

Sensors and control (level 1), standards, regulations Research and development analysis and findings

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Focus of investigations in reviewing:

Sensors and control (level 1), standards, regulations



- Measurement devices and sensors used to collect data of the furnace
- Measurement-based furnace control (level 1)
- Relevant standards & regulations (EU level)

Main KPIs for furnace measurement technologies over the last 20 years:

- Energy consumption (e.g. GJ/t)
- CO₂ emission (e.g. kg/t)
- Furnace productivity (e.g. t/h)
- Scale loss e.g. (e.g. /m²)

Improvement through better temperature and atmosphere control



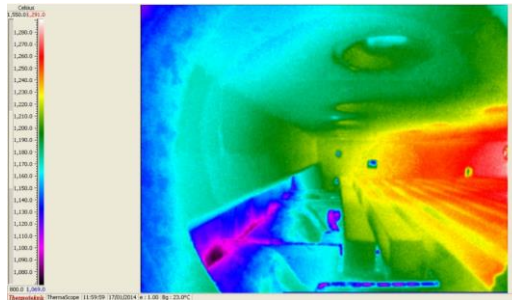
The key technologies reviewed in topic 3 focus on:

- **Furnace and charge temperature measurement and control**

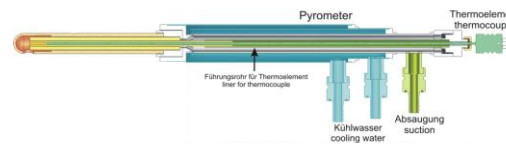
- ↑ Furnace productivity

- ↓ Energy consumption & CO₂ emissions

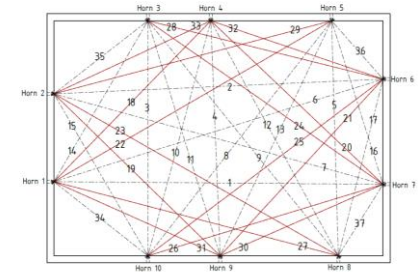
- IR (gas) pyrometer, thermal imaging, suction pyrometer, ultrasonic gas temperature measurement...



Thermal imaging¹



Gas suction pyrometer²



Ultrasonic system¹

1: European Commission, Directorate-General for Research and Innovation, Niska, J., Steimer, C., Broughton, J., et al., Advanced measurements and dynamic modelling for improved furnace operation and control (DYNAMO) : final report, Publications Office, 2017

2: Paul Gothe GmbH

The key technologies reviewed in topic 3 focus on:

- **Furnace atmosphere composition (O_2 , CO) measurement**
 - ↓ Energy consumption & CO_2 emissions
 - ↓ Scale loss
 - Regulation of air-to-fuel ratio, measurement of oxygen content using ZrO_2 probes...



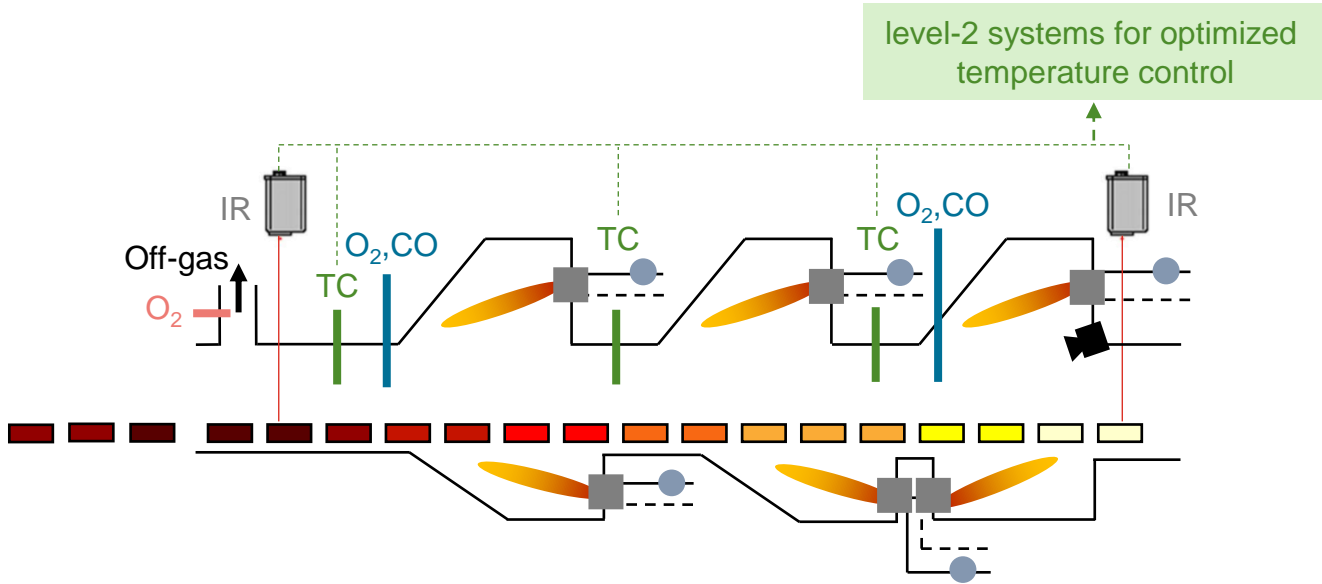
Pneumatic air/gas ratio controls³

Air-ratio controllers ⁴	
Mechanical/pneumatic	Electronic
<ul style="list-style-type: none">▪ Fixed Systems▪ Mechanical connection via linkage/ cam plate▪ Pneumatic ratio controller according to EN 12067-1	<ul style="list-style-type: none">▪ „Conventional“ ratio control via mass flow measurement▪ Type-tested electronic ratio controllers according to EN 12067-2▪ Other redundant or multi-channel solutions



3: Honeywell, Air/Gas Ratio Controls GIK

4: Webinar "Heating System design acc. EN 746-2 & ISO 13577-2", Martin Wicker, 01.06.2023




- Air-gas ratio control
- | O₂, CO measurement in the furnace
- | O₂ measurement in the off-gas

- IR Pyrometer
- Thermocouple
- Thermal imaging



Relevant technologies to enable CO₂ emission reduction:

- No specific new technology concerning measurement and sensors to significantly reduce CO₂ emissions
- Focus on **adaptation of emission measurement systems and standards** (EU Level and national legislation) **for future combustion systems** 
 - **New fuels**: Hydrogen (H₂), ammonia (NH₃), biofuels (e.g. DME), new top gases, blends of natural gas (NG) and these fuels...
 - **New oxidizers**: oxygen-enriched combustion, pure oxygen (O₂)
 - **Fuel flexible operation**





Thank you for the attention!

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