# SAACKE

## *Alternative 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. Fuels We Have Fired
2. Bio Oil Firing - A More Common Approach
3. A Different Approach
4. Alternative Gas Firing
5. Feasibility Study - UK
6. 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

# Alternative Fuels

*What have we fired?*

SAACKE

- Anthracite Dust
- Bioethanol
- Bio Gas
- Blast Furnace Gas
- Carbonisation Gas
- CO Gas
- Coke Oven Gas
- Converter Gas
- Corex Gas
- Diesel
- Ethanol
- FAME
- Furnace Gas
- Generator Gas
- Glycerol
- Heavy Fuel Oil
- Hydrotreated Veg Oil
- Kerosene
- Landfill Gas
- Lignite Dust
- LPG
- Medium Fuel Oil
- Molasses
- Naphtha
- Natural Gas
- Petroleum Coke Dust
- Process Gas
- Pyrolysis Oil
- Rapeseed Oil
- Refinery Gas
- Saw Dust
- Sewage Gas
- Solvent
- Sulphur
- Tallow
- Vent Gas
- Vinasse
- Waste Water Treatment Gas
- etc. etc. etc…….

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 a 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

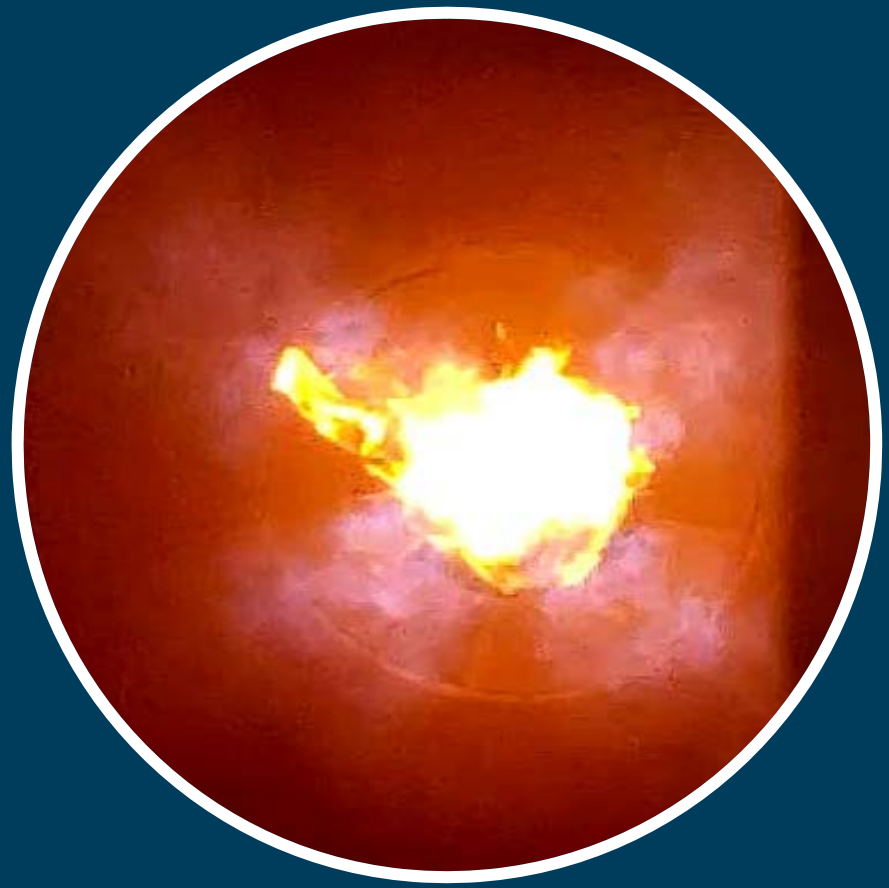
## *Sample Analysis/Sample Firing*

**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

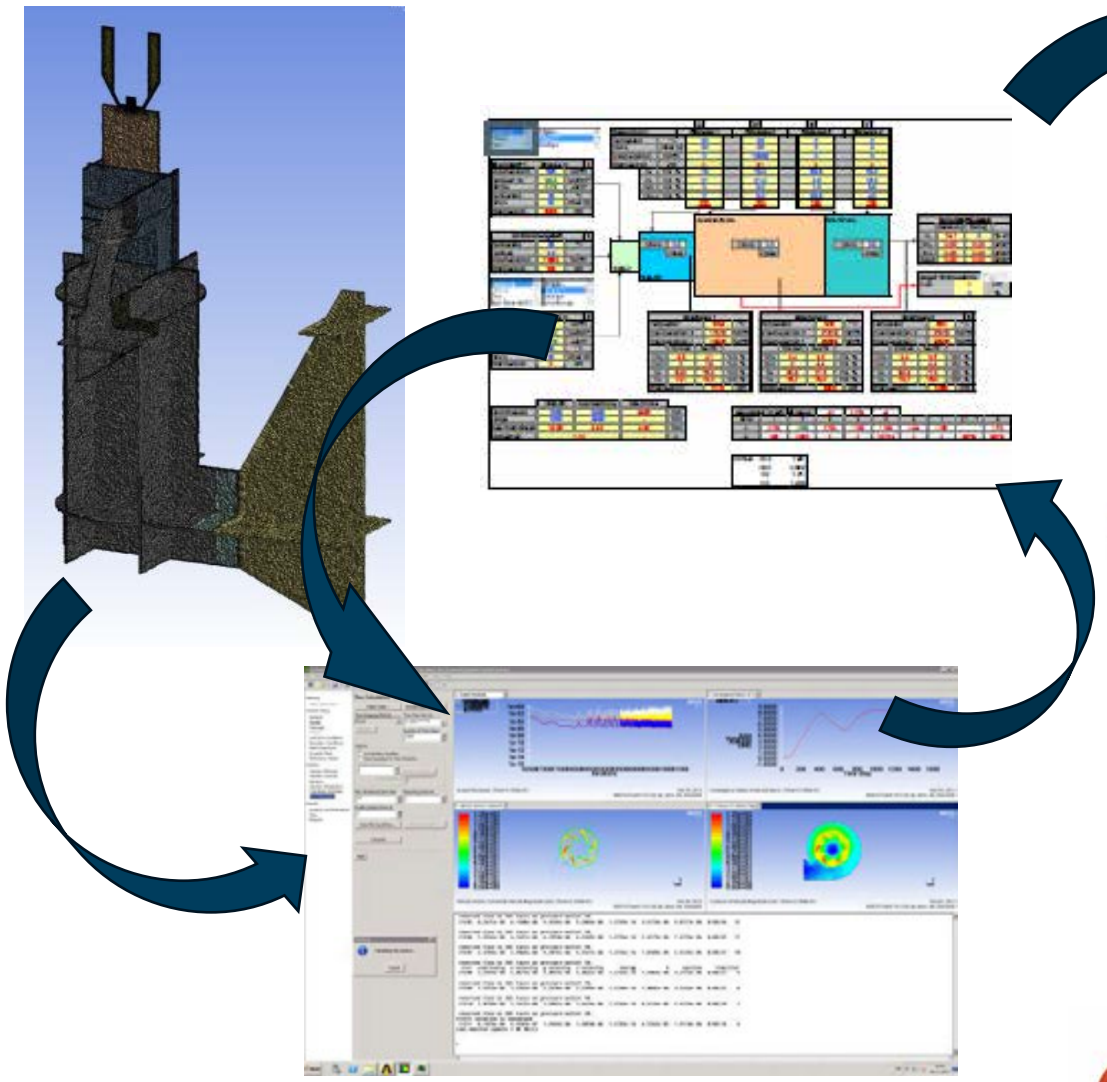
CEA
Combustion Engineering Association

# 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 Years of experience with CFD**

**>100 Years combustion experience**

OMBUSTION BY SAACKE

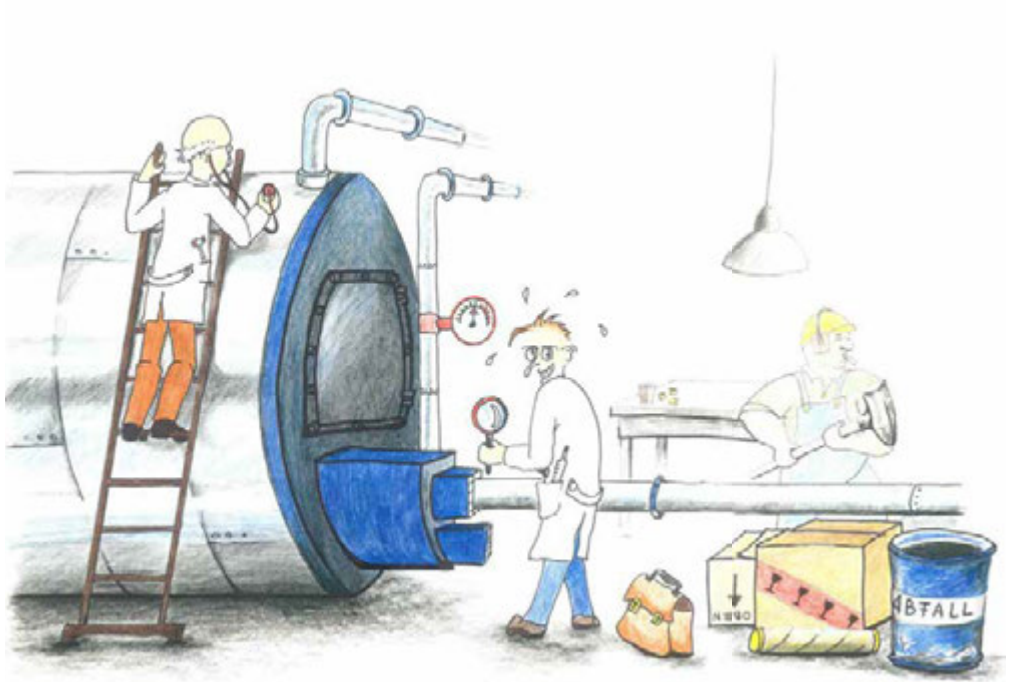
CEA Combustion Engineering Association

# Computational Fluid Dynamics

*CFD requires Computing Power!*

**How does CFD help?**

- Theoretical testing before arriving 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.




OMBUSTION BY SAACKE

CEA Combustion Engineering Association

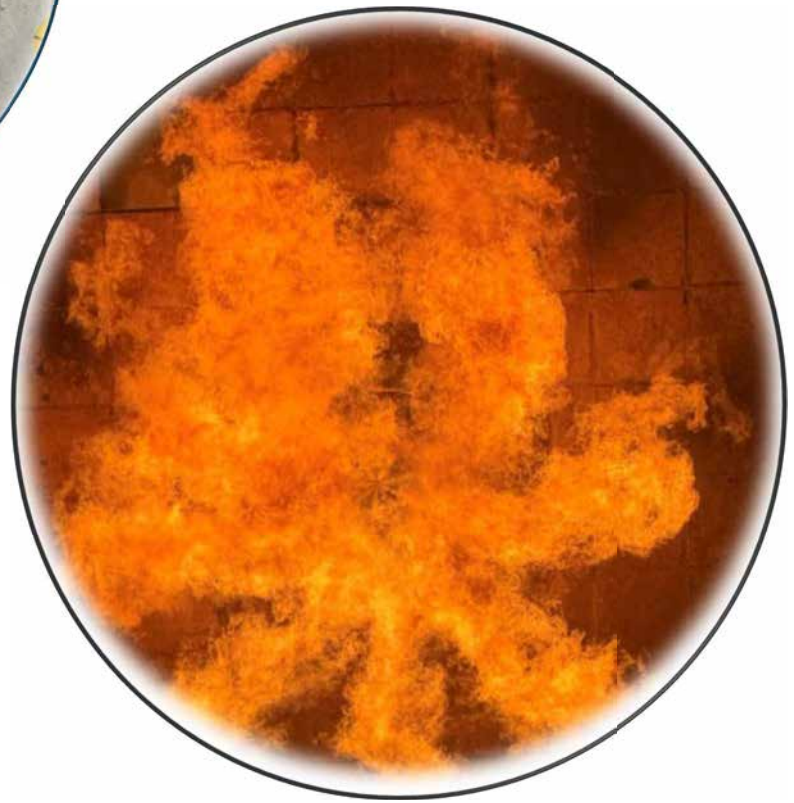
# Bio Oil Firing

*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

*Possible difficulties with some Bio Oils*

## Bio Oil problems:

- Unwanted content
- Acidic abrasive liquid
- Fuel handling
- Atomising temperature
- Pump pressure
- Variable quality

## SAACKE answer:

- Correct level of filtration
- Stainless steel components
- Correct equipment selection:
  - Low temperature for rotary atomiser
  - Low pressure for rotary atomiser
- O2 trim

## Other issues:

- Fuel handling prior to combustion
- May cause excessive fouling of the boiler

***Residue from Glycerol firing***

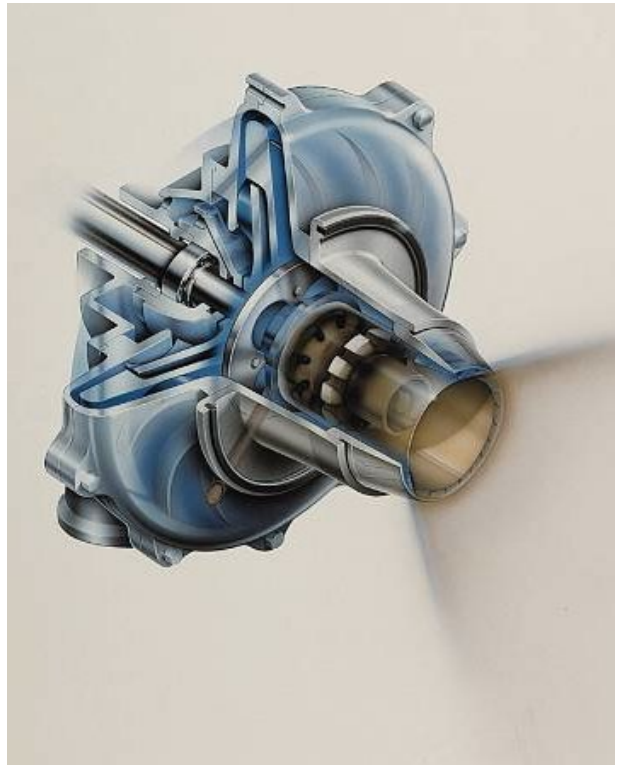
# Bio Oil Firing

*Summary*

**Using liquid Biofuels in industrial firing plants**

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

  **(*these all require careful planning!*)**
- May help with Net Zero targets.
- 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

# Bio Oil Firing

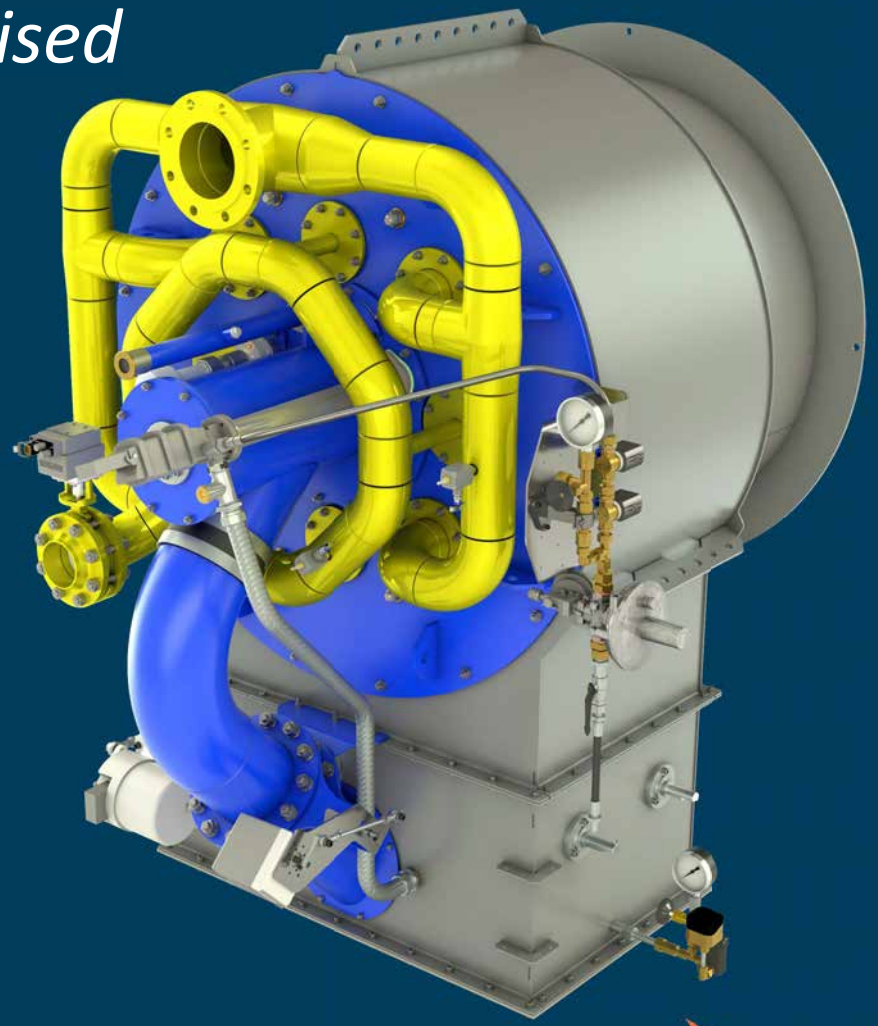
*Where heat potential has been realised*

- Ethanol
- FAME
- Glycerol
- Rape oil
- Tallow

# Bio Oil Firing

*Where heat potential has been realised*

- Ethanol
- Rapeseed Oil
- Molasses
- Naphtha
- Vinasse



SAACKE

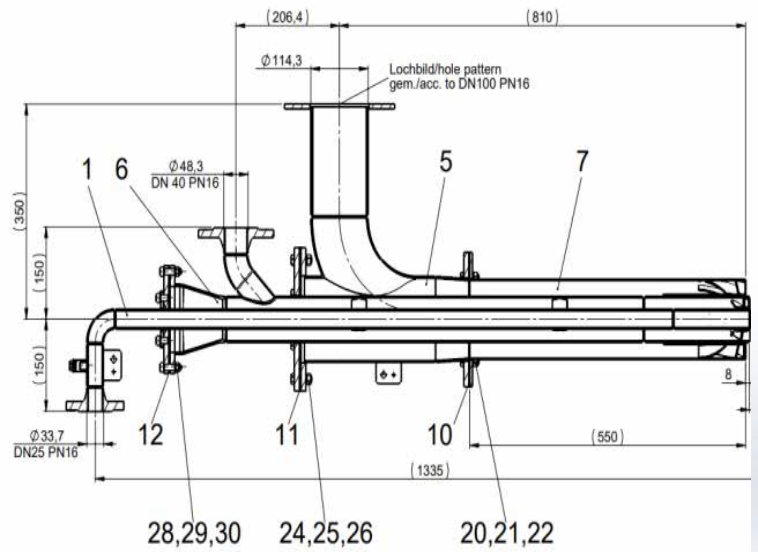
CEA
Combustion Engineering Association

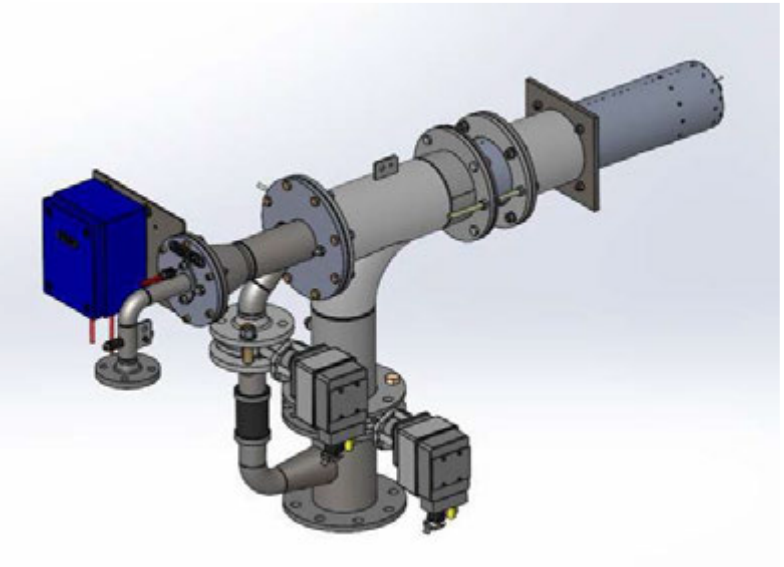
# Alternative Gas Firing

*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



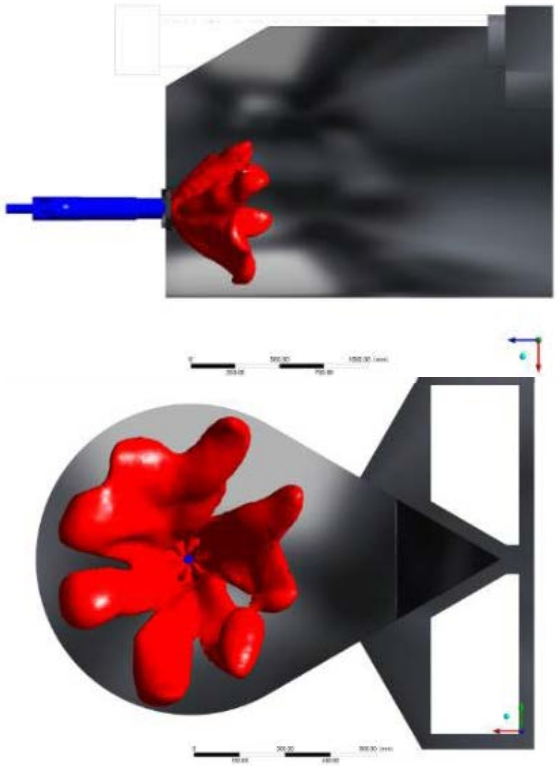



## Project Structure

Feasibility study, engineering → Prototyping → Piloting

# Alternative Gas Firing

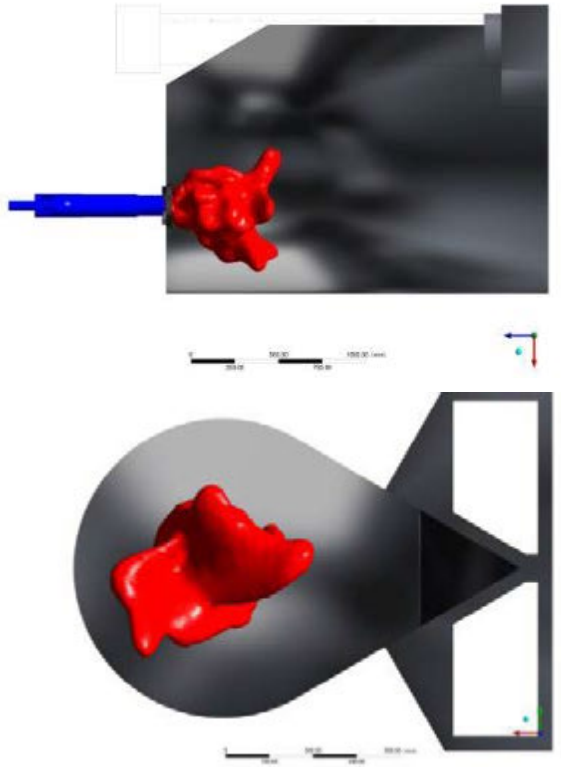
*CFD Modelling of New Burner*



***CFD flame shape for Natural Gas***

## Phase 1 – Engineering

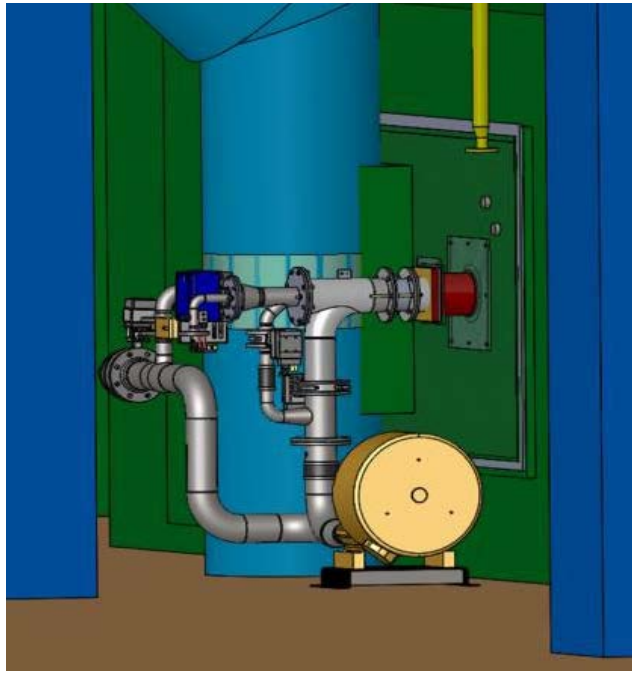
- Simulation paint dryer, 250/500 kW new burners.
- CFD comparison flame shape for natural gas /H2.
- CFD comparison temperature profile for natural gas /H2.
- Is the correct heat where it is needed?



***CFD flame shape for H2***

# Alternative Gas Firing

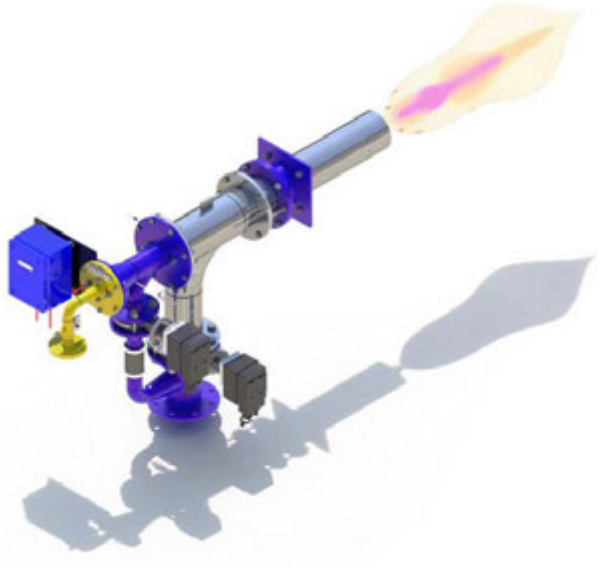
*Prototyping*

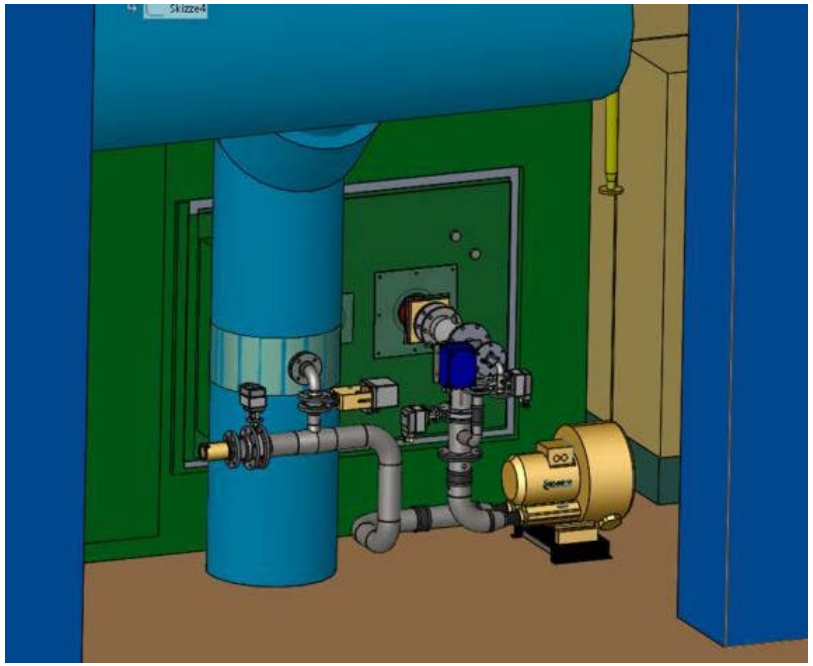


*Prototype Designs*

## 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

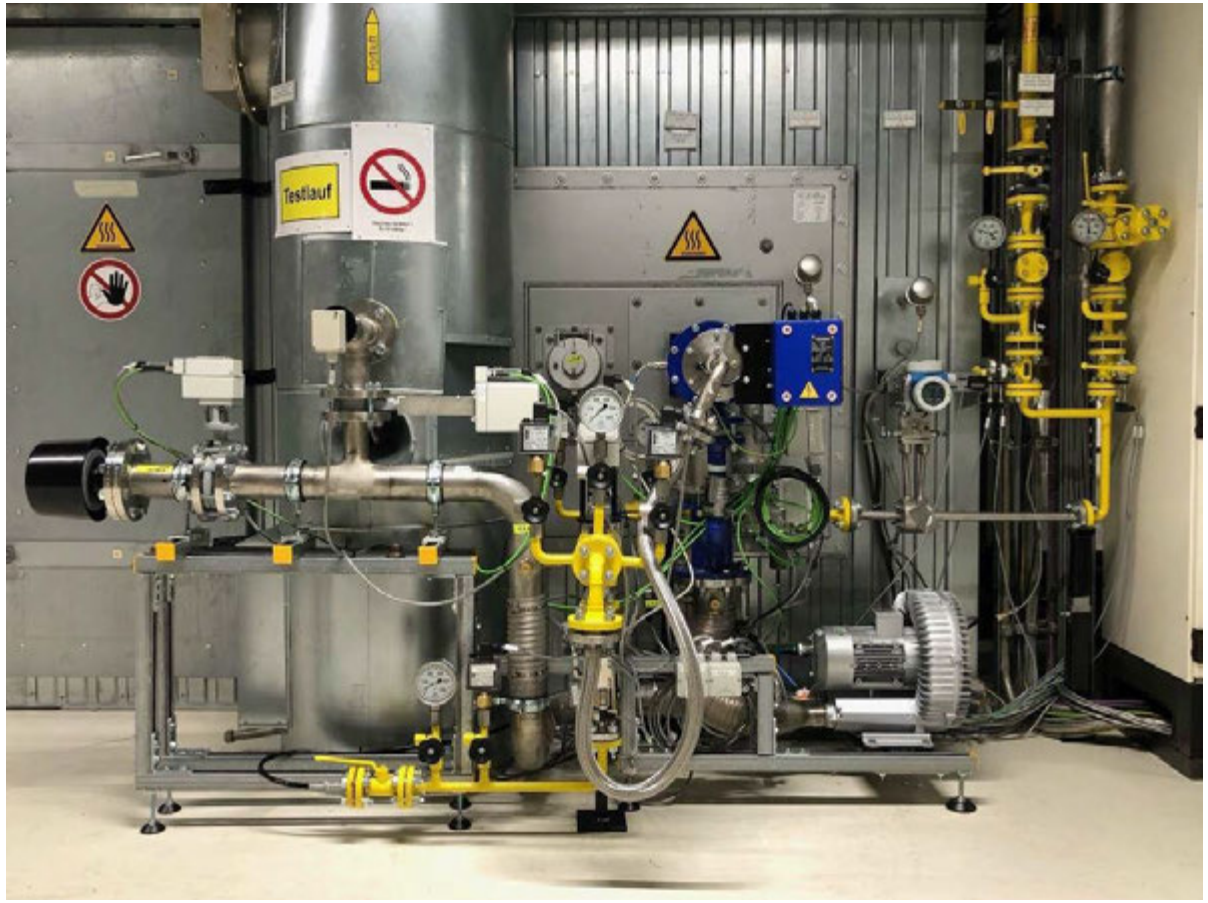
*Further Testing*

## 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*

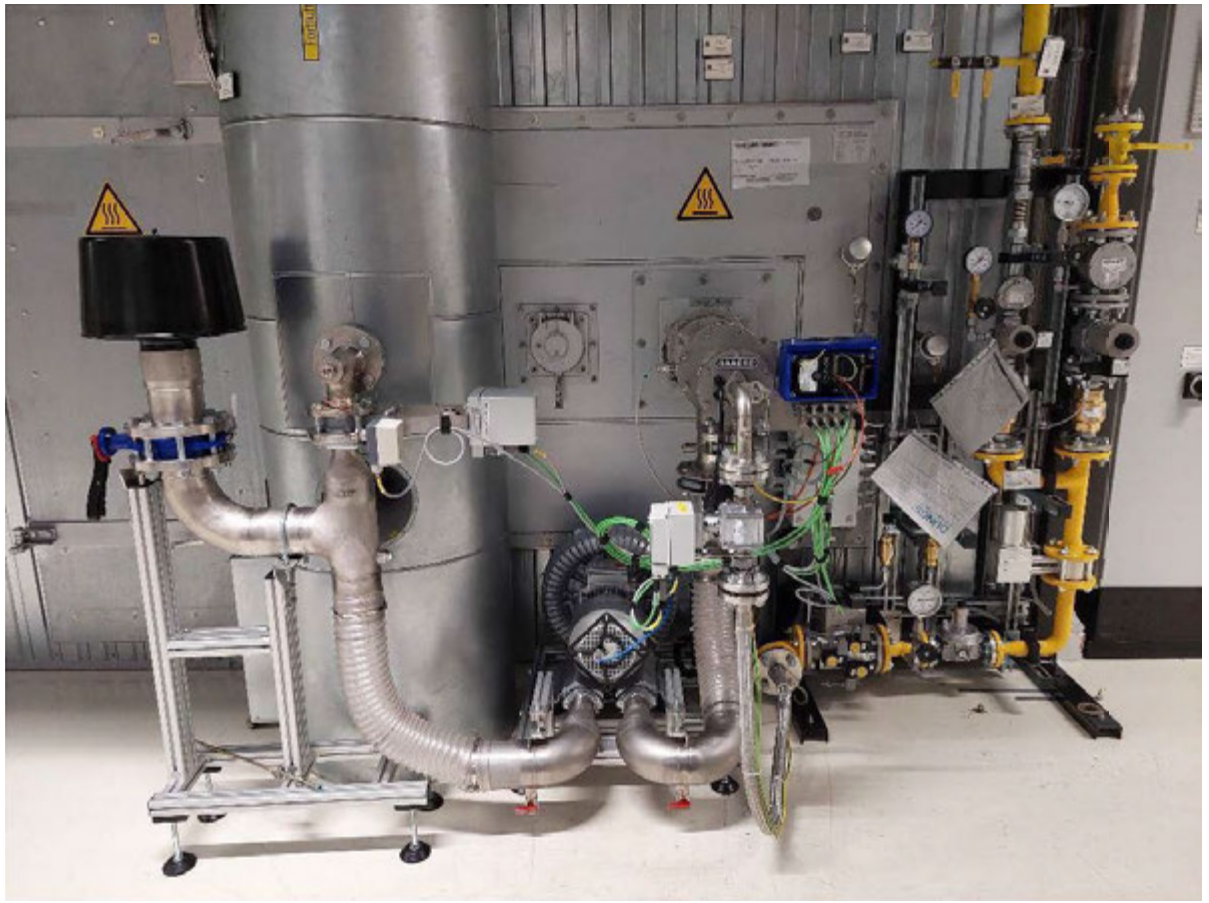
# Alternative Gas Firing

*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 now successfully operating on Hydrogen



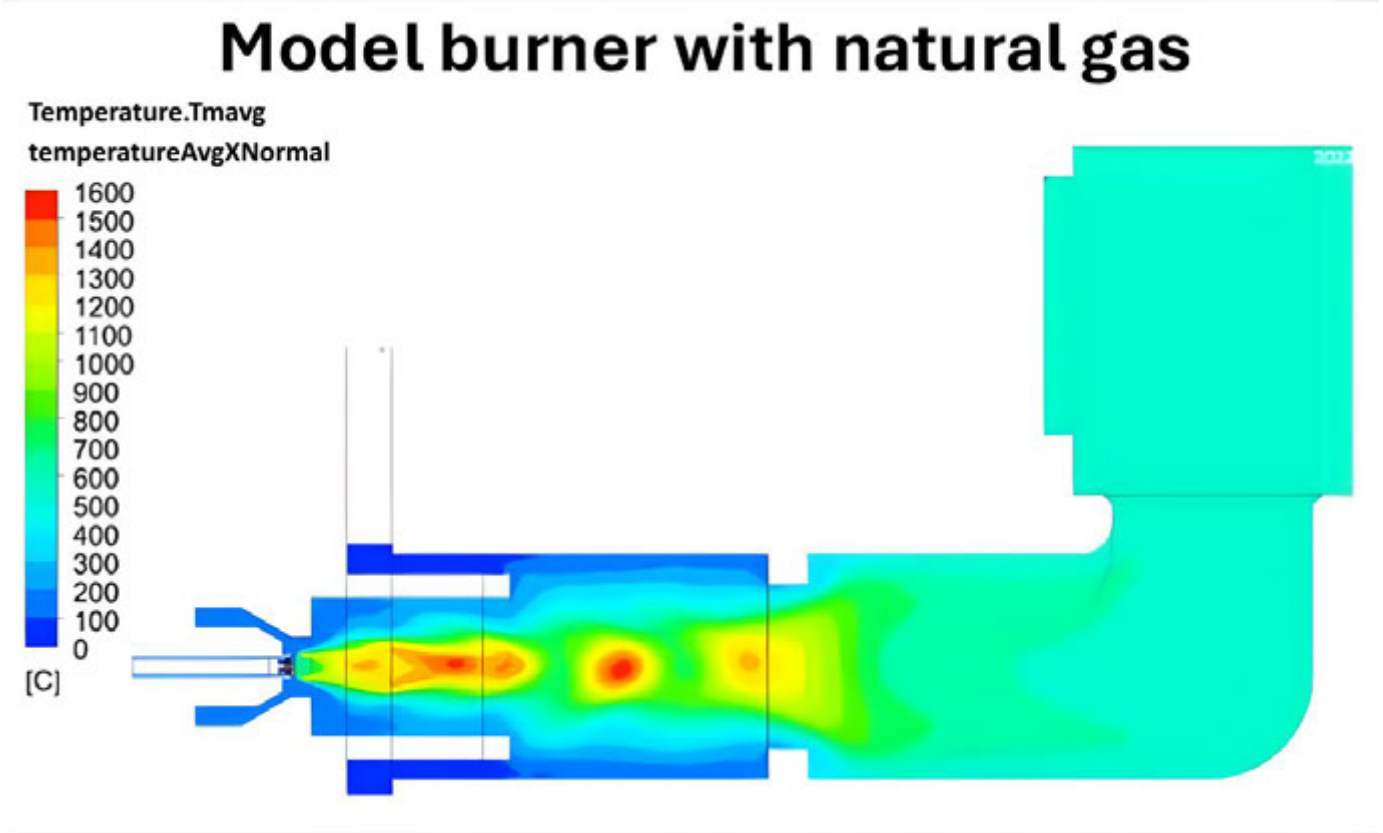
*New Burner in place*

# 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*



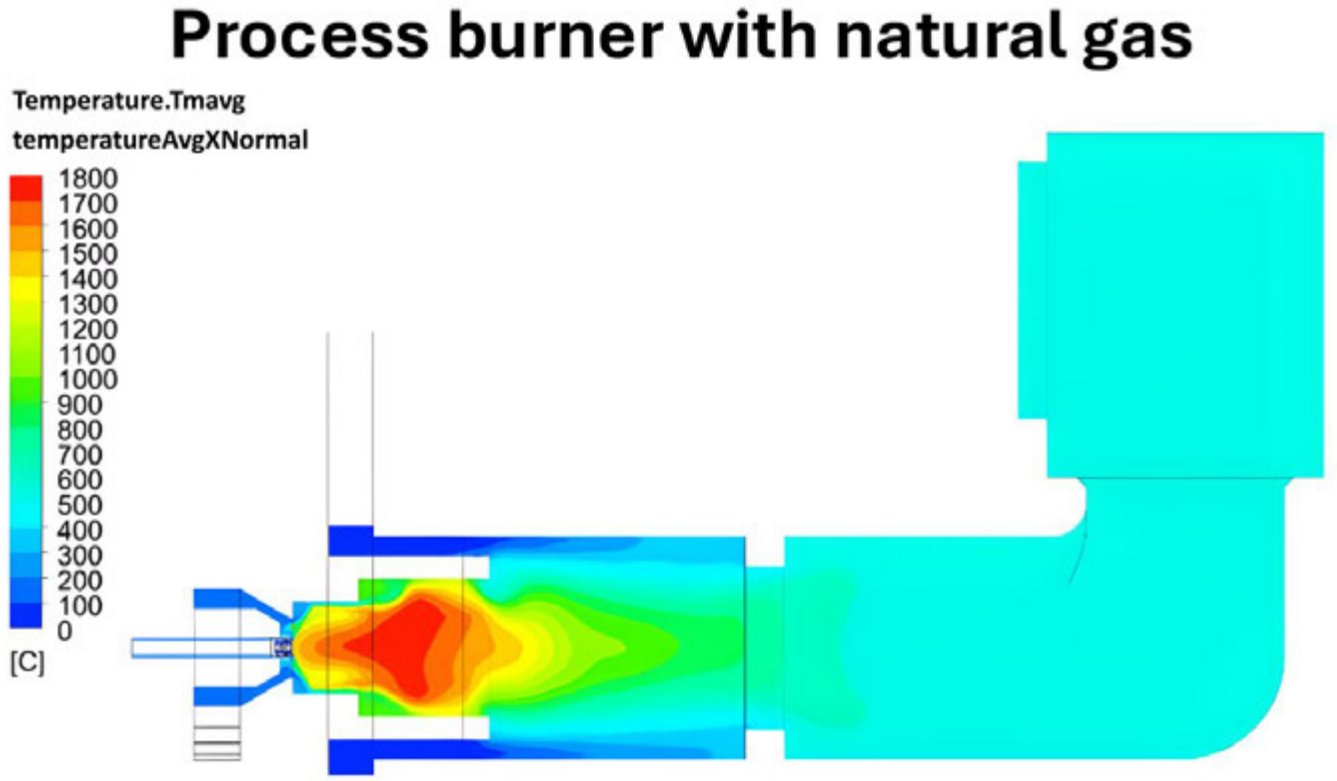

*Temperature distribution on Existing Burner*

# Computational Fluid Dynamics

## *Feasibility Study - UK*

### ***Where next?***

- *What would the SAACKE option look like?*
- *How will the new flame shape react?*
- *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*

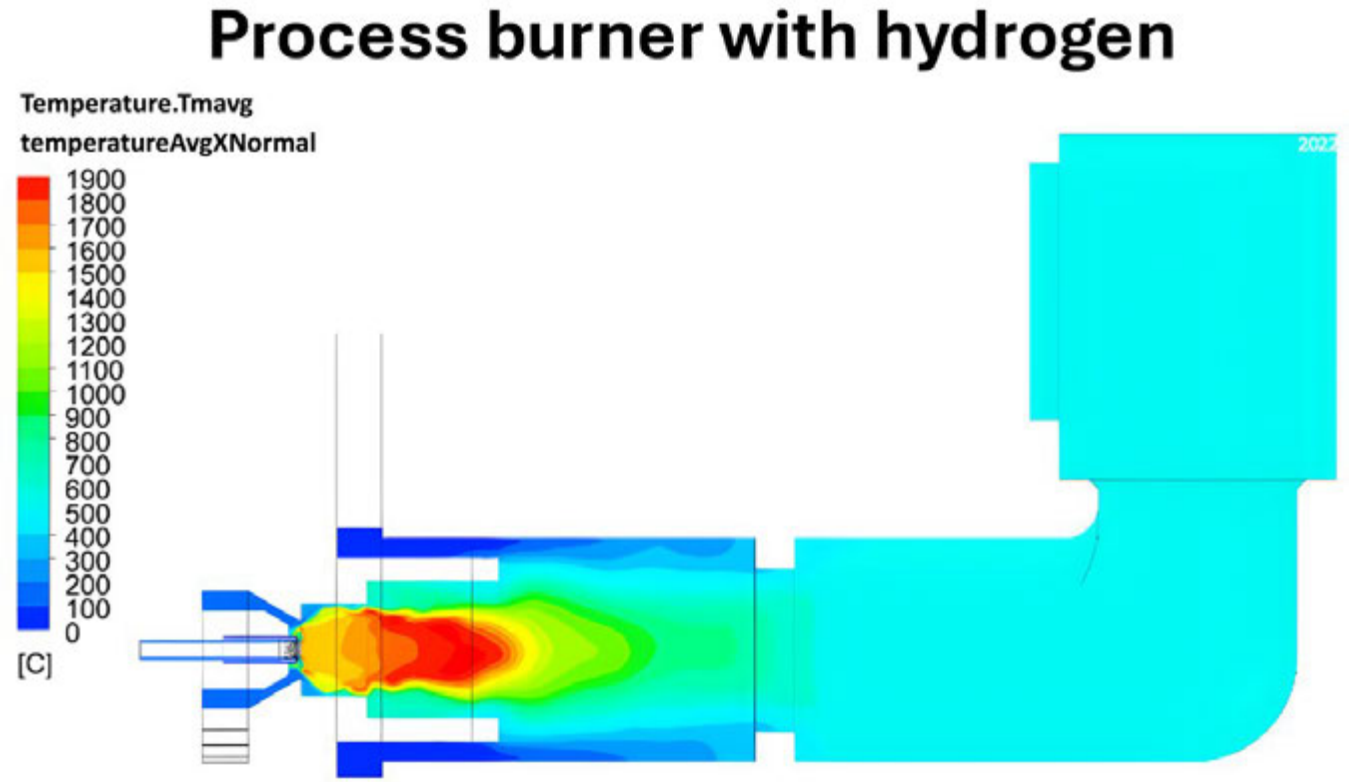
# Computational Fluid Dynamics

## *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.*



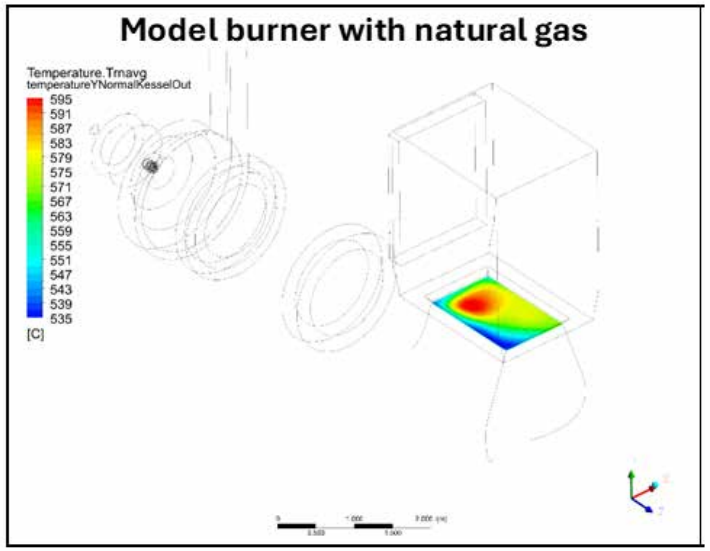

*Temperature distribution new burner - hydrogen*

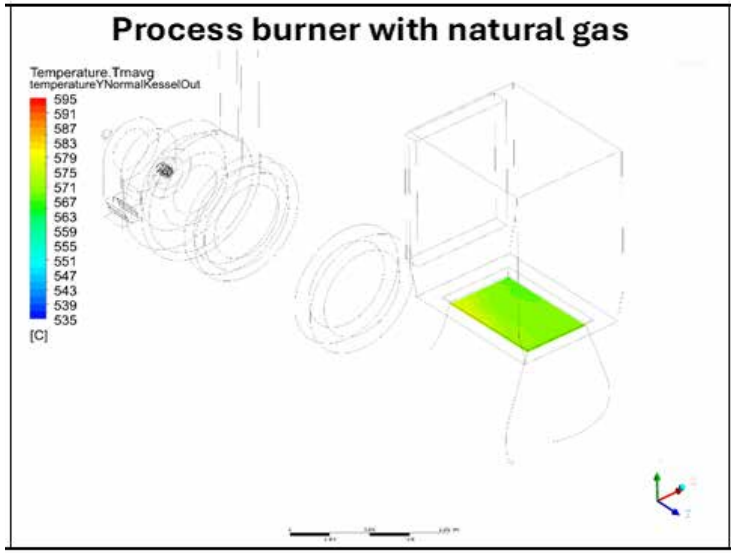
# Computational Fluid Dynamics

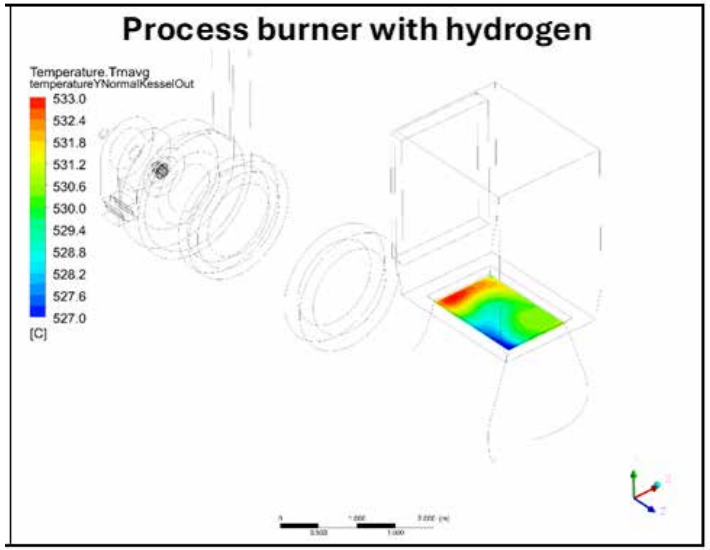
## *Feasibility Study - UK*

### ***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*

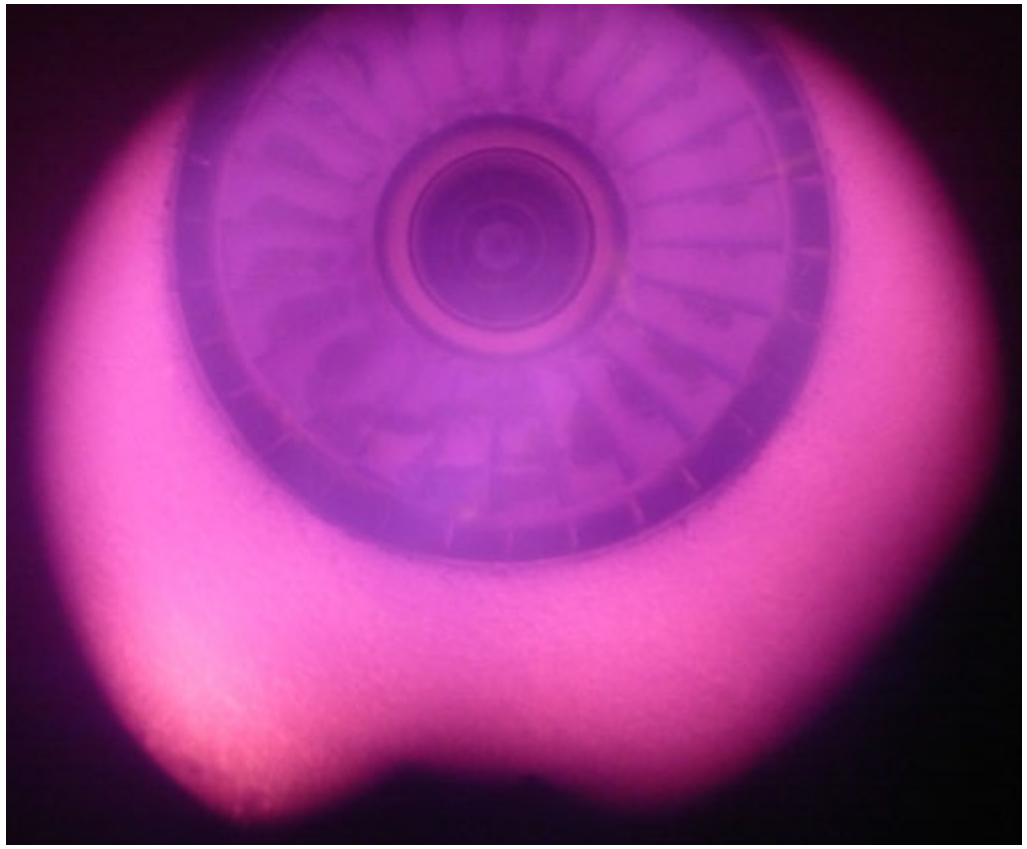
# Alternative Gas Firing

*Next Steps*

## Why does this success matter?

- Being able to checkout the theory in a computer programme, reduces risk.
- Confidence in moving forward safely and efficiently.
- Where can this be taken?

This success is not just for SAACKE, and not just for the customer, but a **big leap forward for the approach to firing Alternative Fuels.**



OMBUSTION BY SAACKE

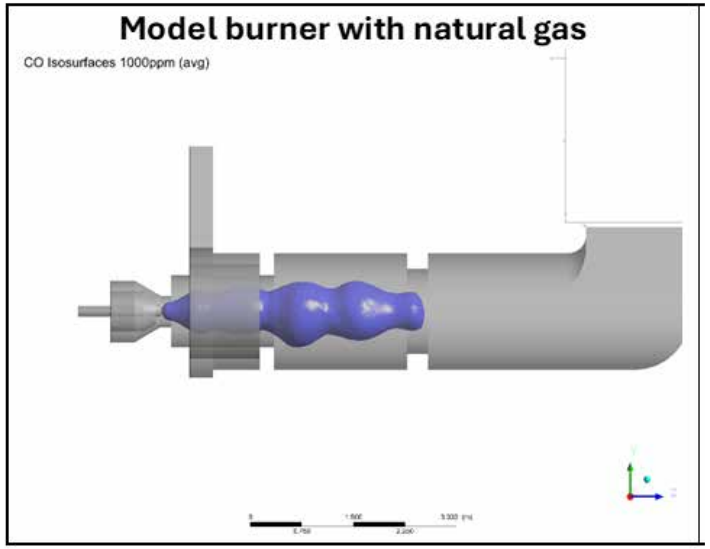
CEA Combustion Engineering Association

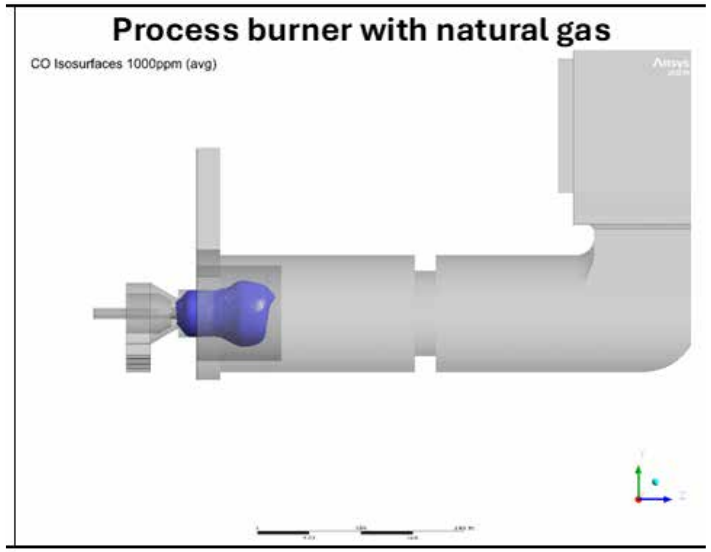
# Computational Fluid Dynamics

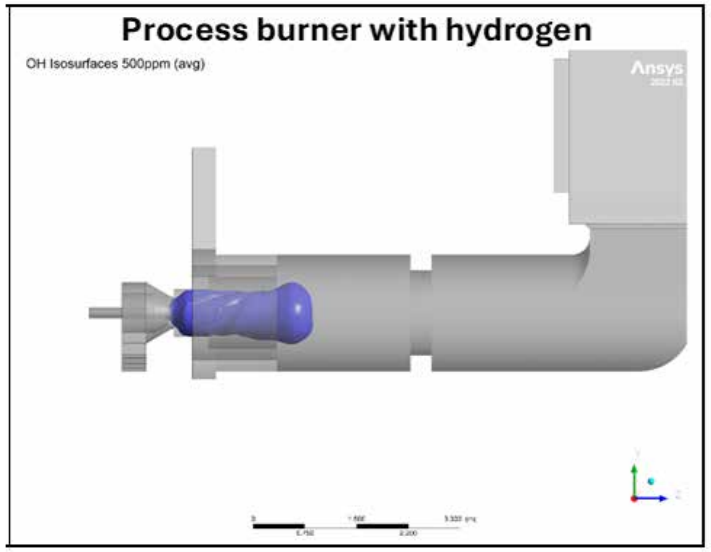
## *Feasibility Study - UK*

### *What does this show us?*

- *Longer flame in the existing burner*
- *Excellent mixing of air and flue gases with the new burner*
- *Fast and efficient mixing in the combustion chamber 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*

# Biogas Firing

*Where heat potential has been realised*

- Biogas
- Coke oven Gas
- Converter Gas
- Landfill Gas
- Waste Water Treatment Gas

SAACKE

CEA
Combustion Engineering Association

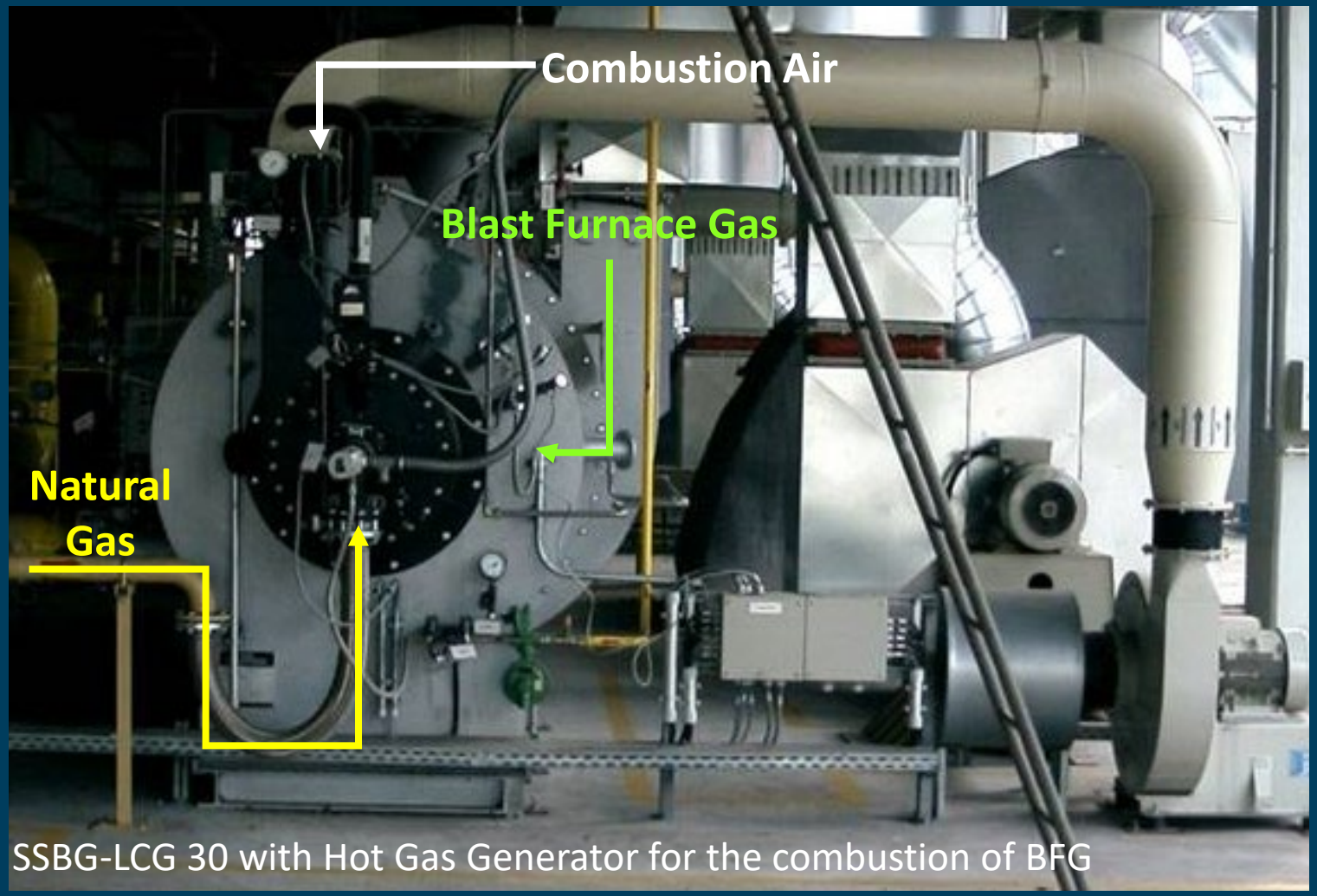
# Biogas Firing

*Where heat potential has been realised*

- Blast furnace gas
- Carbonisation gas
- CO gas
- Corex gas

# Biogas Firing

*Where heat potential has been realised*




SSBG-LCG 30 with Hot Gas Generator for the combustion of BFG

Hot Gas Generator (HGG)
EKO Stahl Eisenhüttenstadt
(Arcelor Group)

# Biogas Firing

*Where heat potential has been realised*

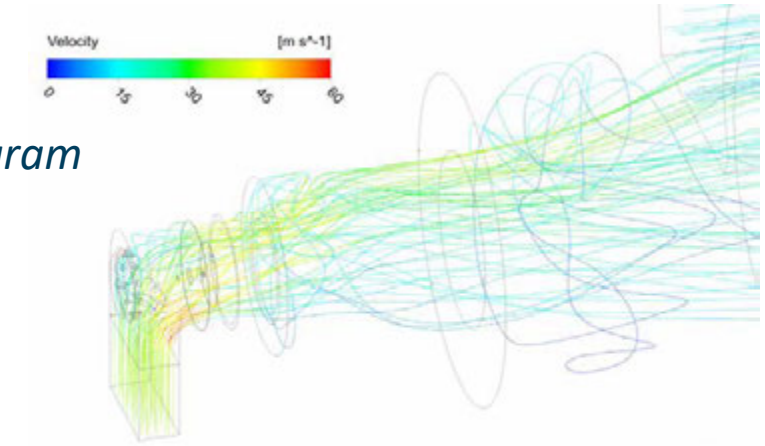
SAACKE

CEA
Combustion Engineering Association

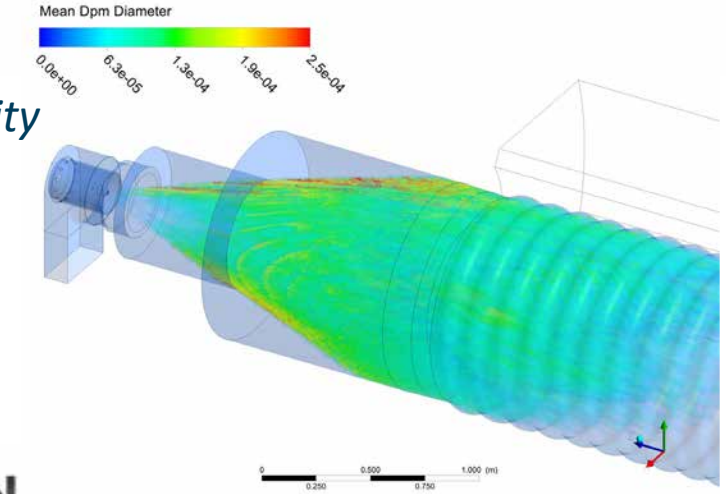
# Alternative Fuels Firing

## *Other CFD Models – Oil Firing*

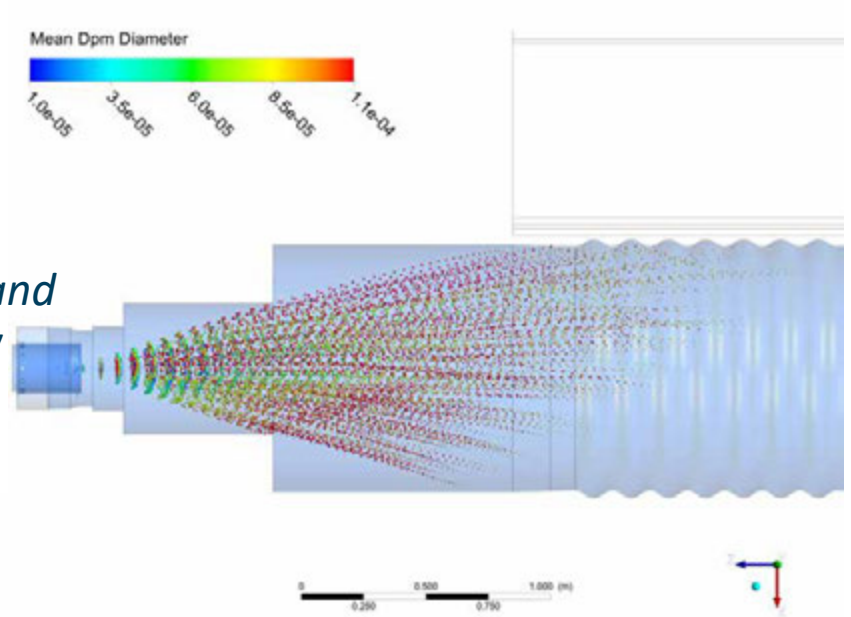
*Velocity Diagram*



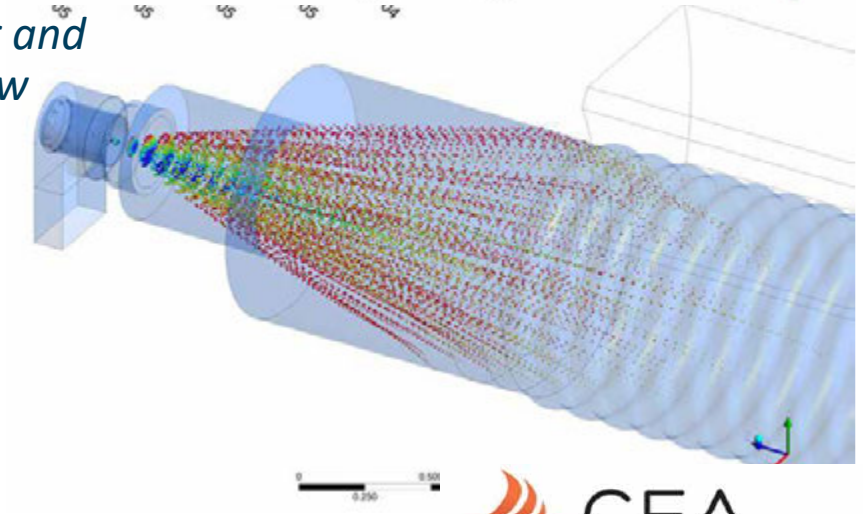

*Particle Velocity Diagram*




*Particle Diameter and flow – plan view*




*Particle Diameter and flow – side view*



# Alternative Fuels Firing

## *With a Different 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


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*