european cement research academy

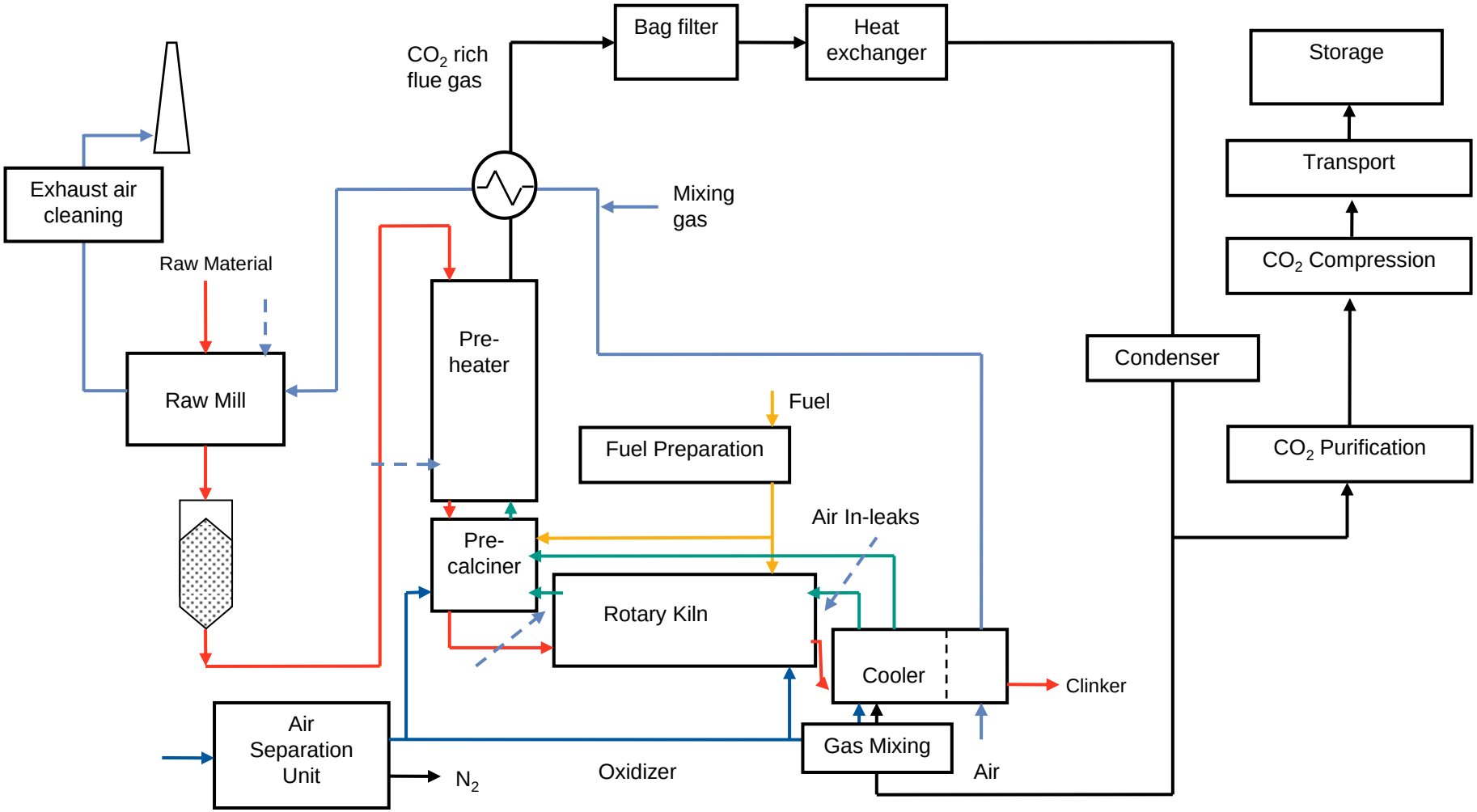
Perspective on oxyfuel capture technology application in a cement plant

Volker Hoenig, Johannes Ruppert

Carbon Capture Technologies in the Cement Industry

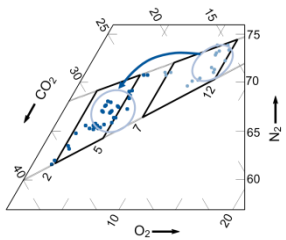
Brussels, 17.10.2018

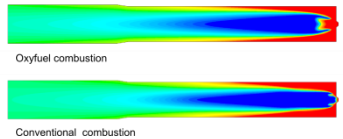
ECRA‘s general layout of an oxyfuel cement plant



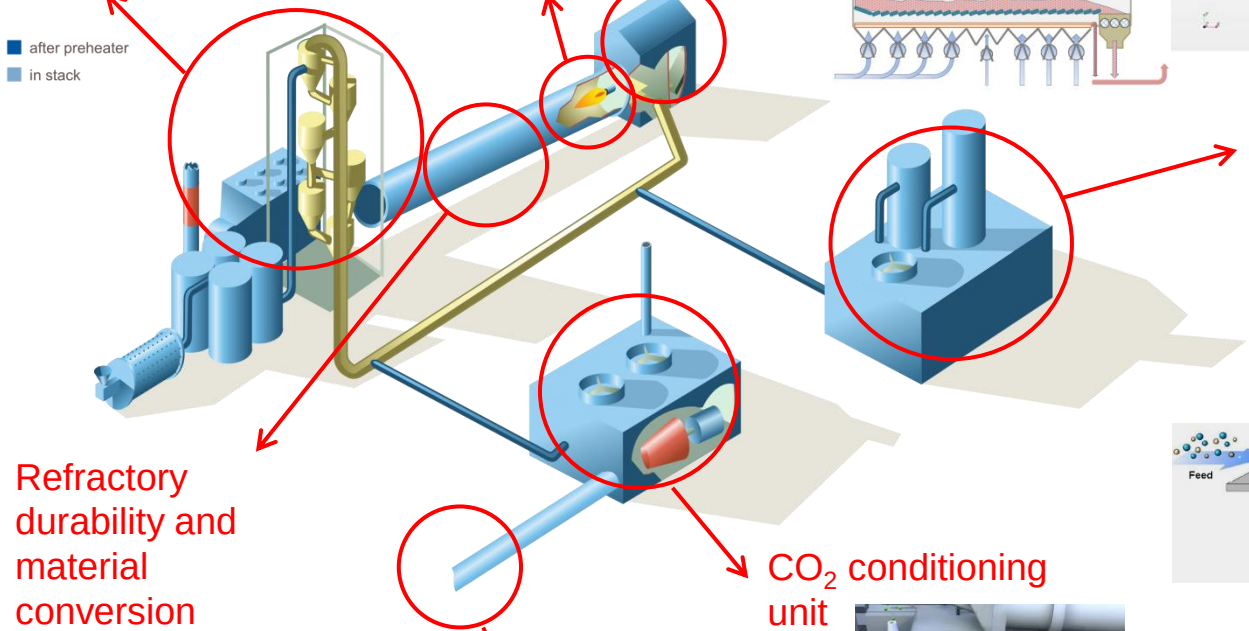
Oxyfuel technology has been investigated in detail

Plant operation and false air reduction

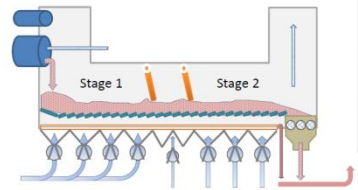


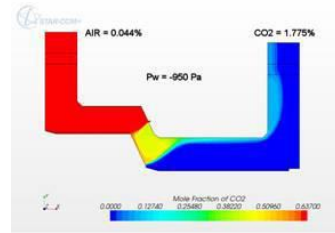


Burner design

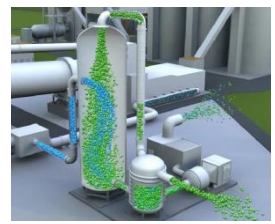


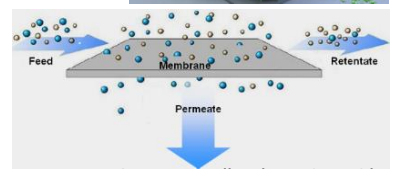
Cooler design





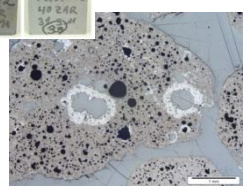
Future oxygen supply systems



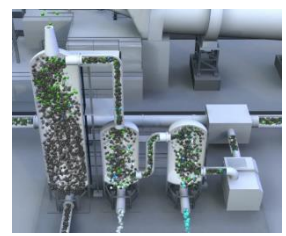


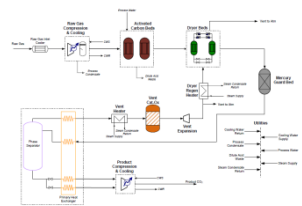
Source: Beilstein J. Org. Chem.

Refractory durability and material conversion



CO_2 conditioning unit

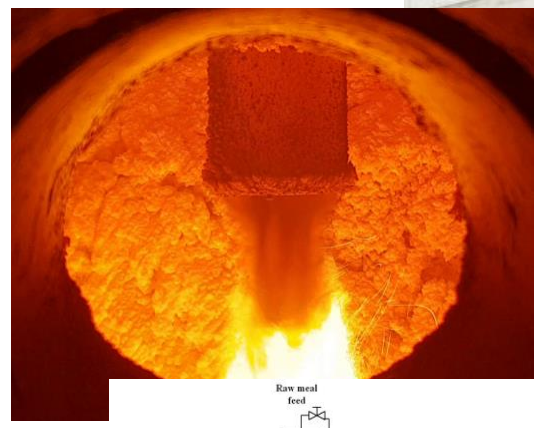


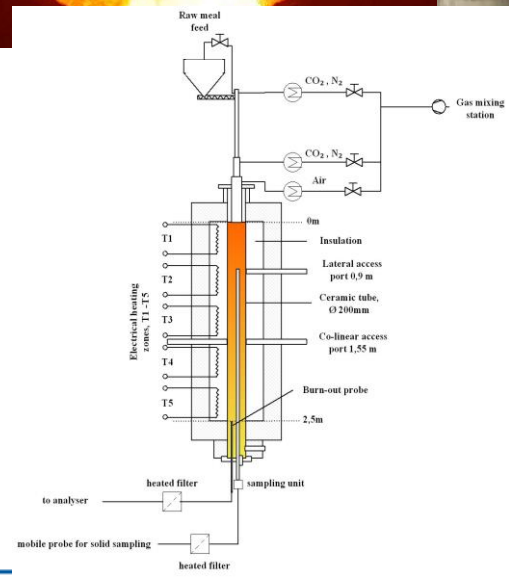


CO_2 reuse

Three important questions to be answered in Cemcap

- Impact on clinker quality due to cooling with CO_2 rich gas?
- New burner design needed for Oxyfuel kiln?
- Is full calcination of raw material possible in Oxyfuel calciner?

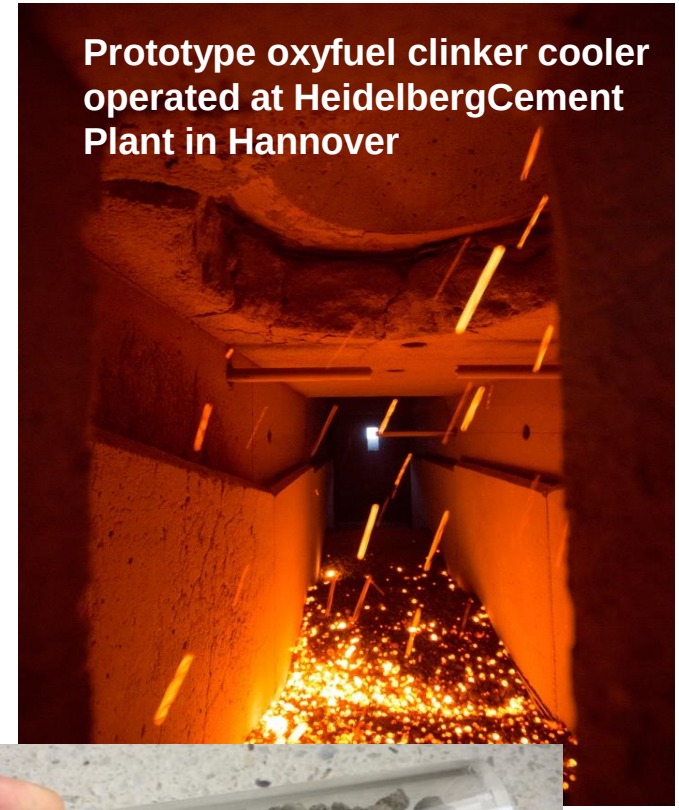




Successful operation of oxyfuel clinker cooler prototype

CEMCAP WP 9

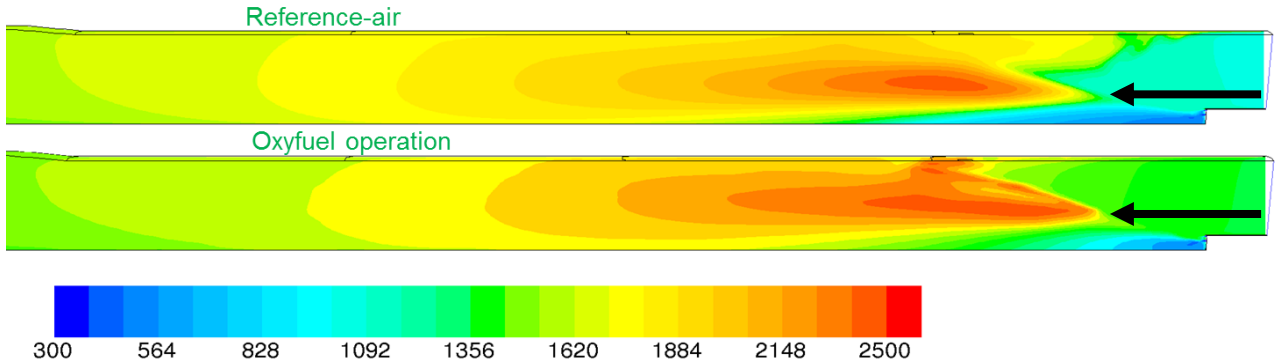
- Clinker cooling was successfully demonstrated under oxyfuel conditions in industrial environment
- No negative impact on cement strength development due to cooling with CO_2 rich gas
- Sealing the cooler outlet against false air ingress will demand special attention in industrial scale projects
- Moisture and dust content in re-circulated gases to be minimized for a trouble-free operation of the cooler



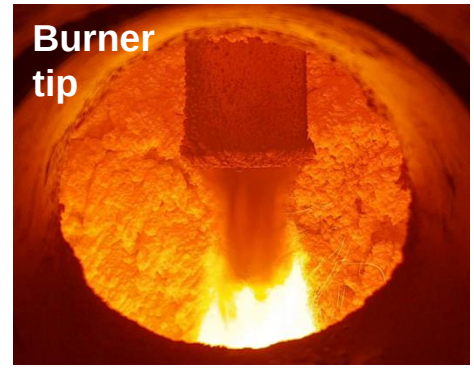
Oxyfuel clinker burning technology

CEMCAP WP6 and WP 7

- Modern cement kiln burners can also be used in oxyfuel operation.
- Similar radiation heat to material can be achieved as in conventional air operation.
- Oxygen enrichment is a new parameter to adjust temperature/heat transfer profile.



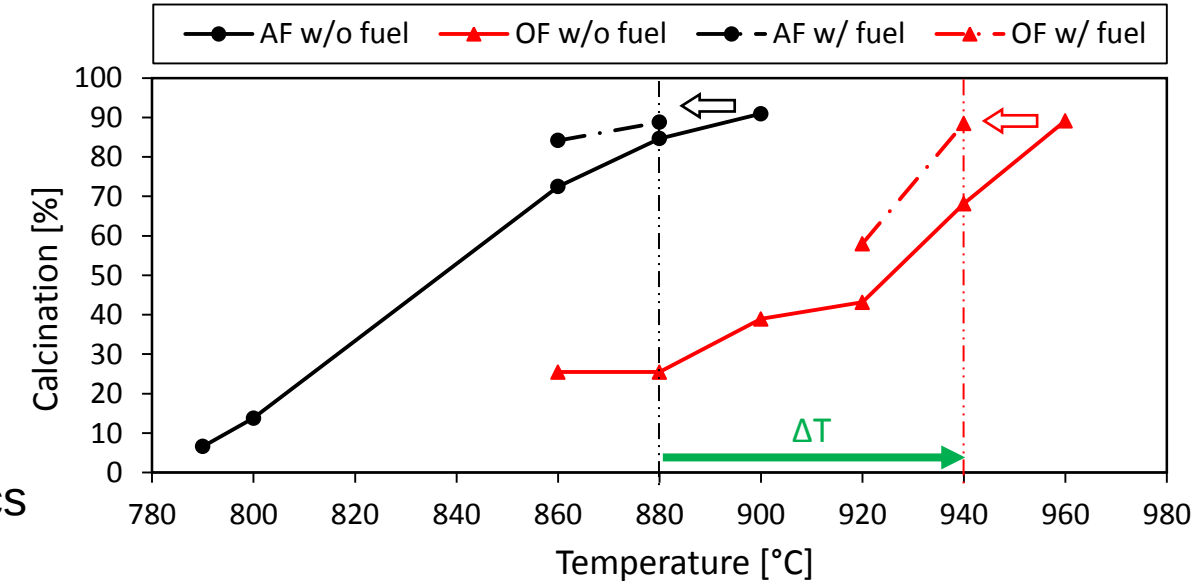
Gas Temperature [K] along the kiln length



Calciner technology for oxyfuel process

CEMCAP WP 8

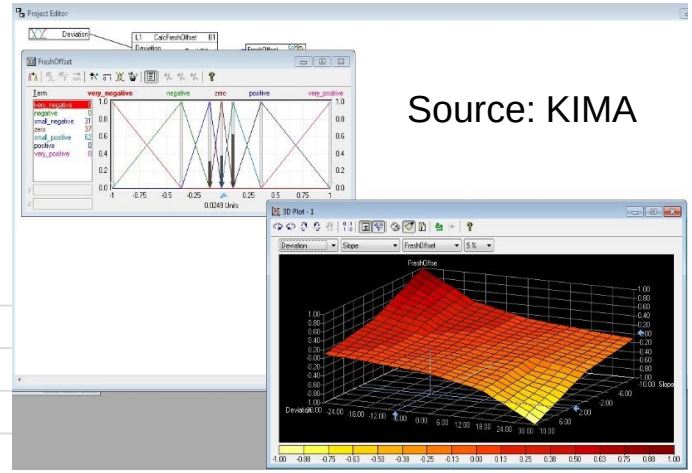
- Higher calcination temperature during oxyfuel operation mandatory
- Optimization of oxyfuel calcination in calciner/kiln to stay within acceptable temperature boundaries
- Heat transfer characteristics to raw meal particles are essential to avoid additional temperature rise



Temperature increase (ΔT) by 50 to 70 K
for calcination in oxyfuel (OF) operation mode

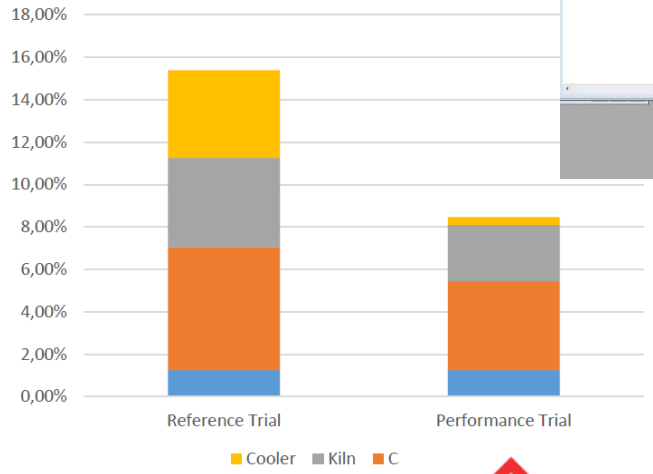
Current ECRA work on Oxyfuel technology

- Automation and instrumentation



Source: KIMA

- False air minimization



- Safety aspects

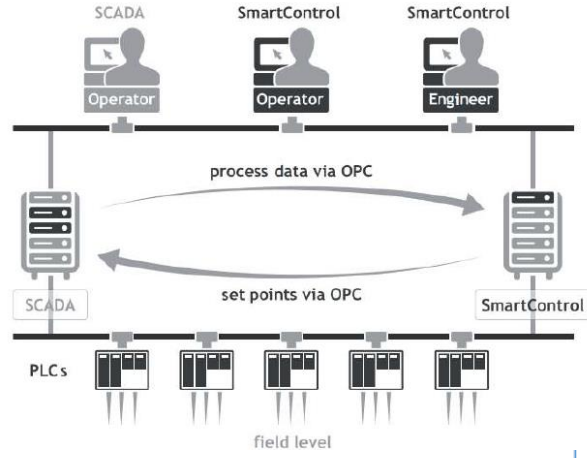
O_2 oxidizing

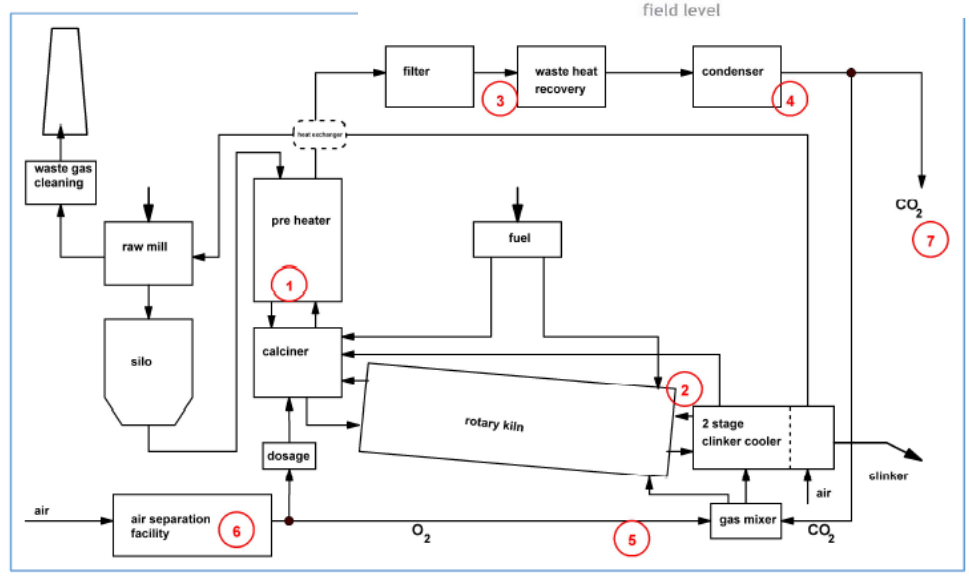
compressed gas

concentrated CO_2 may displace oxygen

Control system for oxyfuel pilot kiln

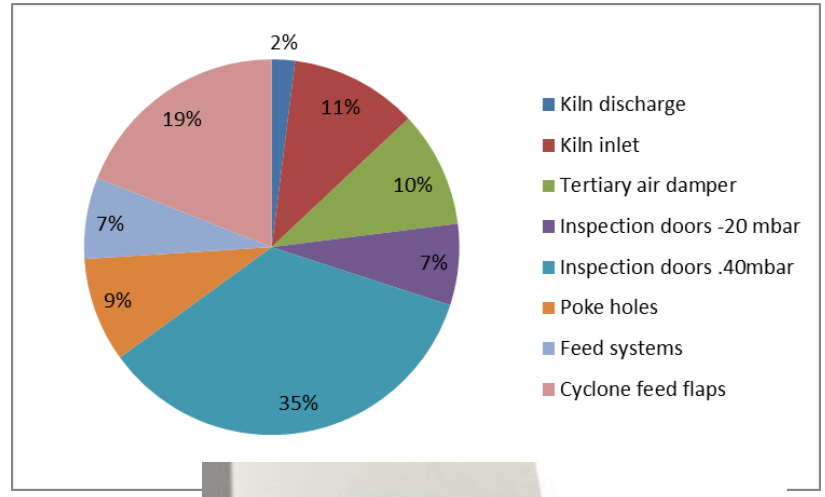
- Oxyfuel kiln operation provides more flexibility regarding process control, e.g. O_2 content in combustion “air”, exhaust air recirculation rate etc.
- Additional measurement systems and control systems required
- New instrumentation needed for:
  - preheater / calciner
  - kiln / clinker cooler
  - waste gas ducts / ID fan
  - CO_2 separation / gas recirculation
  - gas mixer /dosage
  - air separation facility

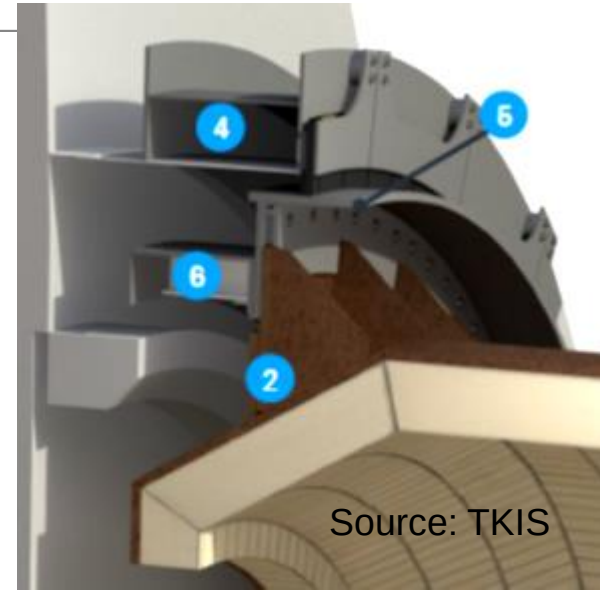




False air ingress

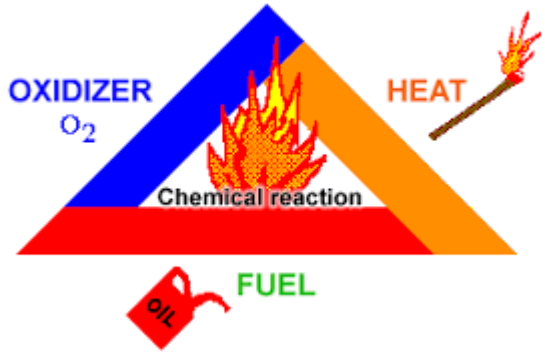
- False air ingress is expected to be one the big challenges for Oxyfuel technology
- False air leads to dilution of CO_2 rich exhaust mainly by nitrogen
- Removal of N_2 in CPU is cost intensive
- Therefore optimized “conventional” maintenance is needed as well as
- Advanced technologies e.g. for
  - kiln sealings
  - minimization of need for poking/cleaning
  - flushing of poke/man holes
  - fans
  - clinker cooler outlet





Safety concept for Oxyfuel kiln

- The operation of a cement kiln in oxyfuel mode requires a safety concept, especially for the handling of the gas streams
- Aspects for safety study:
  - identification, assessment and management of potential new workplace health and safety hazards
  - safe operation with CO_2 enriched flue gas streams
  - safe industrial use of pure oxygen
  - risk assessments, for each major section and for the whole oxyfuel plant (e.g. uncontrolled release of gases)



Acknowledgment

Thanks to colleagues of the ECRA Carbon Capture project and the CEMCAP project consortium: VDZ, University Stuttgart, SINTEF, CTG, ThyssenKrupp, IKN, HeidelbergCement

Kristina Fleiger	Jörg Maier	Giovanni Cinti
Armin Jamali	Alexander Mack	Matthias Böhm
Francisco Carrasco	Rahul Anantharaman	Simon Becker
Manoj Paneru	Simon Grathwohl	Robert Mathai
Marco Lino	Mario Ditaranto	Jørn Bakken
Christoph Hommertgen	Eike Willms	Mette Bugge

The ECRA carbon capture project website and reports are found here:
https://ecra-online.org/research/ccs/

The CEMCAP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 641185.
Project website: www.sintef.no/cemcap, Publications: CEMCAP community in www.zenodo.org

ecra

european cement research academy