Cement oxyfuel technology from a supplier perspective

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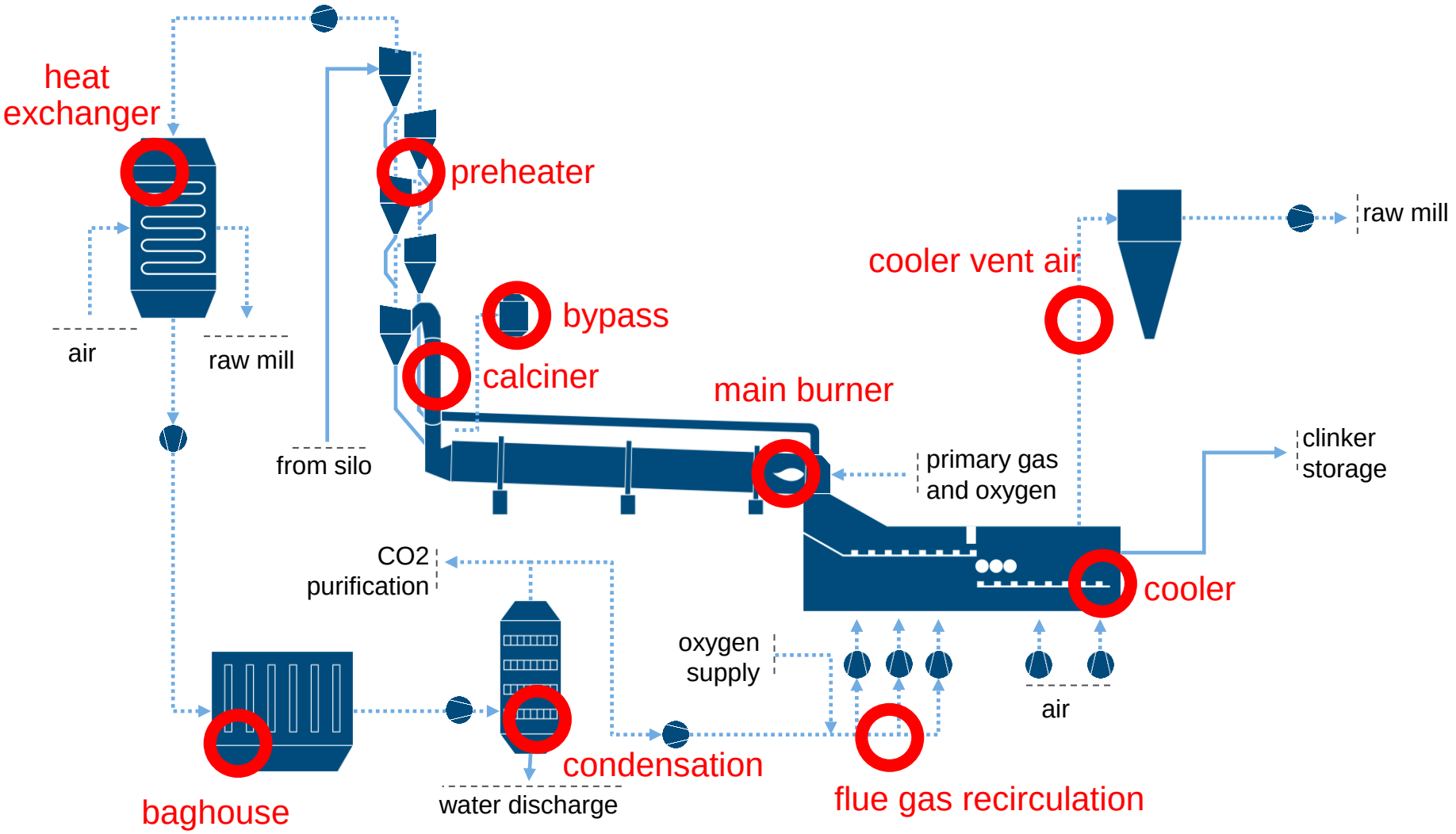
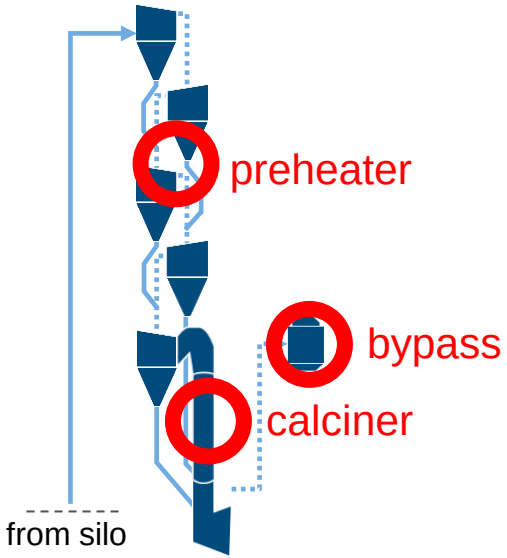
"Oxyfuel clinker burning – substitute nitrogen by carbon dioxide, everything else stays the same..."

"We are ready to build a plant and everything will be a bit different."

Oxyfuel clinker kiln

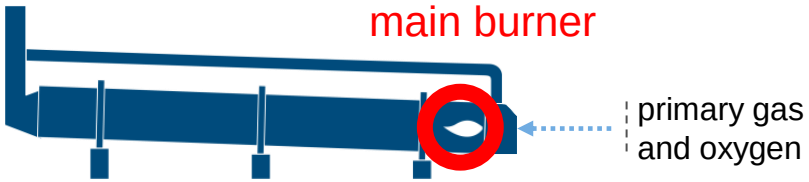


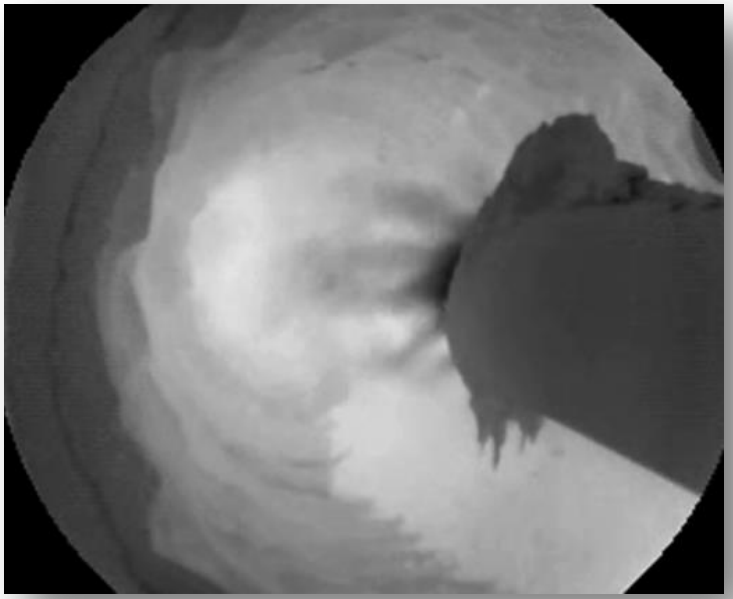
Preheater and calciner



- Increased heat capacity alters the preheater temperature profile
- Retrofitted plants require a flue gas recirculation for temperature control and to ensure the material lifting
- Calciner temperature is raised by 50...100 K due to increased CO_2 partial pressure
- Acceptable sulphur and chlorine levels will change
- Bypass rate needs to be adjusted
- Bypass gas should be returned to the process

Rotary kiln and main burner

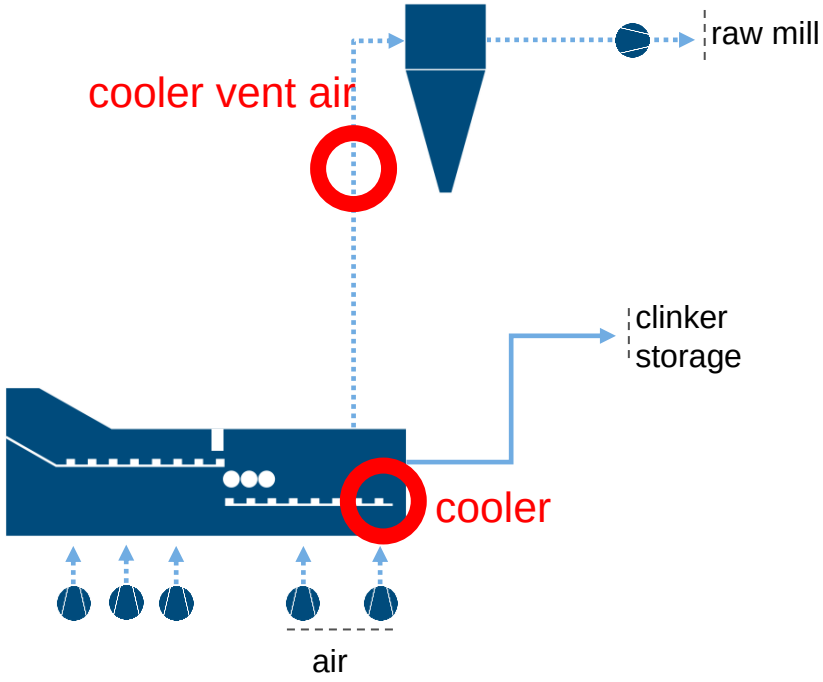




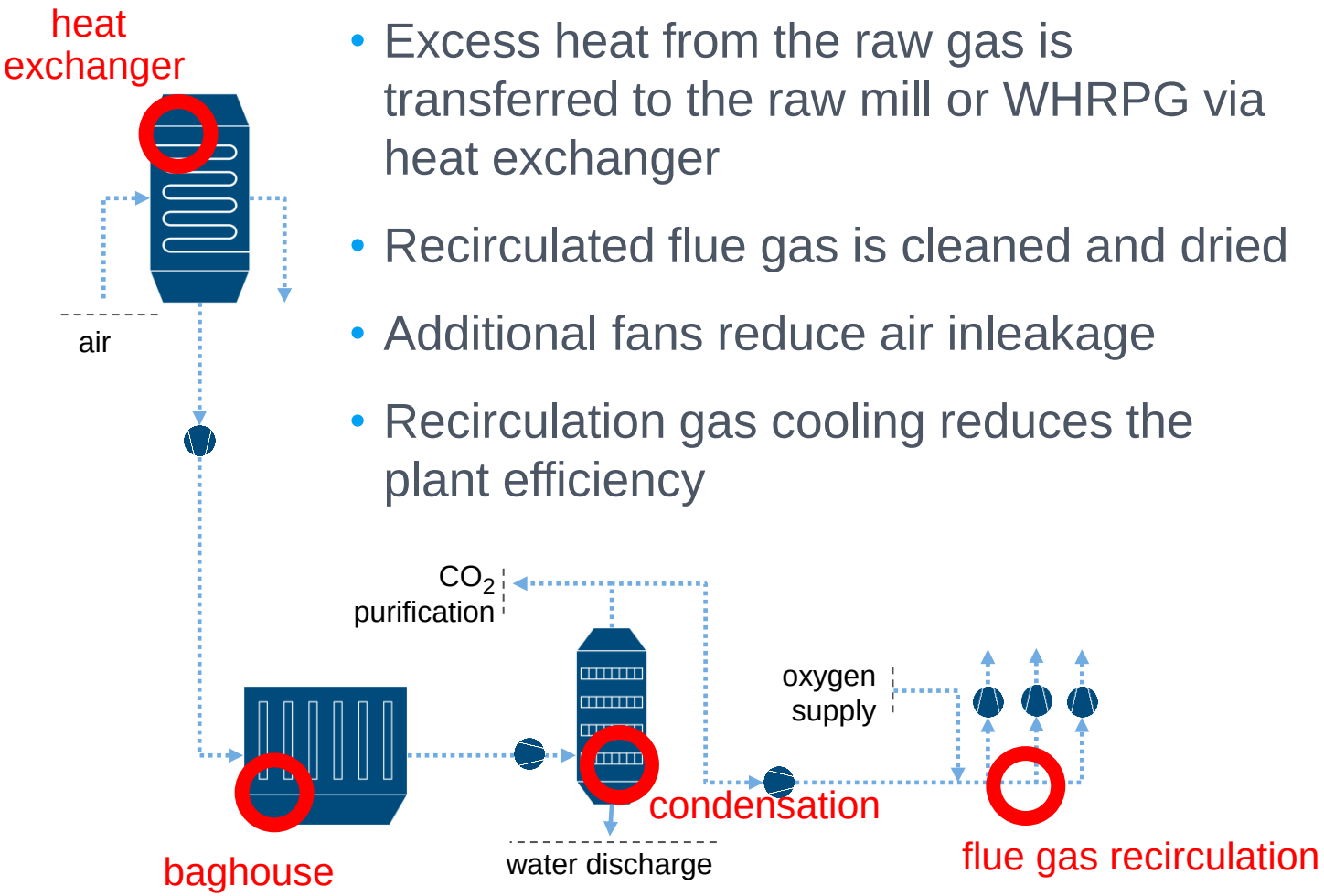
- Existing burner design can be used for oxyfuel as well
- Recirculated flue gas is used for fuel conveying
- Reduced recirculation rate could require fuel shift from the main burner to the calciner

Clinker cooler

- Cooler vent air is utilized for raw grinding
- Grate area of cooler is separated into CO_2 and air compartment.
- Air must not enter the CO_2 section
- Modified control loop for cooling fans



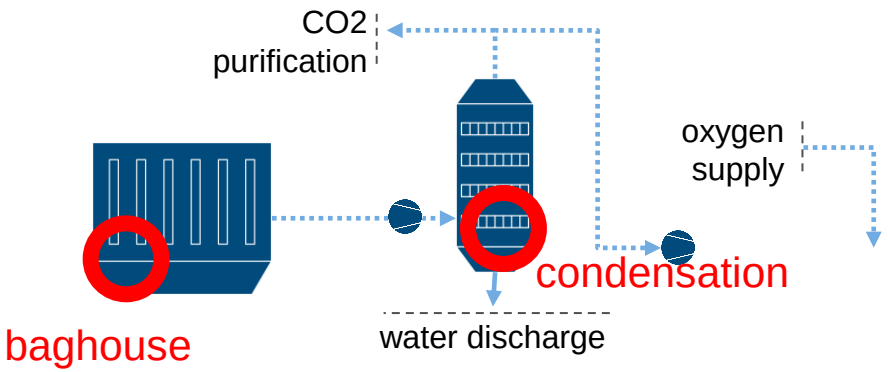
Flue gas treatment and recirculation



- Excess heat from the raw gas is transferred to the raw mill or WHRPG via heat exchanger
- Recirculated flue gas is cleaned and dried
- Additional fans reduce air inleakage
- Recirculation gas cooling reduces the plant efficiency

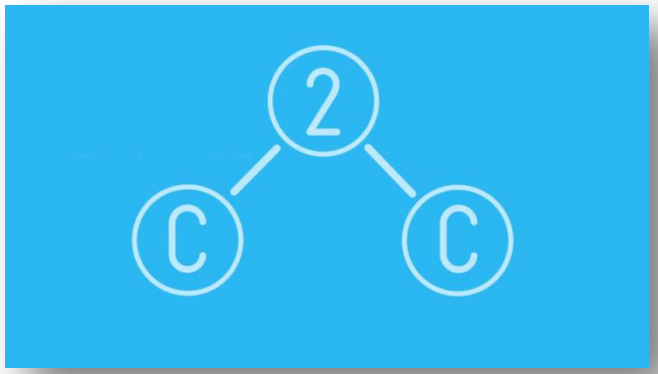
Process control and utilities

- Oxyfuel clinker line requires two grids for pressurized air and pressurized CO_2 (for air cannons, baghouse cleaning, fuel conveying etc.)
- For startup, fresh air is used until sufficient flue gas can be recirculated
- Reducing the recirculation rate will increase CO_2 concentration and make the process control easier
- Necessary auxiliary equipment is state-of-the-art and available on market



CO_2 utilization

- CO_2 utilization often cause strict limits on certain gas components (SO_x, HCl, HF, heavy metals)
- Subsequent utilization may have an impact on the oxyfuel process design due to
  - Possible heat integration
  - Hydrogen production also releases oxygen which could be used in the oxyfuel kiln
- Overall optimization of the CCU chain could cause increased energy use or fuel cost for clinker burning due to
  - Higher bypass rates
  - Flue gas limits



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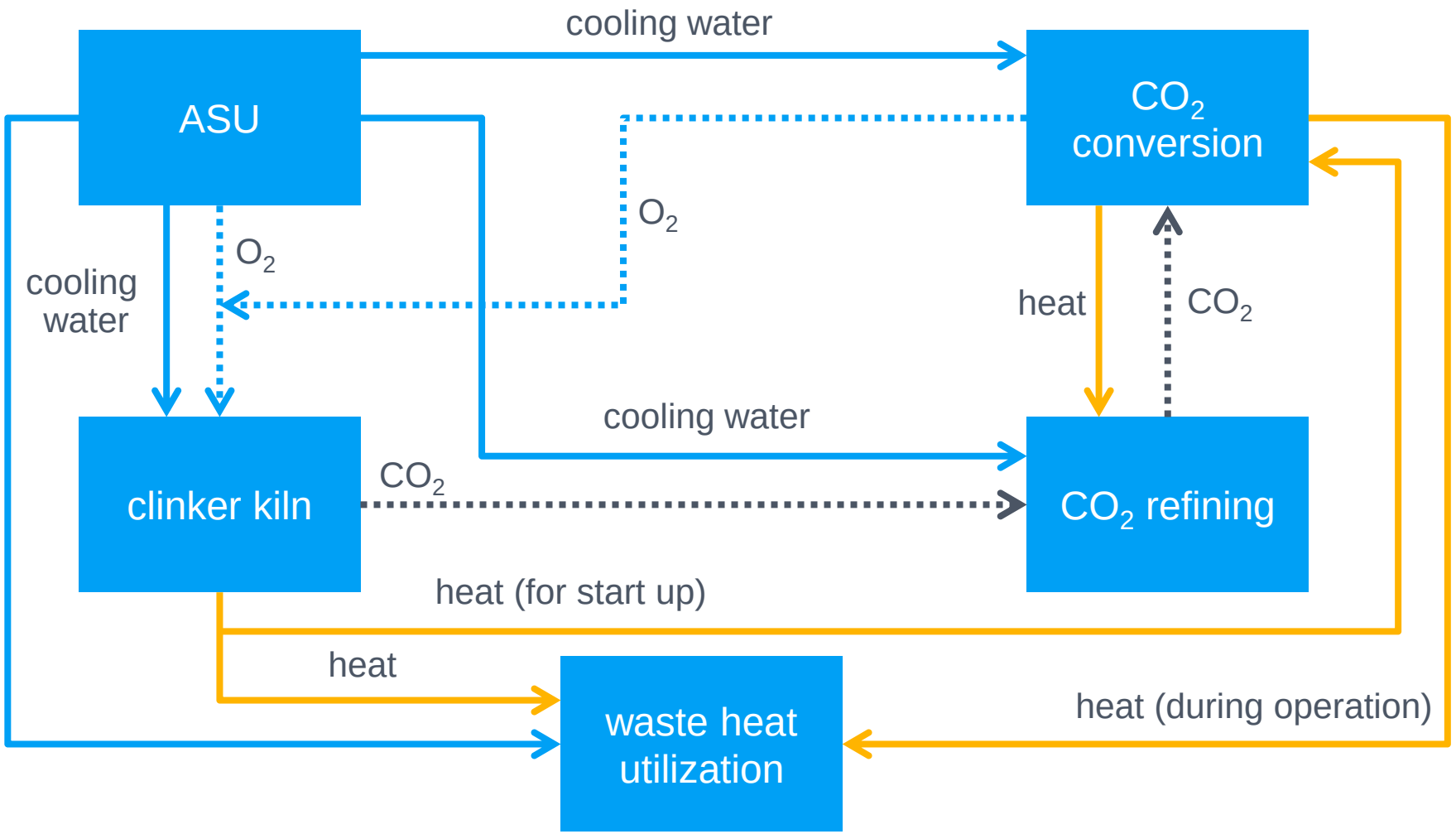
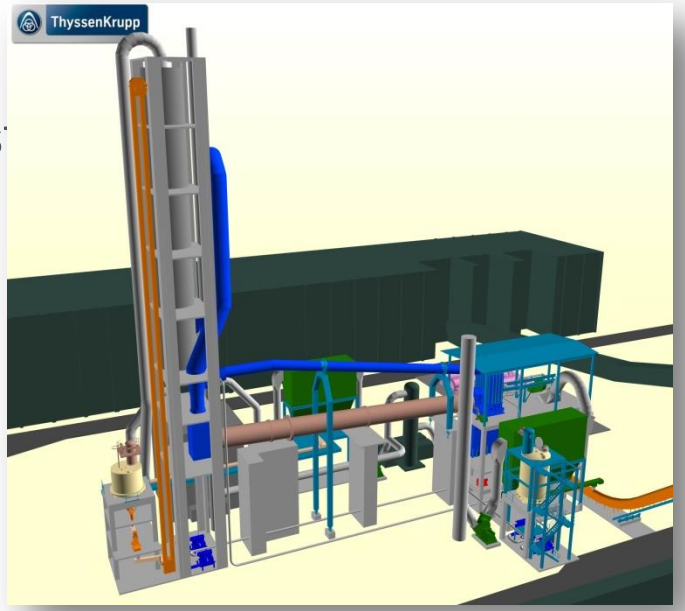
Integration potentials



Summary and outlook

- Retrofitting existing plants is technically viable
- All unit operations are well proven technology
- As the complete plant is affected by the oxyfuel operation, the experience from a first demonstration plant will be quite important
- Demo Plant experience will enable to test optimization approaches and will be beneficial for the layout of new oxyfuel project.



Let us make the next step towards CCU!

Thank you

for your Attention!