dissHEAT

Heating and Burner technology

Research findings and technical development over the last 20 years

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Structure

- Focus of topic haeting and burner technology in review
- Initial situation and driving forces for past developments
- Main developments in past 20 years
- Success-story - developments applied in industry

Sources for review

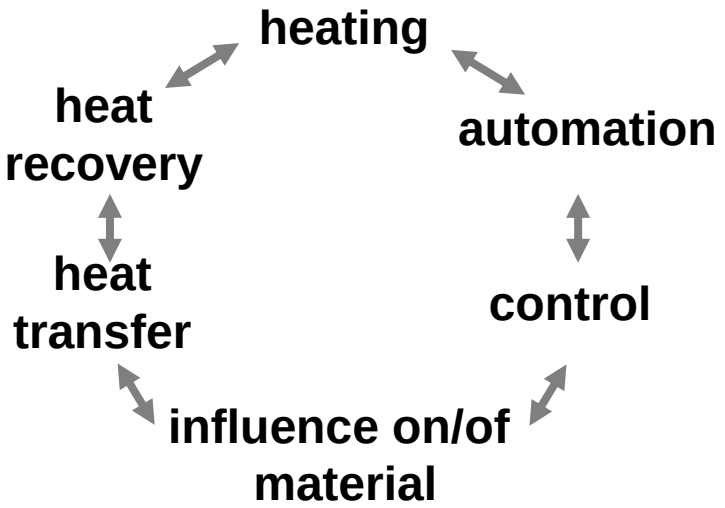
Review and analysis of:

- RFCS reports 11 relevant of 13 related to this topic
  - TRL at end 5 to 9
- Horizon-Europe reports/deliverables 2 relevant of 10 related to this topic
  - TRL at end 4 to 5
- National research project reports 2 relevant for topic
  - TRL at end 7 to 8
- Literature 7 relevant of 27 related to this topic
- Other (company reports, websites)

Focus

Focus in review of topic heating and burner technology

- Considered in review
  - Efficiency, productivity, flexibility related to steel quality/ type
  - Temperature in product during its heating
  - The following rolling process
  - Scale loss and furnace atmosphere
  - NO_X or GHG emissions
- Interaction of all topics
  -> overlapping

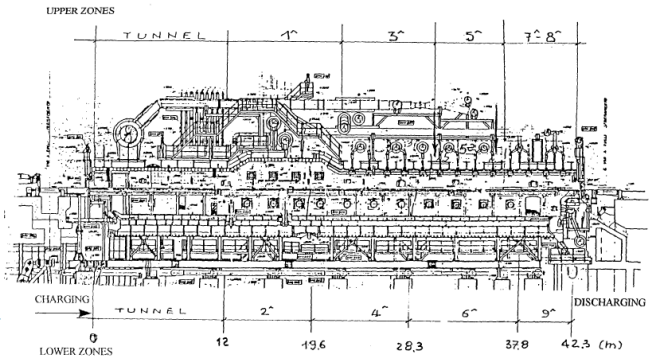


Initial situation, driving forces

Initial situation when research was initiated, i.e.:

- Old furnaces (some 30 to 50 years) [2], [3], [35], [34]
- Old burners mainly with recuperative heat recovery or firing with cold air [2], [3], [35], [34]
- High flue gas temperature -> high sensitive heat loss [2], [3]
- Furnaces without control-system (level 2), without measurement of furnace atmosphere [7], [10], [27]

Sources: see D3.2 on dissheat.eu



Source: https://op.europa.eu/en/publication-detail/-/publication/61ac72c9-7083-45fe-b030-617017782df9

Initial situation, driving forces

Driving forces for developments:

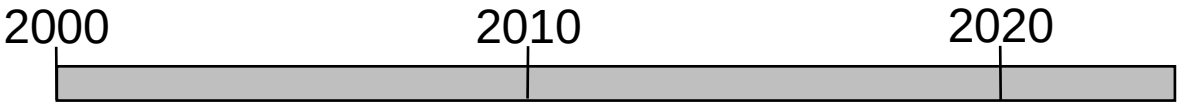
- Efficiency of hole furnace at low and high flue gas temperture
- Increase furnace productivity
  Motivation: Modify existing furnaces to increase output
- Using process gases in integrated steel mill to substitute i.e., natural gas, oil for furnace heating
- NO_X – decrease
  - regulations
  - thermal NO_X caused by high combustion air temperatures from regenerative heat recovery <-> efficiency related developments

Developments of past 20 years

Main fields of research in past 20 years:

- Energy consumption and CO_2 emission decrease (see dissHEAT topic 5)
- Furnace productivity and product quality
- NO_X emission decrease
- Process gases as alternative fuels
- Latest research on Burners for HEC and 100% H2

Developments of past 20 years



Research focus of last 25 years: what /when

- Furnace automation (level 1) and control (level 2)
  from 1998 to now
- Furnace productivity, efficiency and regenerative heating
  from 1989 to 2018
- Process gases instead of NG for furnace heating
  from 2009 to 2015
- Preheating process gases
  from 2008 to 2018
- NO_X emissions in connection with high preheated air
  from 2000 to 2005
  due to regulations from 2008 on and 2019 on H_2

Relevant findings

Efficiency, energy consumption and CO2 – reduced by

- Heat recovery from flue gas for regenerative combustion air preheating; savings 30-40%
- Furnace automation (level 1) and control (level 2) with temperature and furnace atmosphere control; savings 5-10%
- Process gas to substitute NG, over all energy consumption reduced

Relevant findings

Efficiency, energy consumption and CO2 – reduced by

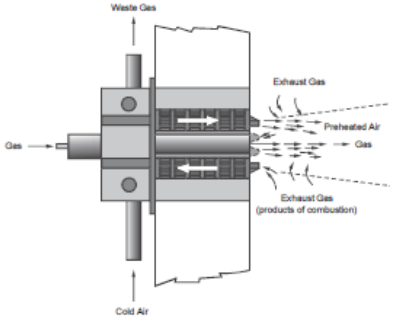
- Heat recovery from flue gas for regenerative combustion air preheating; savings 30-40%
- Furnace automation (level 1) and control (level 2) with temperature and furnace atmosphere control; savings 5-10%
- Process gas to substitute NG, over all energy consumption reduced
- Fuel heating of low calorific gases with sensitive heat
- Oxy-fuel combustion, reducesd sensitive heat loss with significant fuel savings

Source: https://doi.org/10.1016/j.egypro.2017.07.215

Relevant findings

Furnace productivity and product quality increased by

- Heating the dark zone
- Replacing the burners by regenerative burners increased and uniform heat transfer
- Applying NG or LPG oxyfuel combustion
- Increase temperature uniformity by costomized burner design high momentum and long flames, optimized burner positions
- Temperature control and temperature measurement

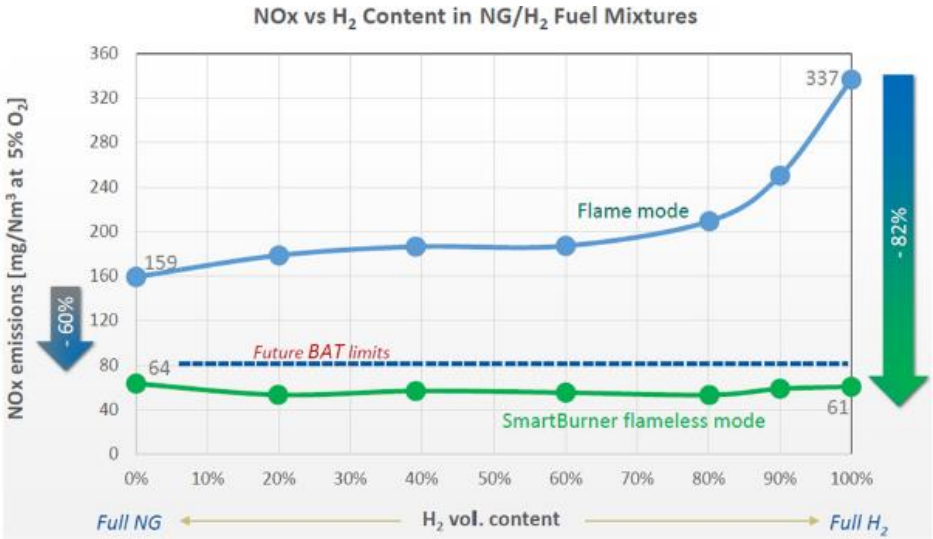


Source:
https://op.europa.eu/en/publication-detail/-/publication/d65a4234-7143-40ed-a7ff-69a7314faafa

Relevant findings

NO_x – emission decrease

- Primary measures: ultra Low-NO_x systems or with flameless combustion combined with regenerative heat recovery to achieve
  - Low-NO_x at high efficiency
  - Low-NO_x for HEC or H_2 combustion
- Secondary measures: de- NO_x systems in flue gas SCR or SNCR



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

Success

Flat flame regenerator burner national project

- Numerous research projects. For batch type furnaces/ forging furnaces with regenerative heat recovery the national project KINAMI in Germany **[3]** 2012. In this project 3 batch type furnaces where fully equipped with regenerative burner system and one of these furnaces with the process gases COG and BOF.
- Because of good results at least 300 regenerative burner systems for NG where worldwide sold. The systems are in operation mainly in batch type furnaces.

Sources: see D3.2 on https://dissheat.eu

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Research Fund for Coal & Steel

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