Interreg North-West Europe IDEA
European Regional Development Fund

UNIVERSITY OF TWENTE.

CO2 FROM BIOGAS USING MODIFIED BENTONITE CLAY

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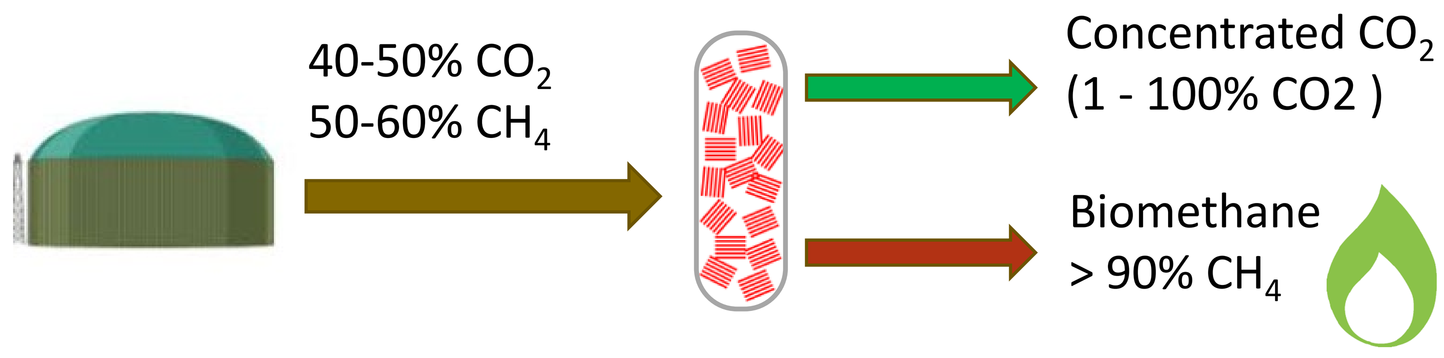
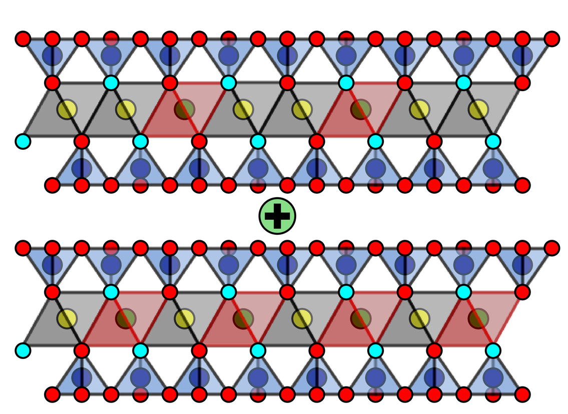
INTRODUCTION



Above 1% CO_2 in air (vs. 400 ppm) is typical sufficiently concentrated for microalgae cultivation

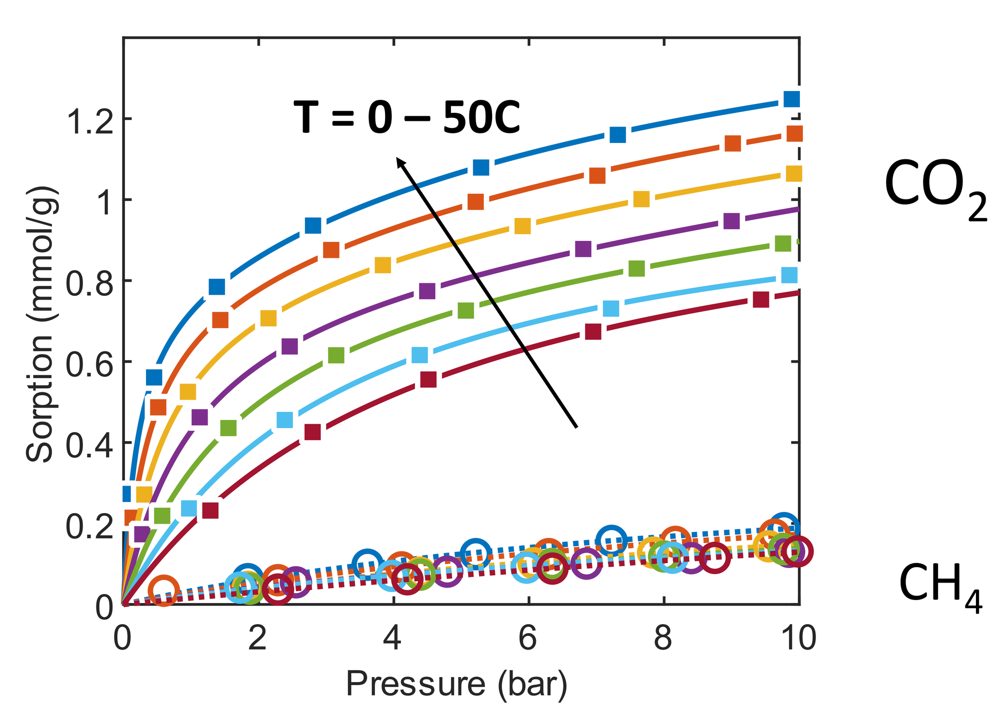
Separating biogas into a concentrated CO2 stream for microalgae cultivation and biomethane (for bio-LNG, local methane gas grid or CHP) on small scale (say, 10-100 Nm3/h) requires a cost effective and robust separation technology.

MODIFIED CLAY AS SORBENT

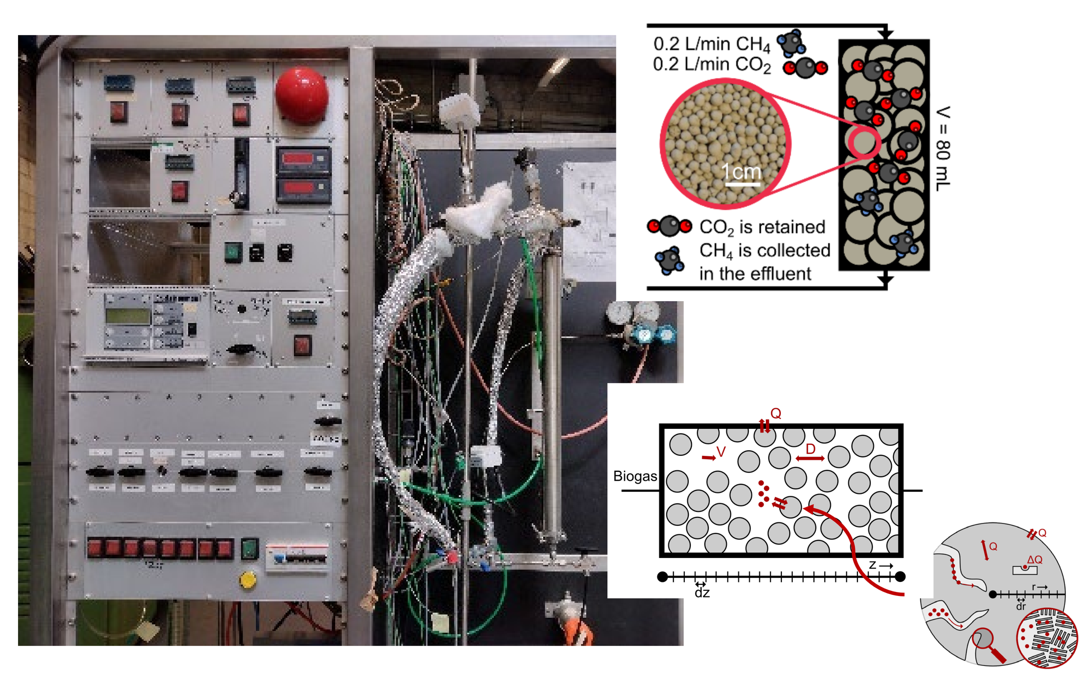


- Natural, layered aluminosilicates are abundantly available (e.g. montmorrilonite, bentonite)
- Negatively charged layer are compensated by (*exchangeable*) interlayer cations
- The size of the cation sets the interlayer spacing. By exchanging the cation, the spacing varies
- Above certain cation size CO_2 can enter the interlayer …
- …and since CH_4 (13-13.5 Å) is larger than CO_2 (12 Å), intermediate sizes allow CO_2 to enter, but do exclude CH_4 !
- Hence: selective CO_2 capture (in the interlayer) can be realized !
- Next to adsorption in the interlayer both CO2 and CH4 can adsorb on the external surface area

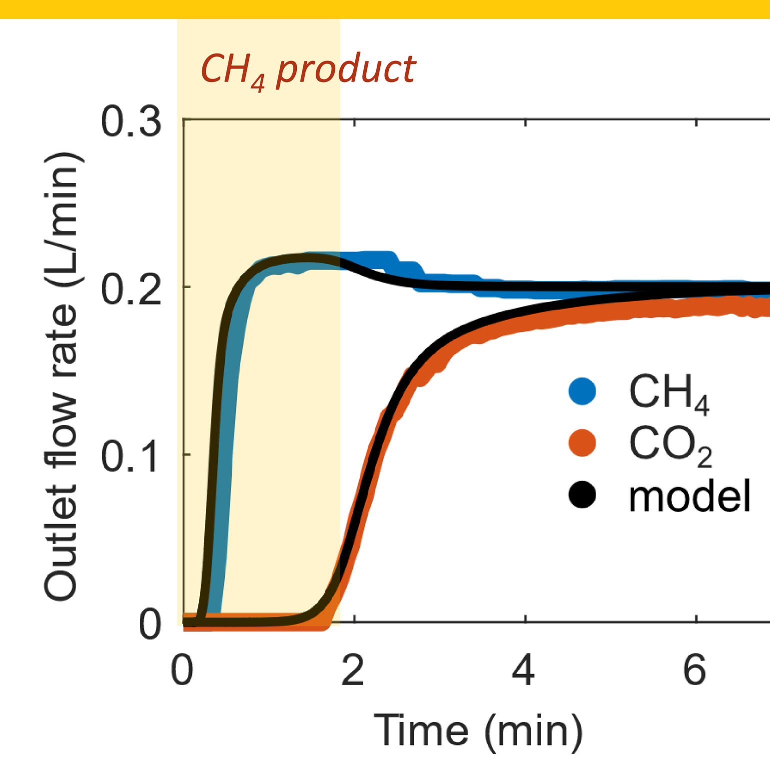
ADSORPTION ISOTHERMS



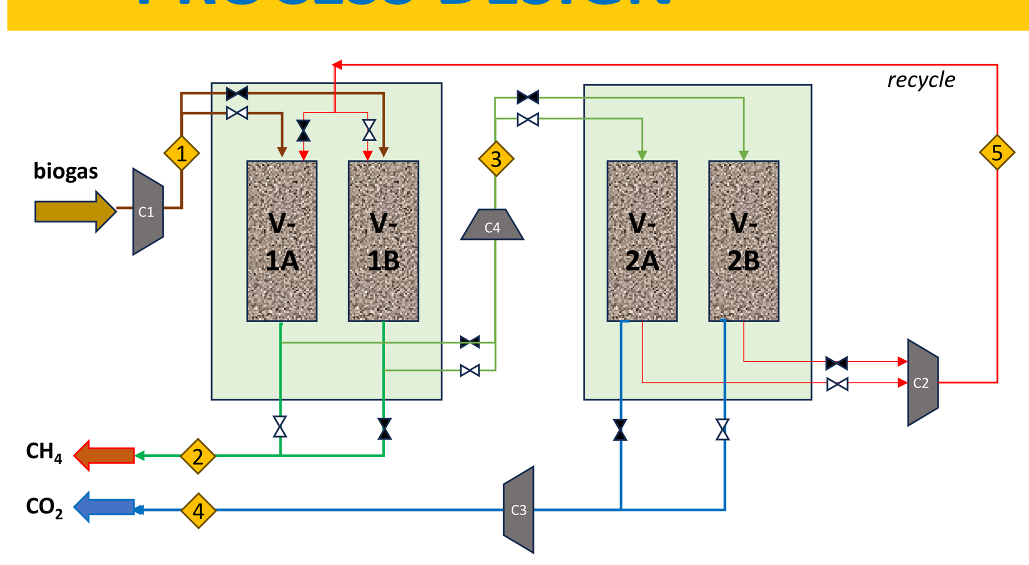
FIXED BED EXPERIMENTS



PROOF OF CONCEPT



PROCESS DESIGN

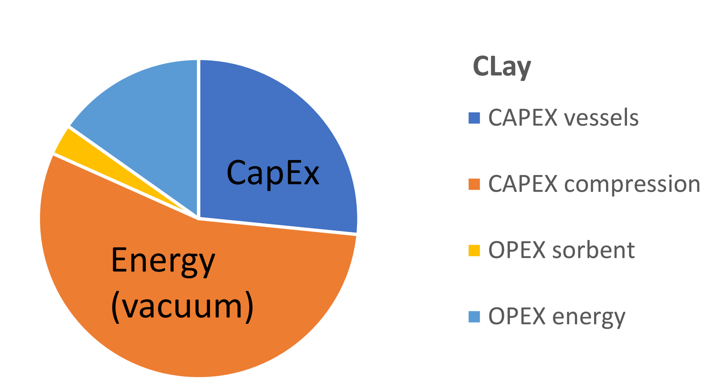


TARGETS: purity: CH_4 > 90%; CO_2: > 1%
recovery: CH_4 > 99.5 %; CO_2: (high)
productivity: as high as possible
energy consumption: (minimize)

DESIGN - OPTIMIZATION

- Two adsorption stages for CH_4 recovery > 99.5%
- Operation: Temperature (ADS+DES): ambient (20°C)
  Pressures (ADS: 2.5 bar; DES 0.1 bar)
- Cyclic capacity: 0.2 mol CO_2/kg
- CH_4 purity 93% & CH_4 recovery 99.7%
- CO_2 purity 99.3%
- 87% CO_2 recovery for microalgae (rest in bio-CH4)
- Productivity: 25 Nm³/h per m³ sorbent
- Power consumption: 0.13 kWh/Nm³
- Estimated costs: 0.16 €/Nm³ biogas

CONCLUSIONS



Concept proven
Conceptual design is prepared
Next steps required: outdoor piloting

Interreg North-West Europe IDEA
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IDEA - Implementation and development of economic viable algae-based value chains (NWE639)

Duration: 9/2017 – 10/2021, capitalisation till 12/2023

Website: www.nweurope.eu/IDEA

Lead partner: VITO, Belgium

Full IDEA partners:

JÜLICH, Innovatiesteunpunt, CentraleSupélec, FEED DESIGN LAB, THOMAS MORE, cogasc, UNIVERSITY OF TWENTE., Prifysgol Abertawe Swansea University, pcfruit, Heirbaut aLgriculture