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CO_2 Emission Reduction Potential and Technological Aspects of the Oxyfuel Technology in Cement Clinker Production

Dr.-Ing. Volker Hoenig, Dipl.-Ing. Kristina Koring

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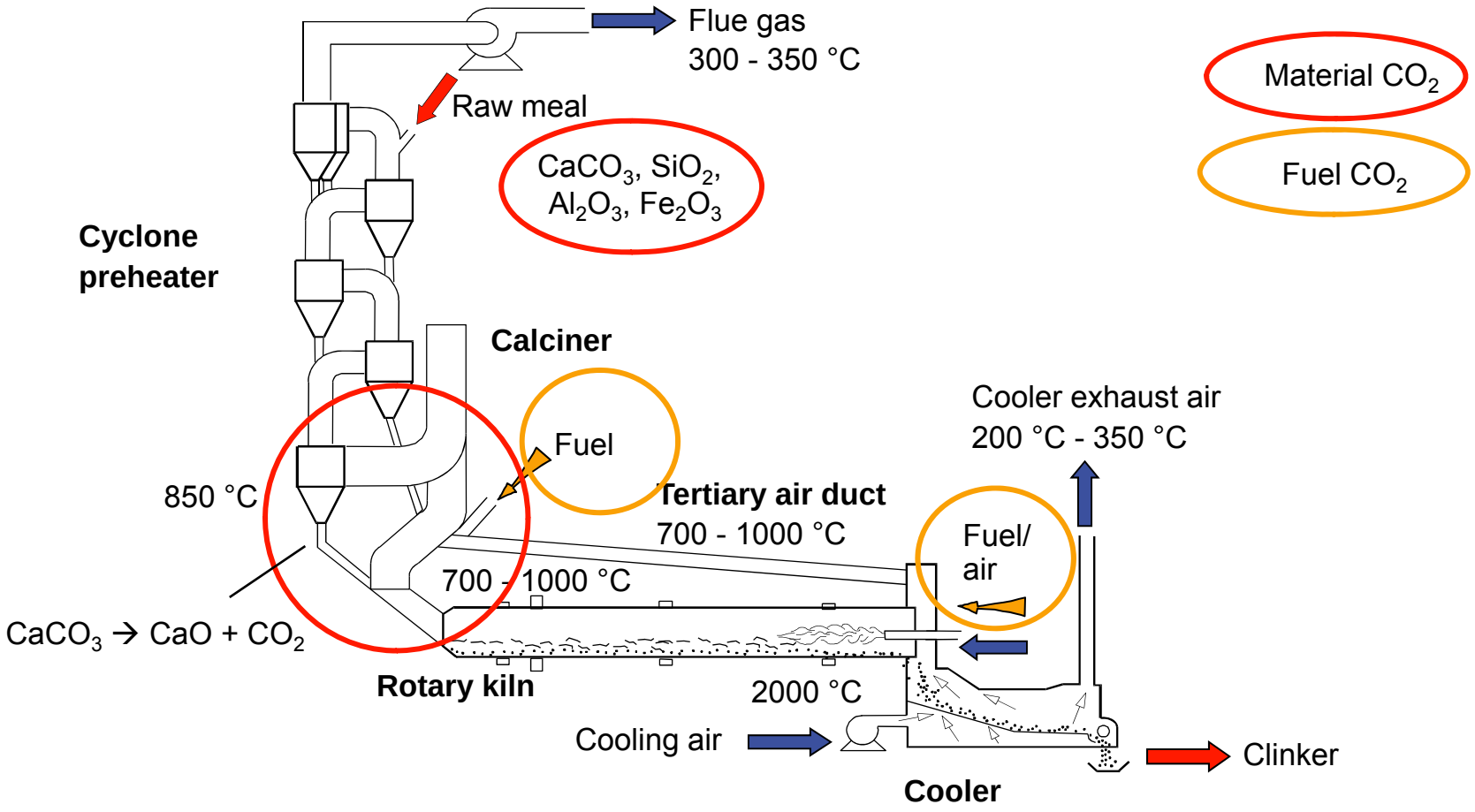
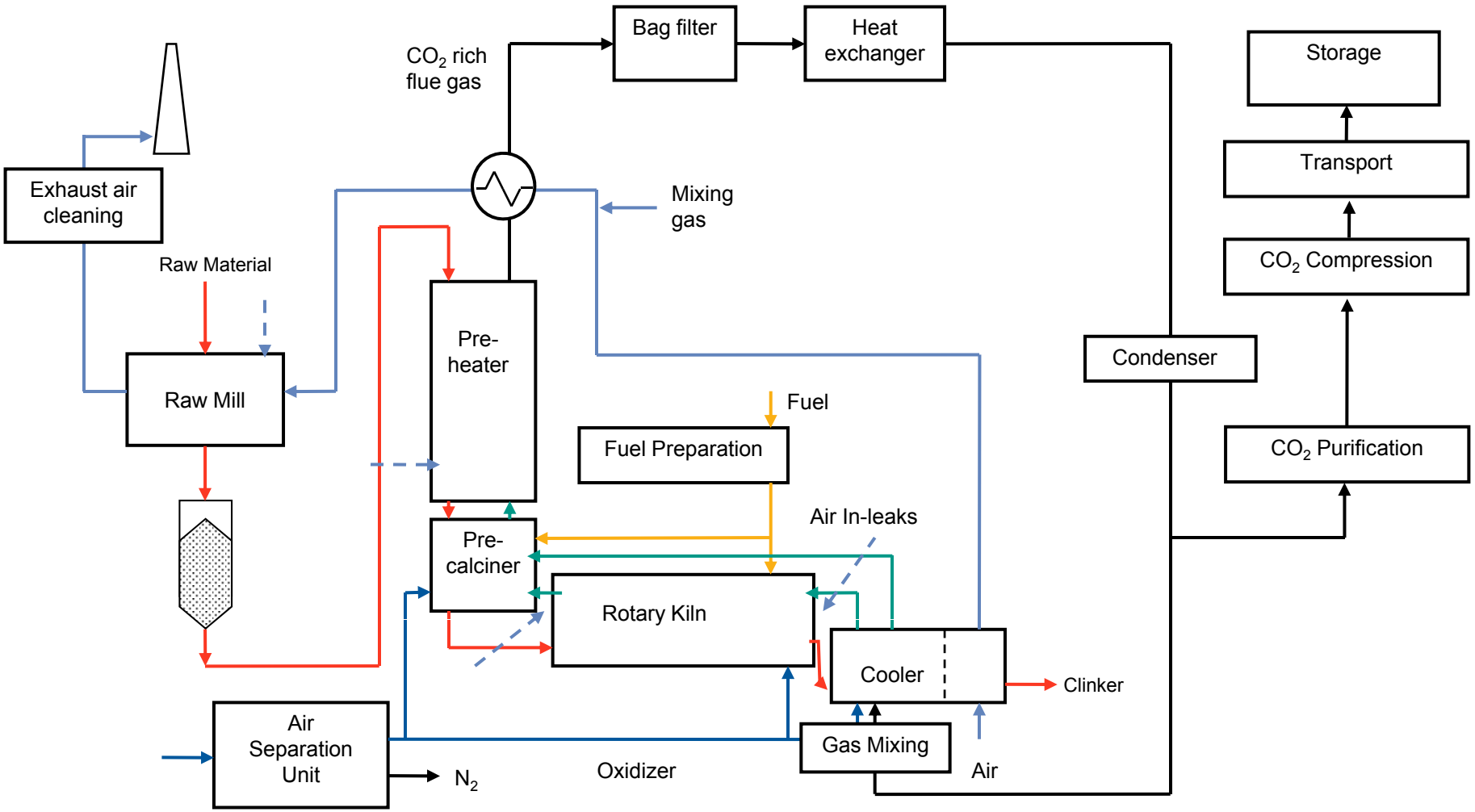
AGENDA

1. Introduction - Clinker burning process

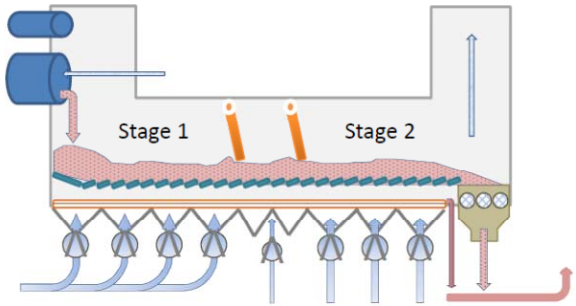


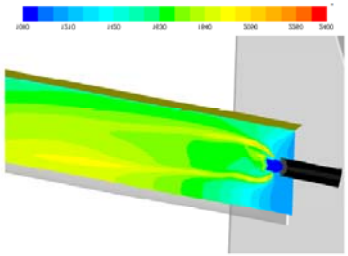
2. General layout

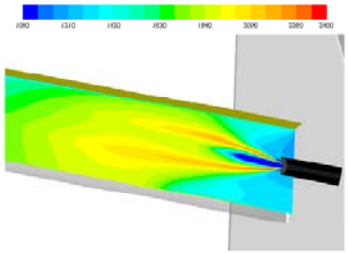


2. Retrofitting boundaries

- Important aspect for the application of oxyfuel in Europe
- Retrofitting an existing **burner** for oxyfuel application is unlikely, but replacement by a suitable design is possible
- Designing a gas-tight two-stage **cooler** is feasible
- **False air intrusion** could be reduced to the greatest possible extent by overhauling/ replacing inspection doors and similar devices (< 6%)
- New **safety and controlling devices** necessary
- **Space** requirements of ASU/CPU
- Conventional behavior in **trouble shooting** restricted (no opening of doors/flaps in the plant etc.)





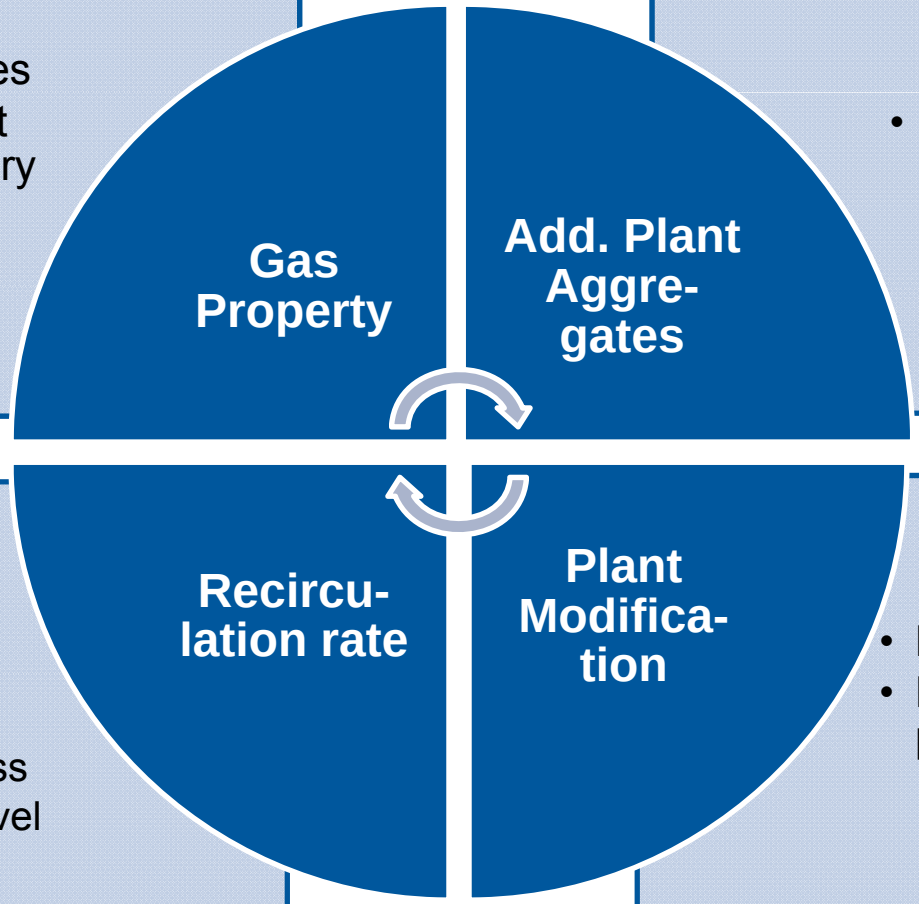


Retrofitting is feasible

3. Impact on plant operation

- Influence on heat transfer and temperature profiles
- Adaptation of plant operation necessary

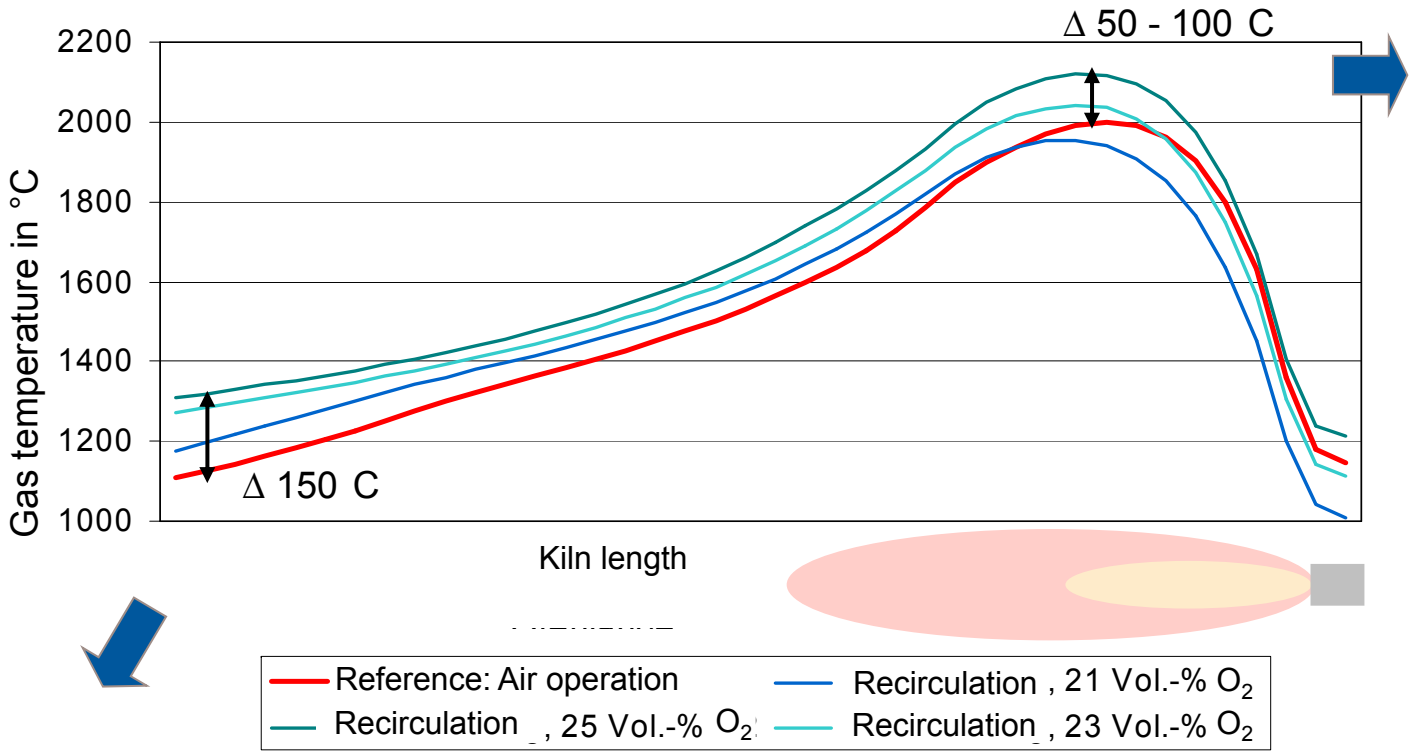
- Air separation and CO_2 purification are energy intensive
- Energetic integration required



- Recirculation rate: Fraction of total flue gas, which is reciculated to process
- Setting of oxygen level

- New installations
- Retrofitting existing plants

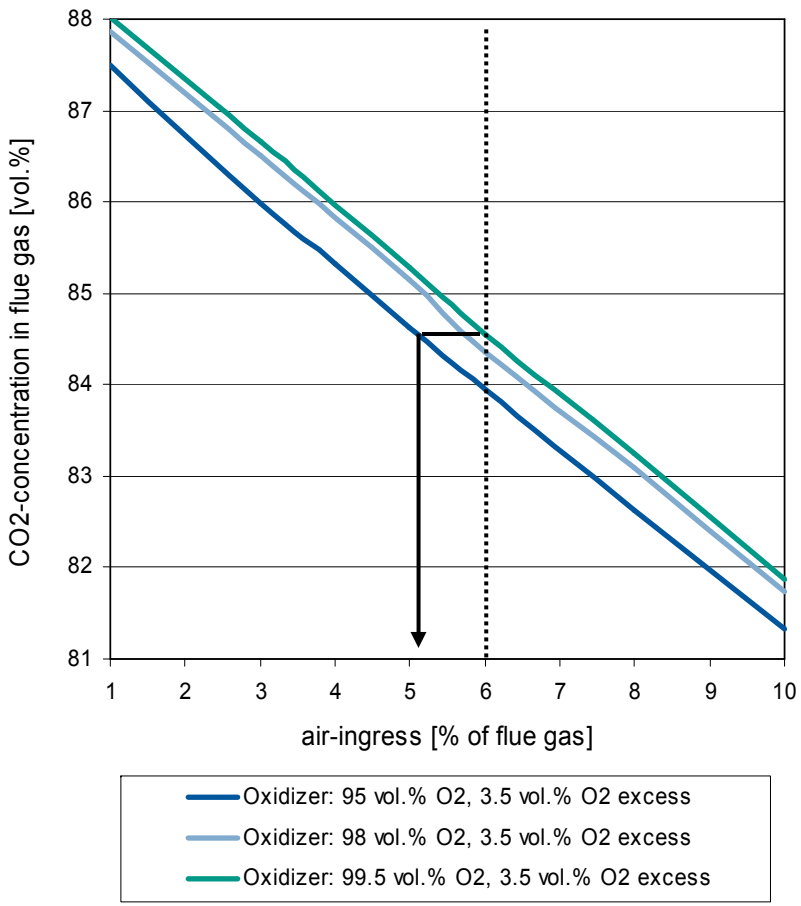
3. Impact of gas properties



Stress on refractory

Potential increase of coating formation

3. False air ingress and flue gas composition

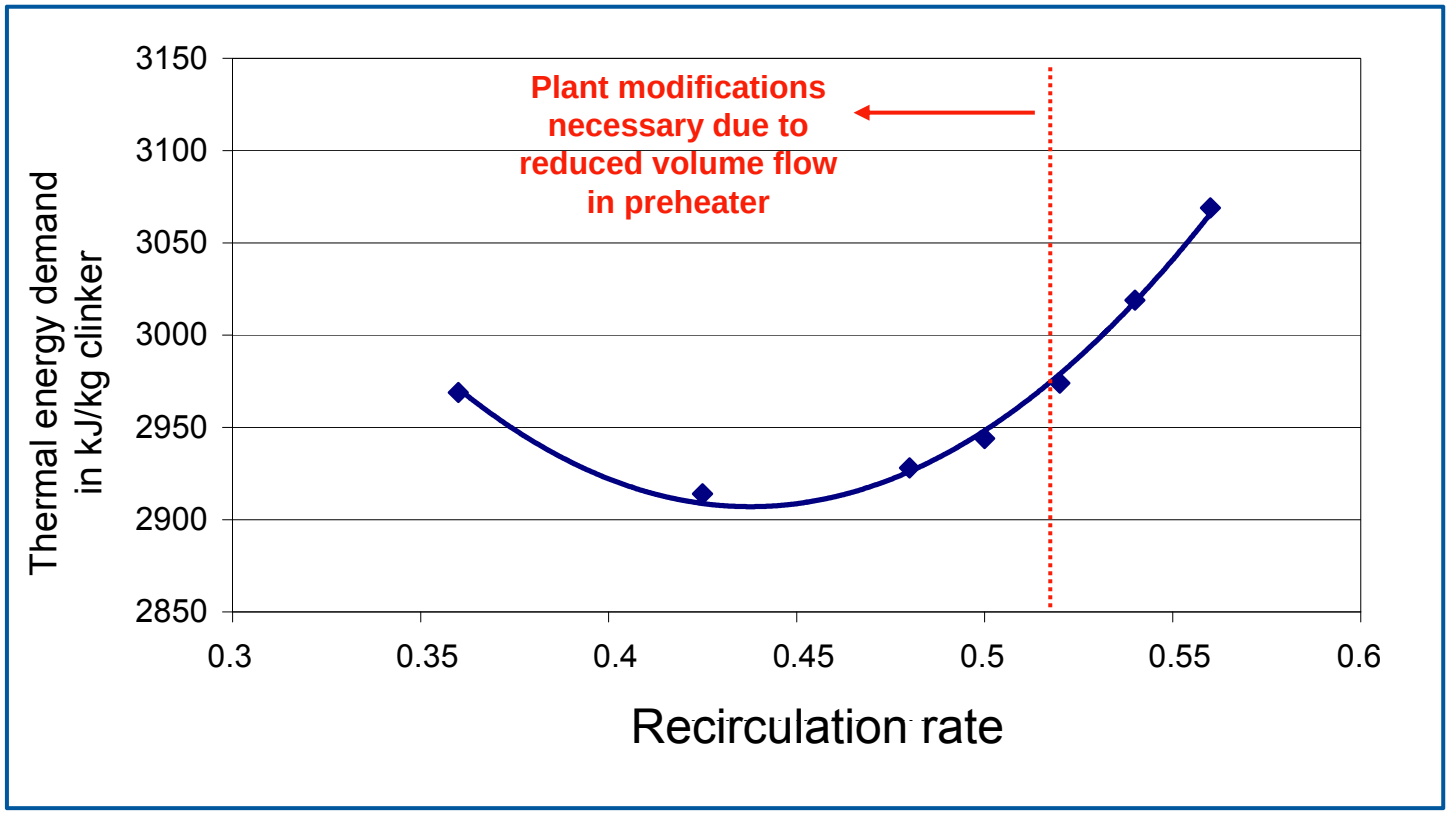


Influencing parameters:

- Oxygen purity
- False air ingress
- Oxygen excess
- Fuel type

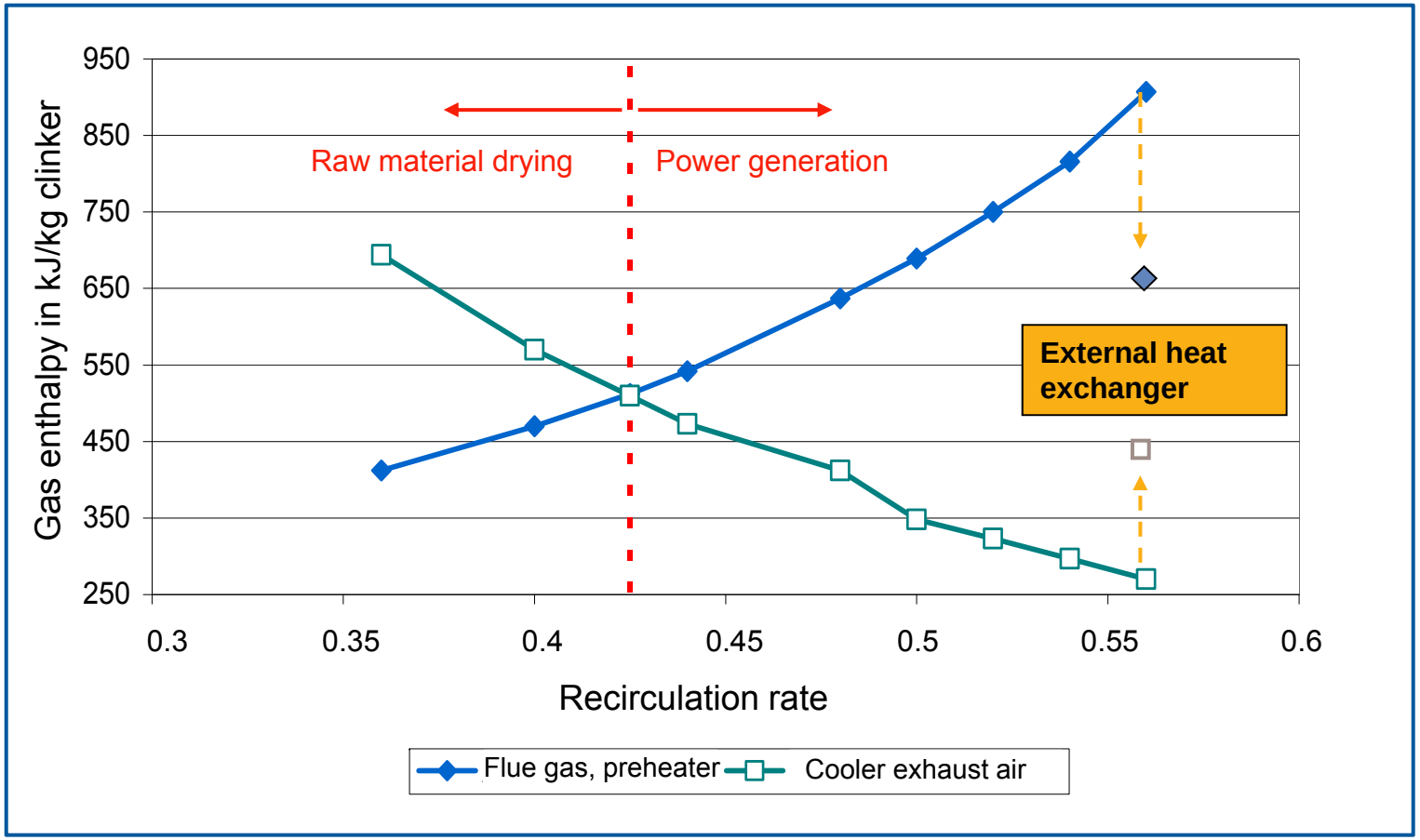
False air reduction of 6 - 8 % technically feasible by improved maintenance without additional sealing methods (like e.g. waste gas flushed systems)

3. Flue gas recirculation



- Fuel energy demand is depending on flue gas recirculation and treatment
- Decreasing recirculation rate includes less flue gas losses

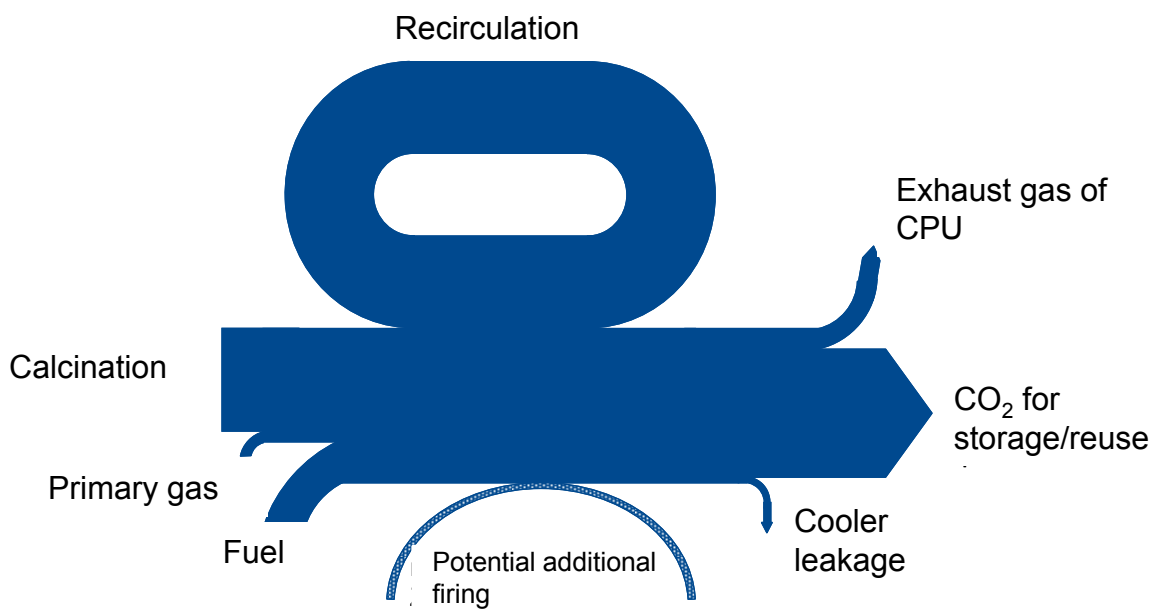
3. Energetic consideration



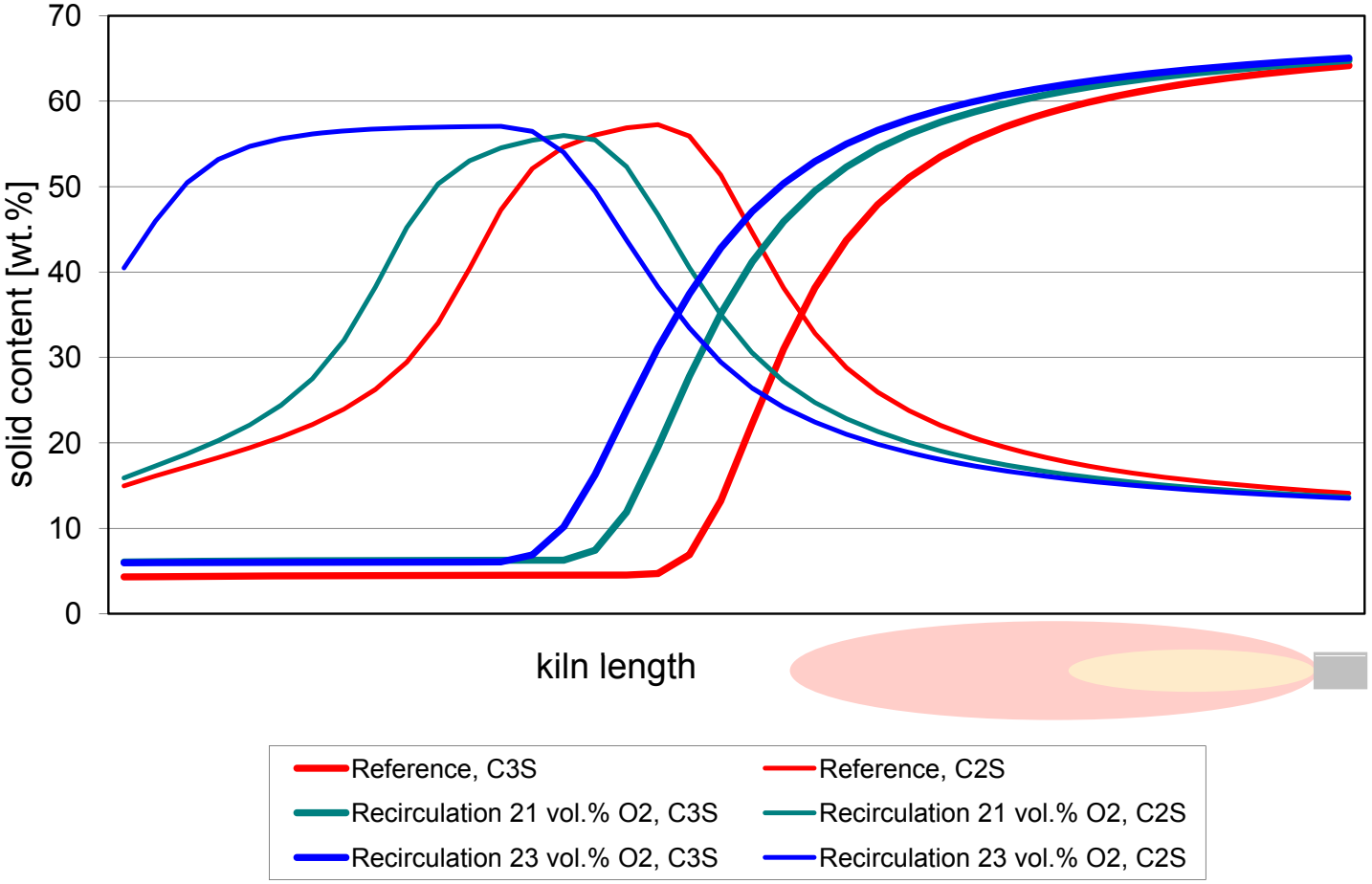
Recirculation rate determines the energy distribution and therefore waste heat recovery potential

3. CO_2 emission reduction potential

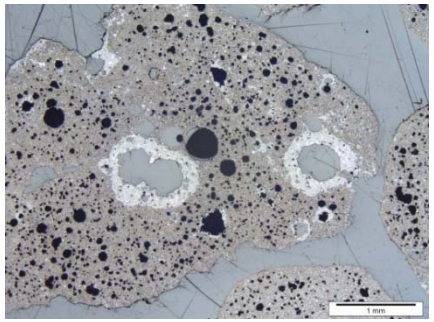
- Capture rates of 88 to 99 % feasible
- Capture rate independent of recirculation rate
- Reduction of capture rate possible by
  - Exhaust gas of the CO_2 purification unit (- 1 to 10 % capture)
  - Additional firing for raw material drying (- 1 to 2 % capture)
  - Leakage at cooler stage sealing (up to - 1 % capture)

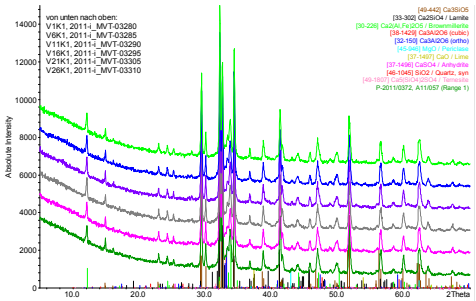


4. Kiln operation – Impact on solid conversion



4. Limiting factors by quality and durability requirements

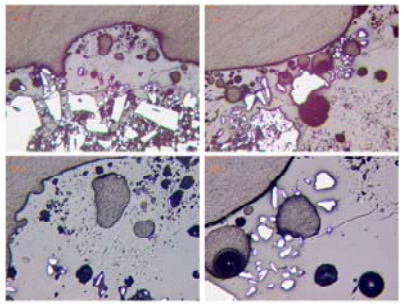




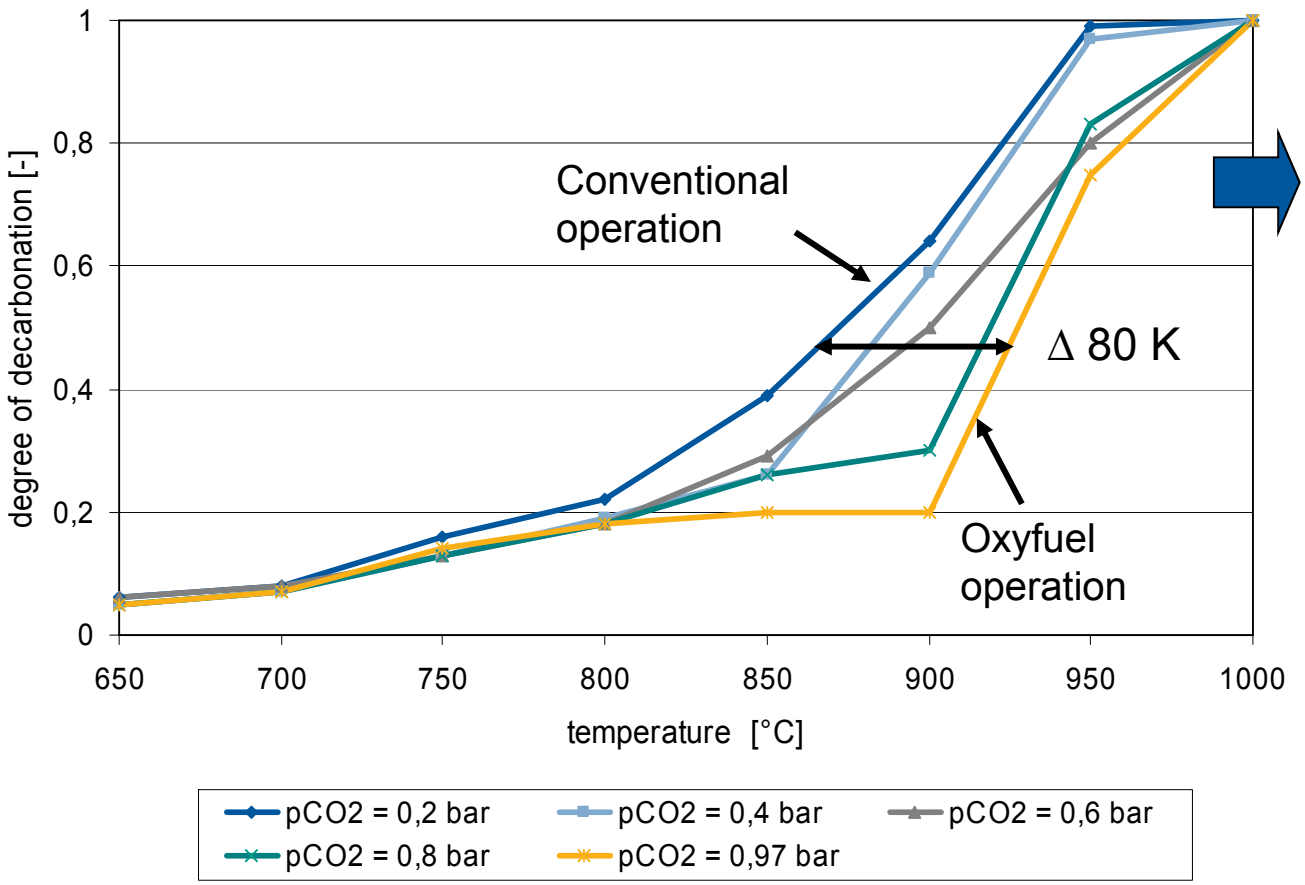
- No serious influence on clinker composition
- Slight differences in cement properties (caused by Fe^{2+}) are in range of assured quality

- No negative influence on basic refractory material detected
- Using non-basic materials an increasing thermo-chemical reaction expected
- Adaption of refractory brickwork necessary
- Long-term test for evaluation advisable

No barriers expected from clinker quality and refractory durability



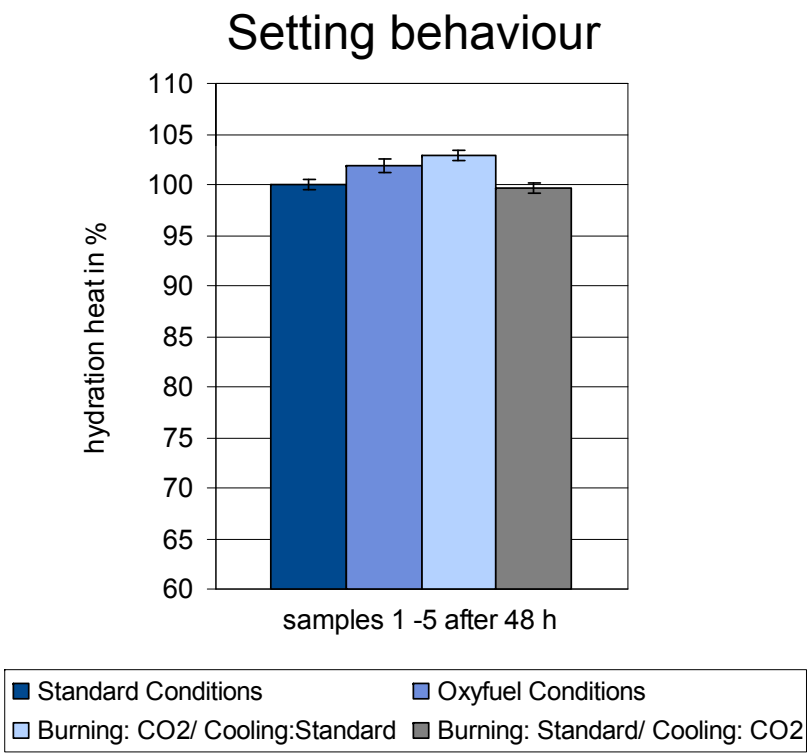
4. Impact on decarbonation

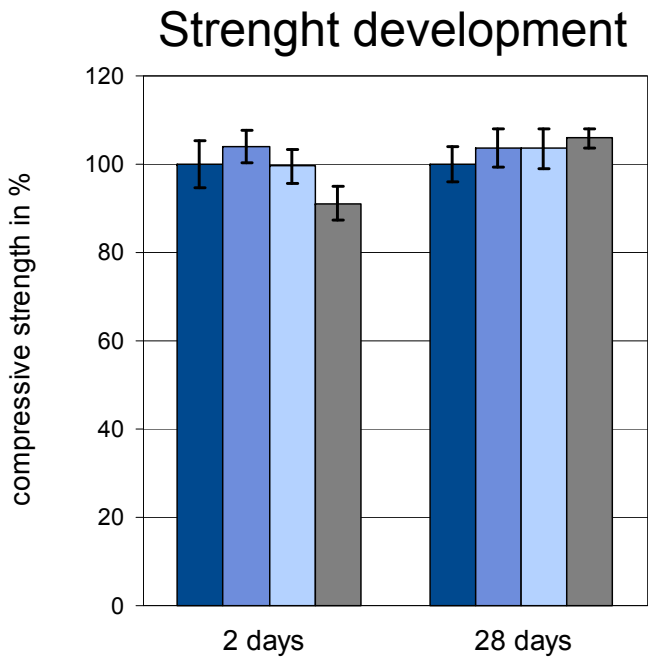


Increase of temperature level:

- Problems with burning low-calorific fuels in calciner may occur
- Higher risk of coating formation in the calciner

4. Impact on cement properties

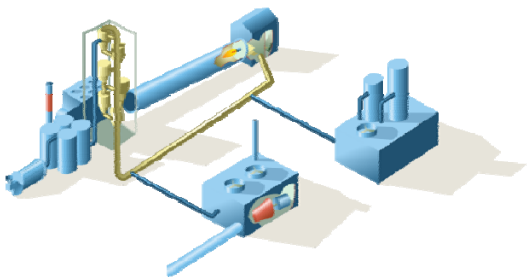




- Testing at five clinker types of different reactivity
- No influence on chemical-mineralogical composition
- Cement properties are not influenced

5. Cost Estimation

Investment costs



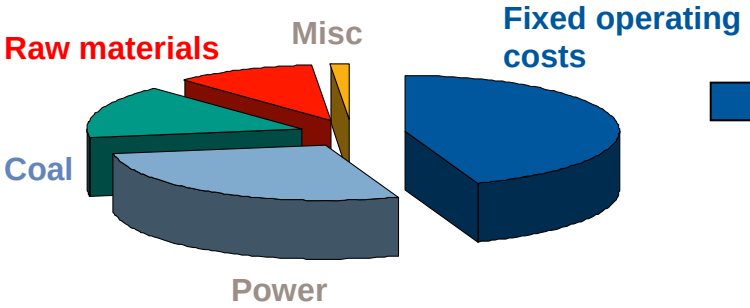
New installation (2 mio tpy annual clinker capacity):

2030: 330 - 360 Mio € (Reference: 260 Mio €)

2050: 270 - 295 Mio €

Remark: Costs for demonstration plant in 2020 would be significantly higher

Operational costs



plus 8 to 10 €/$t_{clinker}$ on top of base case

transport and storage excluded

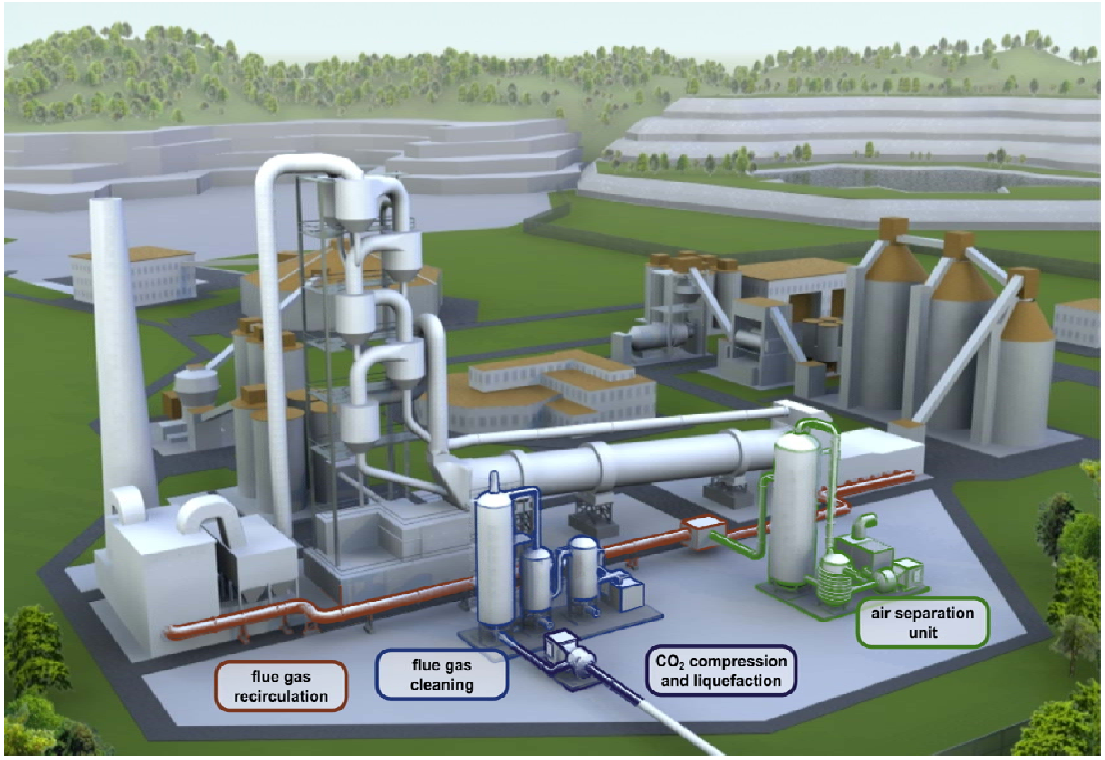
Total cost increase of about 40 %

Additional costs per ton of avoided CO_2 : 33 - 36 €/t $_{CO2}$

6. Summary and Outlook

- Oxyfuel technology in the cement clinker burning process technically feasible
- Retrofit of existing plants is possible
- Cement properties are not impaired
- Optimum operational mode depends on local specification of the cement plant (e.g. raw material moisture)
- Capture rate between 88 and 99 %
- Production costs are increased by ~ 40% (excl. transport and storage)
- Oxyfuel technology will not be available in the cement sector before 2030
- ECRA CCS Project Phase IV.A is dealing with the further detailing of previous phases and the concept study of an oxyfuel pilot plant

Thank you for the attention!



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