Influence of hydrogen burners in the electric arc furnace

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Outline

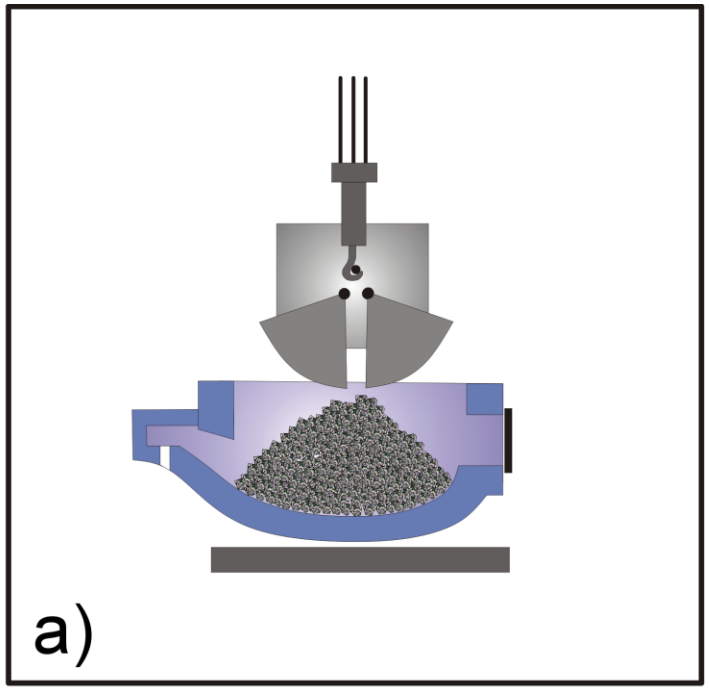
- EAF process
- EAF process model
- Influence of hydrogen burners
- Free flame trials
- Conclusion & outlook

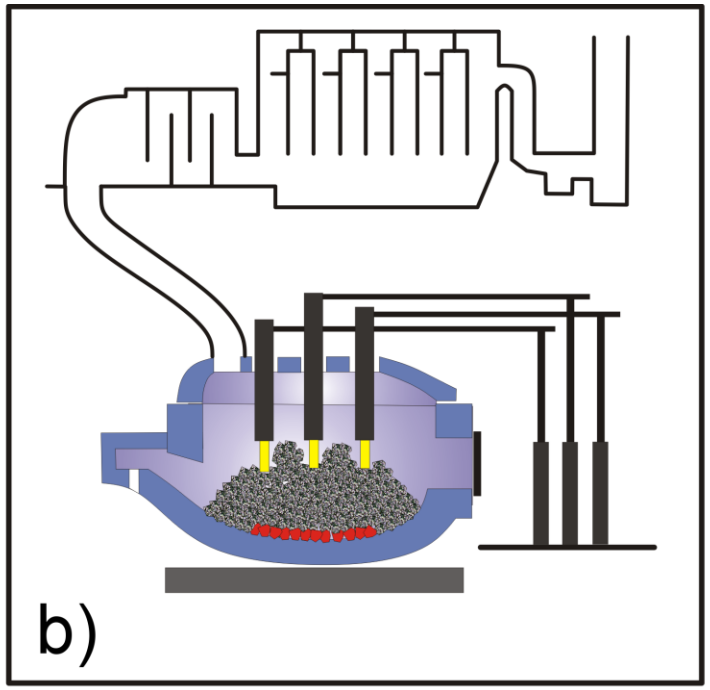
RFCS project – DevH2forEAF

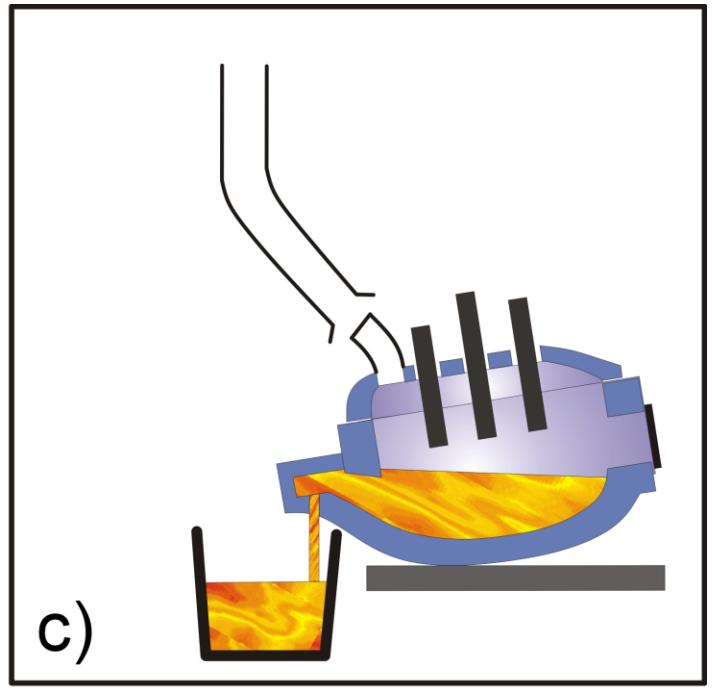
- Project: **Dev**eloping and enabling **H2** burner utilization to produce liquid steel in **EAF** (DevH2forEAF)

- Main goals:
  - Analysis of the influence of hydrogen burners in EAFs
  - Design of a hydrogen burner for the EAF application
  - Usage of hydrogen burners in pilot-scale EAFs
  - Trials with full-scale hydrogen burner in industrial EAF

Electric Arc Furnace (EAF)

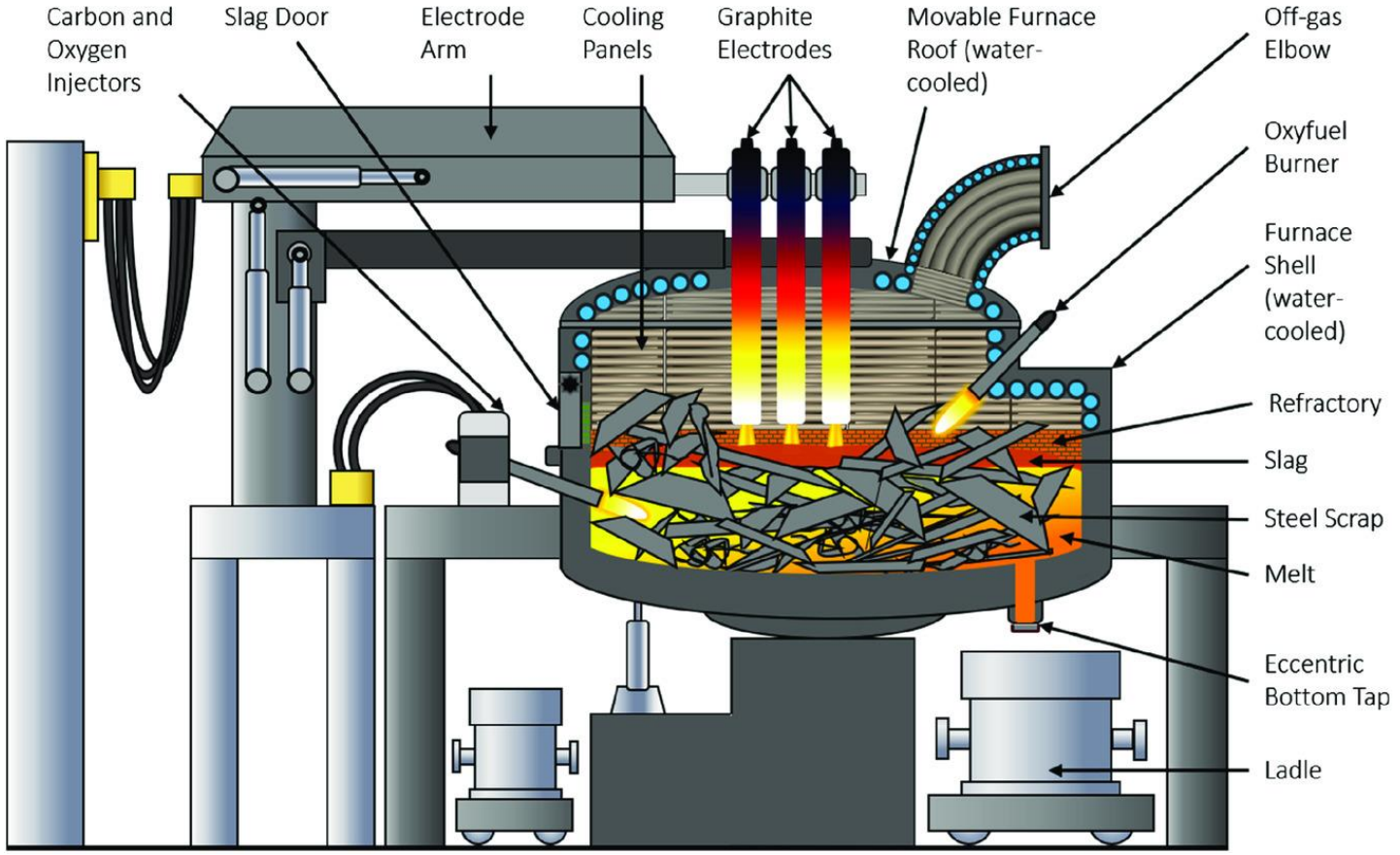






Pfeifer, H.; Nacke, B.; Beneke, F. (Hrsg.): Praxishandbuch Thermoprozesstechnik - Band II, 2. Auflage, Vulkan-Verlag, Essen, 2011

Electric Arc Furnace (EAF)

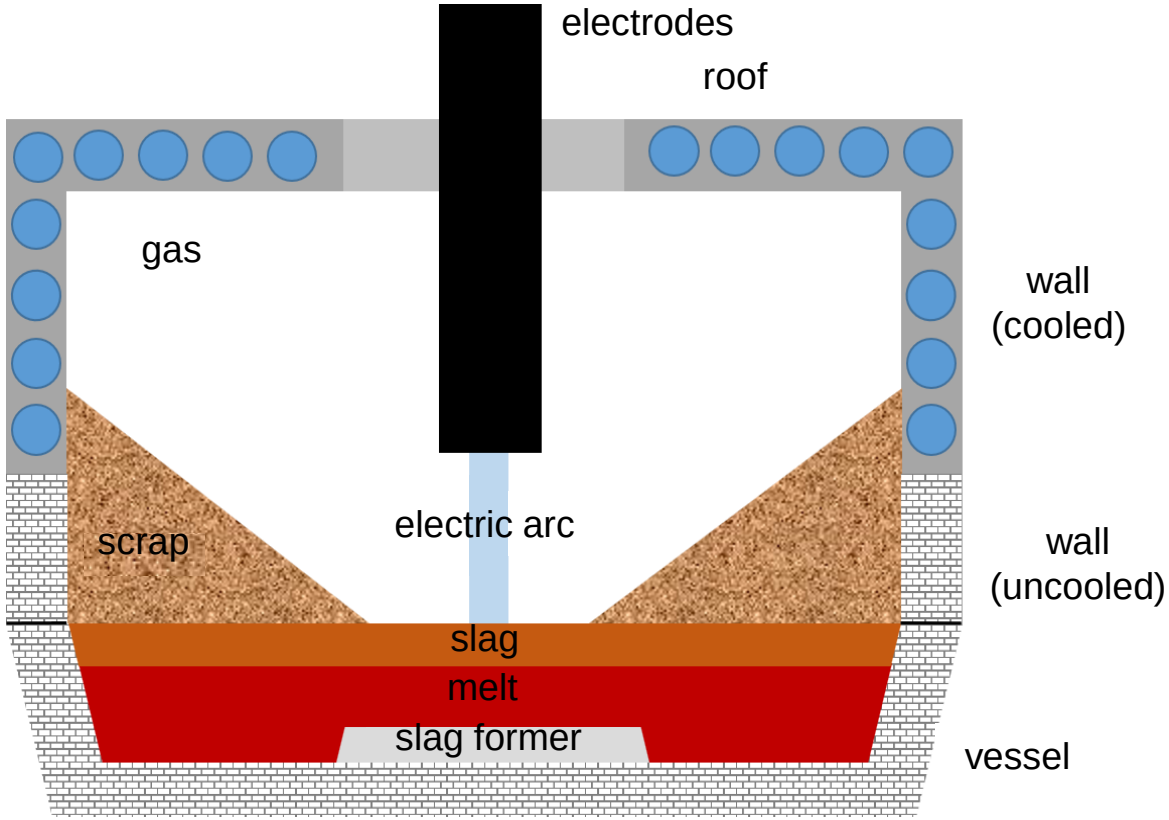


Meier, T.: Modellierung und Simulation des Elektrolichtbogenofens, Dissertation, RWTH Aachen University, 2016

EAF process model

Zone model

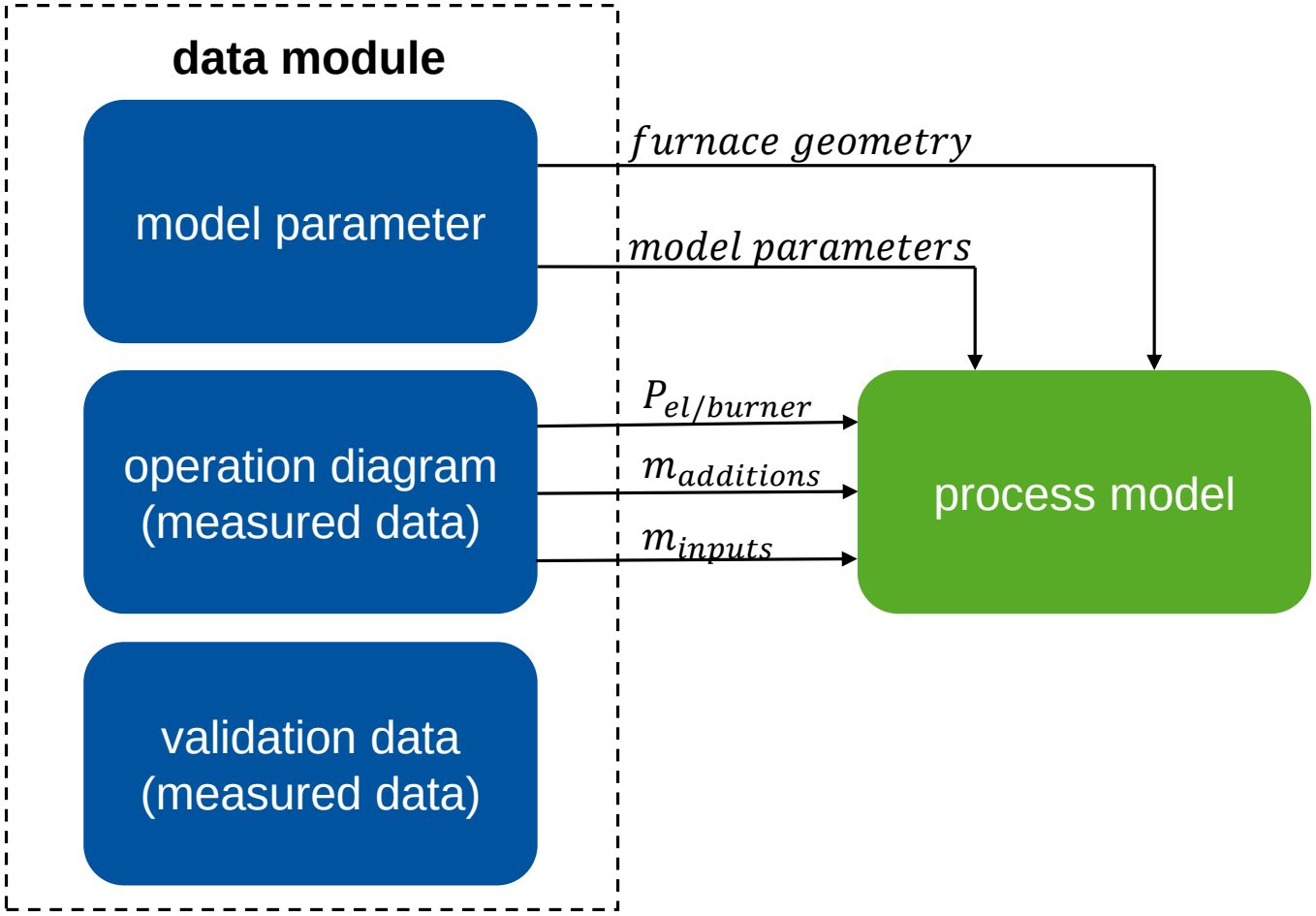
- Model of the EAF process
- Grouped by zones
- Energy and mass balance
- Energy and mass transport between the zones



EAF process model

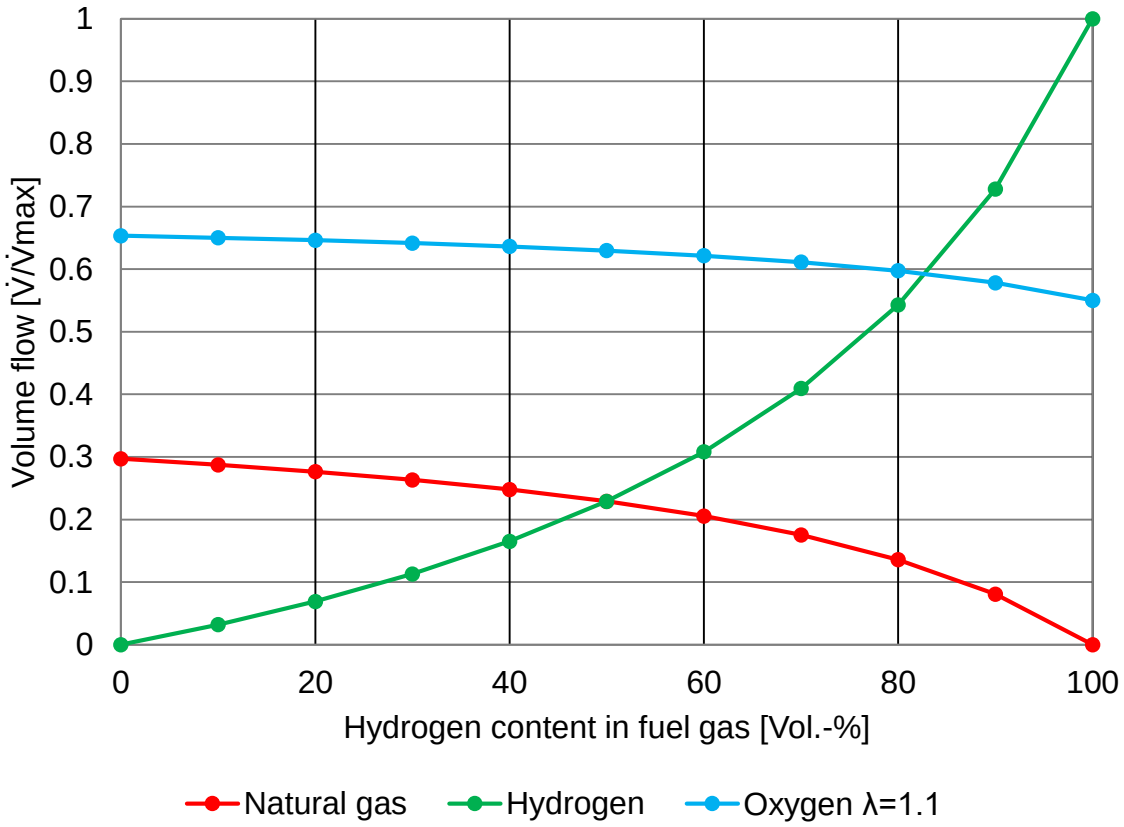
Data module

- Unique for each EAF
- Adjustment to EAF under investigation
- Validation of model results with unused measured data
- All in- and output during one heat are considered in the operation diagram



Influence of hydrogen burners

- Adjusted EAF process model for investigated EAFs
- Usage of validated model for fuel gas variations
  - 100% natural gas to 100% hydrogen
- Effect on the EAF process can be estimated
- In the following results for:
  - 100 Vol.-% natural gas
  - 50 Vol.-% natural gas and 50 Vol.-% hydrogen
  - 100 Vol.-% hydrogen

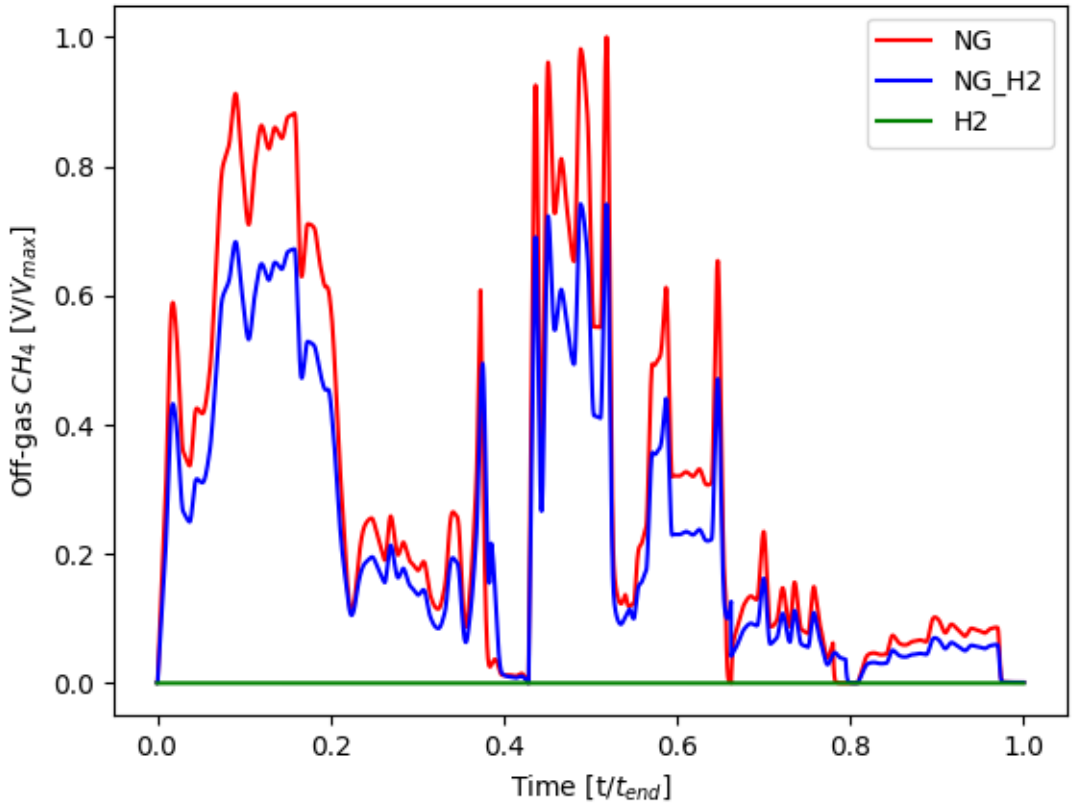


Influence of hydrogen burners

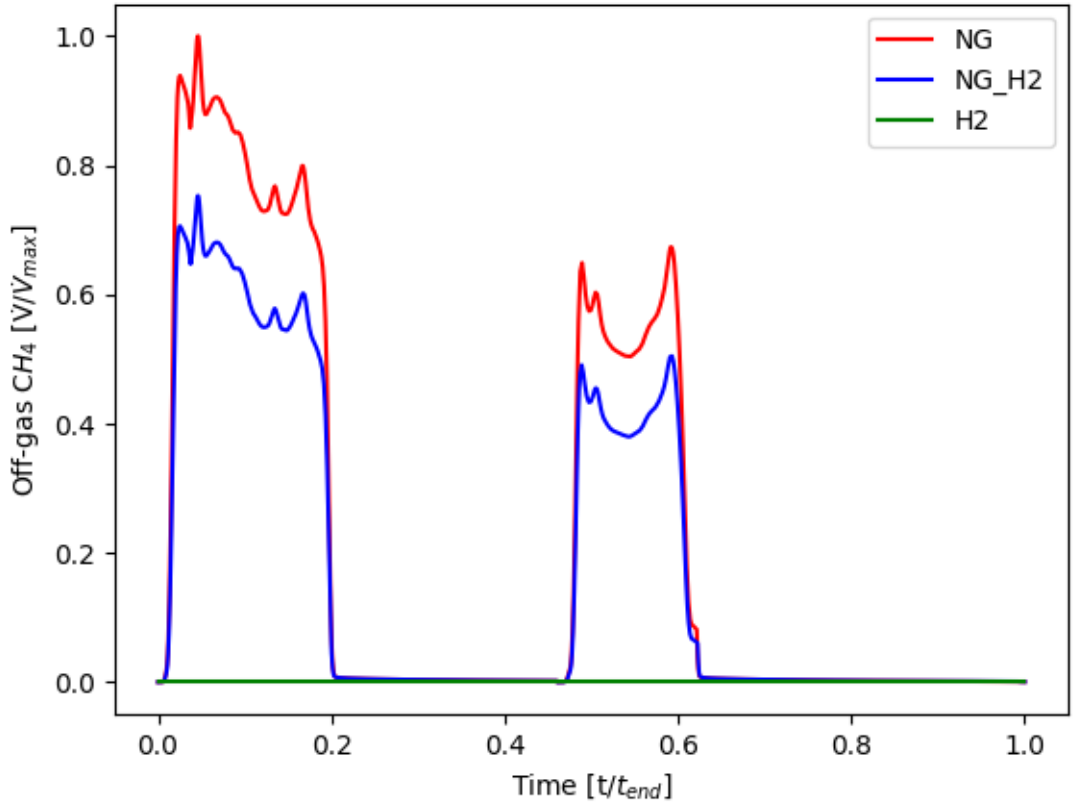
Off-gas analysis – CH_4

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2

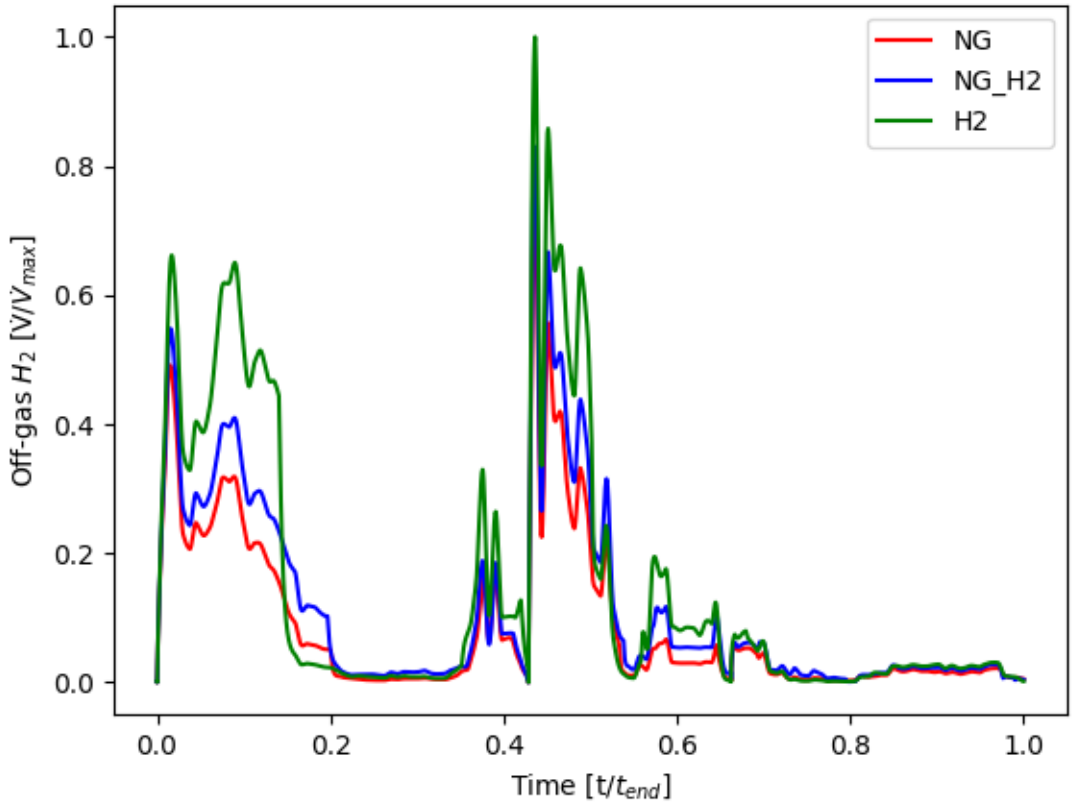


Influence of hydrogen burners

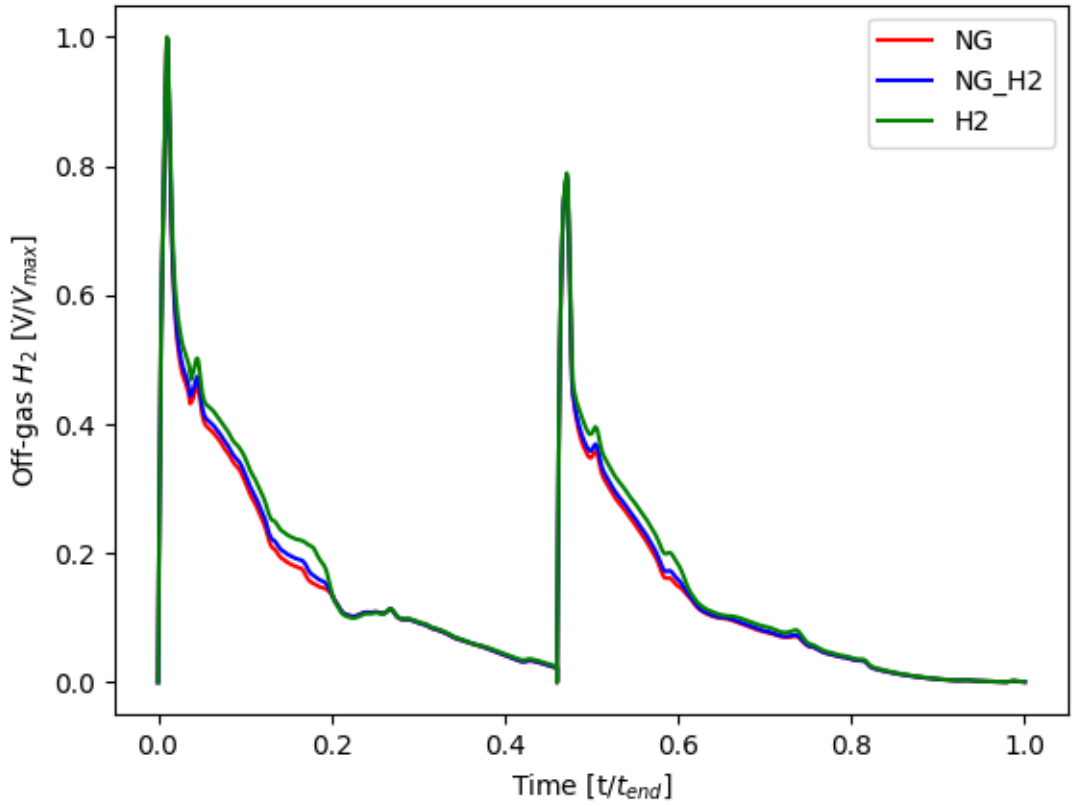
Off-gas analysis – H_2

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2

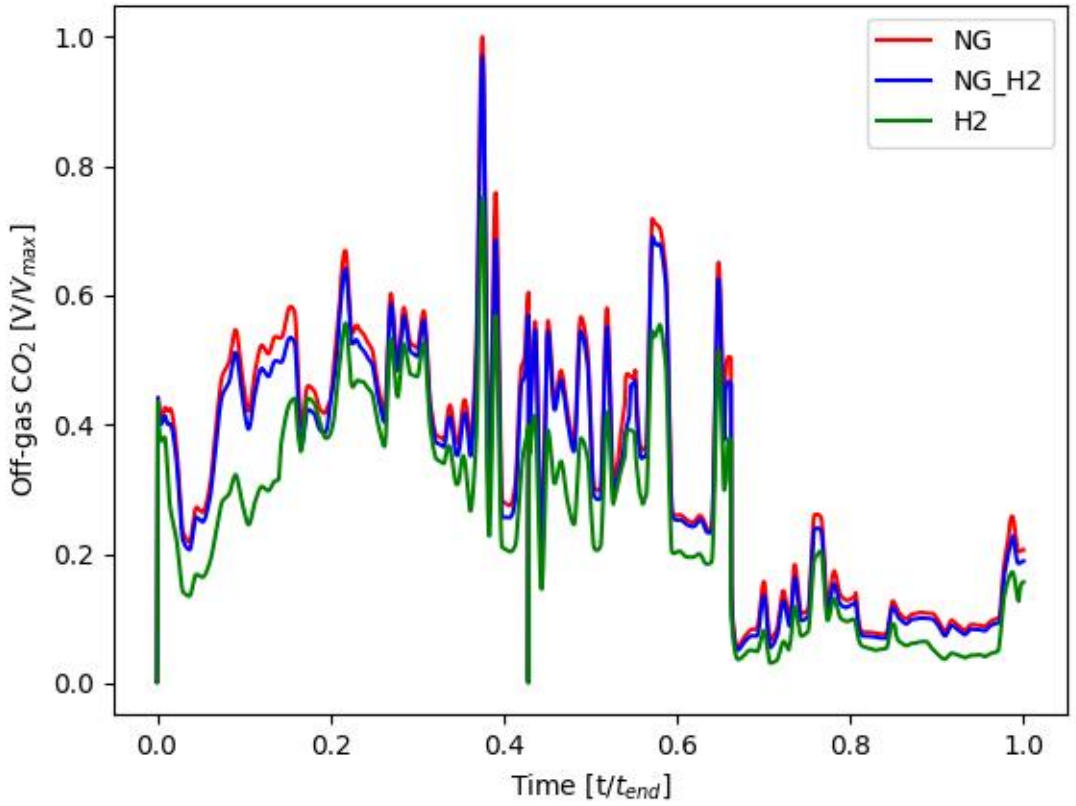


Influence of hydrogen burners

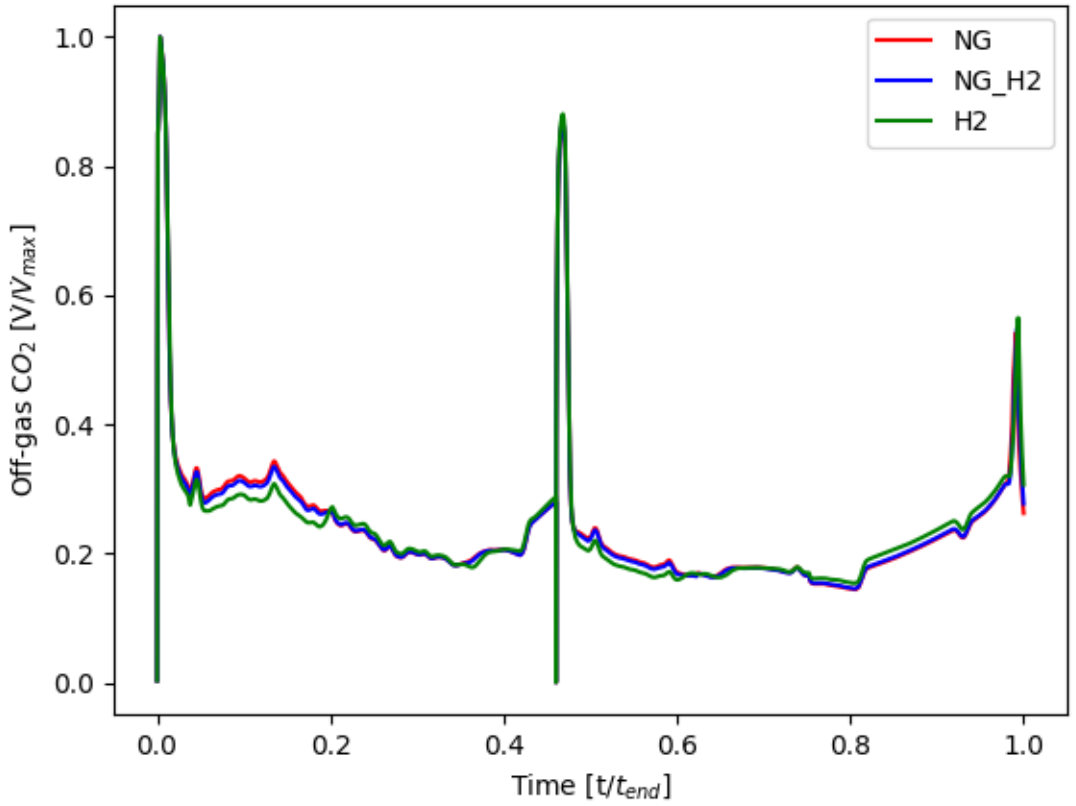
Off-gas analysis – CO_2

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2

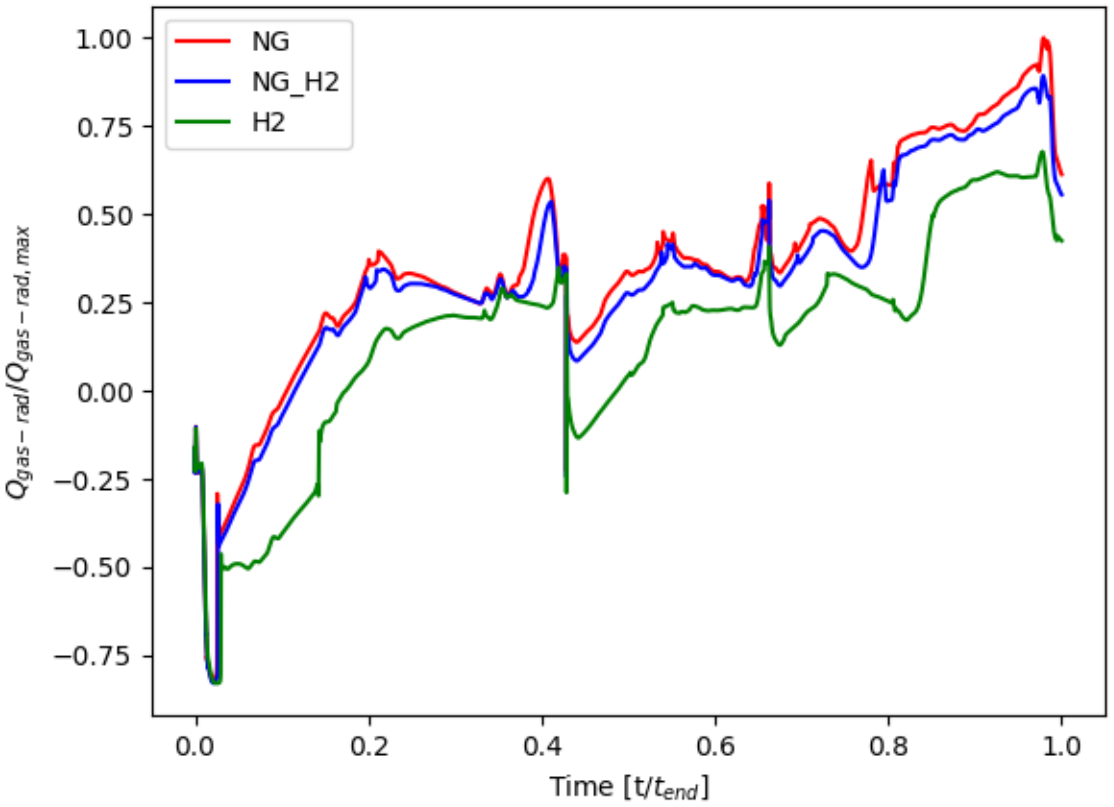


Influence of hydrogen burners

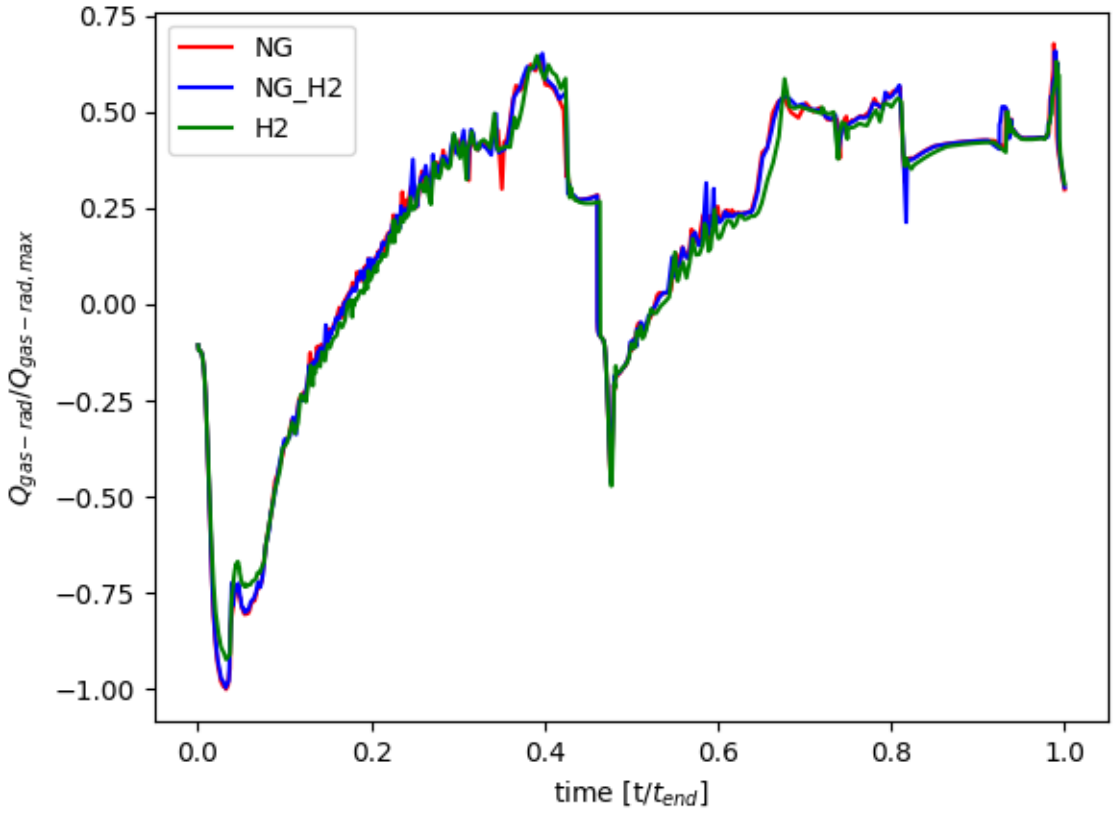
Off-gas analysis – radiative properties

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2

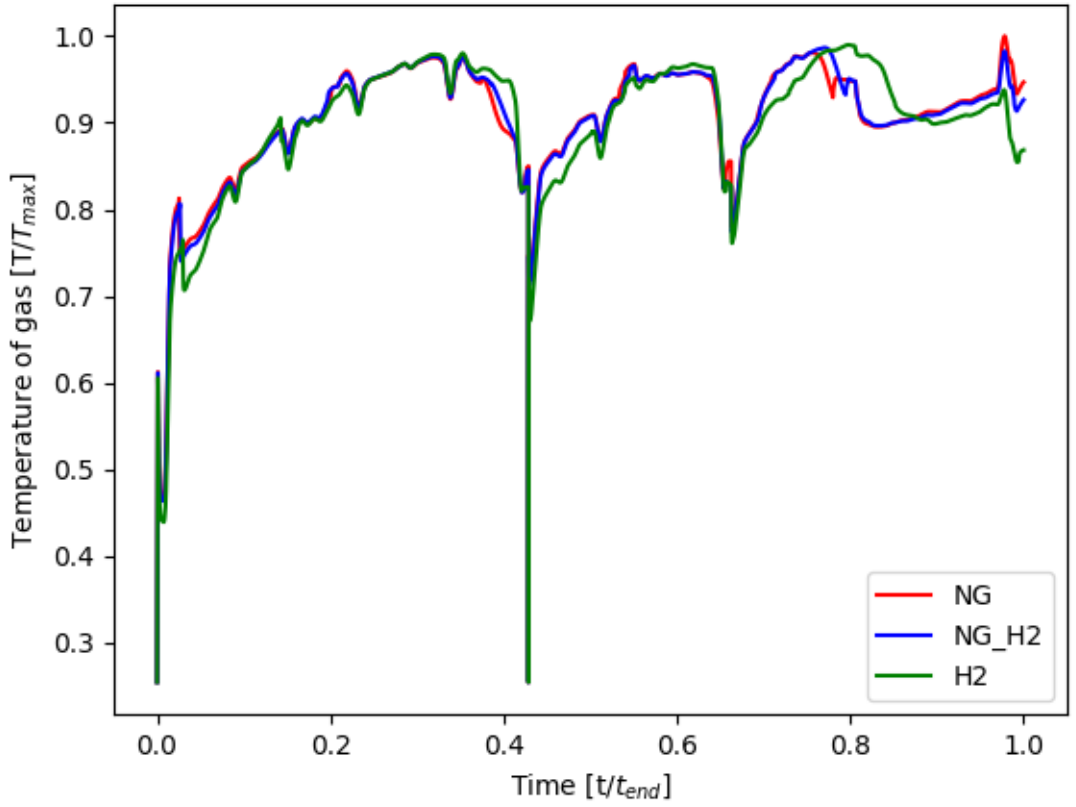


Influence of hydrogen burners

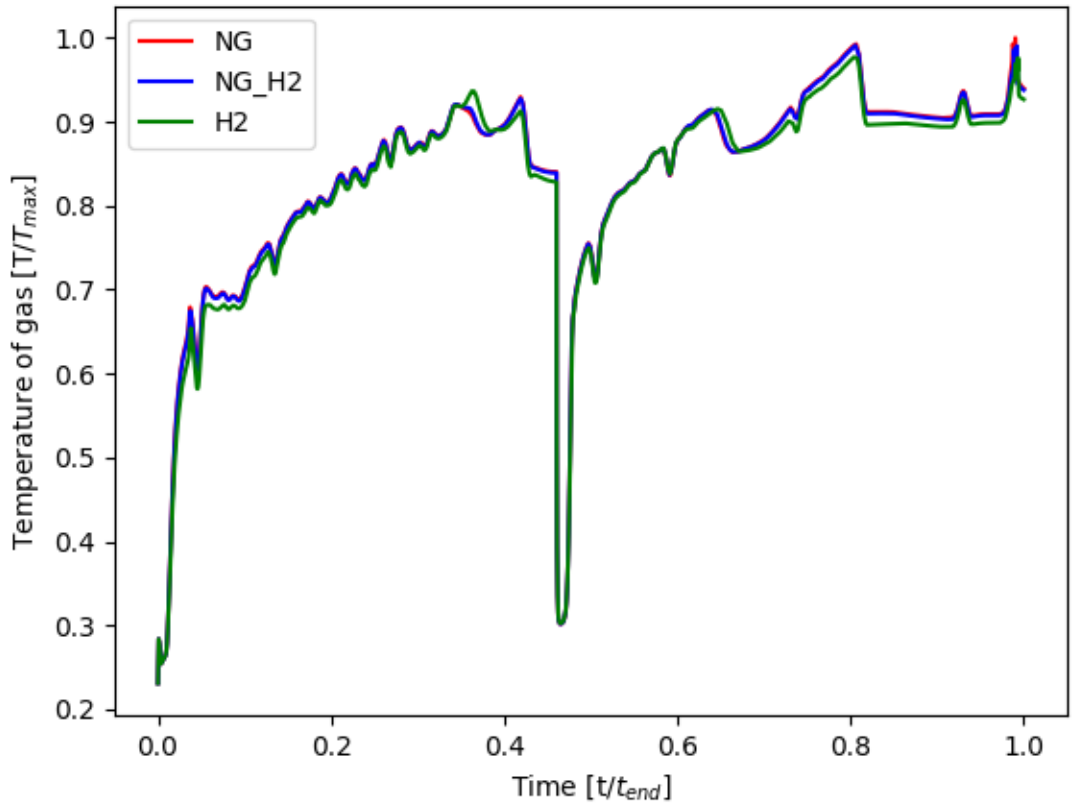
Temperature of gas zone

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2

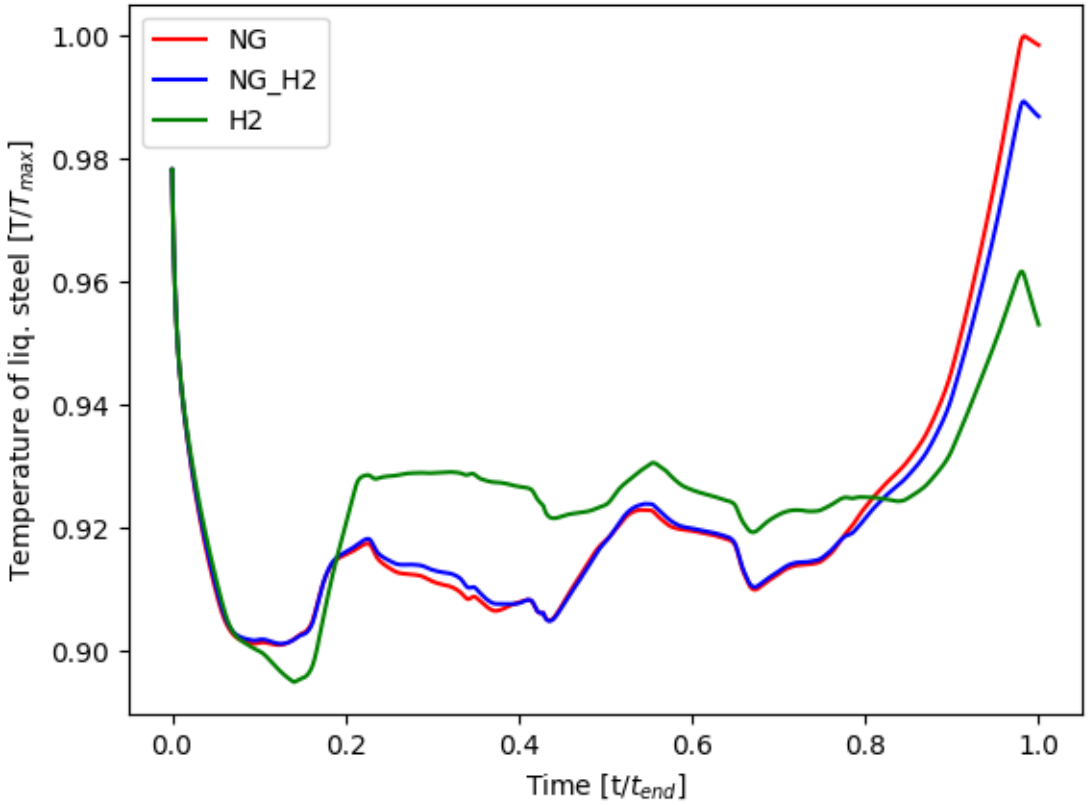


Influence of hydrogen burners

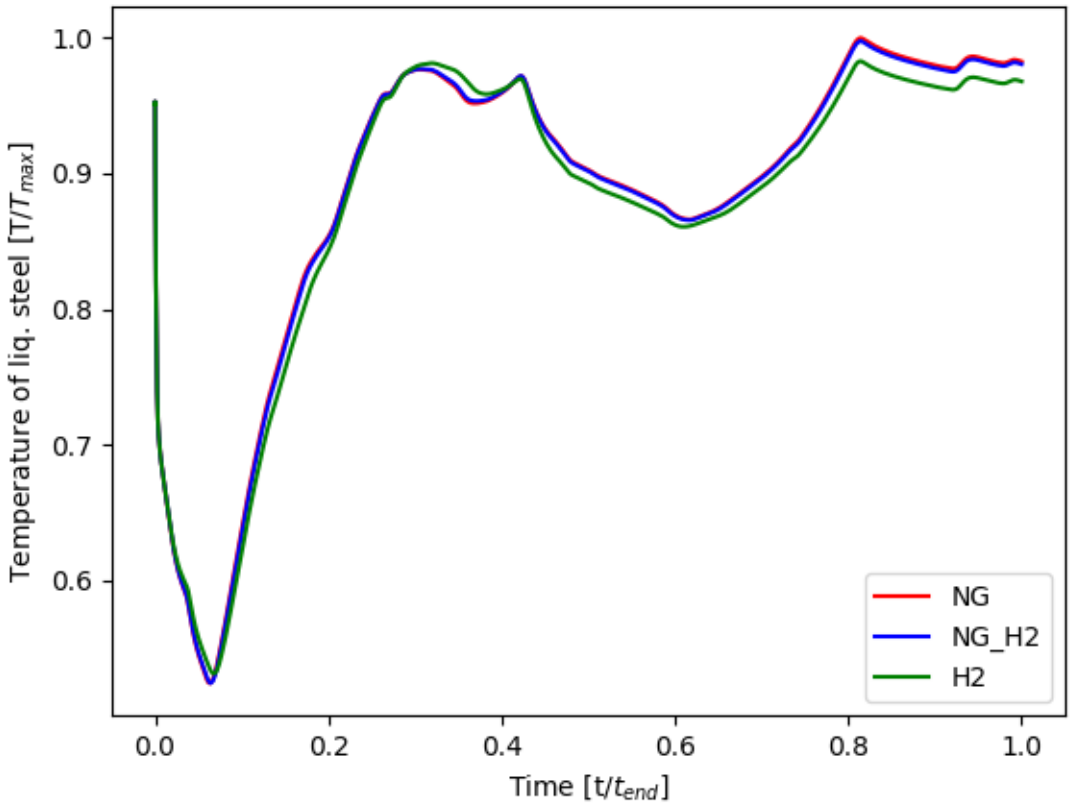
Temperature of liquid steel

100% NG 0% H2
50% NG 50% H2
0% NG 100% H2

EAF 1



EAF 2



Free flame trials

- Const. caloric value of 50 kW
- Fuel gas mixtures from 100% natural gas to 100% hydrogen
- Free flame trials to analyze the flame

Free flame trials

Conclusion & outlook

- EAF process model is able to simulate hydrogen burners
- Model results:
  - Overall process stays the same
  - Less usage of the burners lowers the influence of hydrogen combustion
- Free flame trials:
  - Long, stable flame for all fuel gas compostions
  - Addition of hydrogen stabalizes the flame
- Integration of the 50 kW burner in a pilot scale EAF
  - Investigation of the effects of a hydrogen burner on the EAF process
  - Especially on the compsition of steel, slag and gas
- Validation and adjustment of the EAF model results with data from investigated EAFs using hydrogen burners

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Thinking the Future
Zukunft denken

Your contact

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