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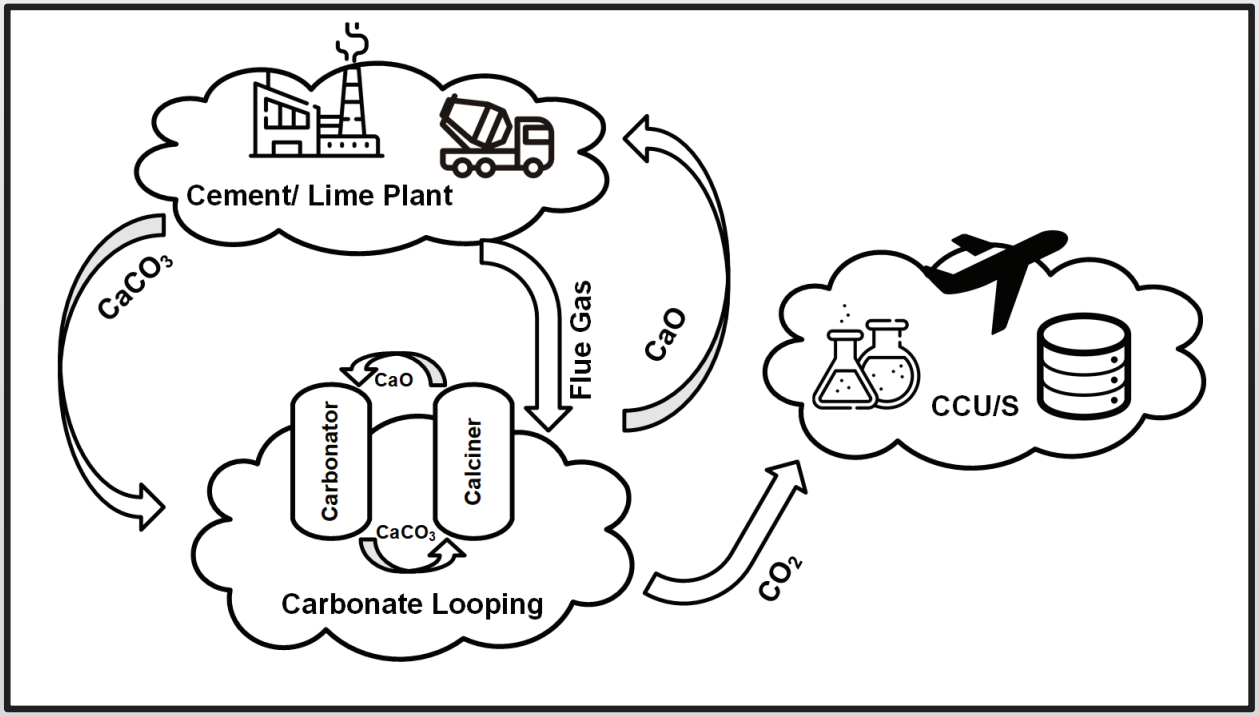
Adaption of a 300 kW_{th} Pilot Plant for Testing the Indirectly Heated Carbonate Looping Process for CO_2 Capture from Lime and Cement Industry

Carina Hofmann*, Martin Greco-Coppi*, Jochen Ströhle*, Bernd Epple*

* Technical University Darmstadt, Energy Systems and Technology, Otto-Berndt-Str. 2, 64287 Darmstadt, Germany

1 Introduction, Process Integration

- Cement and lime industry accounts for over 8 % of global fossil CO_2 emissions [1]
- More than 50 % of CO_2 emissions are unavoidable
- 14 -33 % of CO_2 in exhaust gas [2]

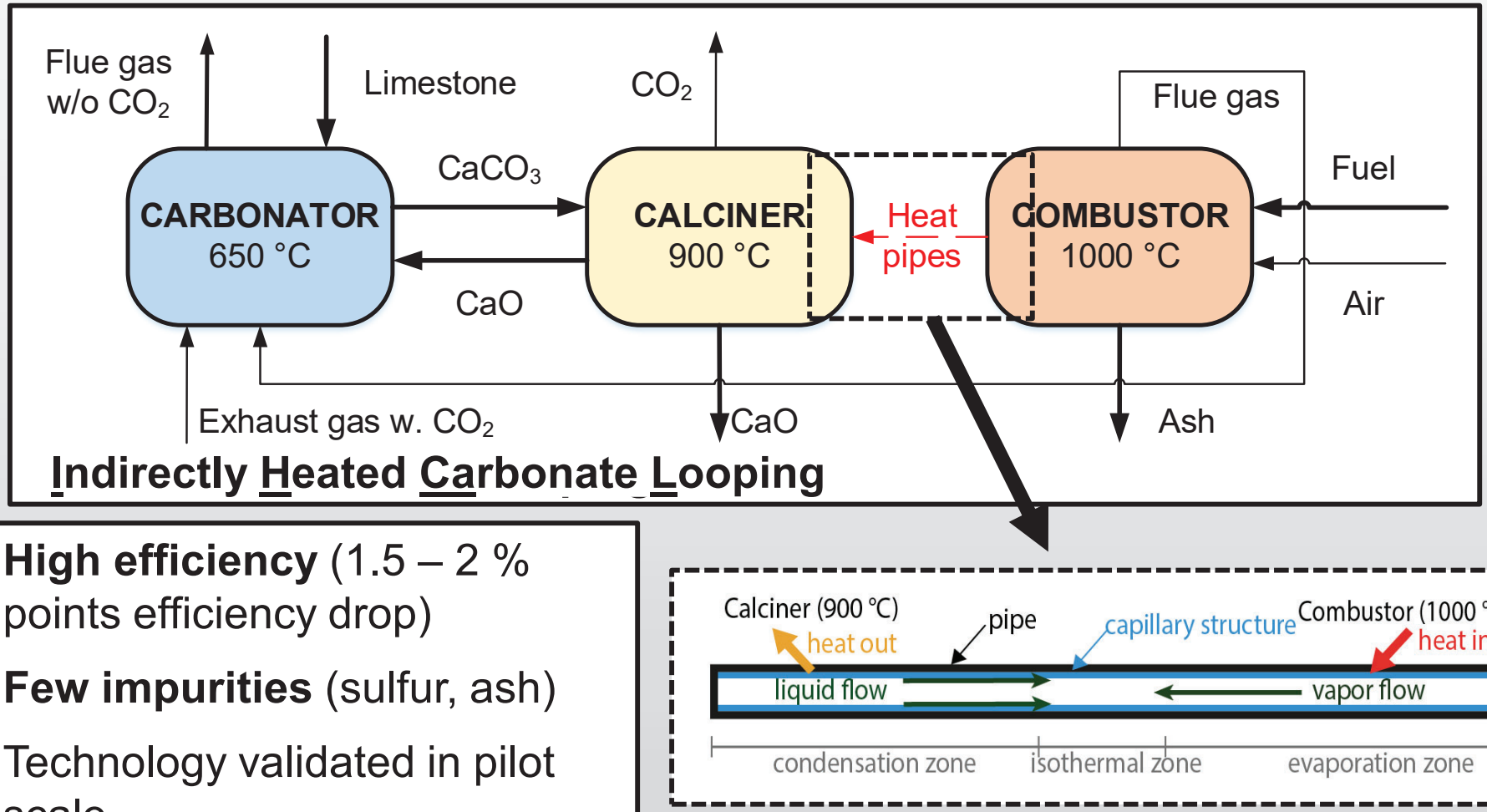


- Using synergies
- Aiming net negative CO_2 emissions
- Reduce CO_2 avoidance costs

[1] European Commission (JRC), Trends in global CO_2 emissions, 2016

[2] Bosoaga et. al, 2009

1 Introduction, Process Scheme IHCaL



- **High efficiency** (1.5 – 2 % points efficiency drop)
- **Few impurities** (sulfur, ash)
- Technology validated in pilot scale

2 Experimental Reactors 300 kW_{th} Pilot Plant

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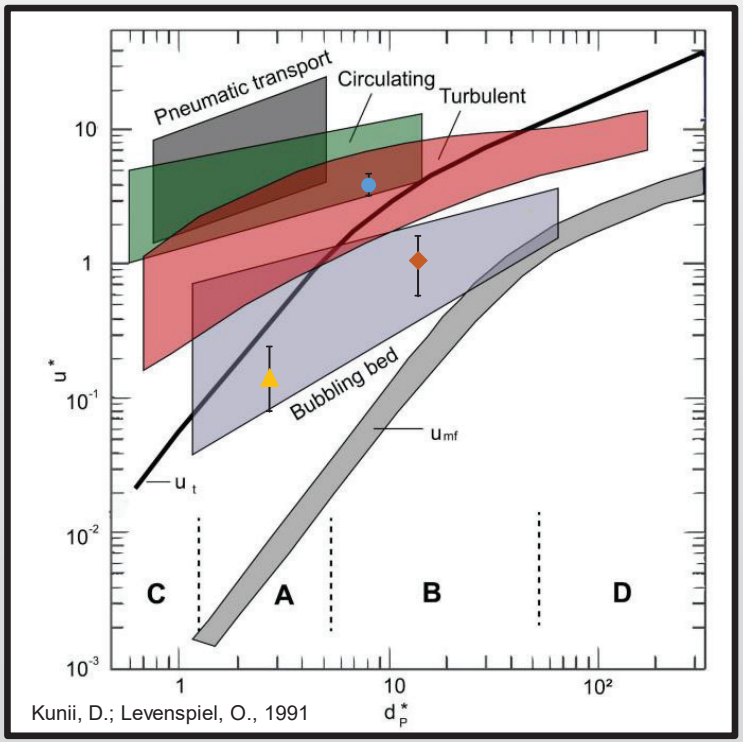
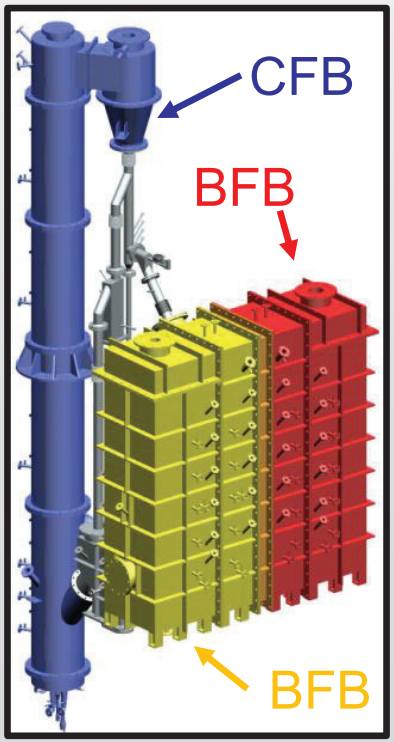
	Carbonator	Calciner	Combustor
Thermal load/ duty	300 kW_{th} flue gas load	~ 180 kW_{th}	~ 310 kW_{th}
Solid inventory	30 – 60 kg (CaO/CaCO3)	400 kg (CaO/CaCO3)	600 kg (silica sand)
Superficial velocity (u_o)	2.5 – 7 m/s	0.2 – 0.4 m/s	0.4 – 1.6 m/s

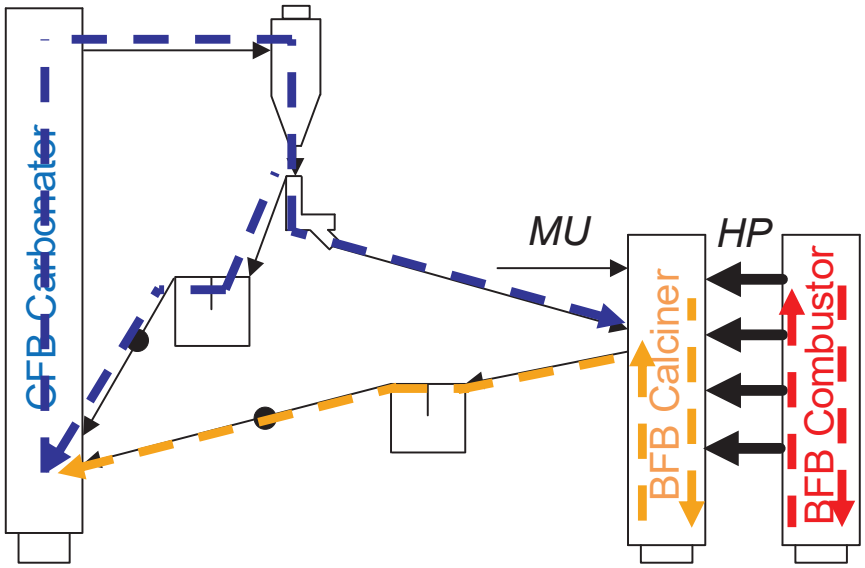




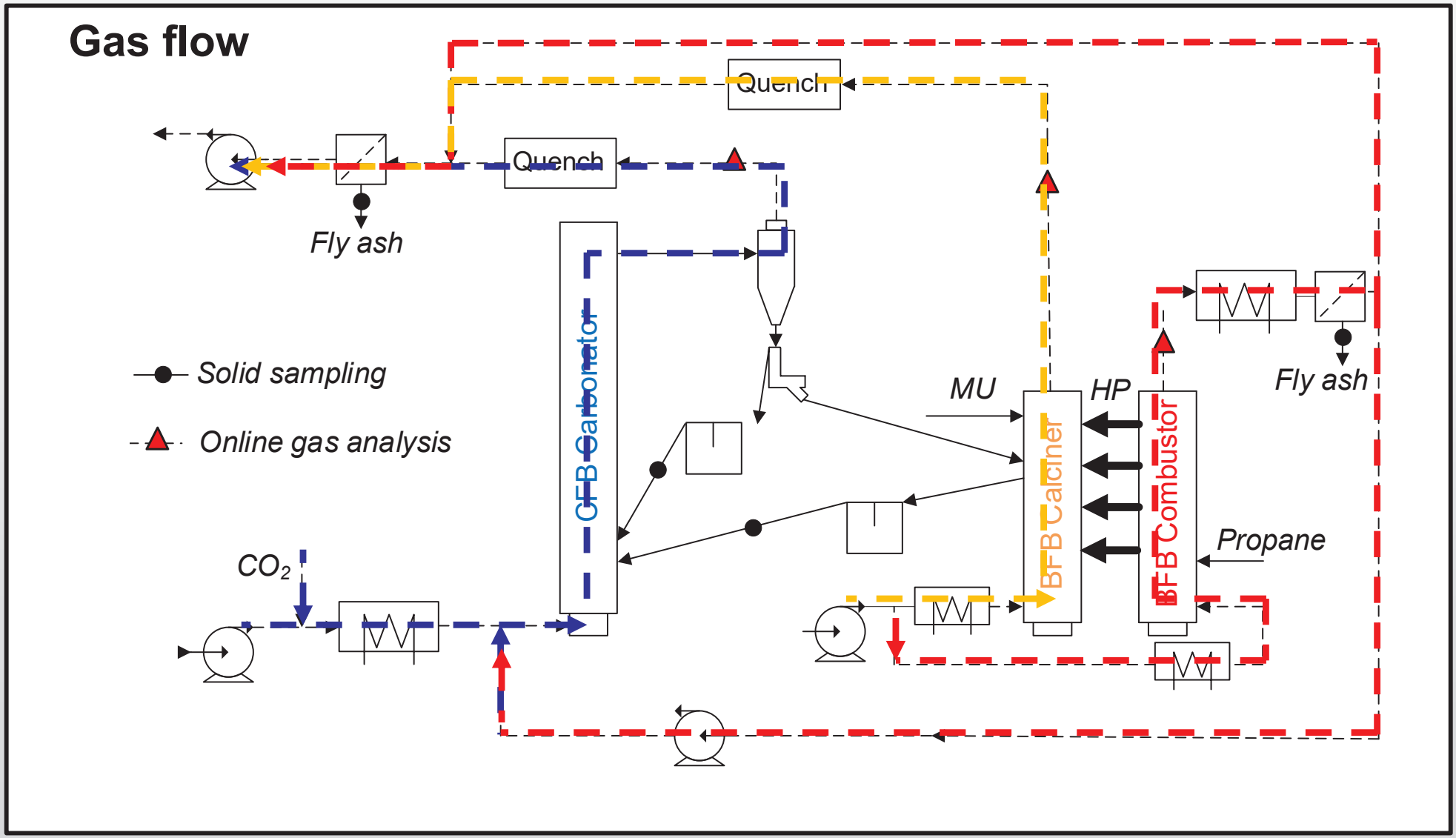
2 Experimental IHCaL Configuration

Solid flow

- *Solid sampling*



2 Experimental IHCaL Configuration



2 Experimental IHCaL Configuration

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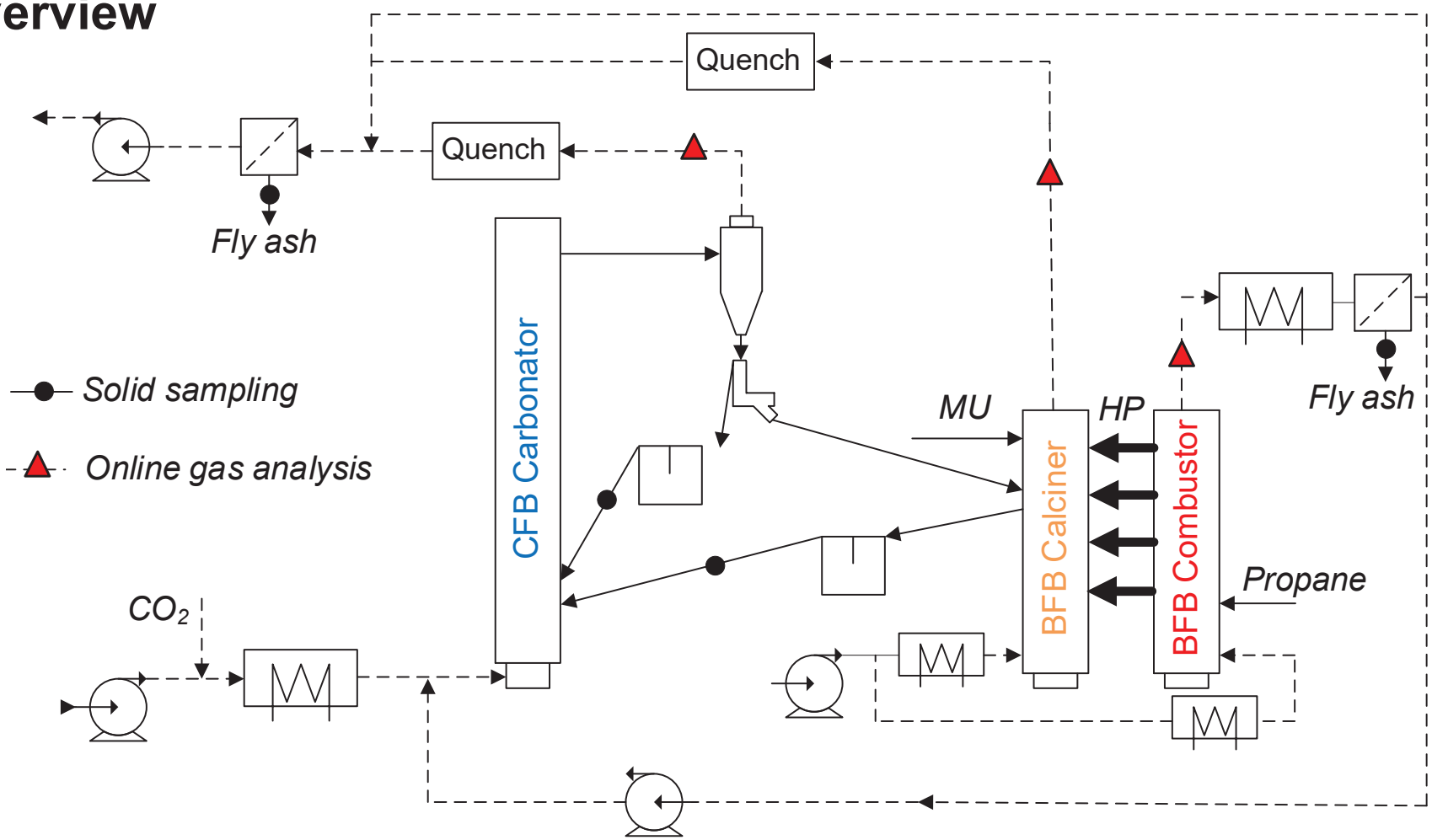
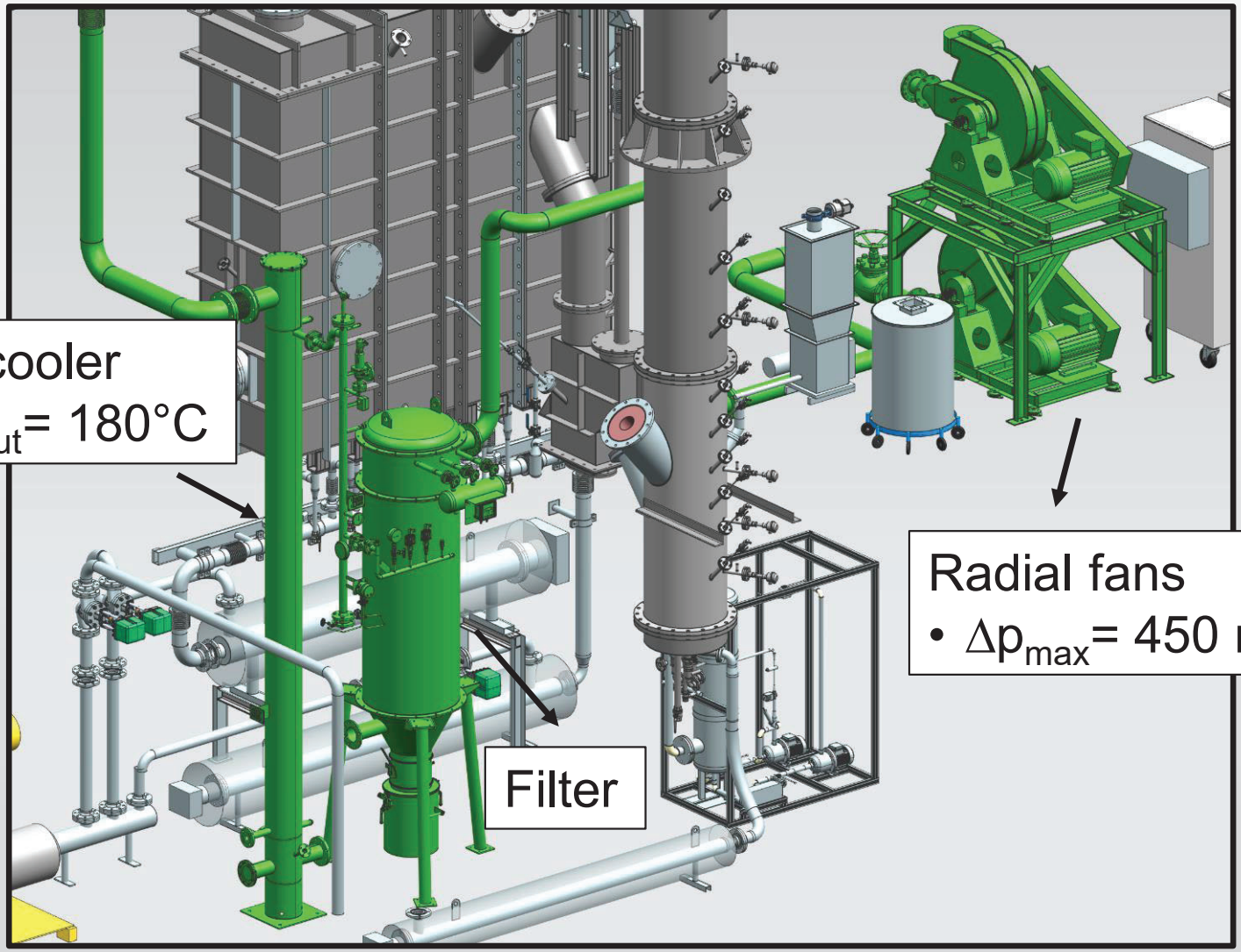
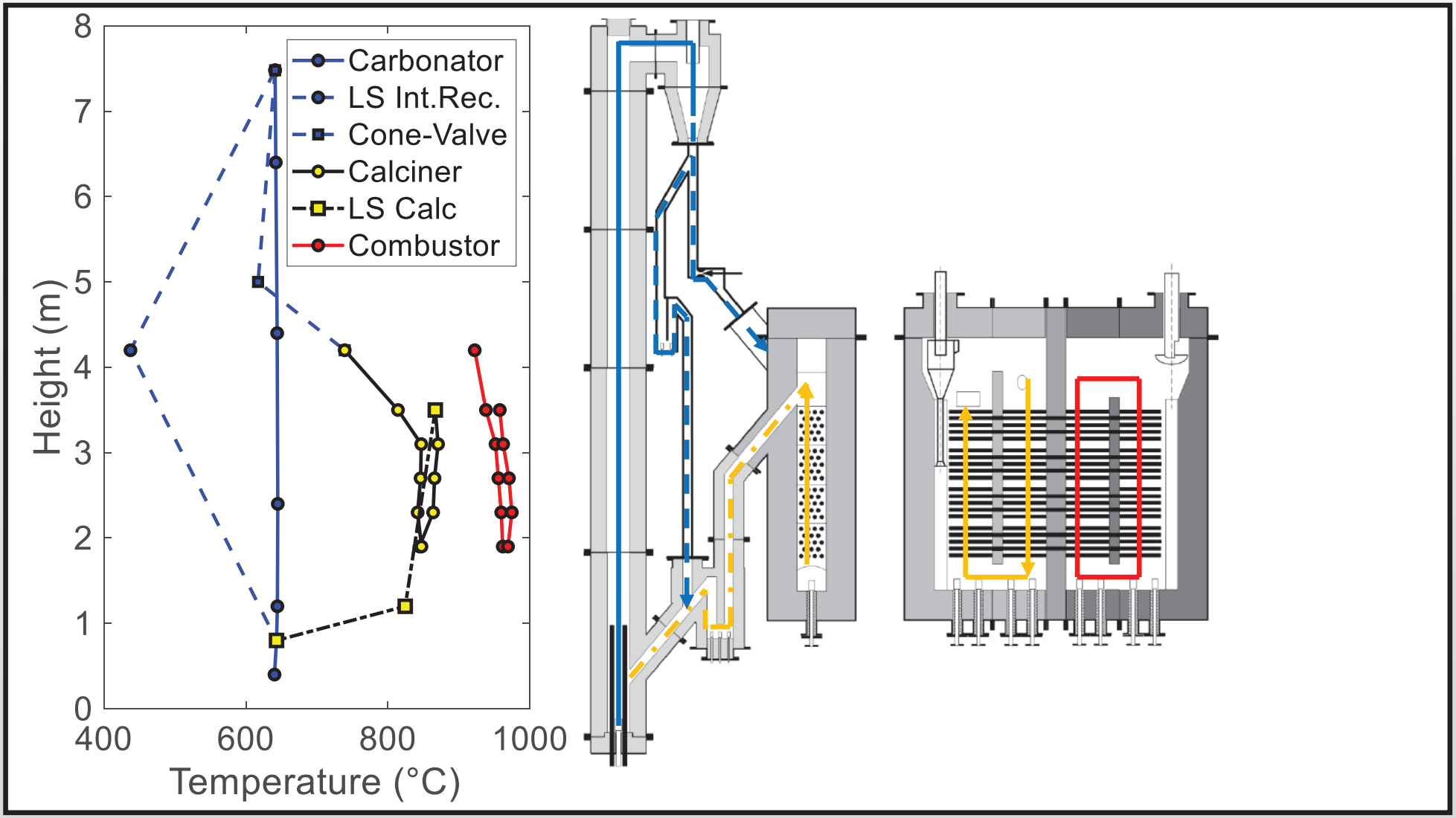
Overview



2 Experimental Adaption Flue Gas Path



3 Experimental Results
Reactor Temperature Profile



3 Experimental Results Chemical Equilibrium

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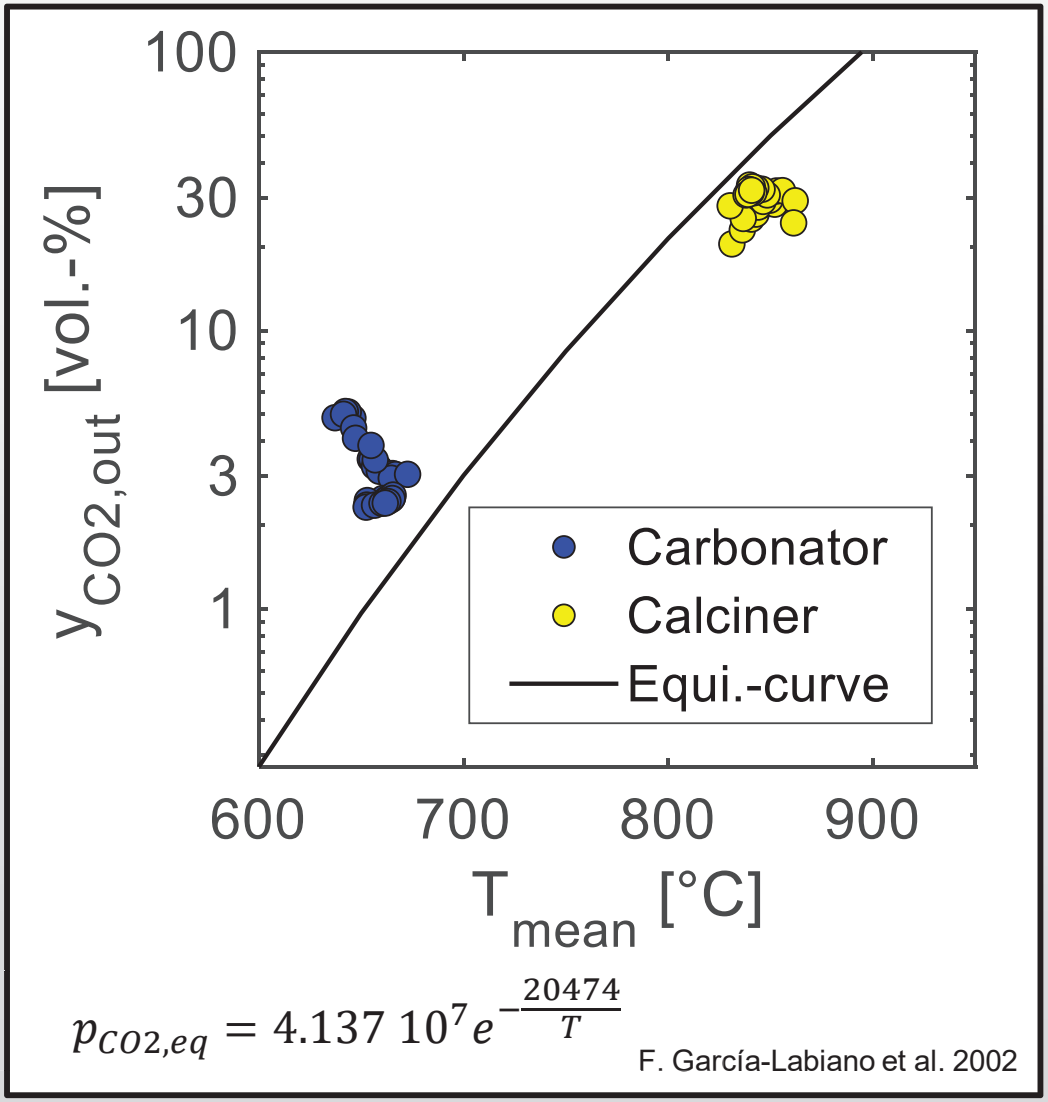
Carbonator

- Inventory: 900 - 3000 kg/m²
- $y_{CO2,in}$: ~ 12 vol.-%
- Active reactor cooling

Calciner

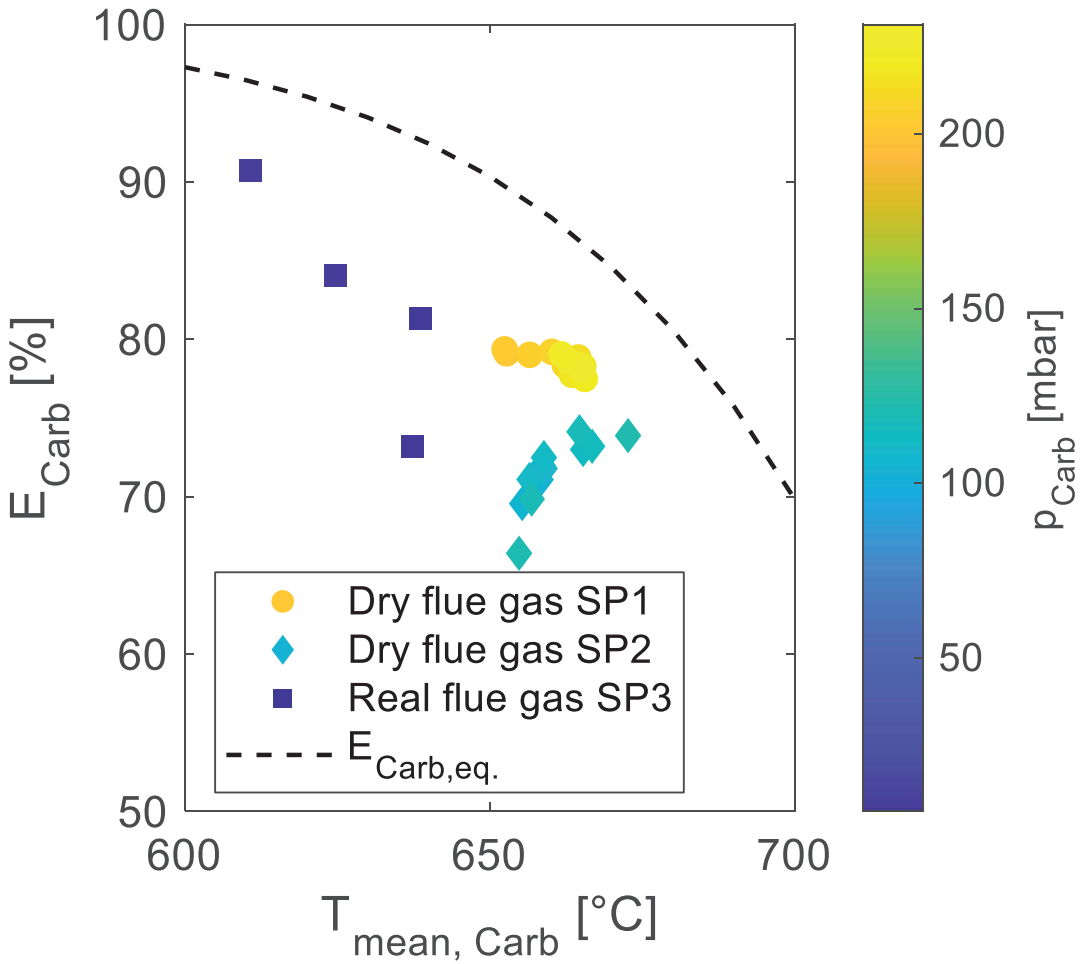
- Inventory: 1050 - 1300 kg/m²
- Air fluidisation



$$p_{CO2,eq} = 4.137\ 10^{7} e^{-\frac{20474}{T}}$$

F. García-Labiano et al. 2002

3 Experimental Results Carbonator Efficiency



$$E_{carb} = \frac{F_{CO2,carb,in} - F_{CO2,carb,out}}{F_{CO2,carb,in}}$$

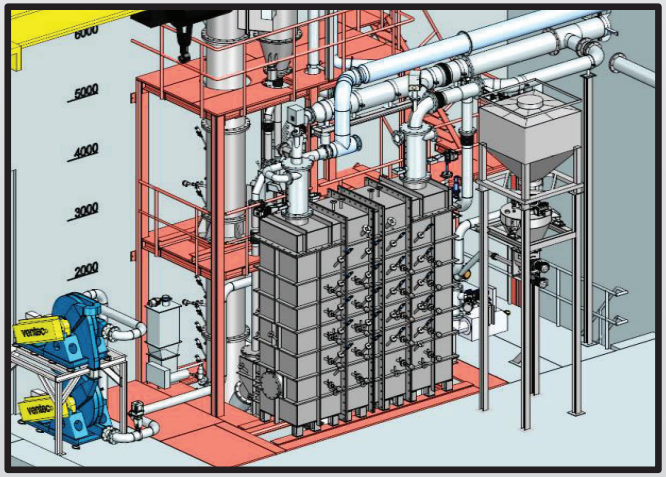
- Each set point (SP) state of at least 3 hours
- Temperature dependency with decreased inventory
- Capture efficiency with real gas up to 90 %

➢ With stabile inventory & moisture content in gas

➢ E_{Carb} > 90 % possible

4 Further Steps

- Analysis and evaluation of sorbent samples
  - ➢ Process performance and usage as educts for concrete
- Improvement of global circulation
- Usage of different solid materials; SRF and cement raw meal



Generation of **experimental data** via **long-term** pilot testing **under real conditions**

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Thank you for your Attention!

Dipl.-Ing. Carina Hofmann
Technical University Darmstadt
Institute for Energy Systems and Technology
Carina.hofmann@est.tu-darmstadt.de