New concepts for industrial heating and burner technology

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Structure

- Concepts with new techologies
- Current research & developement
- Measurement technologies

Concepts

Concepts with new techologies

- Technology analysis:
  Basis is BATREF independetly of available fuel in future
- Relevant for BATREF-analysis:
  - Given situation in plants
  - Ecological impact, availabel recources and green deal
  - Energy consumption and emissions
  - New technologies: H_2 as fuel, electrical heating, AI

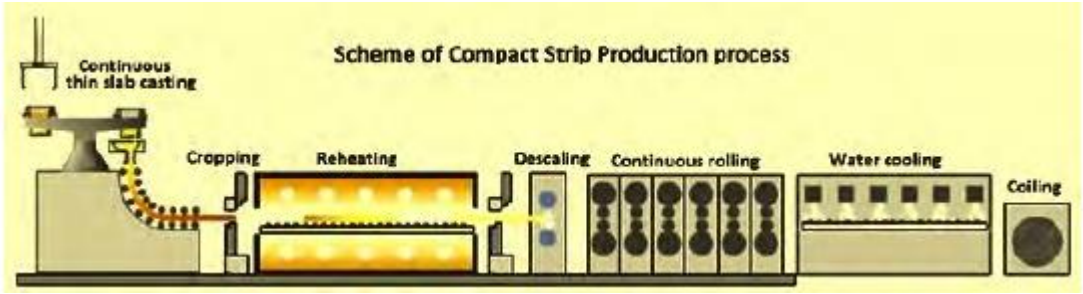
Concepts

- Relevant BATREF techniques for new/future fuels:
  - Costomized, optimized and well designed furnace
  - Flameless, ultral LowNO_x combustion due to NO_x – emissions
  - Heat recovery with regenerative or recuperative air-preheting
    Oxygen enhanced combustion (OEC) with oxydizer-preheating
    <- dependent on O_2- concentration,
    oxy-fuel combustion not
  - Automation and control with i.e. temperature, oxygen control (dissHEAT project-topic 2 and 3)

Concepts

- Relevant BATREF techniques for new/future fuels:
  - Indirect hot charging (300-600°C) or
    direct charging (600-850°C) <- plants with continuous casting & rolling
    => significant energy savings
  - Combining rolling and casting: near-net-shape casting,
    compact strip production (CSP):
    => efficient reheating

Source: https://op.europa.eu/en/publication-detail/-/publication/0923f1e0-751f-11ed-9887-01aa75ed71a1

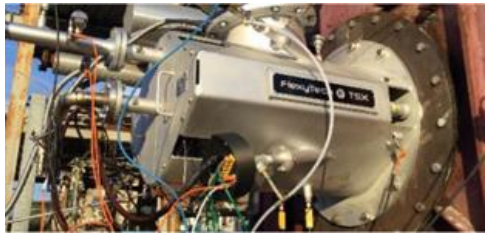


- **Merge with new developments**

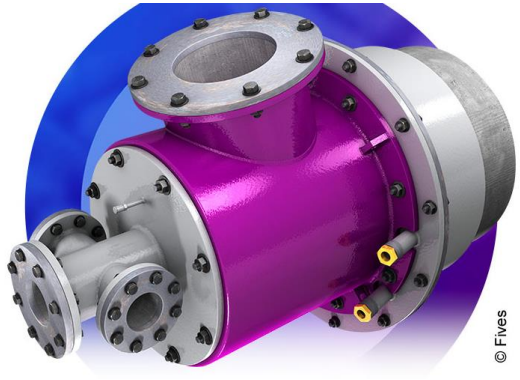
Technologies of suppliers

HEC burner and H_2 burner (examples)

Source: https://www.danieli.com/en/news-media/news/danieli-hydro-mab-take-step-ahead-green-steel_37_596.htm



Source: https://doi.org/10.1051/mattech/2022012



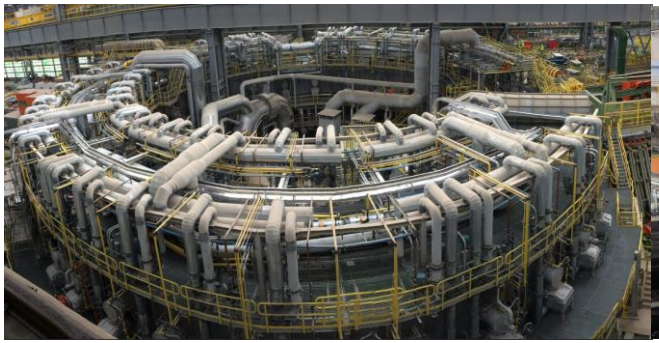
Source: https://www.fivesgroup.com/steel/reheating/combustion-systems

Source: https://www.sms-group.com/en-us/insights/all-insights/a-burner-for-all-mix-ratios-of-natural-gas-and-hydrogen

Technologies of suppliers

Furnaces BAT (examples)

Source:
https://www.danieli.com/en/products/products-processes-and-technologies/product-lines/reheating-furnace-long_26_159.htm



Sources:
https://tenova.com/technologies/rotary-hearth-furnace
https://tenova.com/technologies/walking-beam-furnace-slabs

Current research

Current research and development **examples**:

Clean hydrogen combustion and digital tools for reheating and heat treatment for steel **HYDREAMS** (RFCS)

- Steel producers, manufacturers: H_2 electrolyser, burner & refractories, research institutes
- Testing of 100% H_2/O_2, H_2/OEC HEC/OEC in reheating and annealing furnaces
- Development of new burner types for efficient combustion of (oxy-)fuel gas mixtures
- Trials in pilot furnace with up to TRL 7.

Current research

Avoiding CO_2-emissions in steel industry by appling hydrogen for heating batchwise operating anealing furnaces, **H_2-DissTherPro** (national project, Germany)

- Substitute NG by H_2
- Investigating H_2 or HEC combustion with existing burners in annealing plant
- HEC to 100% H_2 with modified burners.

Source: https://www.industrie-energieforschung.de/interviews/h2distherpro_wasserstoff_stahlindustrie_thyssenkrupp_rasselstein_bfi

Current research

Hydrogen technologies for decarbonization of industrial heating processes, **HyInHeat** (Horizon Europe)

- Large project with 28 partners from steel and aluminium industry
- Substitute NG by H_2 in both industries
- HEC or H_2 combustion with air and pure O_2
- 8 furnaces adapted for H_2 combustion trials

https://hyinheat.eu/

Current research

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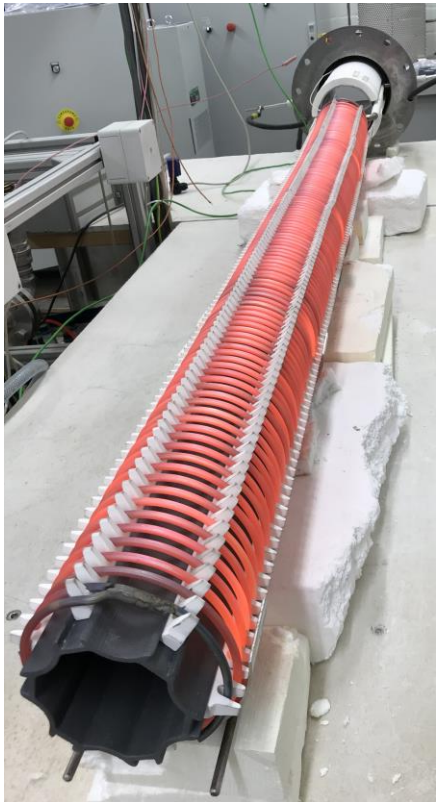
Developing a radiant tube burner for **hybrid heating** of industrial furnaces with fuel gas and electrical energy (national project, Germany)

- Energy flexible alternative to adapt to availability of renewable energies
- Radiant tube burner for steel strip furnace



Current research

Gradual integration of REnewable non-fossil ENergy sources and modular HEATing technologies in EAF for progressive CO_2 decrease, **GreenHeatEAF** (Horizon Europe):

- HEC to decrease fossil fuels in EAF process
- Investigating HEC with existing burner for EAF heating by combustion
- Simulation study of combustion and EAF heating
- Other topics regarding CO_2-decrease

Measurement techniques for H_2-combustion

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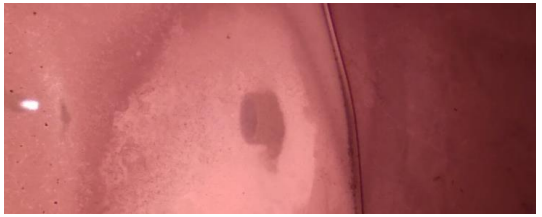
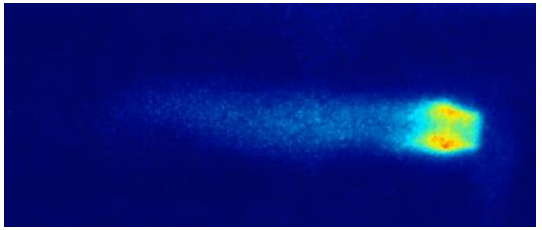
Flame diagnostics with **UV-camera endoscope**

- High temperature applications (T > 800 °C) gaseous flames are barely visible
- In hydrogen and hydrocarbon combustion reaction regions characterized by OH*-radicals /high chemiluminescence
- BFI operates a water-cooled endoscope with UV optics: 2D images of OH*-radicals
  - Analysis flame structure, ignition, depletion, stability
  - Mobile setup for laboratory and industrial trials at up to 2.000 °C





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Research Fund for Coal & Steel

Thank you for the attention!

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