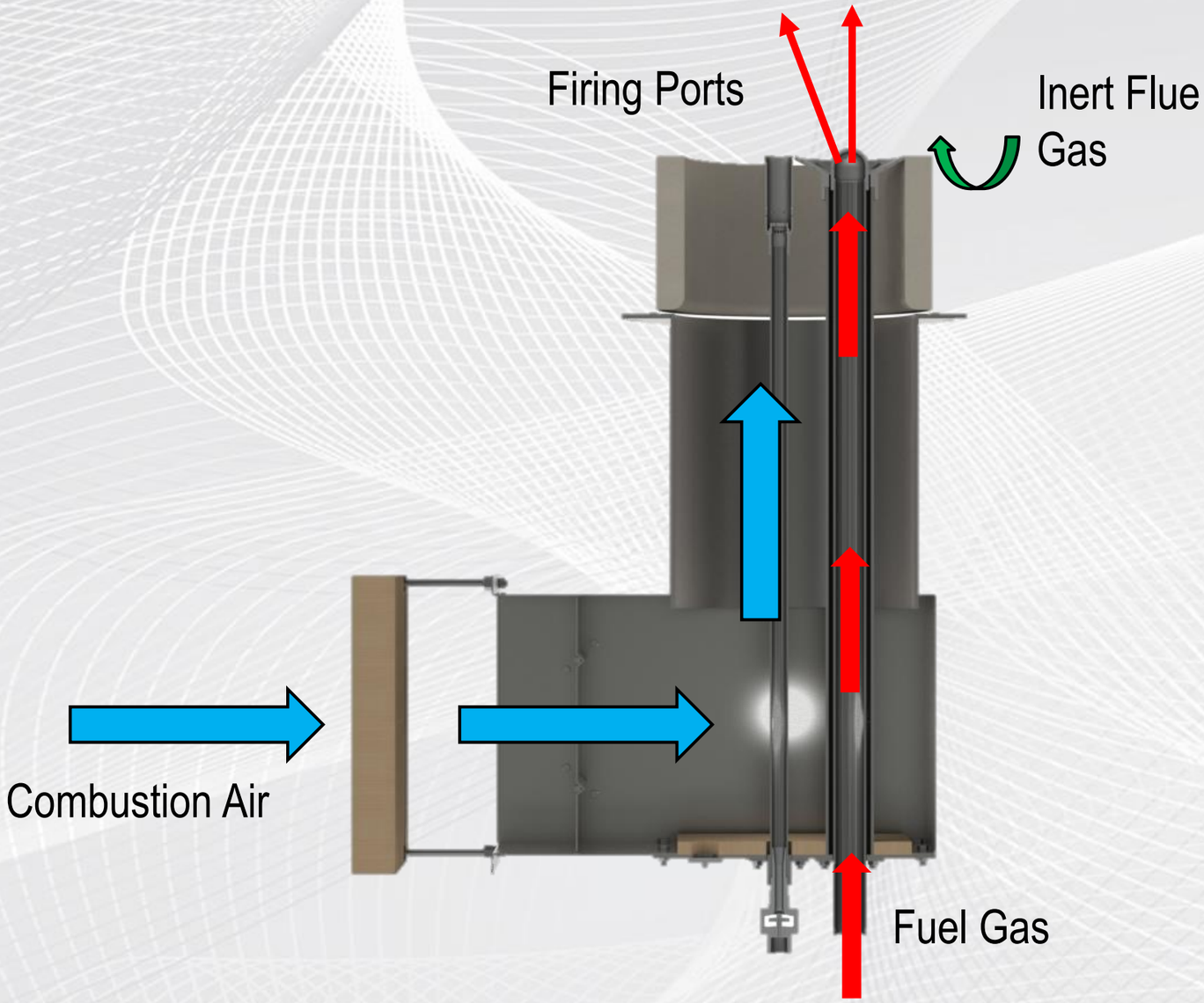
Zeeco Solution

- Supply GB Single Jet ultra-low emissions kit:
  - Gas lance / tips
  - Stabilisation cone
  - Burner tile
- Retain existing:
  - Windbox
  - Damper / damper controls
  - Pilot
- Guaranteed NO_x emissions of 120 mg/Nm^3 on natural gas
- Design for 10% excess air (≈2.1% O_2 by vol. of dry flue gas)

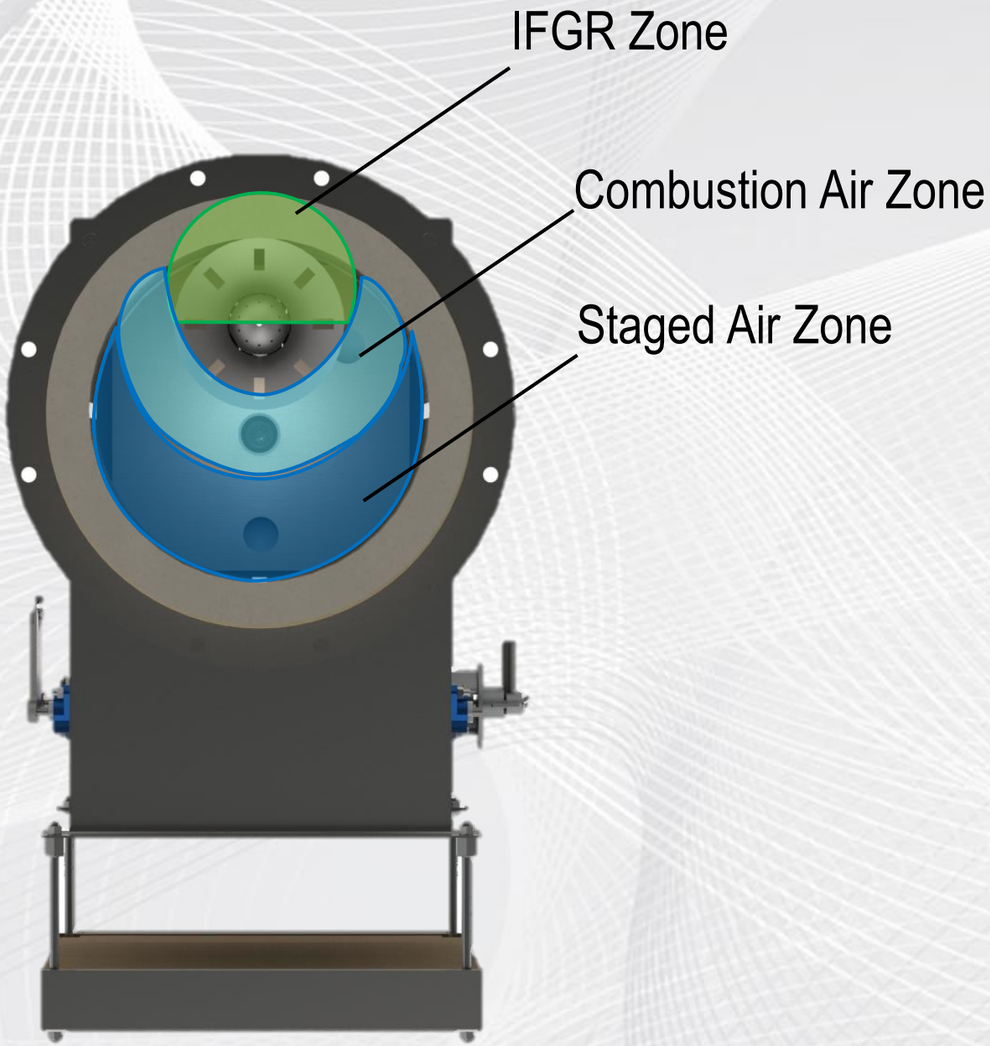
Zeeco Solution



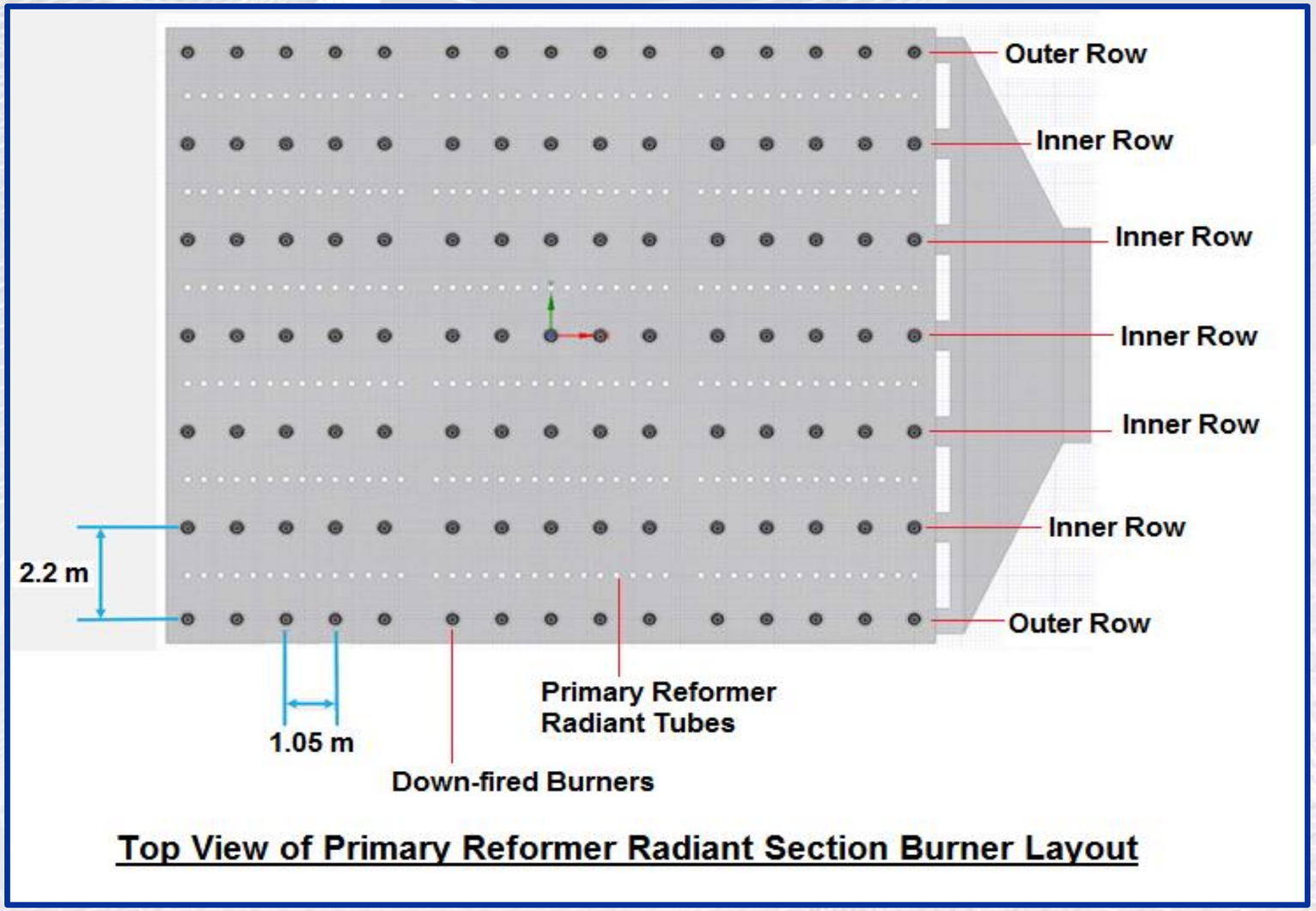
Zeeco Single-Jet Ultra-Low Emissions Burners



Zeeco Single-Jet Ultra-Low Emissions Burners



Primary Reformer Radiant Section - Plan View



Top View of Primary Reformer Radiant Section Burner Layout

Radiant Section – Heater Process Information

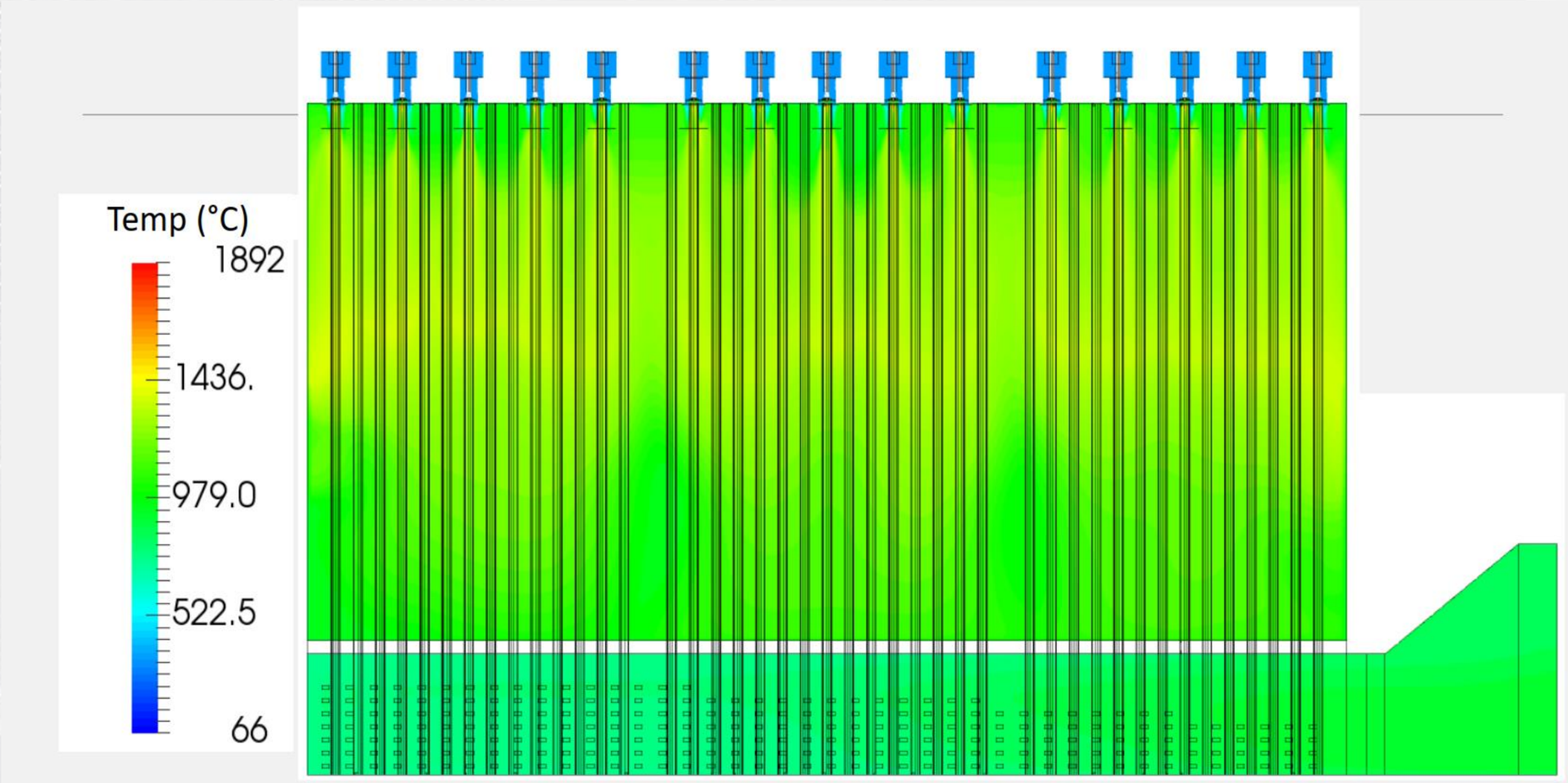
Type of Reformer Furnace	Ammonia Reformer
Type of Draft	Forced
Direction of Firing	Downfired
Primary Reformer Width, m	14
Primary Reformer Length, m	16.4
Primary Reformer Roof Area, m^2	229.6
Total Number of Burner Rows	7
Distance Tube to Tube Between Tube Rows, m	2.2
Total Maximum Heat Release for Reformer, MW	158.19
Total Normal Heat Release for Reformer, MW	131.84
Heat Release per Roof Area at Maximum Duty, MW/m^2	0.689
Heat Release per Roof Area at Normal Duty, MW/m^2	0.574

Radiant Section – Burner Process Information

Type of Burner	Zeeco GB Single Jet Inner Burners	Zeeco GB Single Jet Outer Burners
Total Number of Burners	75	30
Number of Burners per Row	15	15
Number of Rows of Burners	5	2
Maximum Heat Release per Burner, MW	1.674	1.088
Normal Heat Release per Burner, MW	1.395	0.907
Turndown	6:1	6:1
Design Excess Combustion Air, %	10	10
Combustion Air Temperature, degrees C	300	300
Furnace Temperature, degrees C	1200	1200
Total Heat Release at Maximum Duty, MW	125.55	32.64
Percentage of Total Heat Release, %	79.4	20.6

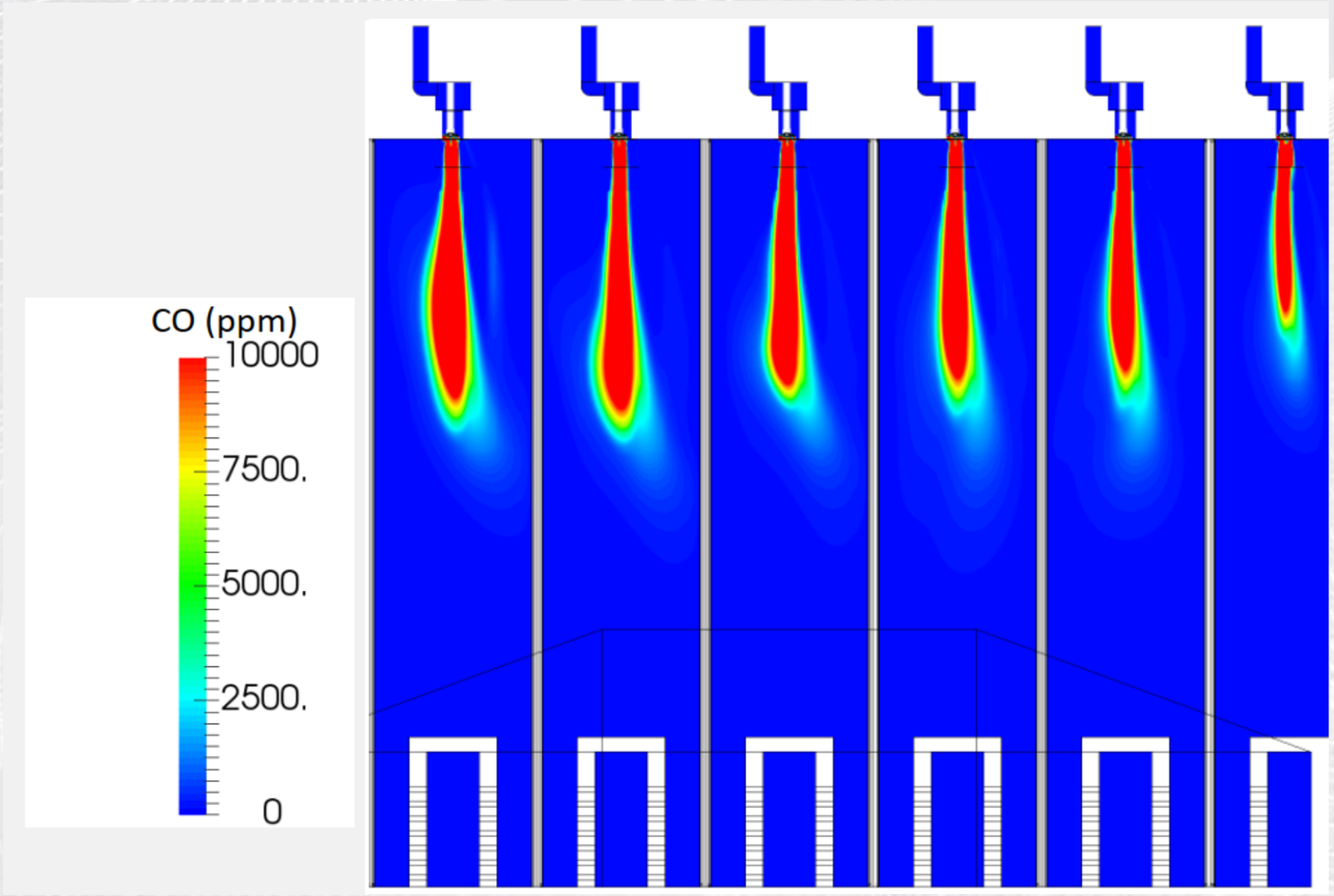
CFD Study

- Gas temperature contours



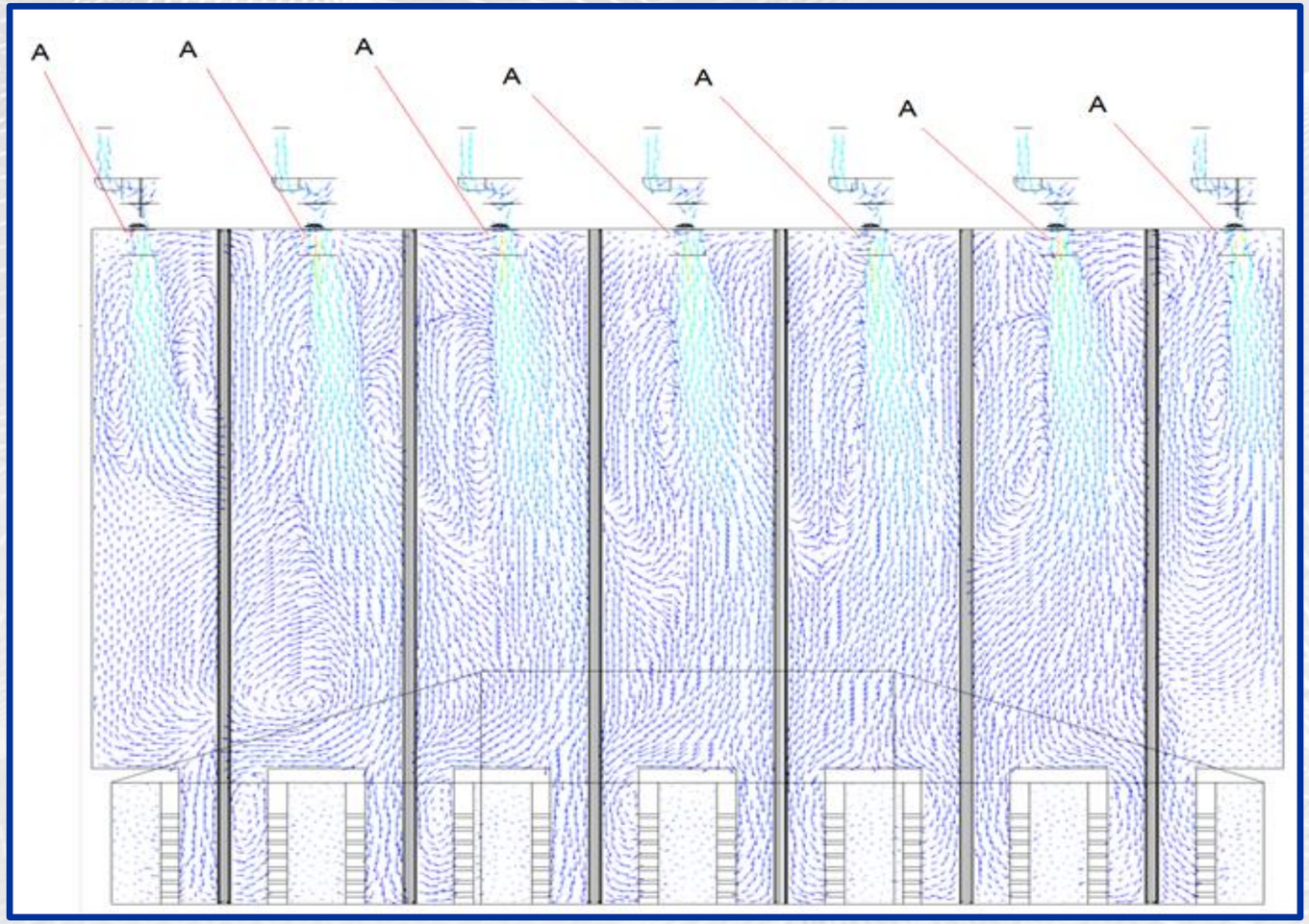
CFD Study

- CO contours confirmed minimum flame interaction



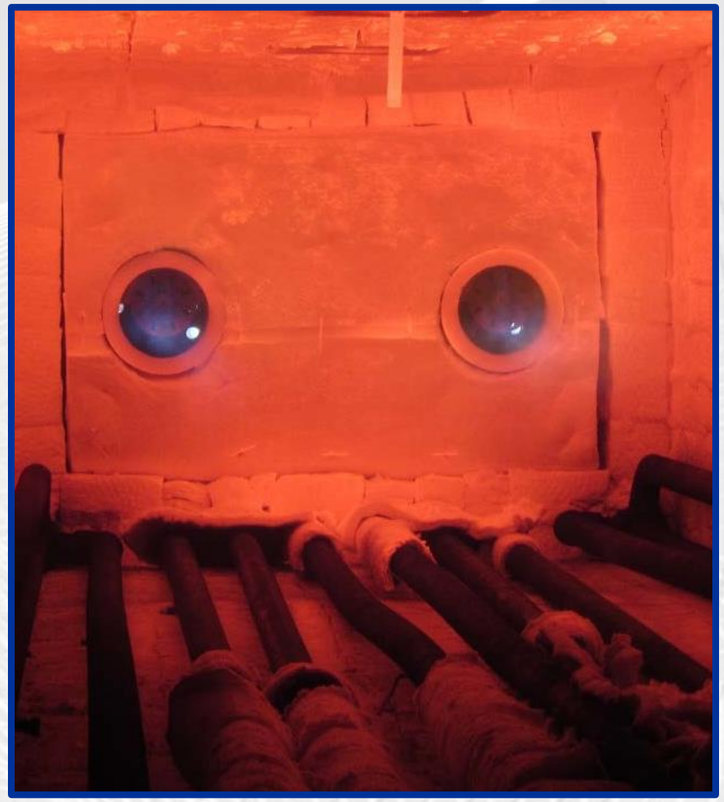
CFD Study

- Location A: Inert products of combustion drawn into fuel gas



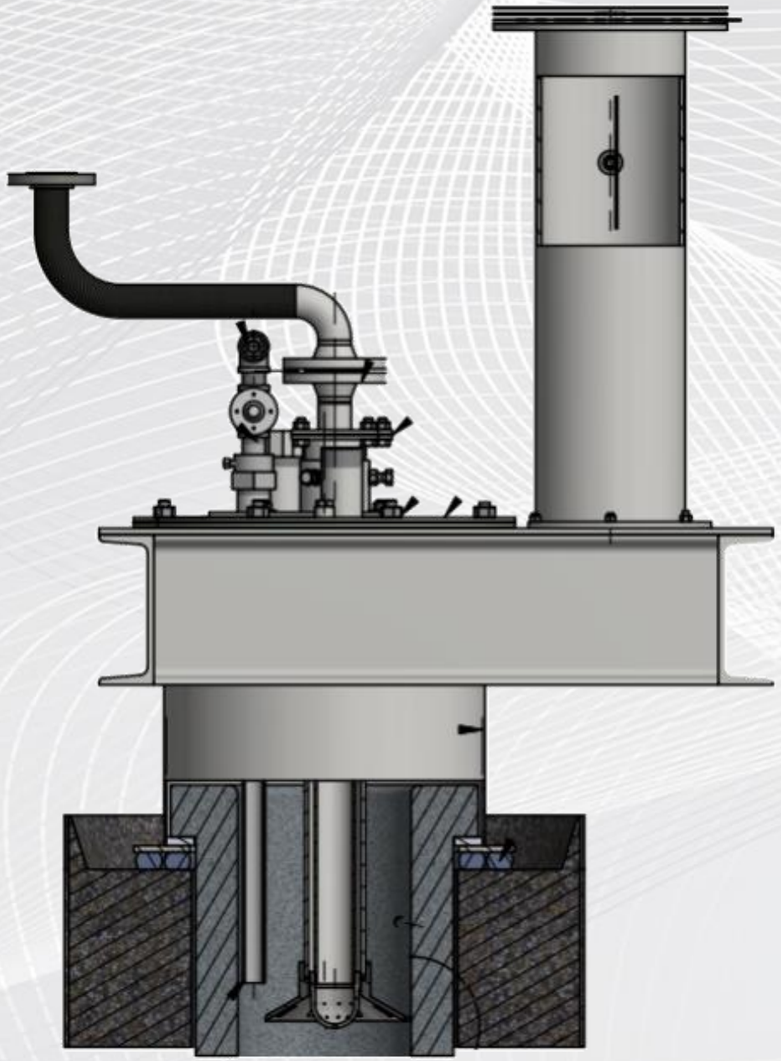
Burner Testing at ZEECO

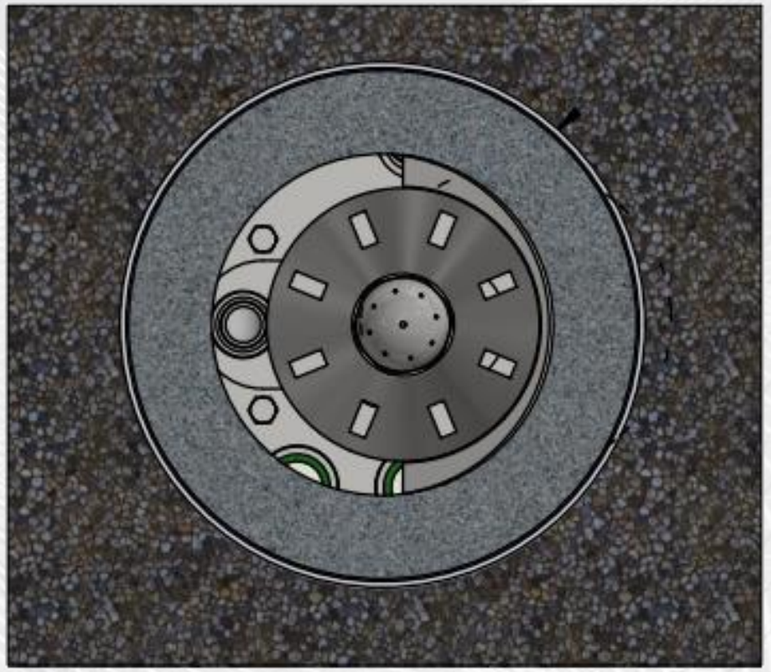
- Combustion test performed at Zeeco Global HQ.
- Multi-Burner testing to verify NO_x emissions
- 80-90 mg/Nm^3 NO_x at 2.0% O_2
- Confirmation of no flame-to-flame interaction
- Proven flame stability at 1.1% O_2 (dry basis)



Zeeco Test Furnace

Burner General Arrangement Drawing





TILE VIEW

Installation

- Burners were installed early 2018
- Retrofit kits minimised installation time and labour requirements
- Burners utilised Zeeco ProFlame™ scanners for flame detection
- Flexible hoses used for gas connections

Burner Performance

- Burners are achieving 90 mg/Nm^3 NO_x
  - Significantly lower than the guaranteed NO_x (120 mg/Nm^3)
- 3.0% O_2 measured in the flue gas; therefore, further reductions will improve NO_x
- No flame-to-flame interaction
- Improved heat flux profile

Conclusion

- Zeeco supplied 105 GB Single Jet inserts for a downfired reformer at a European ammonia facility
- NO_x emissions, heat flux profile, and flame-to-flame interaction were confirmed by CFD and burner testing
- Current NO_x emissions average 90 mg/Nm^3 at 3% O_2 which meets European legislation and NO_x guarantees
- Burners are operating with lower excess air; therefore, fuel gas consumption rate is lowered in the radiant section
- NO_x emissions can be reduced further if the furnace excess air is trimmed

Questions?

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