

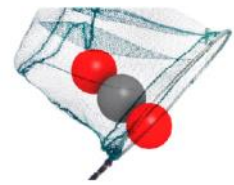
WP9 – HeidelC, VDZ, IKN

Oxyfuel Cooler Prototype (and upscaling)

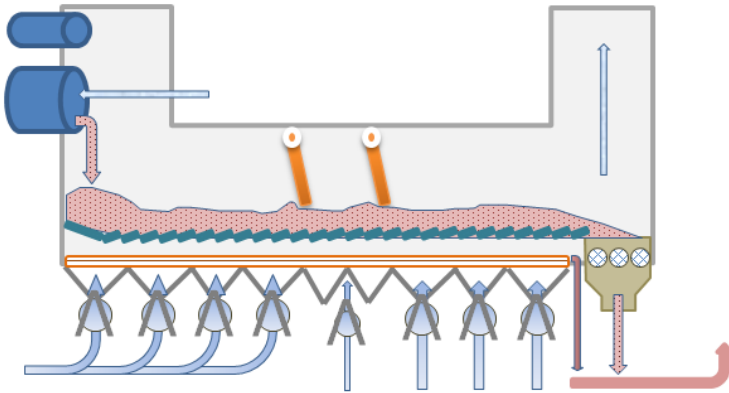
ECRA / CEMCAP Workshop 6th/7th of November 2017, Düsseldorf

Dr. Robert Mathai

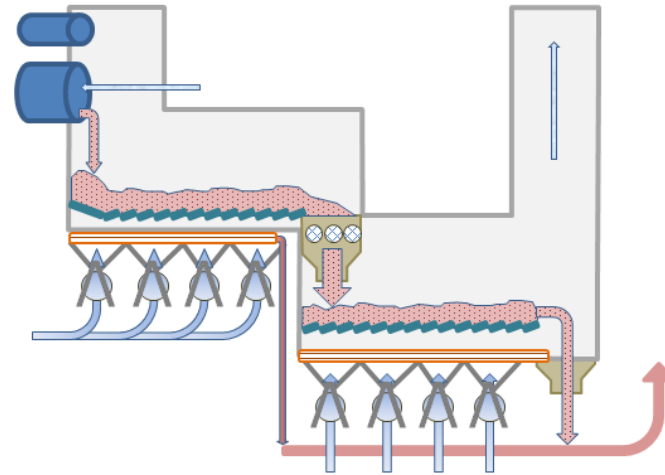
IKN



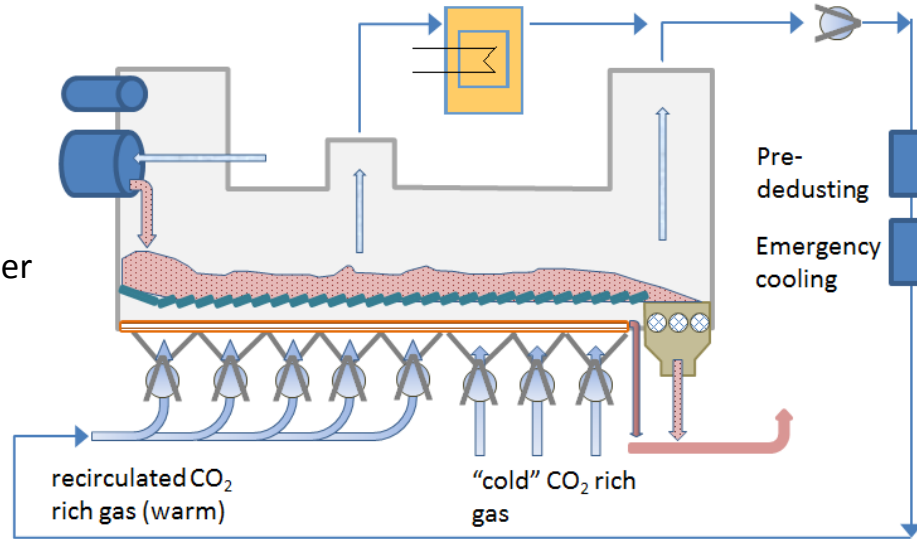
Single stage cooler with sealing shields



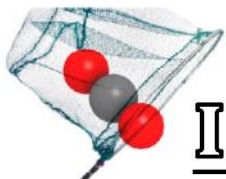
Two stage cooler



Full recirculation cooler



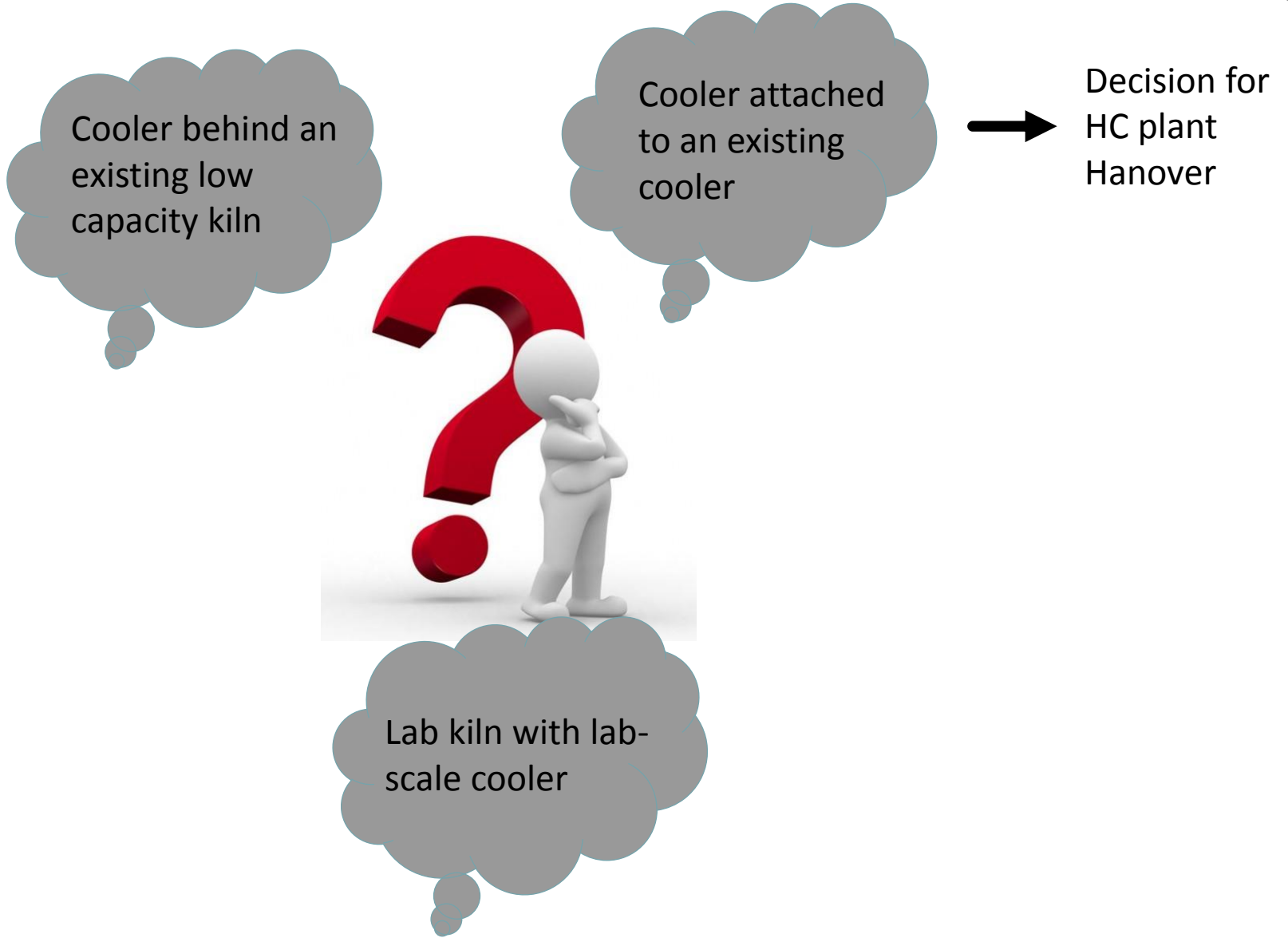
Concepts



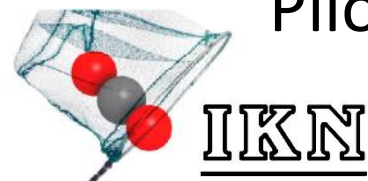
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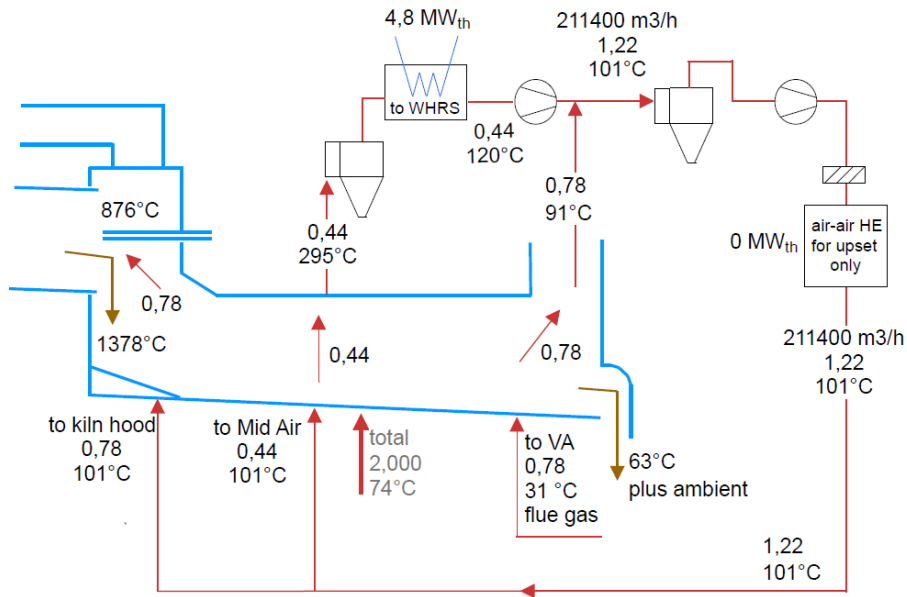




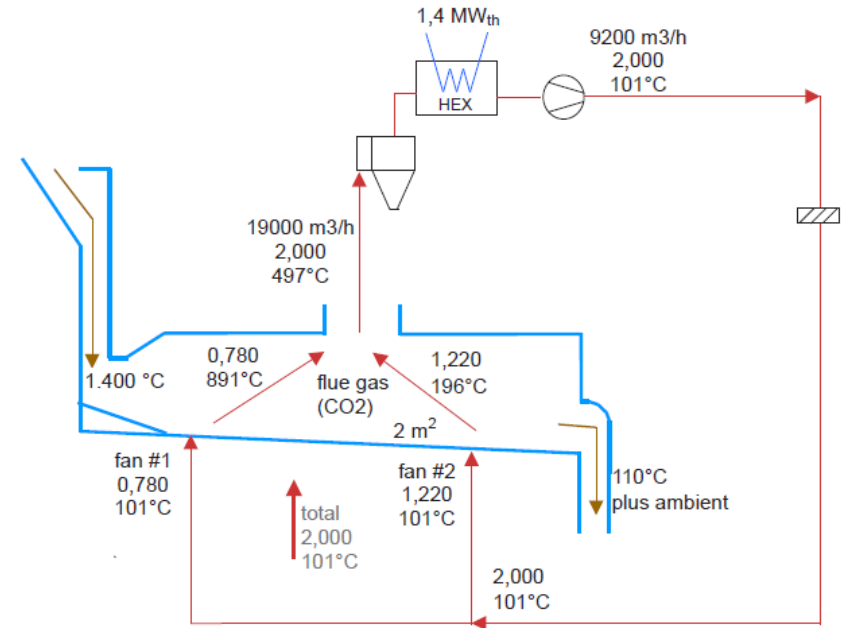
Pilot Cooler ideas



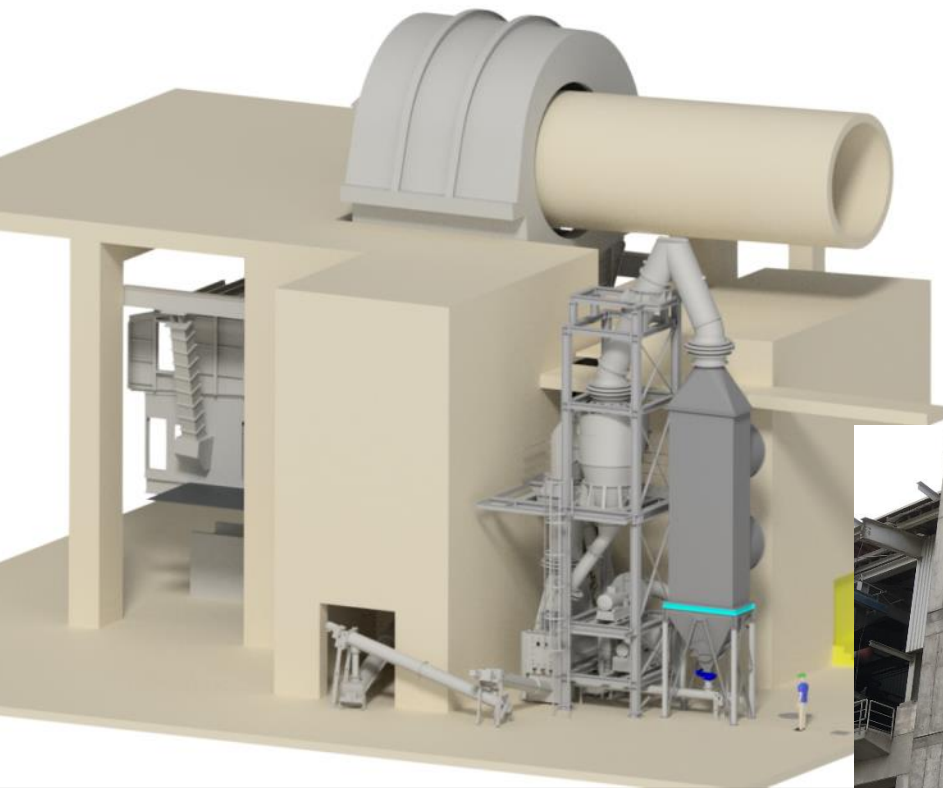
Heat balance cooler
@ 3000 t/d



Heat balance Pilot cooler
@ 80 t/d



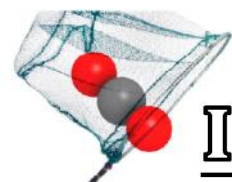
Heat balances – recirculation cooler



Pilot cooler system:

- Extraction tube
- Cooler
- Pre-dedusting cyclone
- Gas to air HEX
- Fans
- Clinker transport system

Oxyfuel Cooler Prototype

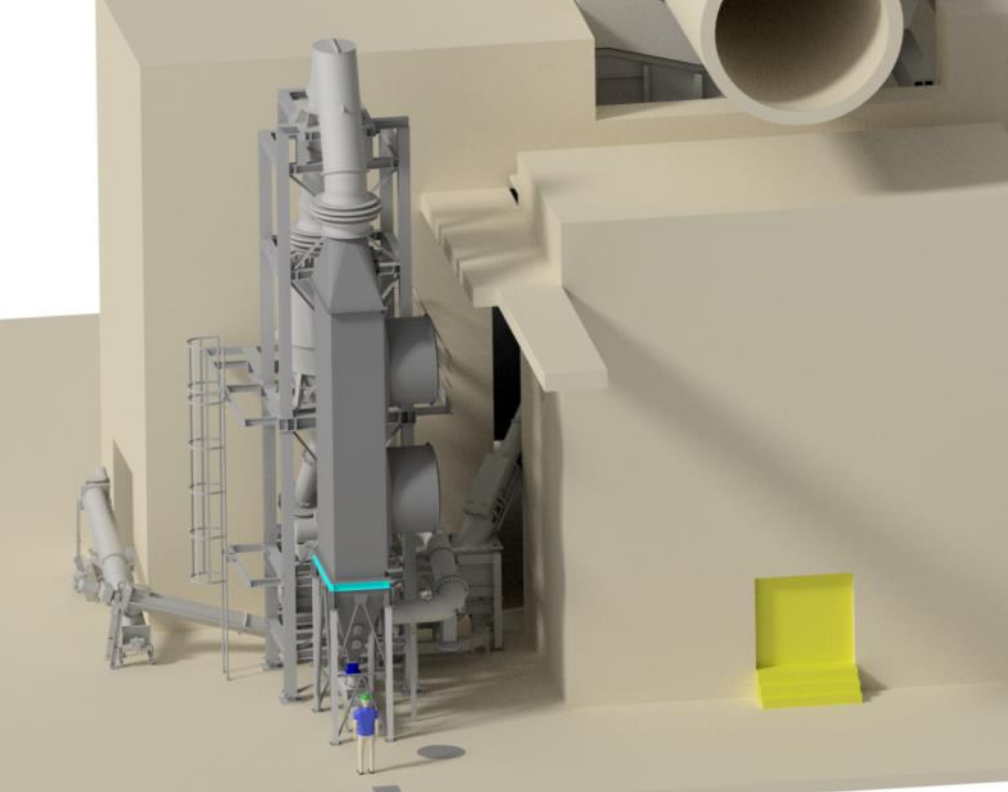


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Pilot cooler system:

- Container for control system
- CO₂ Injection system



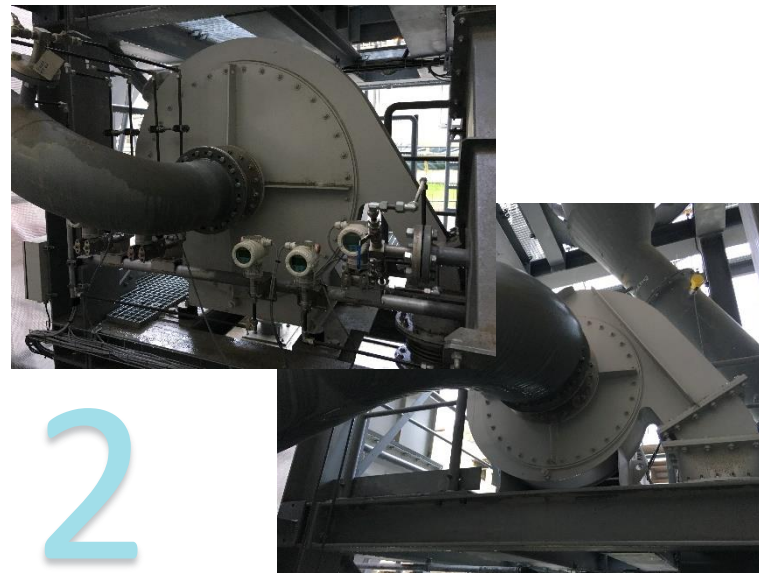
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1



2

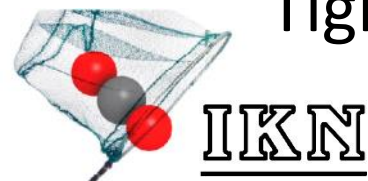


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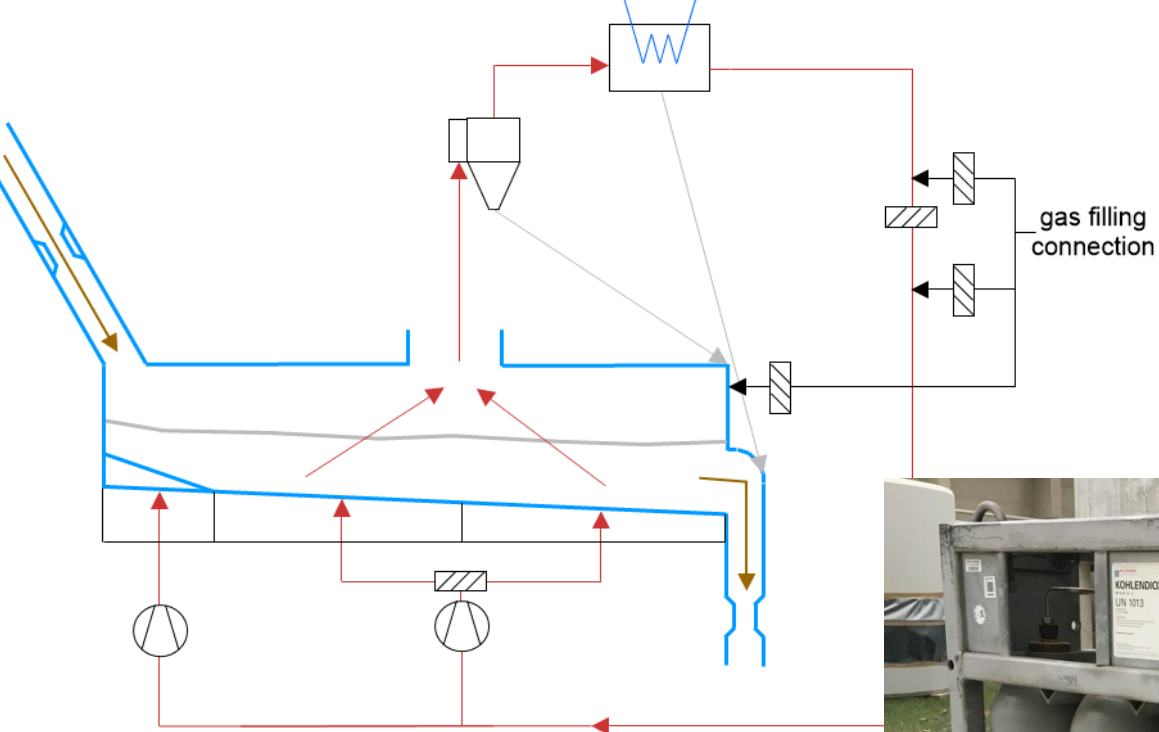
4

Tightness tests

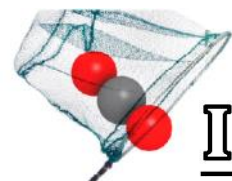


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Filling with CO₂

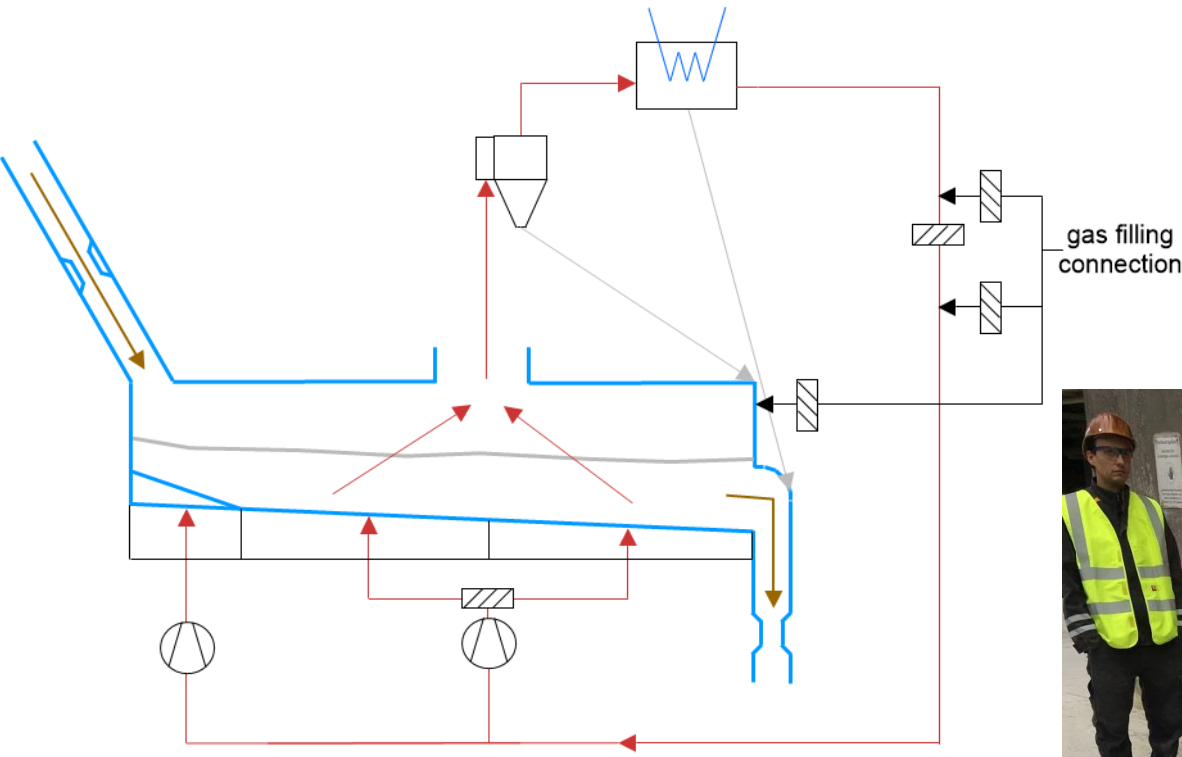


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Determination Mass flow



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Challenges:

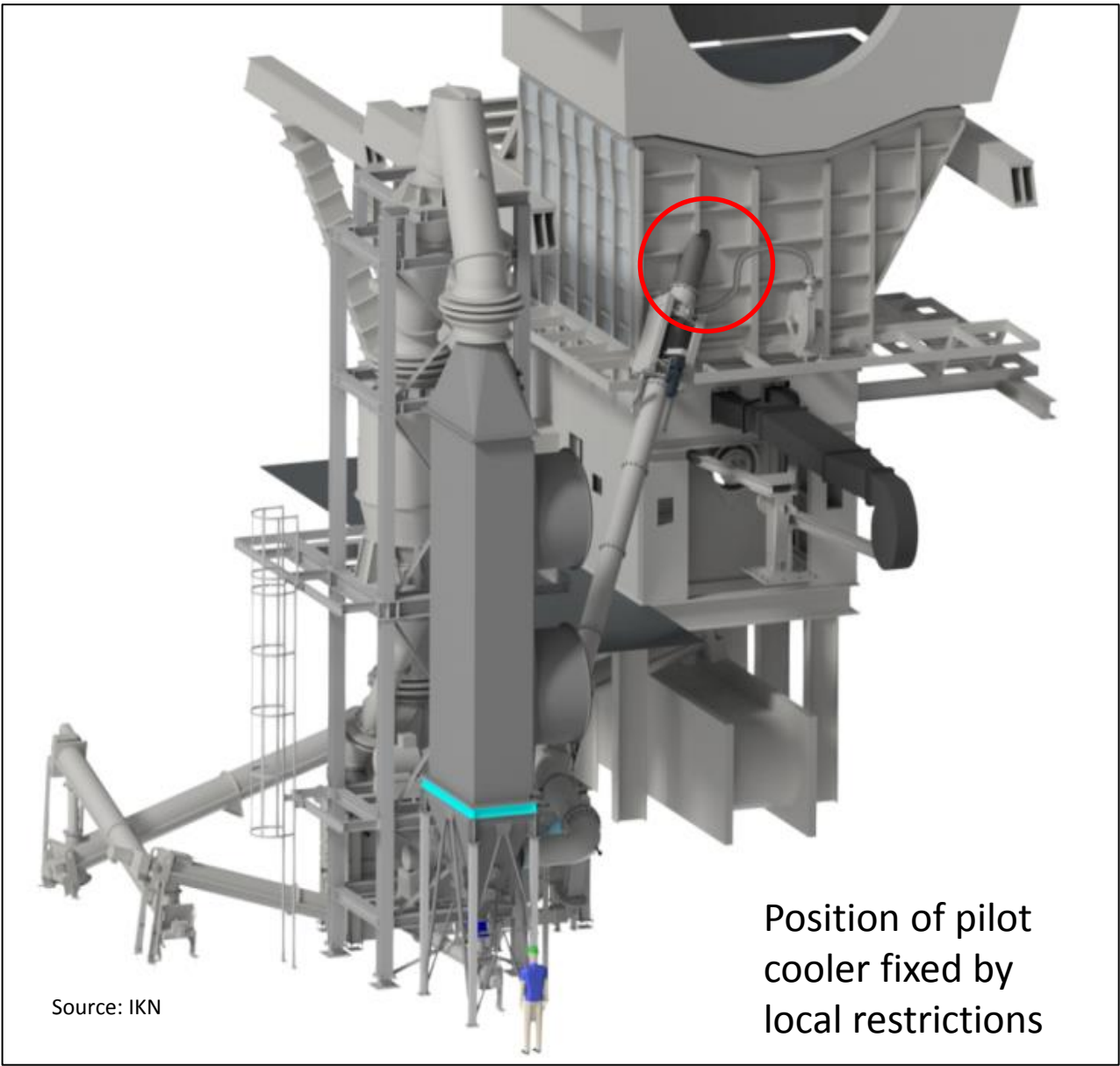
- How to extract 1400°C hot clinker?
- How to control mass flow?
- Adjustable tube – inserted to the stream of falling clinker
- Rotating device since the inclination was not sufficient for a static tube
- Insertion depth adjustable
- Progressive rotating to “catch” clinker

Problems:

- Clinker dropping point changed with chemistry, production and AF rate
- Big clinker balls and coating pieces destroyed the tip by mechanical impact



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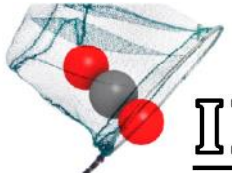


Source: IKN

Position of pilot cooler fixed by local restrictions



Extraction tube



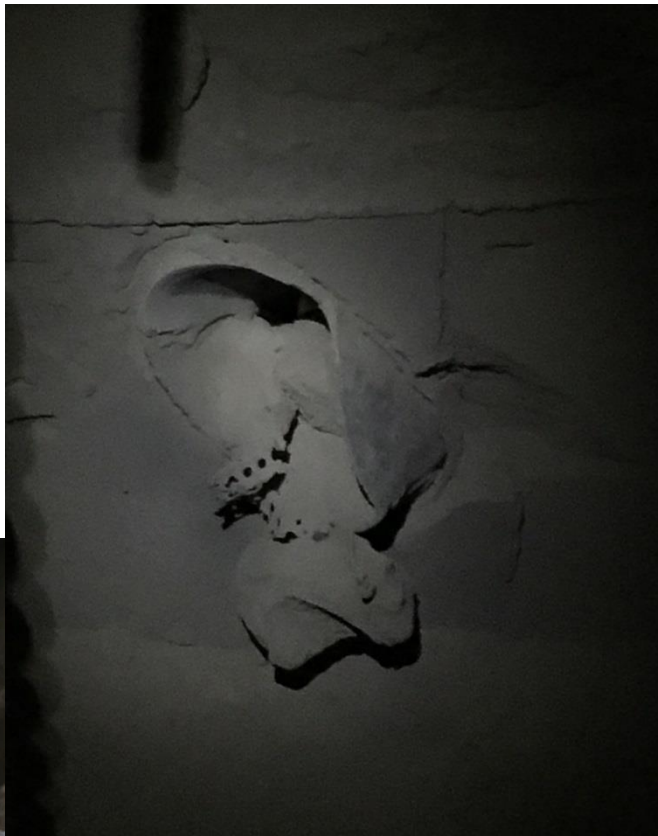
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Damages by mechanical impact



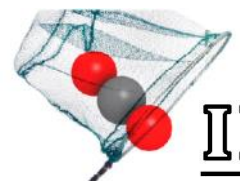
Repaired tube



Max. size passes lumps



Damage & repair of tube



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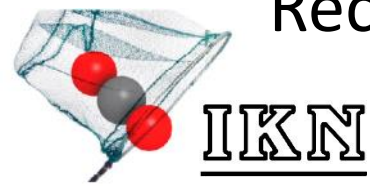


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- ☺ Amount of received clinker adjustable and comparable stable
- ☹ Due to routing of rotating tube no proper landing zone

Received Clinker



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Limit of downscaling



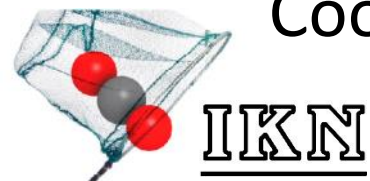
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Cooler consists of

- Static inlet
- Moveable grate
- Mechanical drive
- 0,6m width
- Cooling area 2m²
- Max. 80 tpd



Cooler design



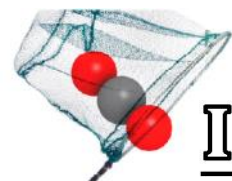
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Screws for clinker transport:

- Strong false air intake observed

Clinker transport system



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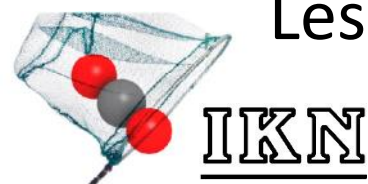
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1. Downscaling and simplification of a pilot is a challenge
2. Simplifications limit the flexibility to react to unforeseen events
3. Influence from “main Pyroline” were stronger than expected (in regard to process and time schedules)
4. 100% recirculation is critical in regard to false air → air in leakage is more critical than CO₂ escape to ambient
5. Position of measuring ports should have higher priority during design phase
6. Moisture as potential issue during operation was not forecasted
7. CO₂ escape via extraction tube and CO₂ demand was not expected in such extend
8. False air via Hex & fans etc. was minor than expected (leakage test with closed system and running fans successful)

Lessons learnt

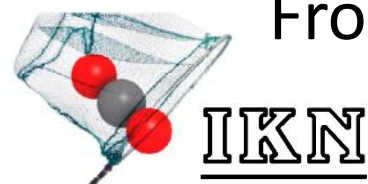


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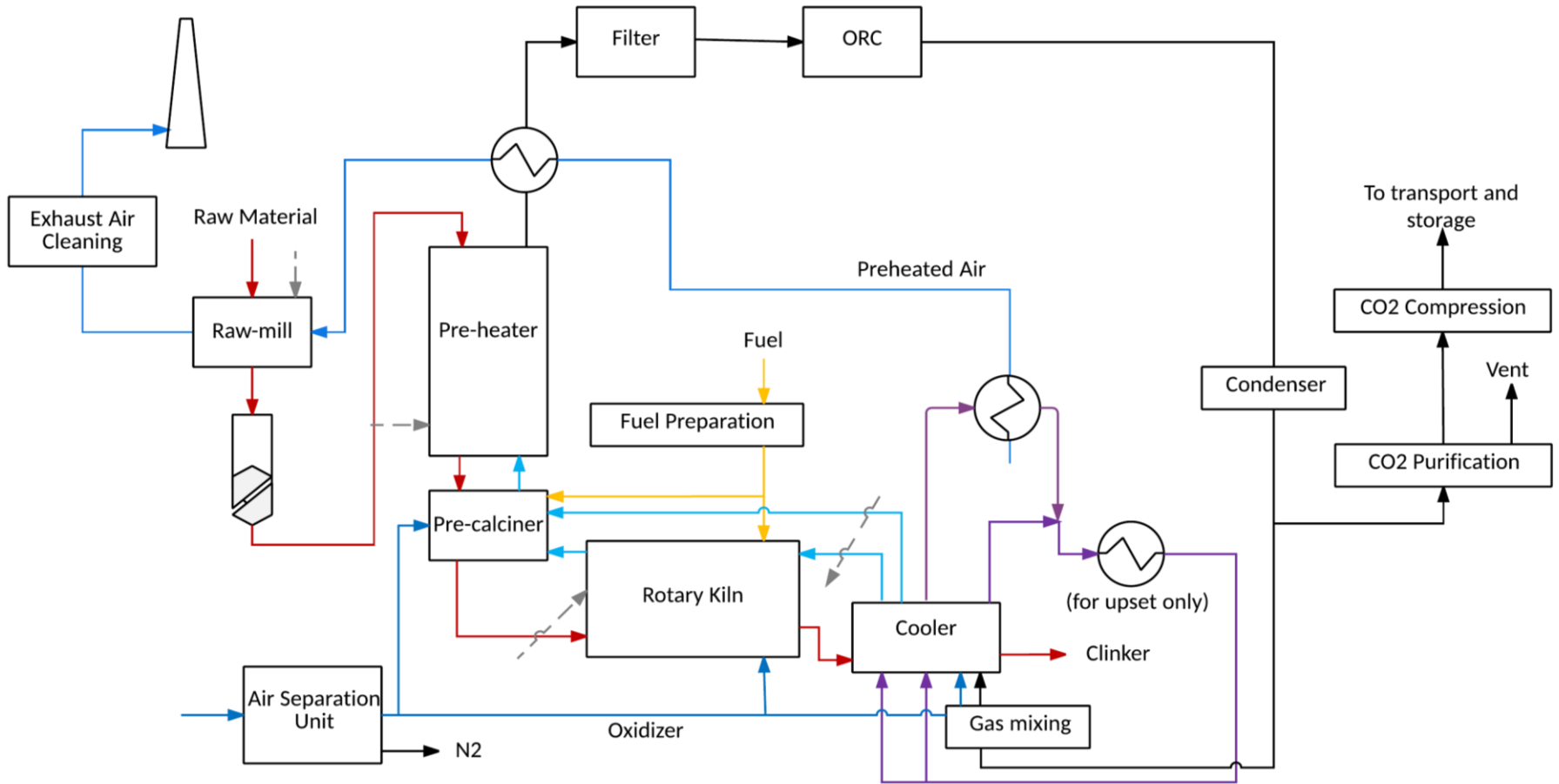
1. The Cemcap Pilot cooler trials were one important step in regard to scale up to an industrial Oxyfuel cooler
2. The industrial Oxyfuel cooler will most likely be a full recirculation cooler
3. Cooler size can be smaller compared to an air cooled cooler
4. Air leakage in the entire Oxyfuel system (cooler, kiln, preheater, heat exchangers, transport systems etc.) needs special attention
5. Sealing the clinker outlet against false air intake remains a challenge
6. High moisture content in the flue gas should be avoided (increase of volume, risk of clogging and possible influence to mineralogy); concept with condenser preferred

From Pilot to Industrial Scale



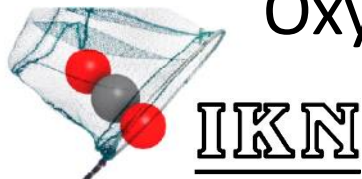
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Flowsheet by ECRA

Oxy Fuel System



Acknowledgements

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