SAACKE

Bio Fuel Firing - A Modern Approach

Moving beyond a heuristic approach *- exploring how innovative modelling, research, and real-world experience are redefining the safe and efficient use of alternative fuels on the path to Net Zero.*

CEA
Combustion Engineering Association

Agenda

1. Bio Oil Firing - Analysis & Testing
2. A Modern Approach - CFD Modelling
3. Alternative Gas Firing - Project Development
4. Feasibility Study - UK
5. Proven Technology - The Switch to Hydrogen Fuel

Moving beyond a heuristic approach - exploring how innovative modelling, research, and real-world experience are redefining the safe and efficient use of alternative fuels on the path to Net Zero.

SAACKE

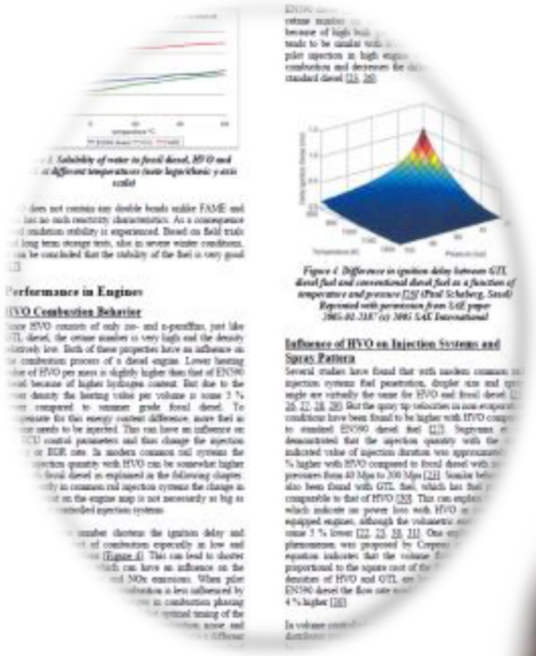
CEA
Combustion Engineering Association

Bio Oil Firing

Sample Analysis/Sample Firing

Before we look at firing a fuel:

- Research the fuel.
- Have we any experience with this or similar fuel?
- Obtain a small sample of fuel for independent analysis.
- Compare the analysis with known fuels.
- Prepare a report on the findings.
- This maybe the end of the process for some customers.

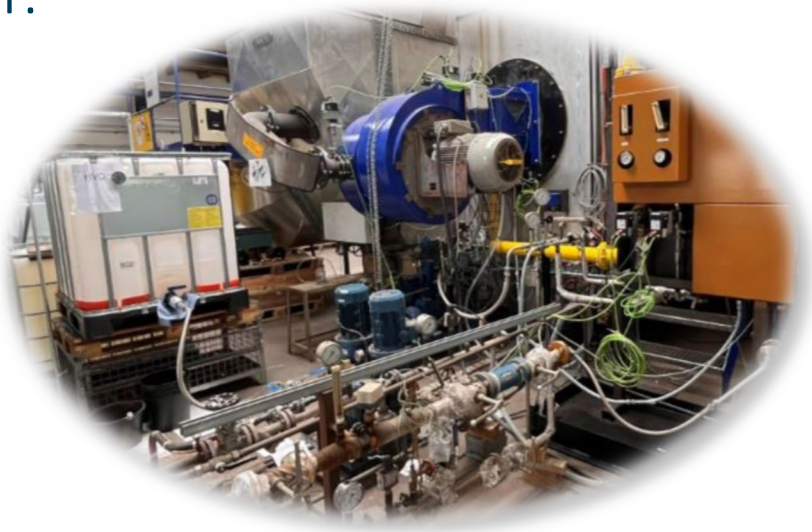


Bio Oil Firing

Sample Analysis/Sample Firing

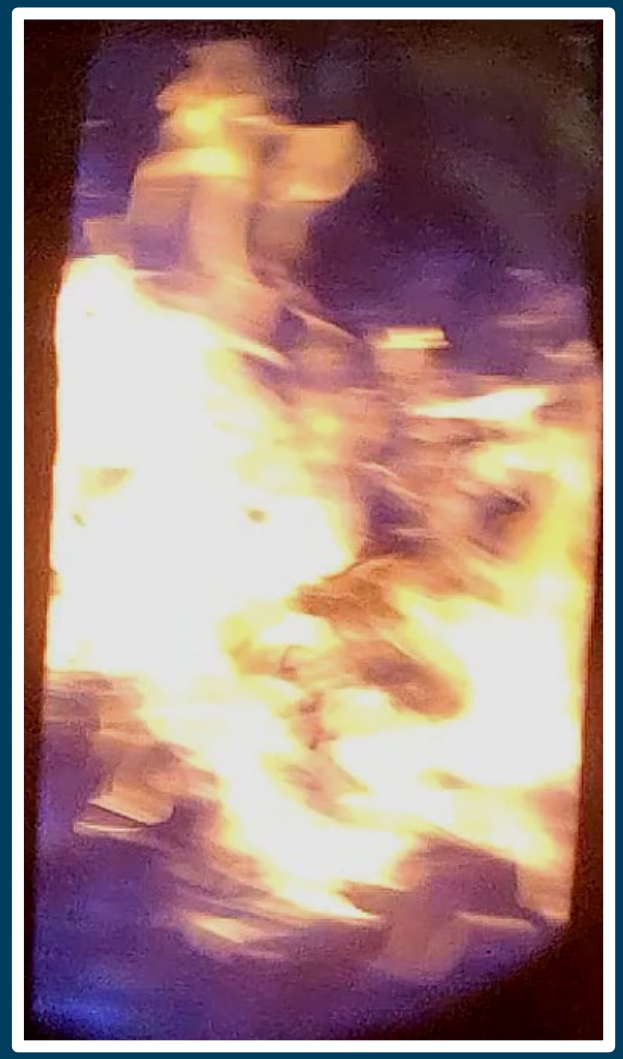
Following research and analysis:

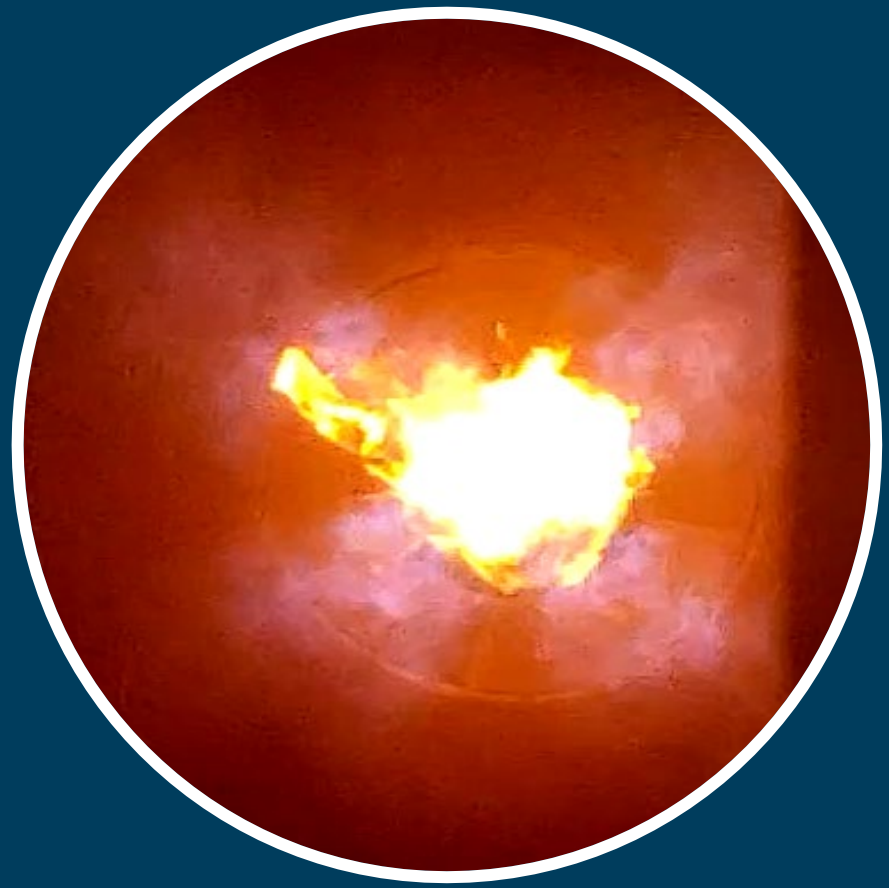
- Larger sample obtained for test firing in the SAACKE ‘Tecnikum’.
- Selection of boiler types available.
  - Shell
  - Water tube
- Selection of burner types available.
  - Rotary Cup
  - Pressure Jet
  - Atomised (either steam or air)
- Test fuel at various temperatures and pressures.
- Compare results with known fuels.
- This may also be the end of the process for some customers.



Bio Oil Firing

Test Firing





SAACKE

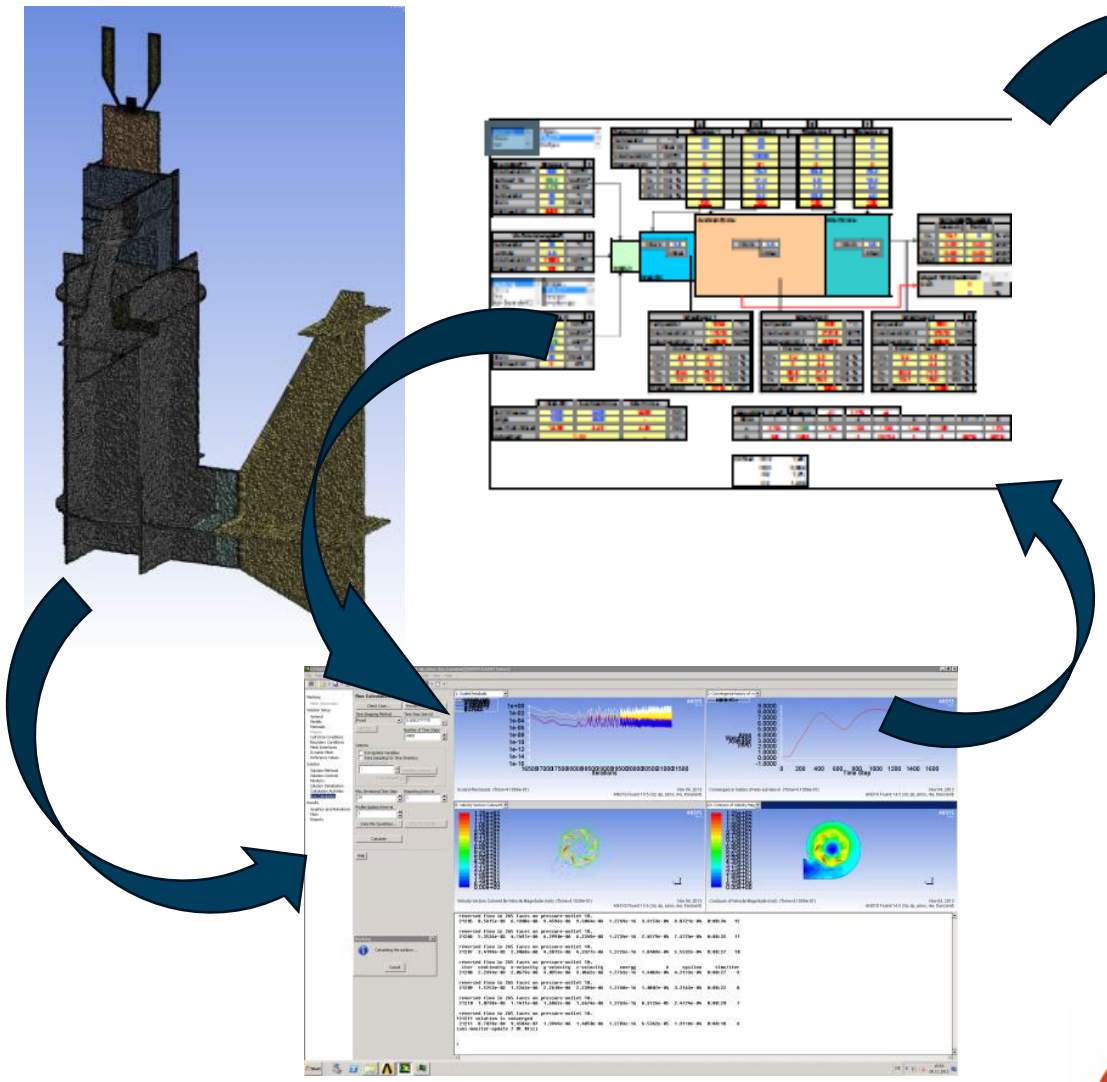
CEA
Combustion Engineering Association

Computational Fluid Dynamics

CFD modelling

Actual set up:

- Geometry, Boundary Limits, Mesh model.
- Combustion Model Setup and Processing.
- Validation and check.
- Revalidation.
- Interpretation of Results.



OMBUSTION BY SAACKE

CEA Combustion Engineering Association

Computational Fluid Dynamics

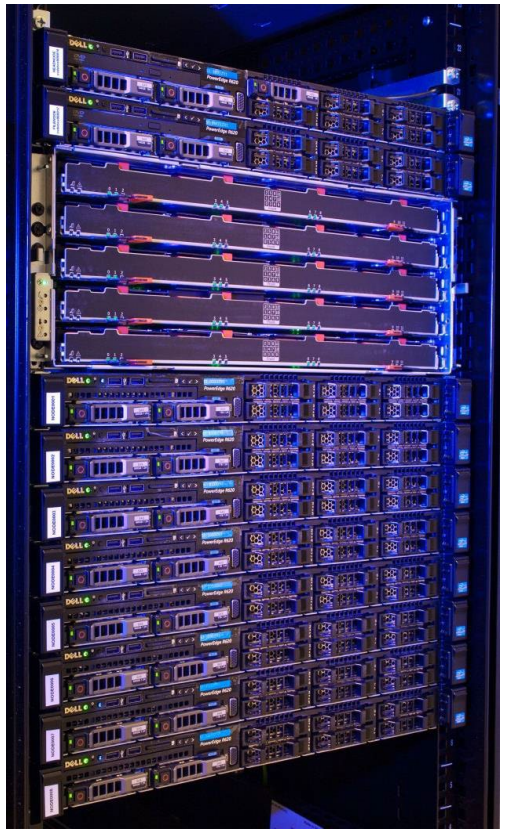
CFD require Computing Power!

CFD needs High Performance Computing

- ANSYS Fluent (Software).
- Computing cluster with:
  - 288 processor cores
  - 36 racks
  - 1.5 TB RAM
  - 160 TB HDD

>10’s of Years of experience with CFD.

>100’s of Years combustion experience.



OMBUSTION BY SAACKE

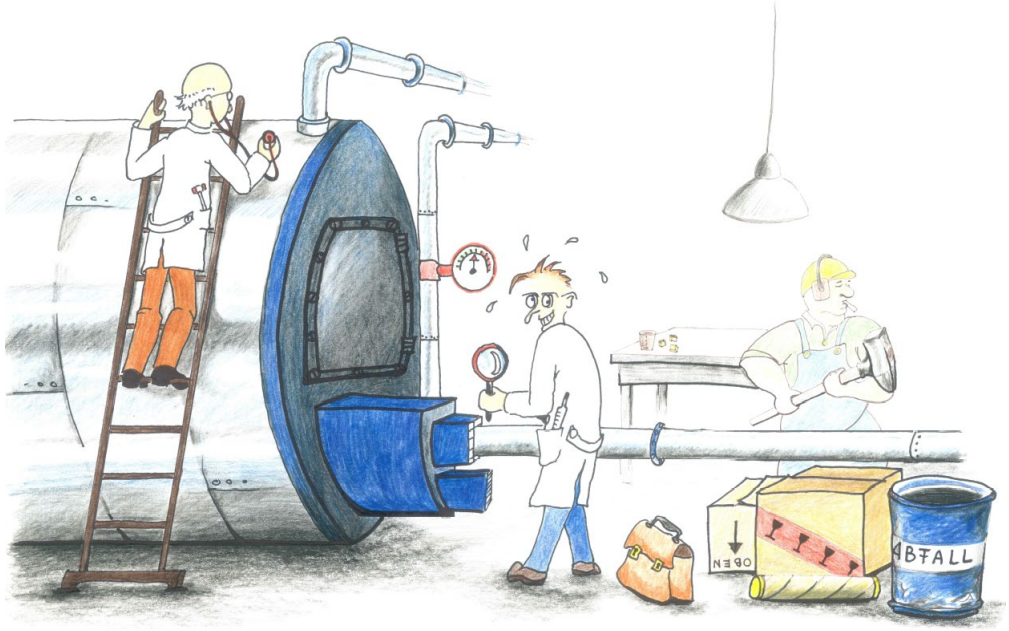
CEA Combustion Engineering Association

Computational Fluid Dynamics

CFD requires Computing Power!

How does CFD help?

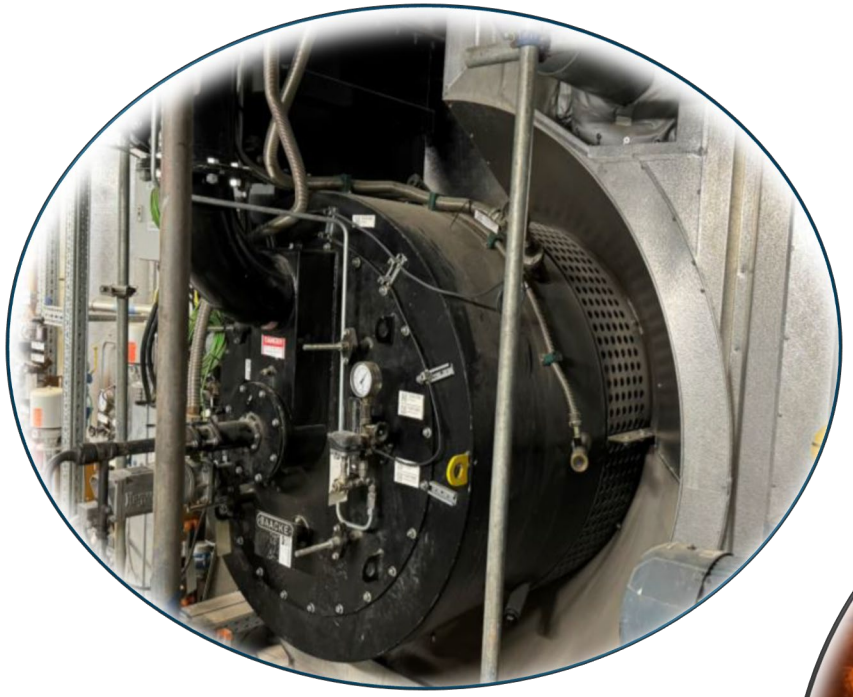
- Theoretical testing before arrival on site.
- Reduced risk:
  - Lower down time
  - Forecasting issues
  - Predicting adjustments
  - Know what to expect
- Predicted limitations of operation.
- Known commissioning process.
- Operators shown the modelling will know what to expect.



Bio Oil Firing

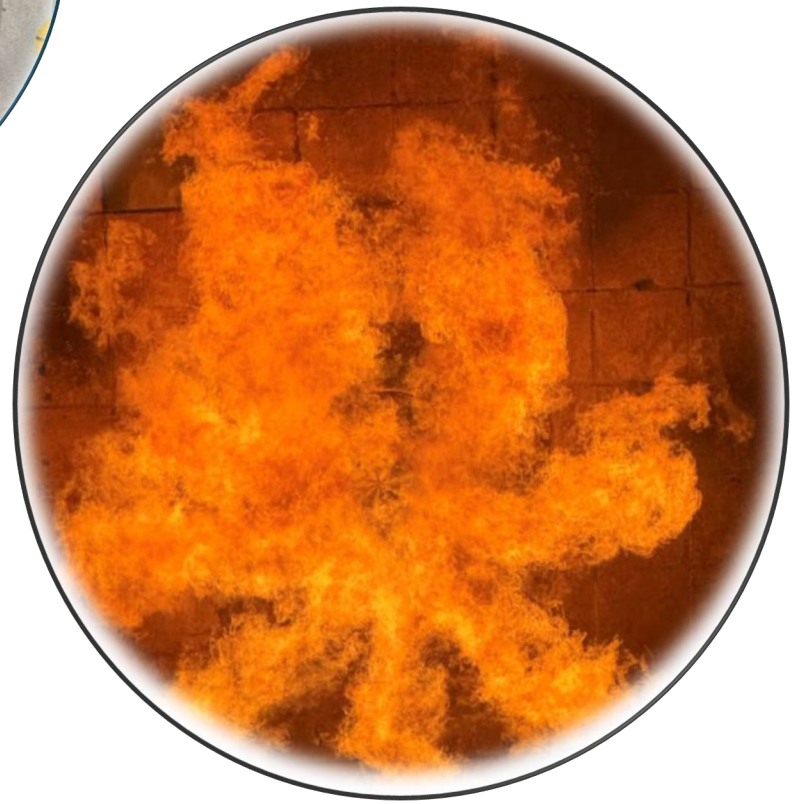
On-Site Firing

- Actual on-site testing.
- Proving the research.
- On-Site Support for Bio Oil firing, was included.
- Commissioning or reset. combustion if required.
- **Results were as predicted.**
- The burners continues to run smoothly.



SAACKE SSB Burner on site

Flame seen on site



OMBUSTION BY SAACKE

CEA Combustion Engineering Association

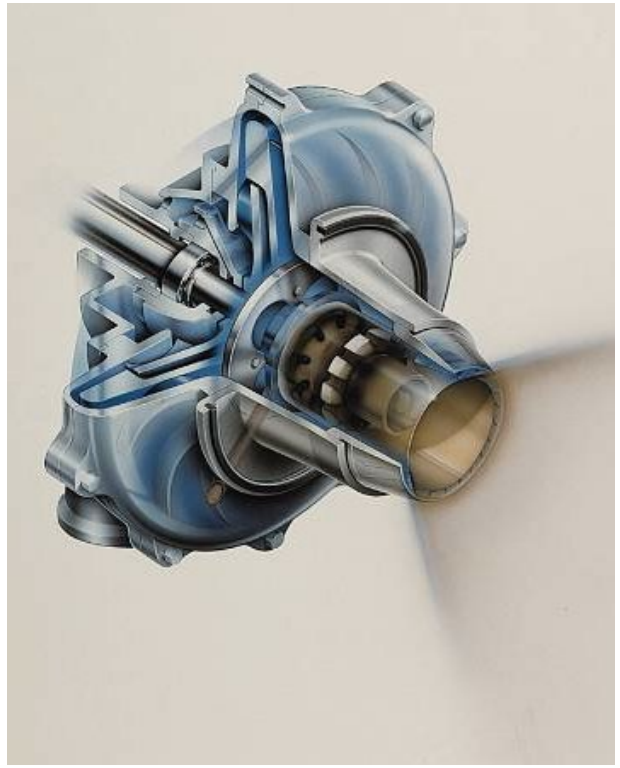
Bio Oil Firing

Summary

Using liquid Biofuels in industrial firing plants

- Requires **specific properties** taken into consideration.
- Places high demands on:
  - The burner and plant engineering
  - The storage facilities
  - Control of the combustion process
  - Fuel handling

  (*these all require careful planning!*)
- It may be **inexpensive or free** but consider other costs.
- Combustion requires **well proven** technology.
- **Matching** the burner to the **fuel** is essential.



OMBUSTION BY SAACKE

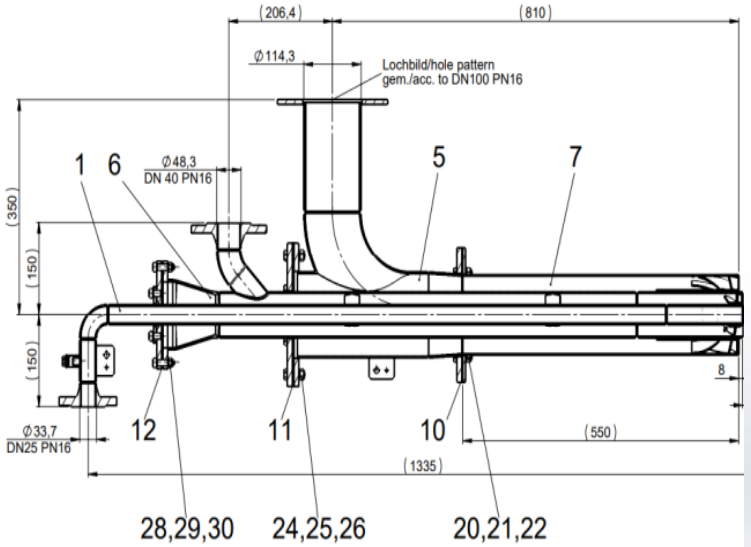
CEA Combustion Engineering Association

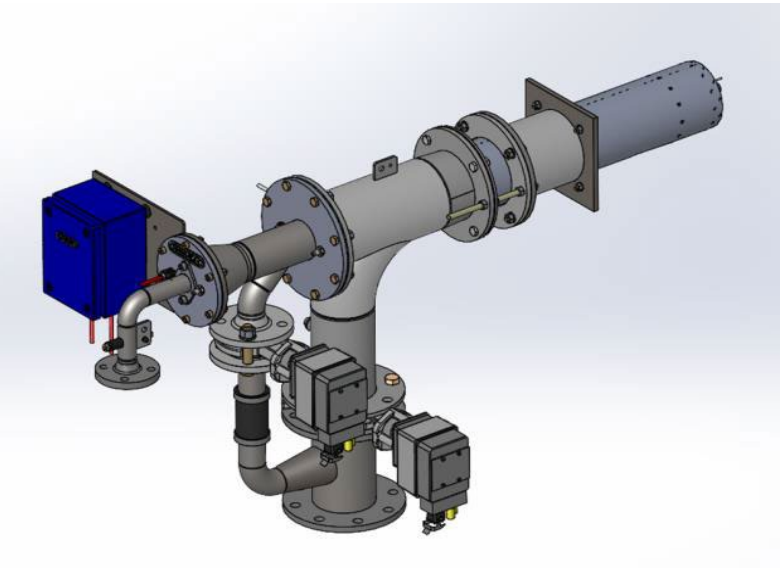
Alternative Gas Firing

Project Development

Car manufacturer (Germany)

- CO2-free car production at the plant by 2025.
- Installed thermal output in production > 40 MW.
- Conversion from Natural Gas to pure Hydrogen.



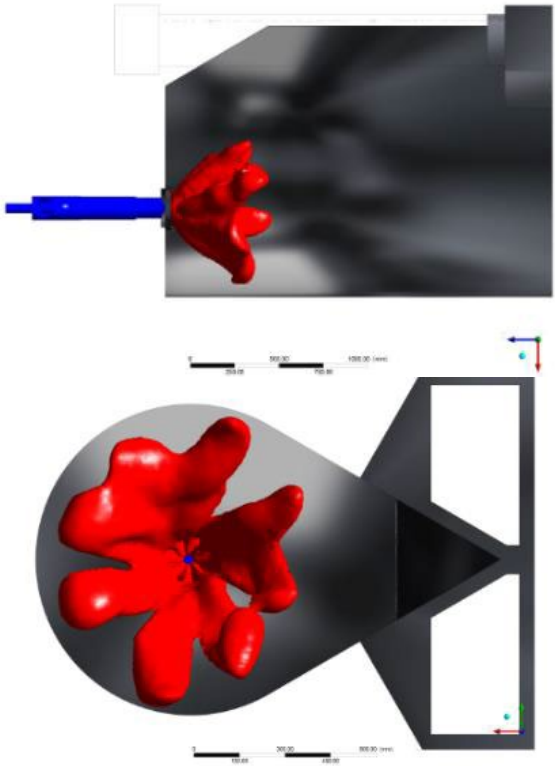


Project Structure

Feasibility study, engineering → Prototyping → Piloting

Alternative Gas Firing

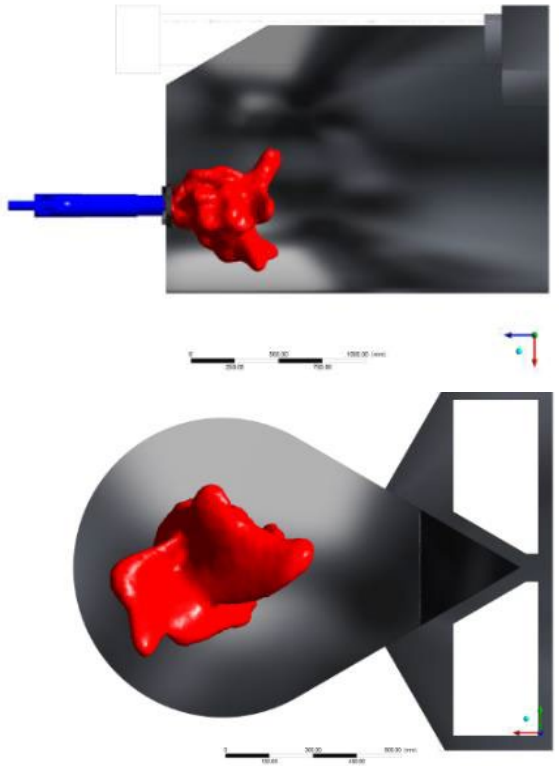
CFD Modelling of New Burner



CFD flame shape for Natural Gas

Phase 1 – Engineering

- Simulation paint dryer, 250/500 kW new burners.
- CFD comparison flame shape for Natural Gas /H2.
- CFD comparison temperature profile for Natural Gas /H2.
- Is the heat at the right intensity where it is needed?



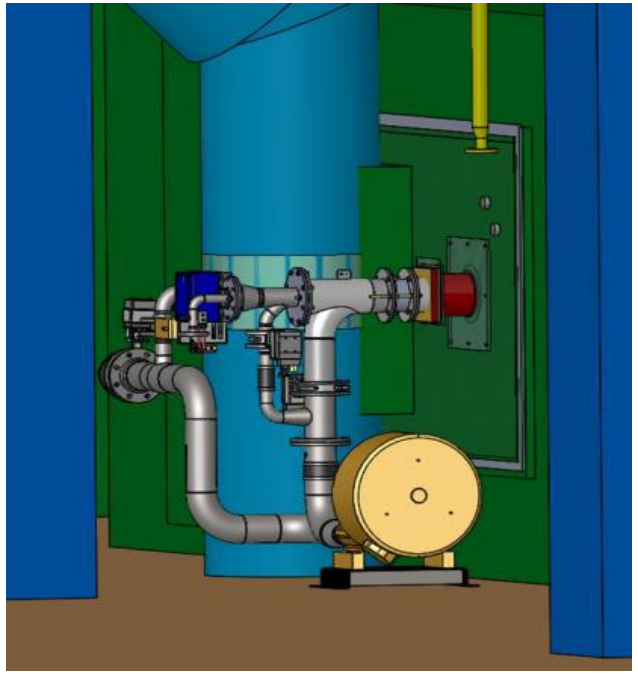
CFD flame shape for H2

OMBUSTION BY SAACKE

CEA Combustion Engineering Association

Alternative Gas Firing

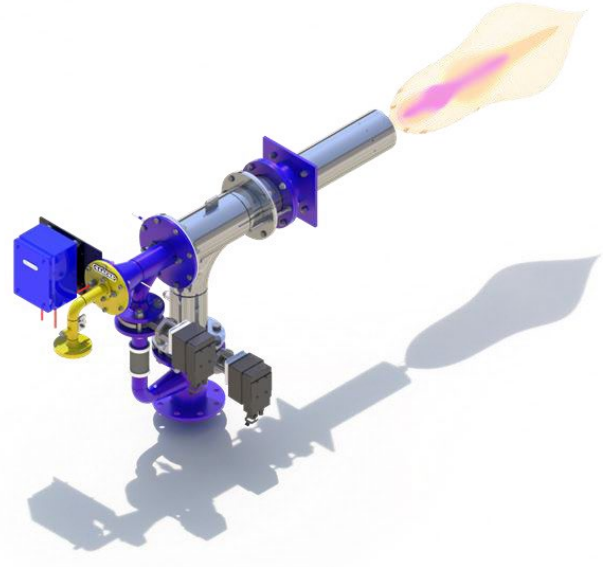
Prototyping

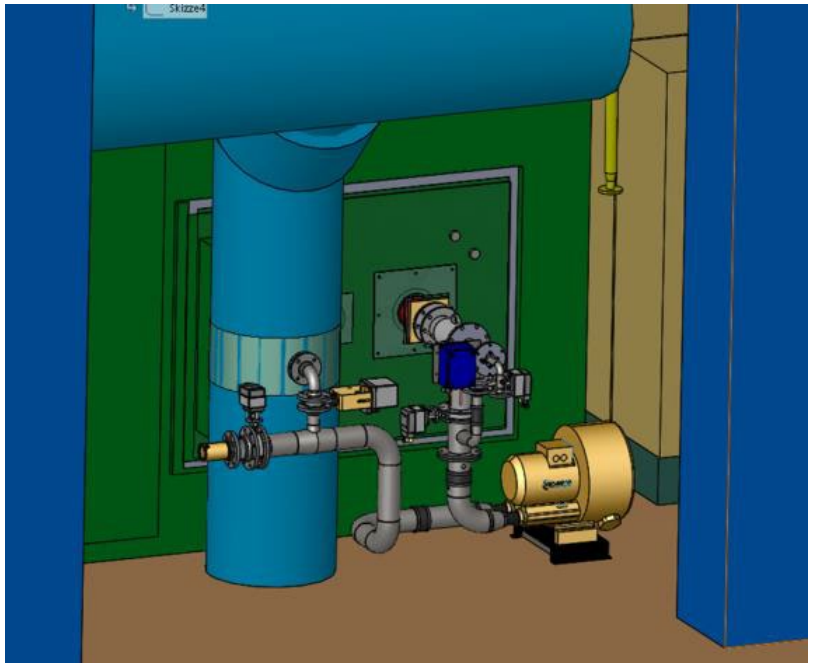


Prototype Designs

Phase 2 - Prototyping

- Following CFD Modelling.
- Test of two prototypes on the paint dryer.
- Firing capacity of 250 kW and 500 kW.





Alternative Gas Firing

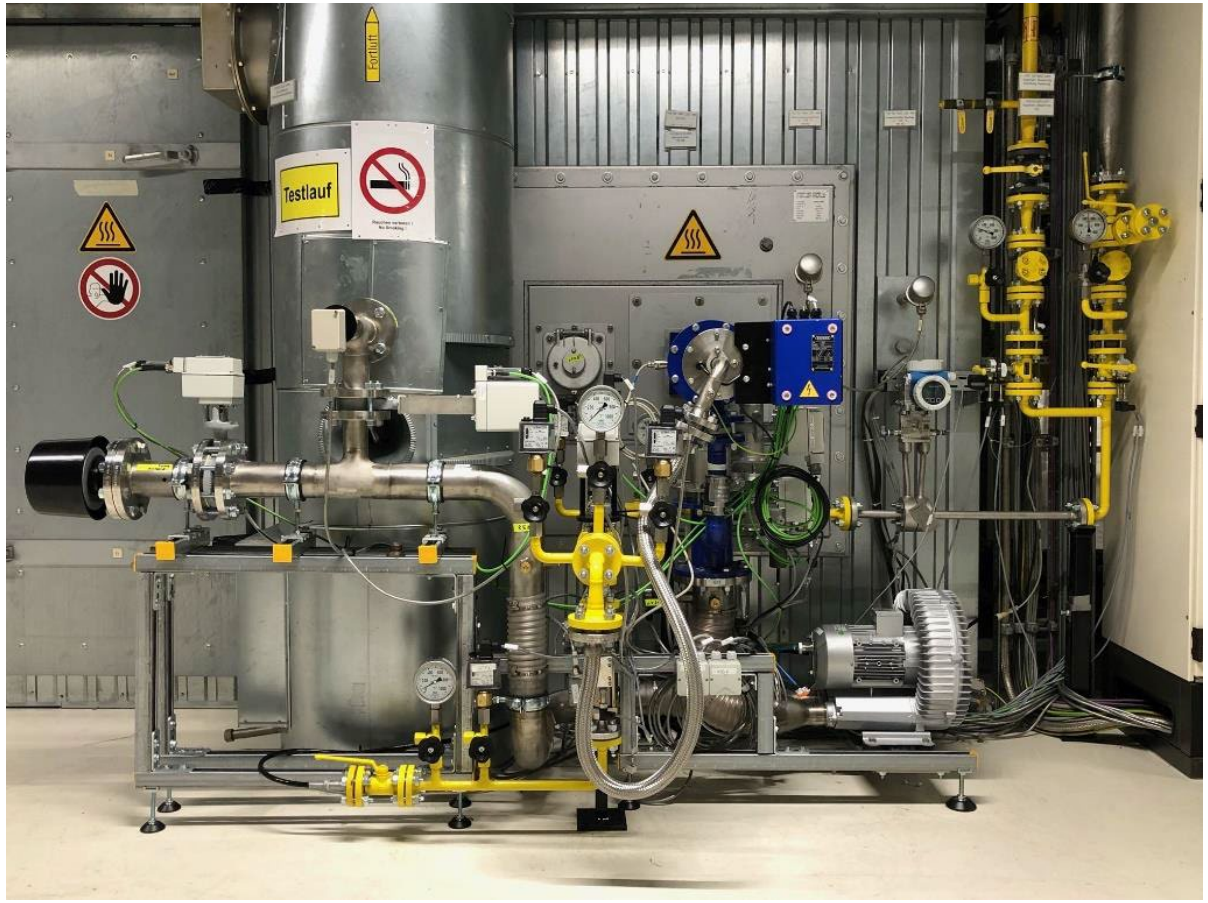
Further Testing

Concept

- Common gas line, at the burner
- No separate gas lance
- Flue gas recirculation via the combustion air fan → Only **low** flue gas recirculation required

Result

The tests were **successfully** completed!



Concept of New Burner in place

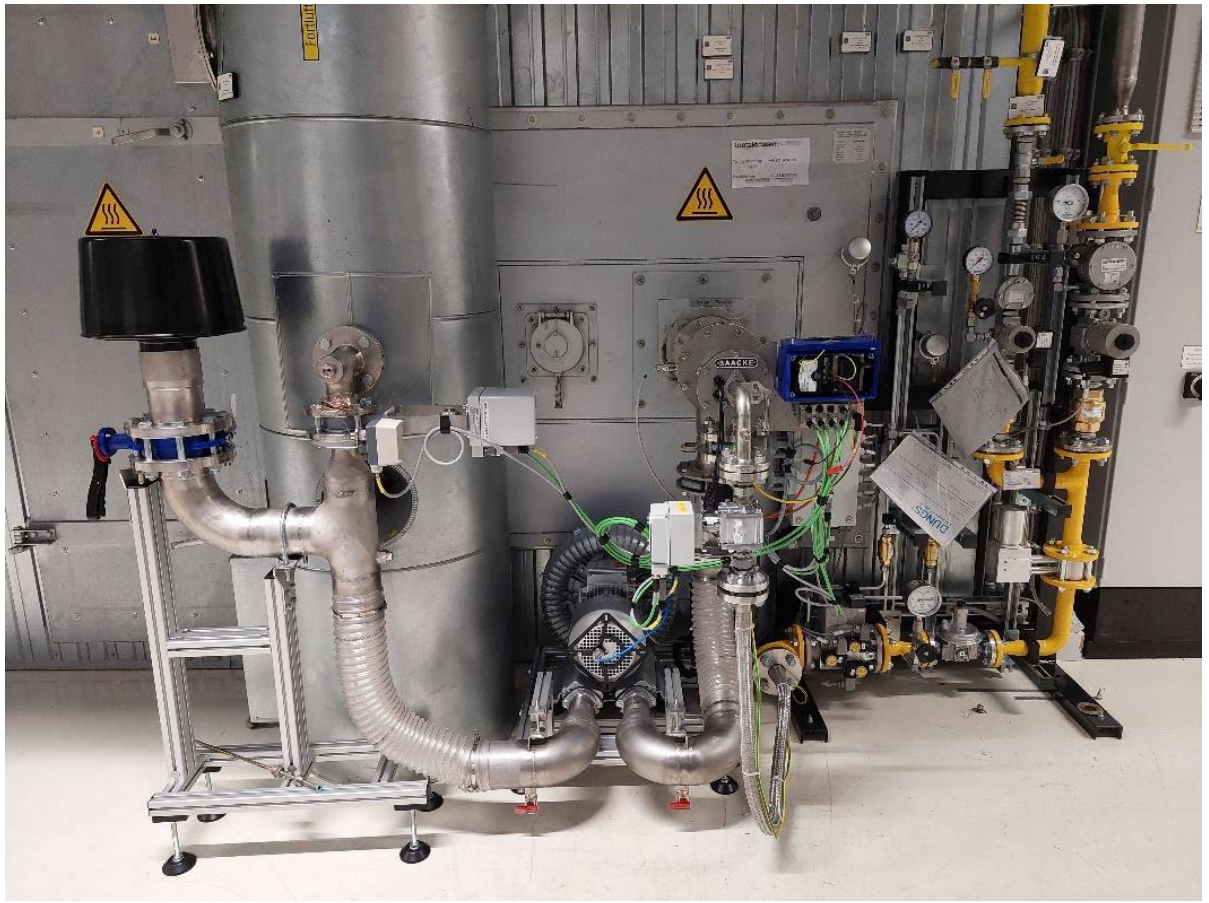
Alternative Gas Firing

Moving Forward

Phase 3 – Piloting

- Initial installation of 5 pilot burners on a paint drying line .
- Firing capacity of 250 kW and 500 kW.
- Installation of a further 6 burners, with a firing capacity from 250 - 600 kW.

All burners can now successfully operate on Hydrogen.



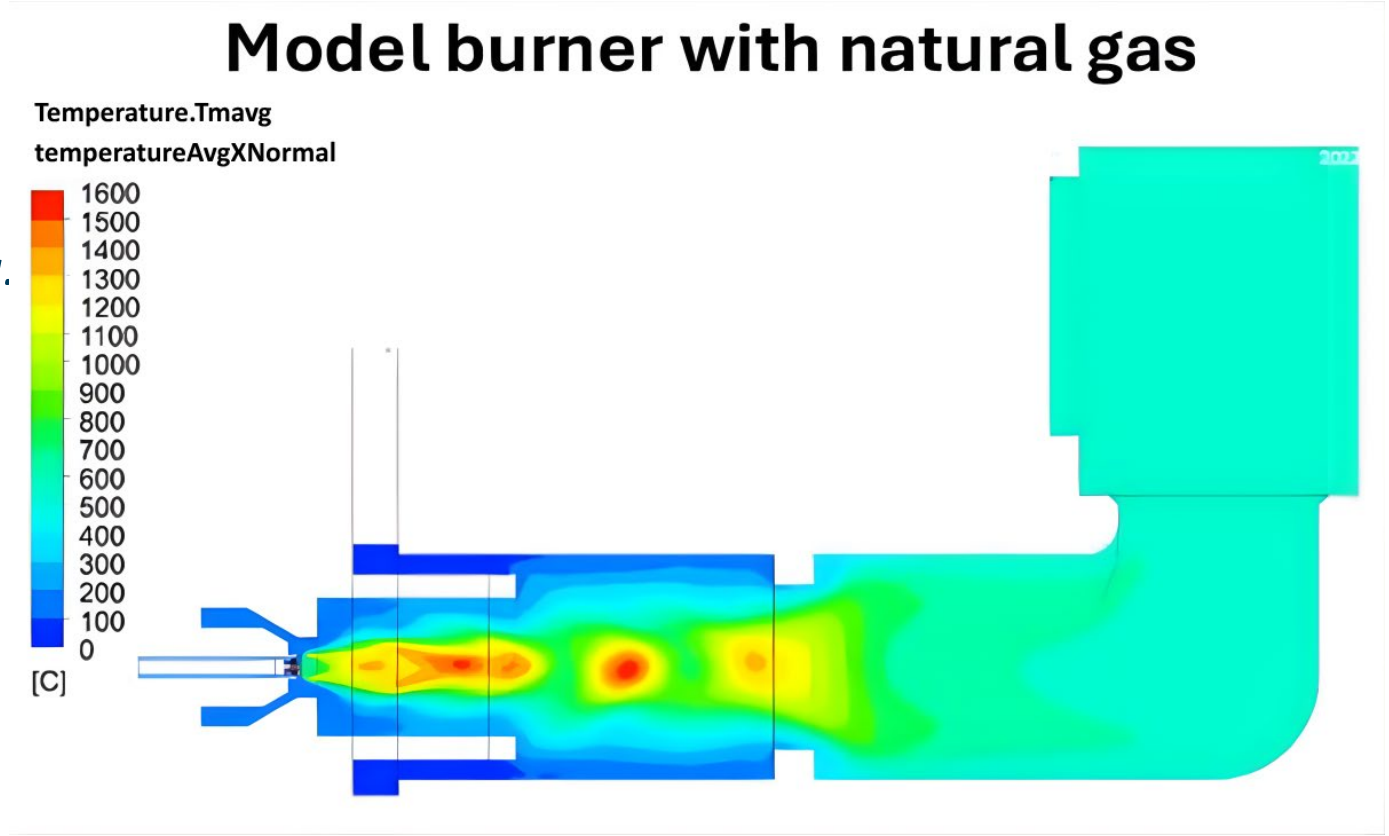
New Burner in place

Computational Fluid Dynamics

Feasibility Study - UK

Early-Stage Study

- *Large food manufacturer in the UK.*
- *Looking at Carbon Reduction/H2 firing.*
- *Currently firing Natural Gas.*
- *Indirect heating - for drying and frying processes.*
- *High CO produced.*
- *Little control of flame shape.*
- *Often seeing damage down stream in the system.*



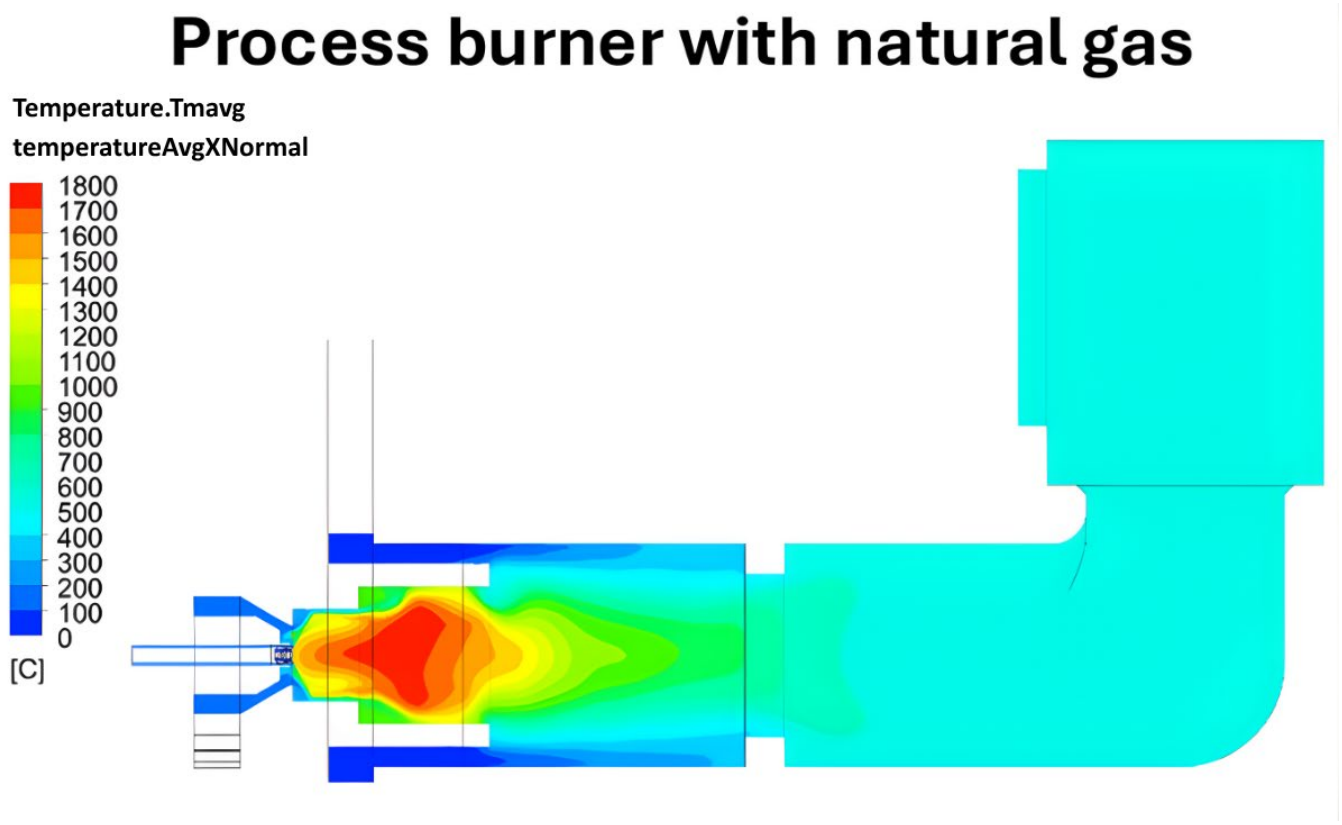
Temperature distribution on Existing Burner

Computational Fluid Dynamics

Feasibility Study - UK

Where next?

- *What would the SAACKE option look like?*
- *How will the process react with the new flame shape?*
- *What is the temperature profile?*
- *Will this help with existing issues, damage/high CO?*
- *Will the new shape cause other issues?*



Temperature distribution new burner- natural gas

Computational Fluid Dynamics

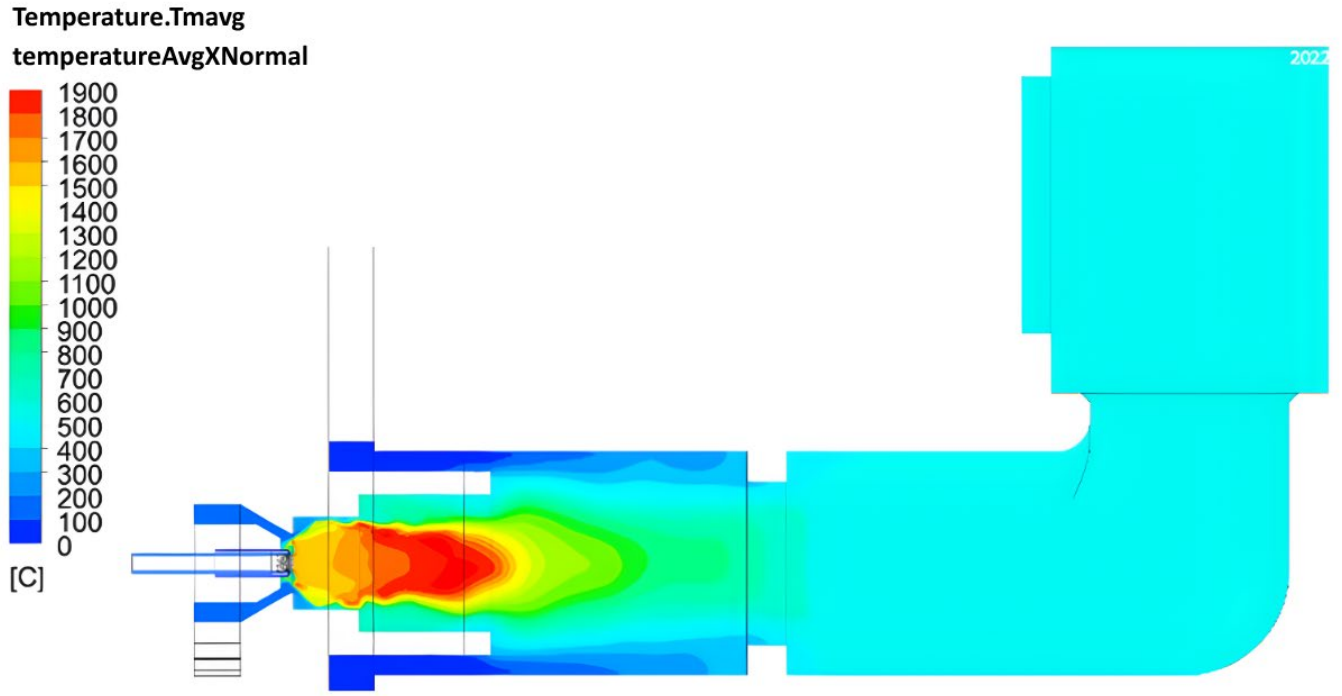
Feasibility Study - UK

Where next?

- *What about an Alternative Fuel (H2)?*
- *Do we predict any adverse effects?*
- *What is the expected flame shape?*
- *Do we still get the required Heat transfer?*

The future is to test this theory on a real plant, with the confidence gained through modelling.

Process burner with hydrogen



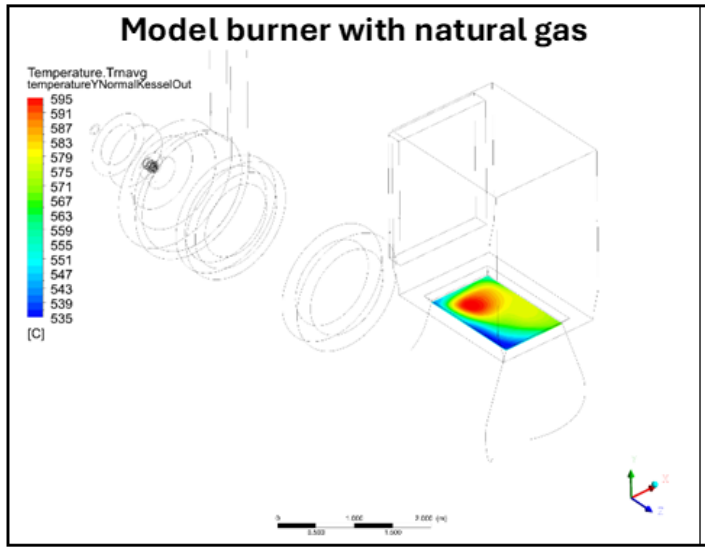
Temperature distribution new burner - hydrogen

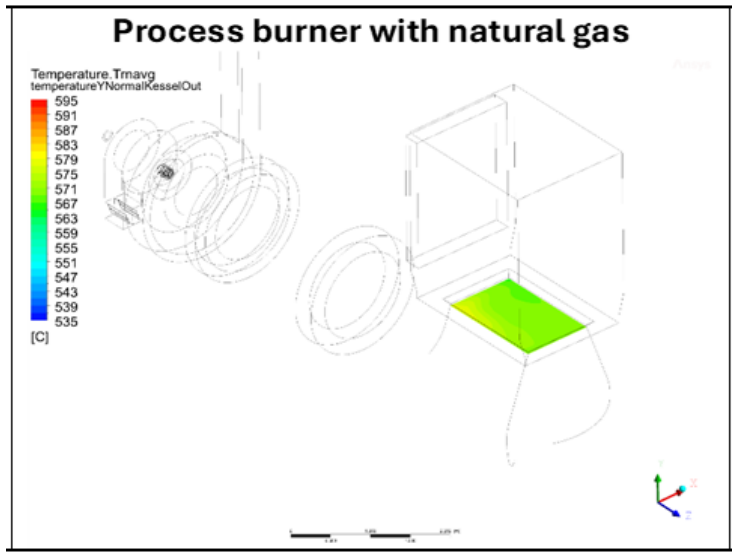
Computational Fluid Dynamics

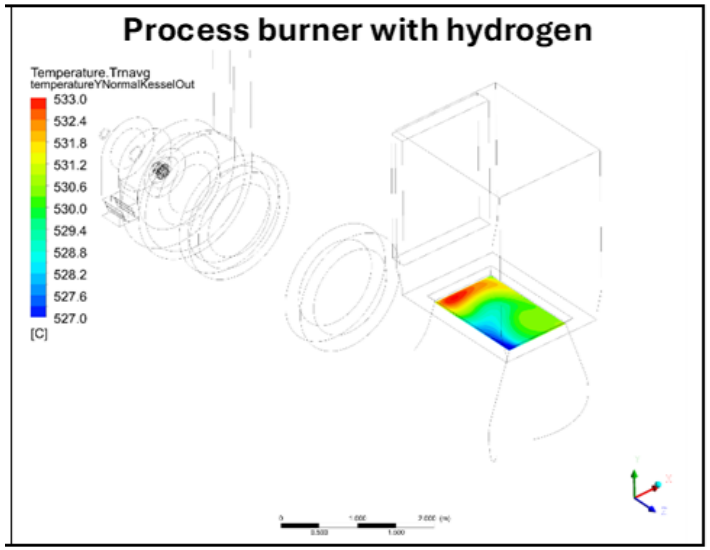
Feasibility Study - UK

Where next?

- *Checking heat profile Combustions Chamber outlet.*
- *New burner provides a more even temperature profile.*
- *Even with Hydrogen - the profile, although different, is relatively even.*







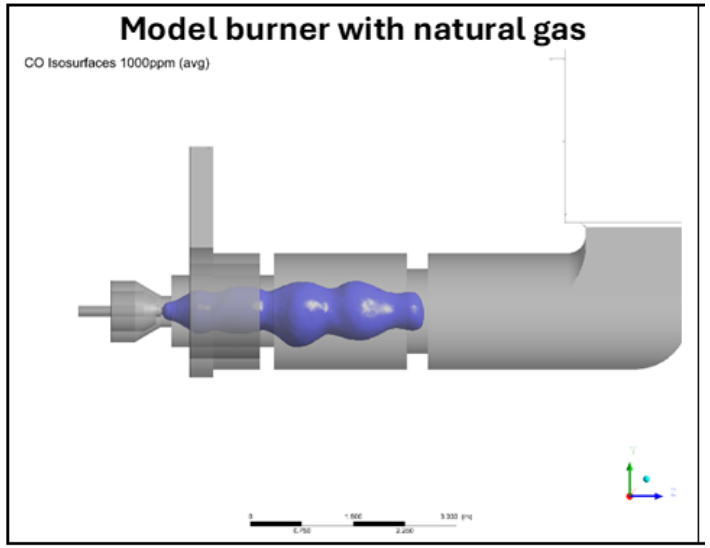
Cross-sectional temperature profiles

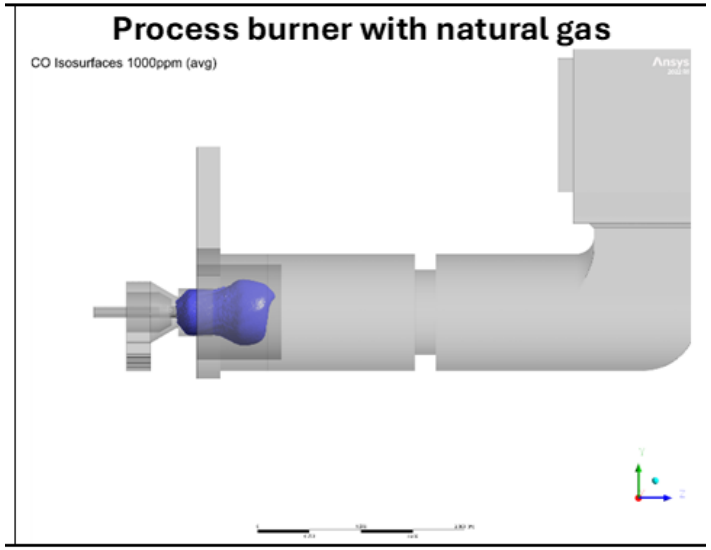
Computational Fluid Dynamics

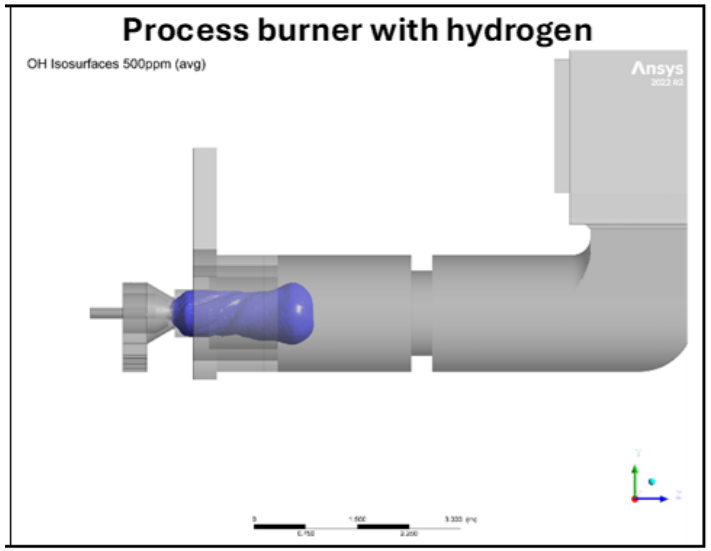
Feasibility Study - UK

What does this show us?

- *Longer flame from the existing burner.*
- *Fast and efficient mixing of fuel and air with the new burner.*
- *Excellent mixing of air and flue gases with the new burner.*
- *Short and compact combustion in the new burner.*
- *It is technically possible to burn 100% H2 with the new burner.*
- *Higher temperatures in H2 operation.*
- ***The process burner together with the chamber is an ideal combination.***





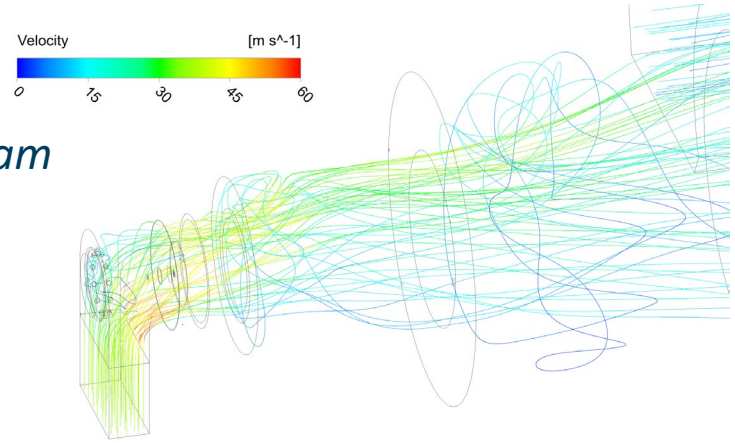


3D flame shapes – vertical section

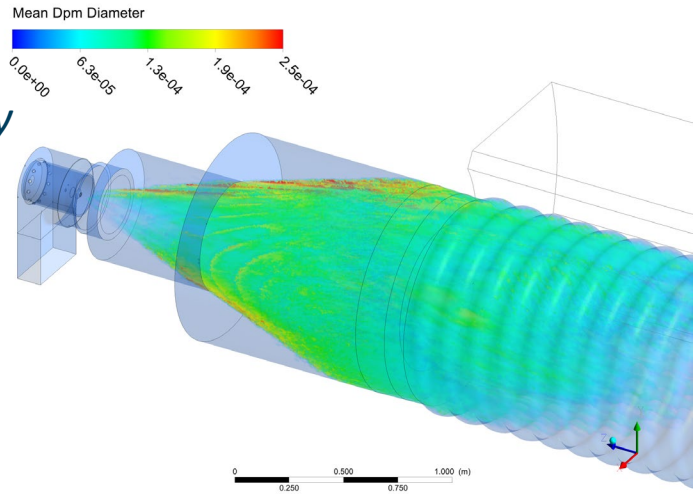
Alternative Fuels Firing

Other CFD Models – Oil Firing

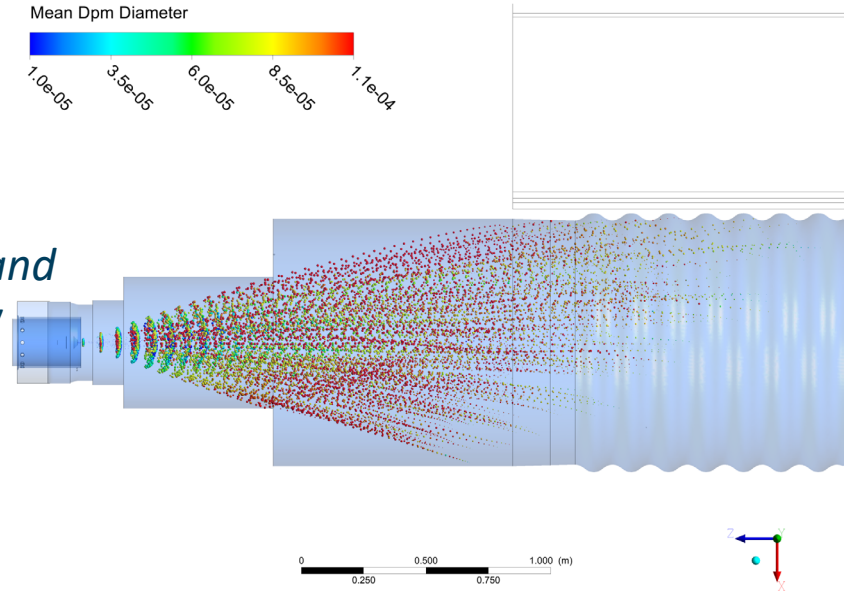
Velocity Diagram



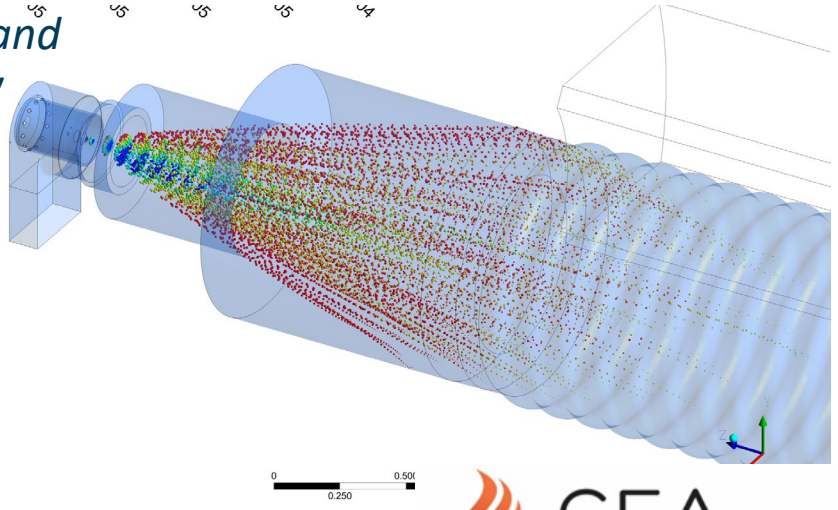
Particle Velocity Diagram



Particle Diameter and flow – plan view



Particle Diameter and flow – side view



OMBUSTION BY SAACKE

CEA Combustion Engineering Association

Alternative Fuels Firing

With a Modern Approach

- *Alternative Fuels must be part of the Net Zero make-up.*
- *Analysis and research are essential.*
- *Industry wide trial and error should be a thing of the past.*
- *Modelling and simulation have their place.*
- *Confidence in ensuring safe, complete and efficient. Combustion.*
- *Technology and experience combined are invaluable.*
- ***This room and the CEA are full of experts, talk to us!***

OMBUSTION BY SAACKE

We are taking the Carbon C 12.011 6 out

OMBUSTION BY SAACKE

CEA Combustion Engineering Association

Alternative Fuels

100% Natural Gas to 100% Hydrogen

Thank you for your attention.

Adrian Rowsell - Business Development Manager

a.rowsell@saacke.co.uk

SAACKE

CEA
Combustion Engineering Association


SAACKE
NHS
LONDON GATWICK
EQUANS
EMPOWERING TRANSITIONS
P&G
Kellogg's
Asahi
TRADE MARK
Heineken
KP Snacks
JLL
DIAGEO
BOSCH
HEINZ
Mondelēz International
ENCYCLIS
VEOLIA
Carlsberg
ABInBev
Pfizer
VINCI
Ministry of Defence
BASF
JAGUAR
LAND ROVER
Unilever
GUINNESS
Heathrow
McCain
suez
KERRY FOODS
Weetabix
Rolls-Royce
PIRELLI
PADDLE STEAMER
WAVERLEY
THE WORLD'S LAST SEAGOING PADDLE STEAMER