Next generation ultra-low NO_x burner by Oilon

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IX Flame Days

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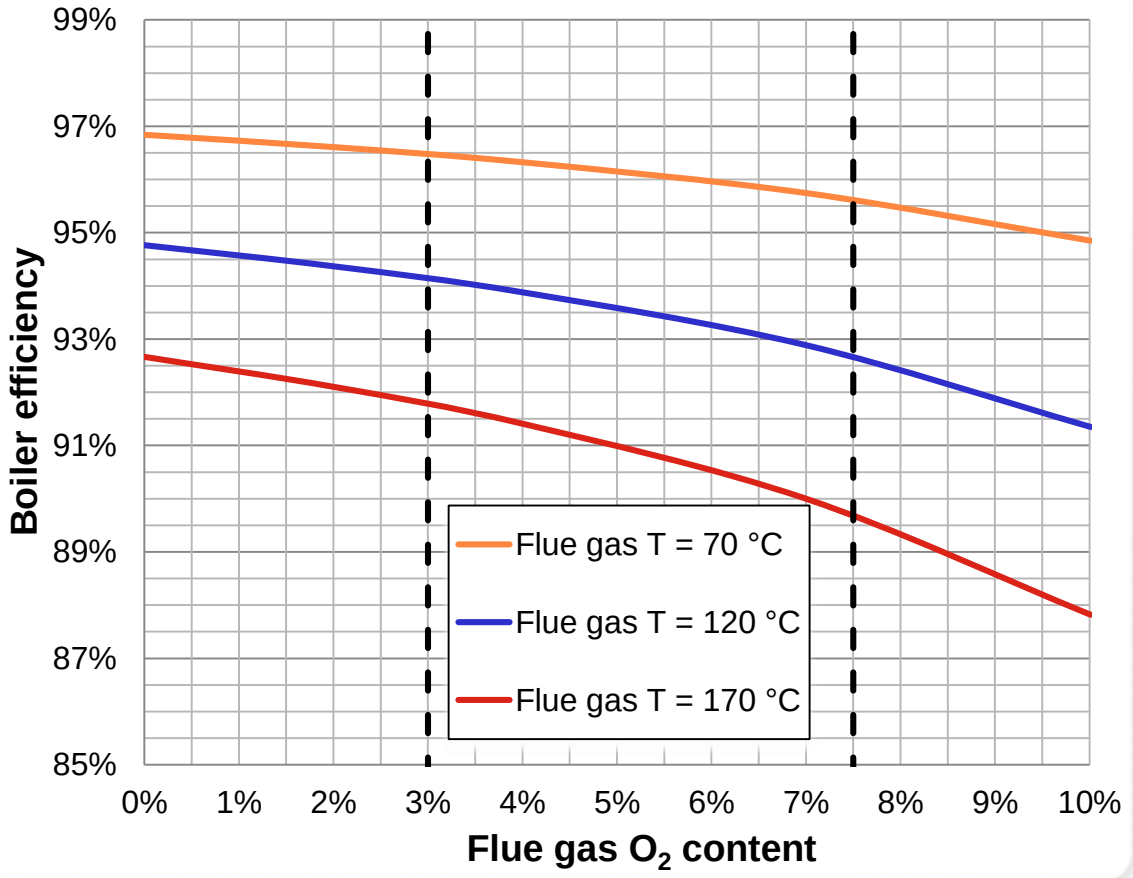
Development goals

- Ultra low NO_x natural gas burner for 850 kW power scale
  - No external FGR
  - NO_x < 15 ppm ($O_{2,ref}$ = 3%) with 3% residual oxygen
  - NO_x < 9 ppm ($O_{2,ref}$ = 3%) with higher residual oxygen

  ⟶ Premix burner?

- Typical premix burners have metal fiber combustion heads:
  - ➢ Frequent maintenance needs
  - ➢ Requires air filters
  - ➢ Sensitive to dirty combustion air
  - ➢ Required residual O_2 > 7,5 %



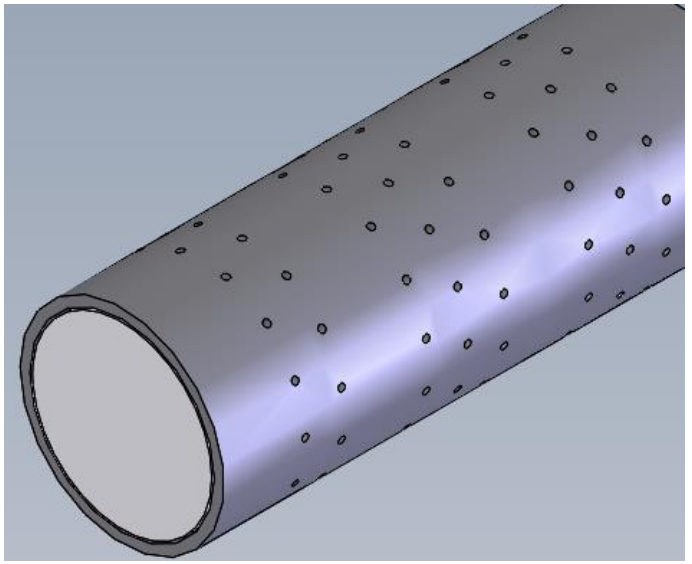
Initial modelling study of premixed combustion

Objectives:

- Validate and optimize the CFD models for premixed combustion
- Better understanding of the premixed combustion concept
  - Problems and limitations
  - Benefits
  - NO_x formation in premixed combustion
  - Stability
  - Power scaling

Test subject: 40 kW prototype

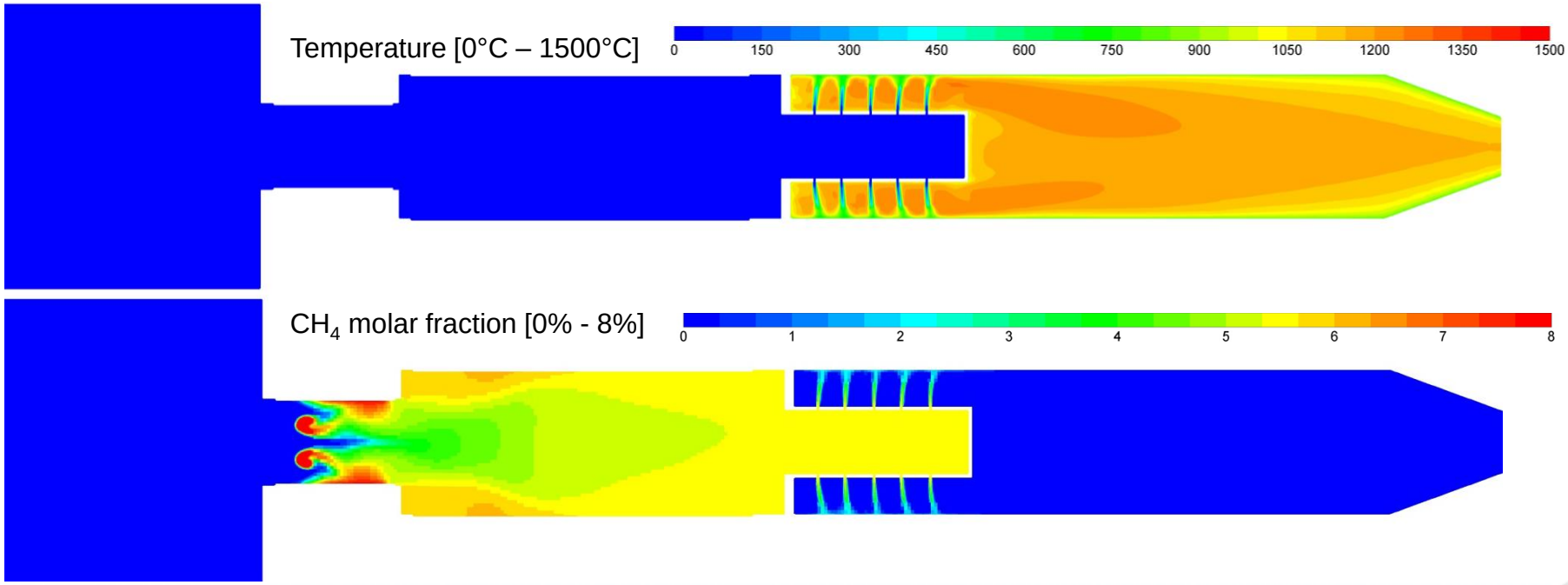
- Part of a catalytic combustion prototype
- NO_x emission ≈ 1 ppm
- Residual O_2 = 10%



Initial modelling study of premixed combustion

40 kW prototype:

- CFD models were optimized and validated against measurements
- The optimized models were later utilized in the design of the commercial premix burner



Concept planning for commercial premix burner

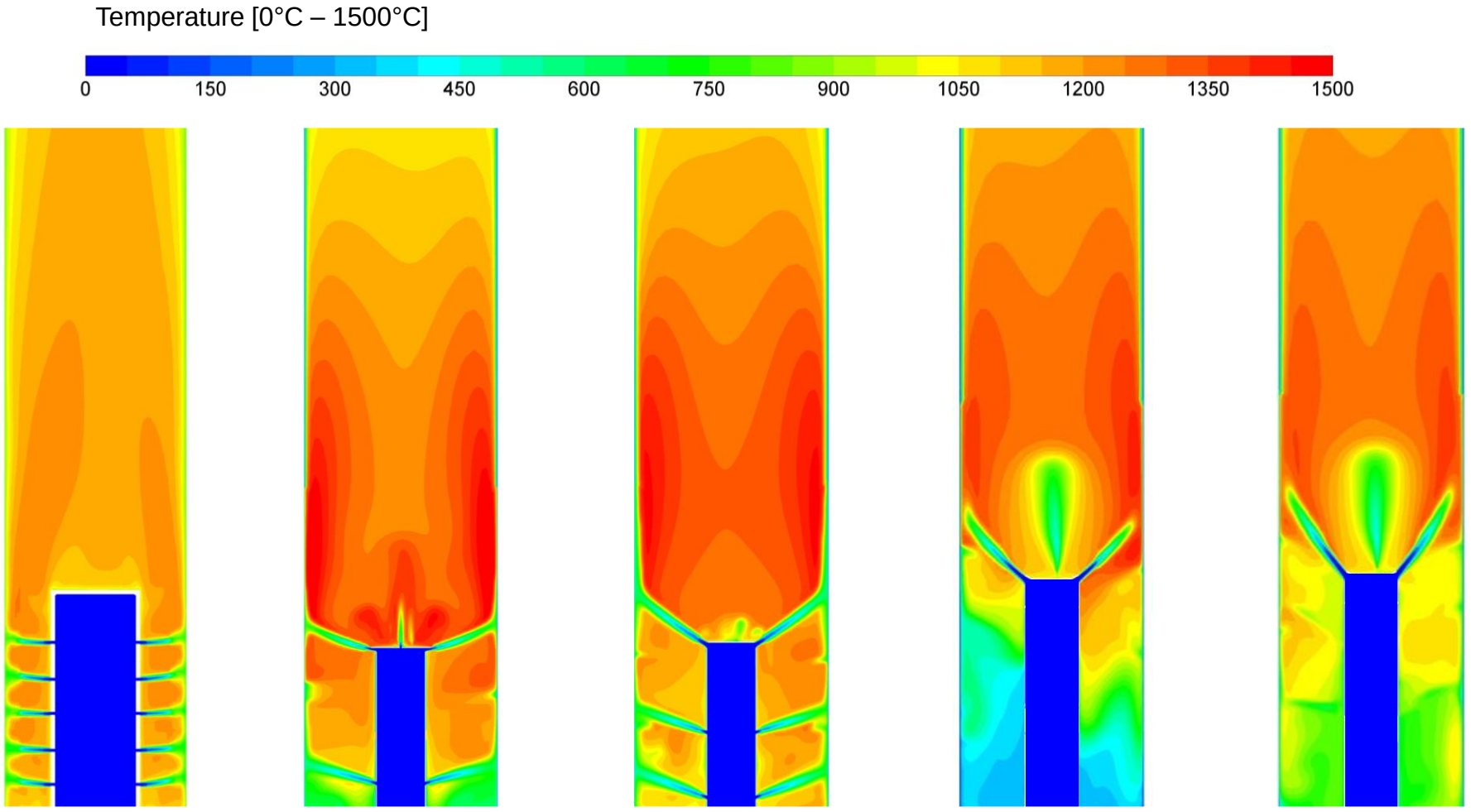
The benefits of the 40kW prototype:

- NO_x < 9 ppm ($O_{2,ref}$ = 3%) with 7% residual oxygen
- No air filter
- No frequent maintenance needs
- No expensive materials

Required improvements:

- Low NO_x **with low residual oxygen**
- Cost-effective
- Compact size
- Must fit to wide range of furnaces
- Power scaling 40kW → 850kW

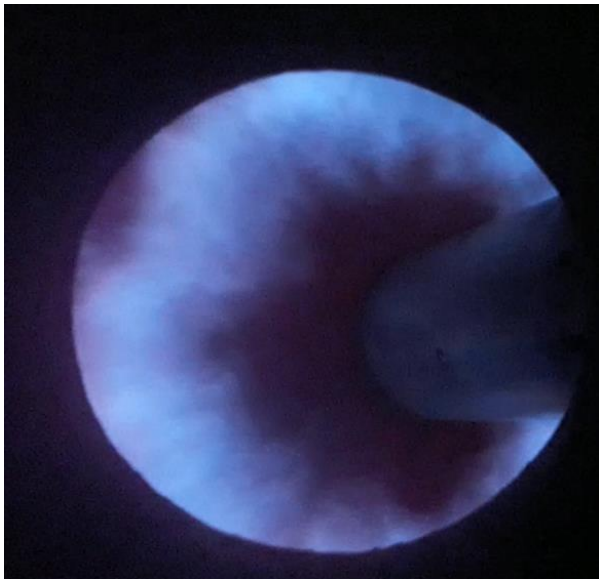
Performance optimization with CFD

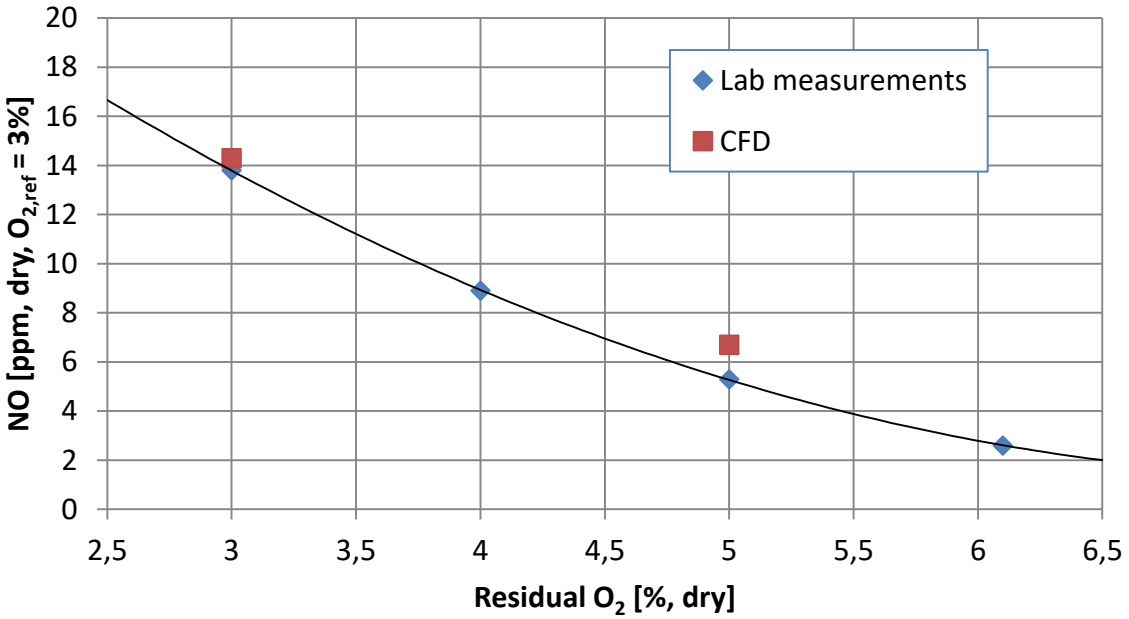


Prototype phase & results

Good agreement between CFD and measurements.

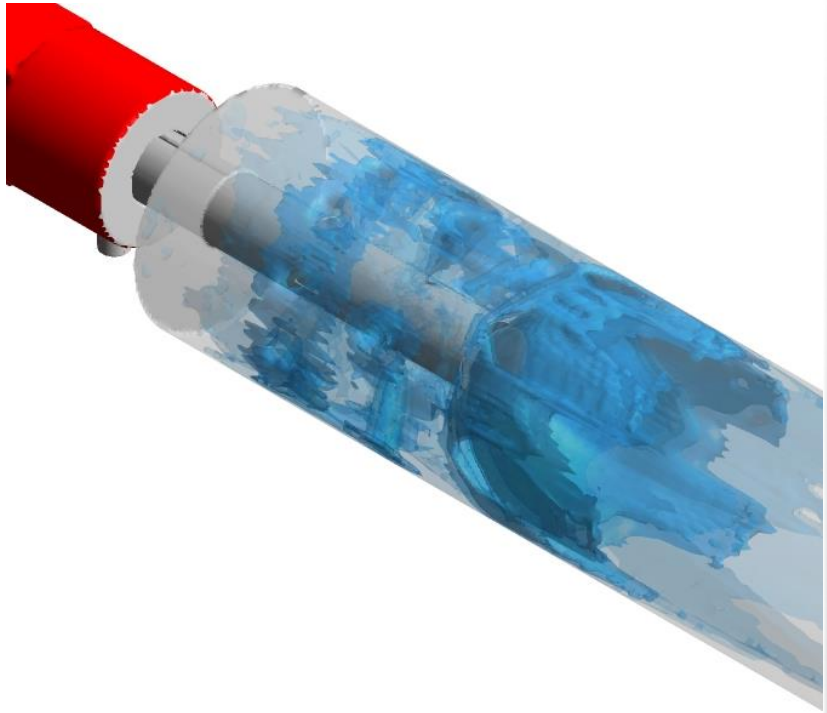
- Two different test furnaces
- Different fuel loads
- Different residual oxygens

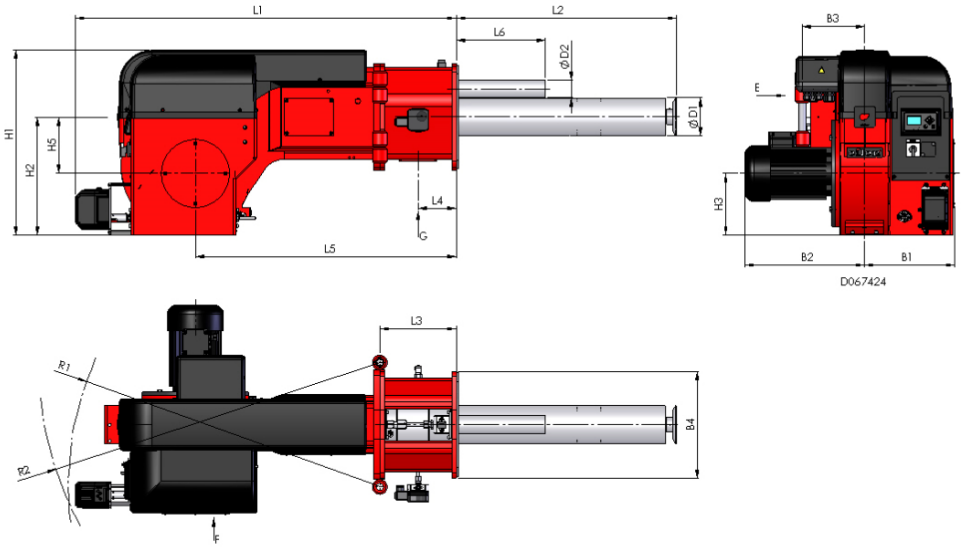




Next steps after R&D

1. Field testing of pilot burners
2. Commercialization
3. Power scaling
4. Production optimization





Summary

- The development of new ultra low NO_x natural gas burner was successful:
  - No external FGR
  - NO_x < 15 ppm ($O_{2,ref}$ = 3%)

  with 3% residual oxygen
  - NO_x < 9 ppm ($O_{2,ref}$ = 3%)

  with higher residual oxygen

- Good agreedment between CFD and measurements

- Many benefits compared to typical premix burners:
  - Low required excess air / residual oxygen
    - Improved boiler efficiency
  - No air filter
  - No frequent maintenance needs
  - Not sensitive to combustion air quality