

CRONUS



SEMPRE-BIO



# Exploring the limits of syngas biomethanation

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# Background

- Energy recovery where anaerobic digestion is unsuitable
- Possibility of Power-to-X



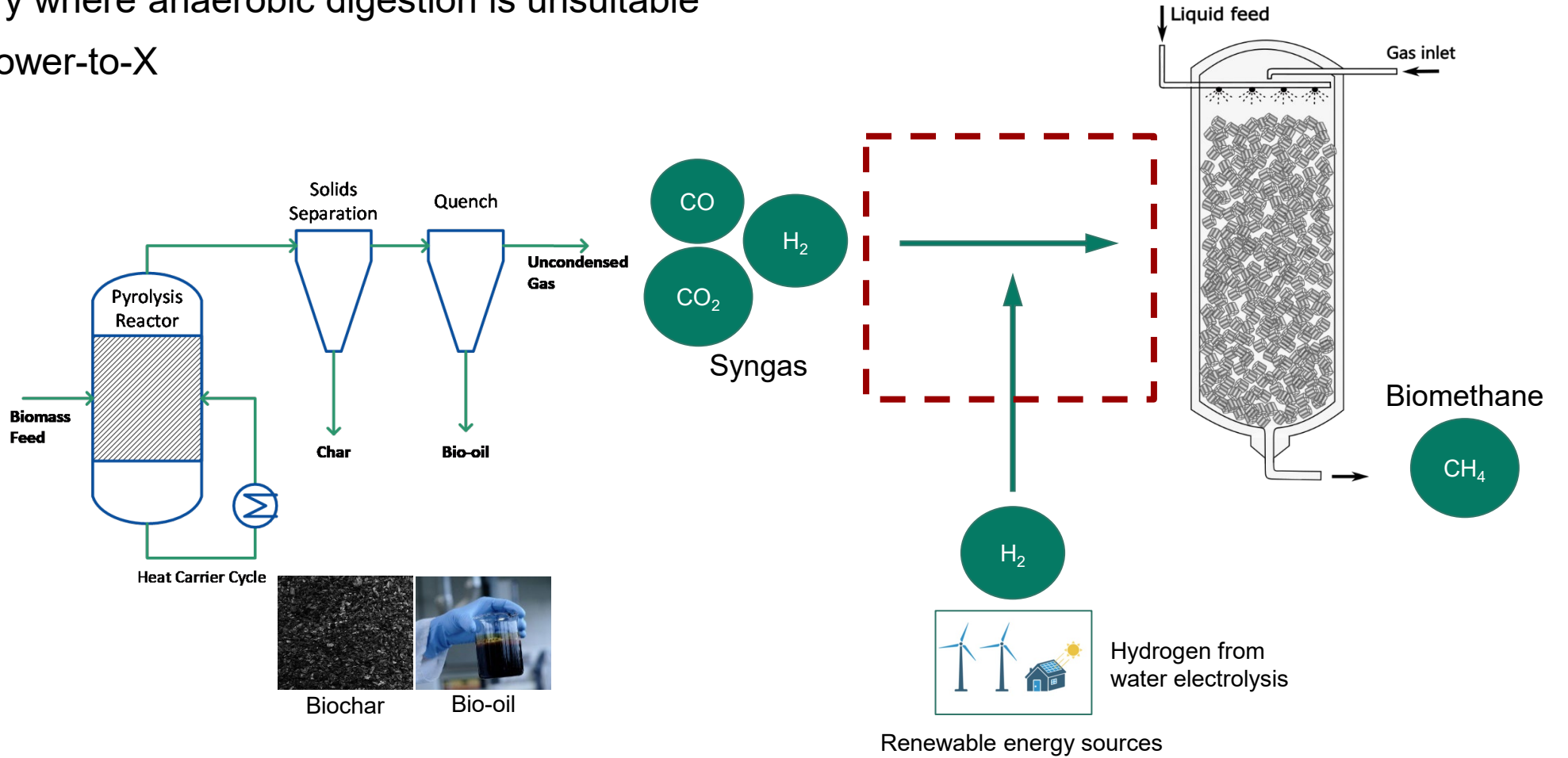
Woody biomass



Straw



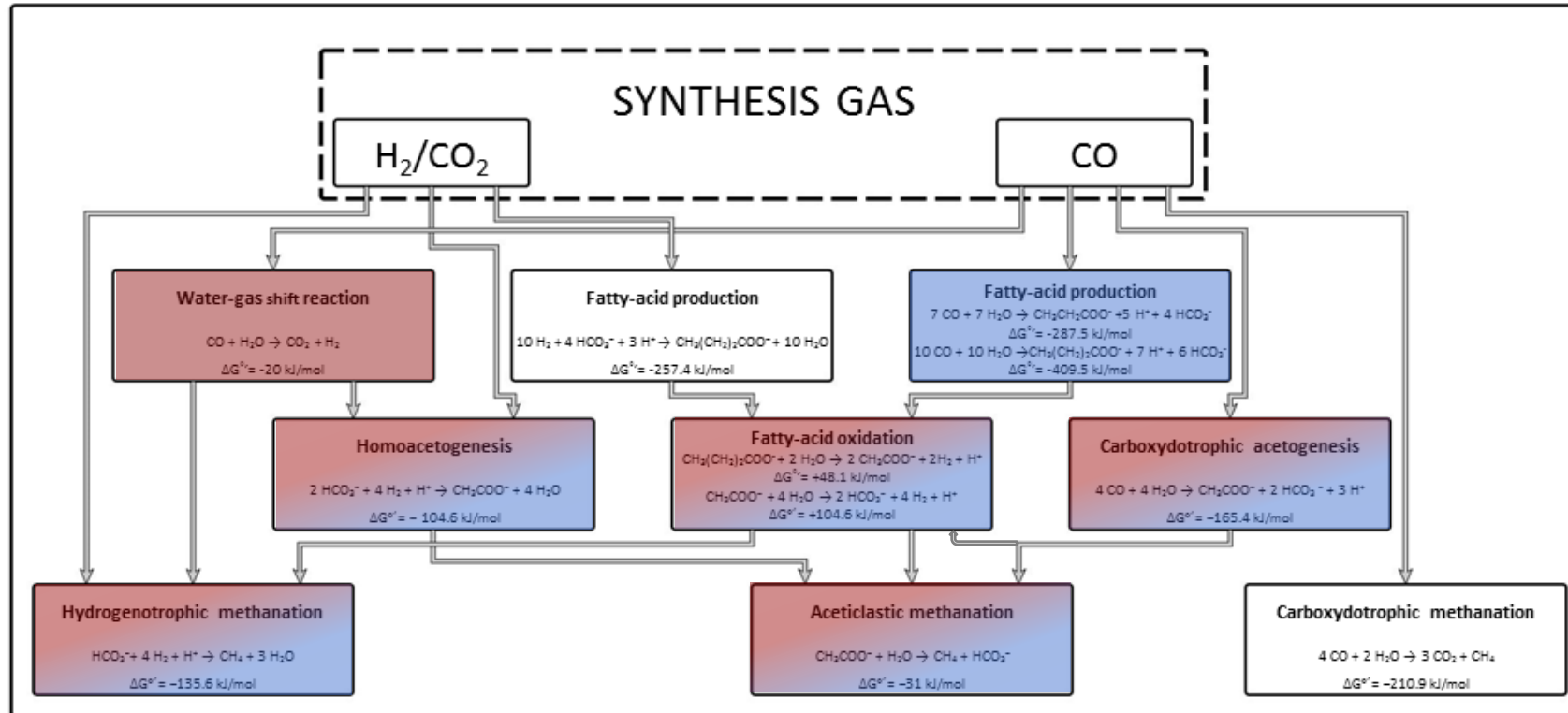
Digestate fibres



# The impact of gas composition on syngas biomethanation

# Background

- Complex catabolic network
- Prevalent pathways modulated by operating conditions
- CO may cause inhibition to multiple microbial groups

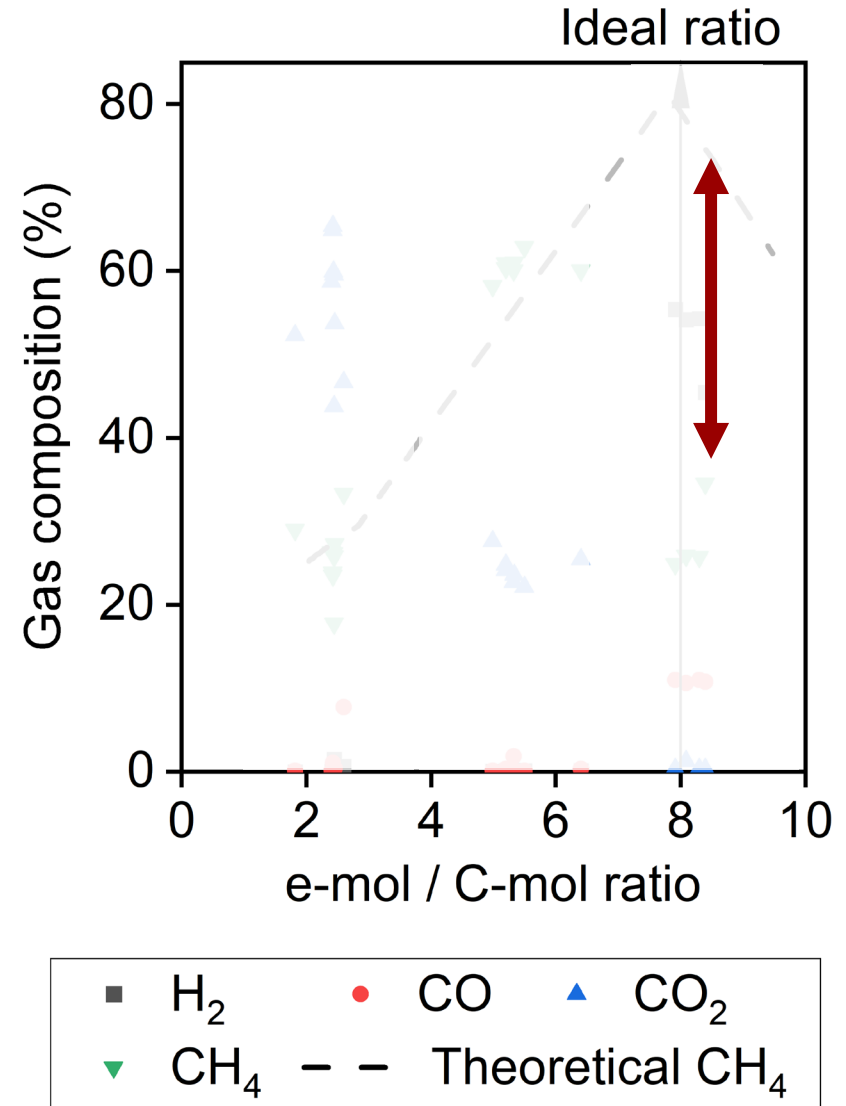


■ Mesophilic conditions  
■ Thermophilic conditions

# Impact of syngas composition

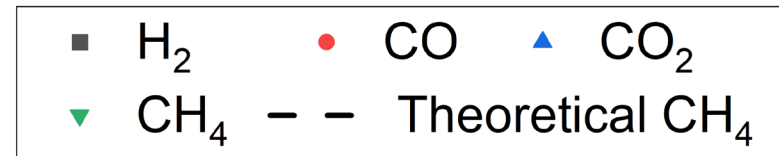
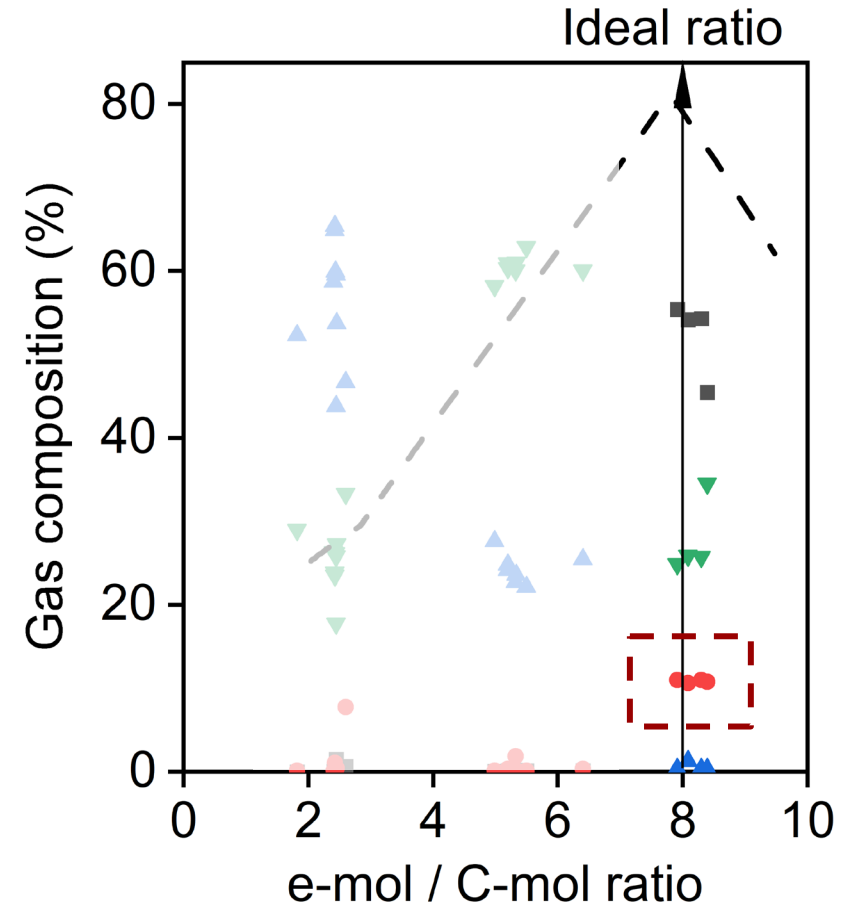
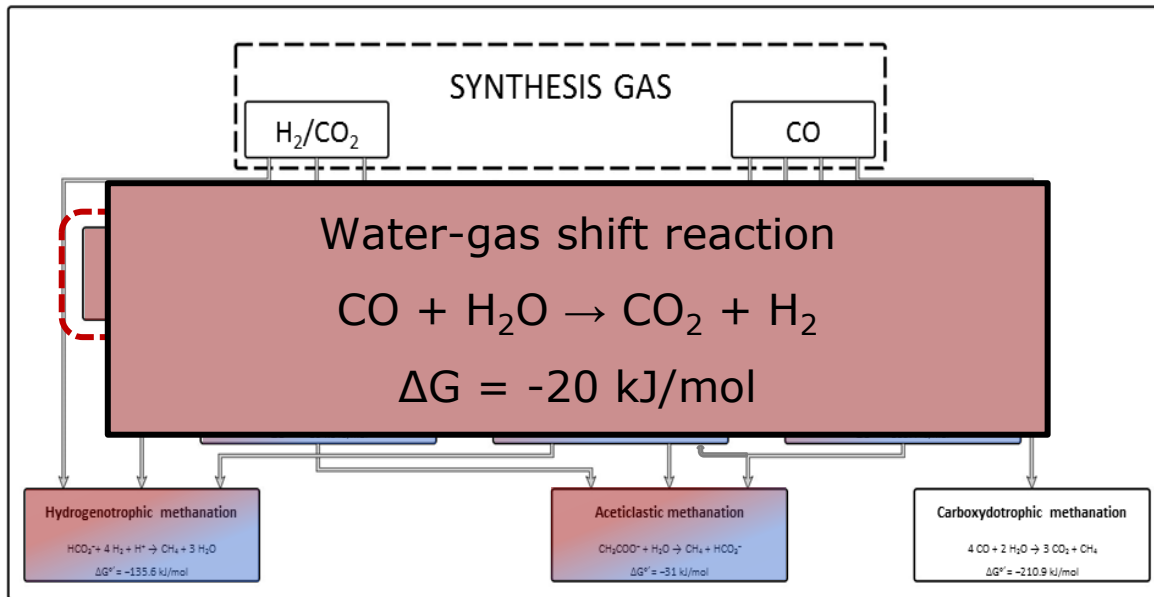
e-mol / C-mol ratio	Condition
5.4	Control
2.4	High CO
8.2	High H <sub>2</sub>

- No inhibition from CO toxicity
- Large quantities of H<sub>2</sub> are necessary to convert all CO<sub>2</sub>
- Addition of H<sub>2</sub> requires careful tuning



# Impact of syngas composition

- Addition of H<sub>2</sub> requires careful tuning





# Background



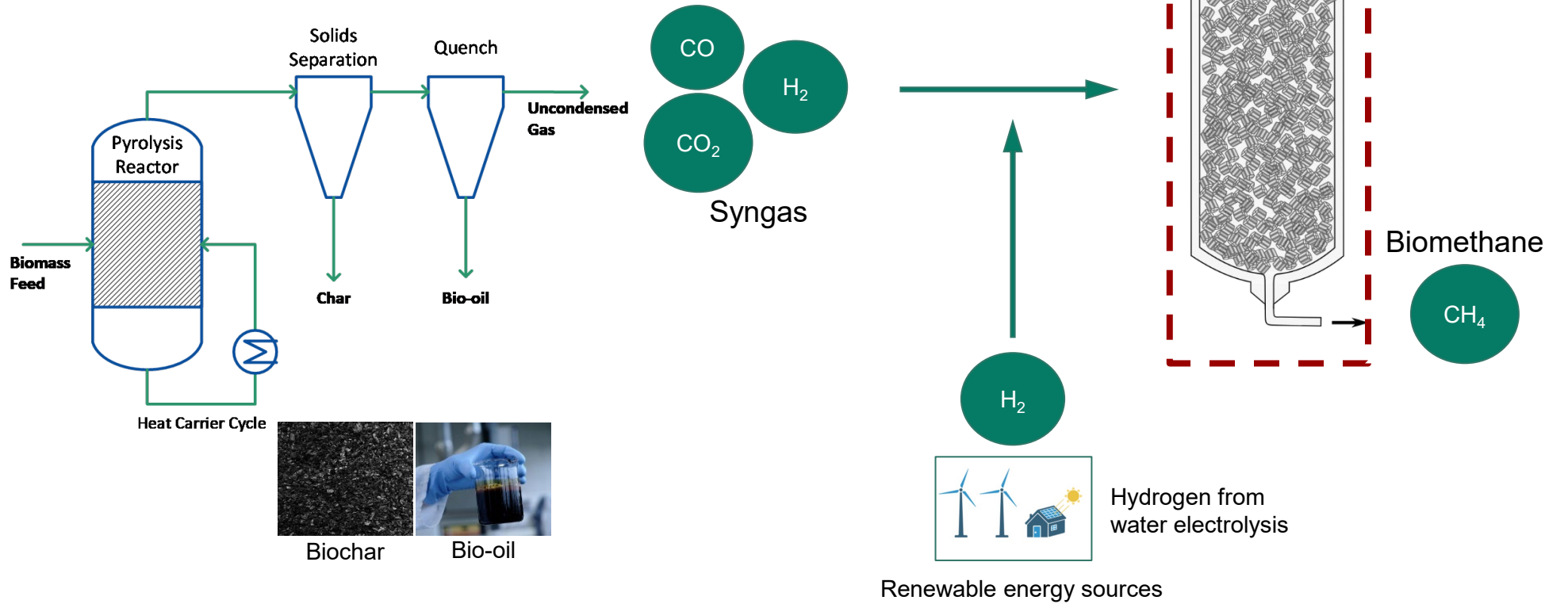
Woody biomass



Straw



Digestate fibres

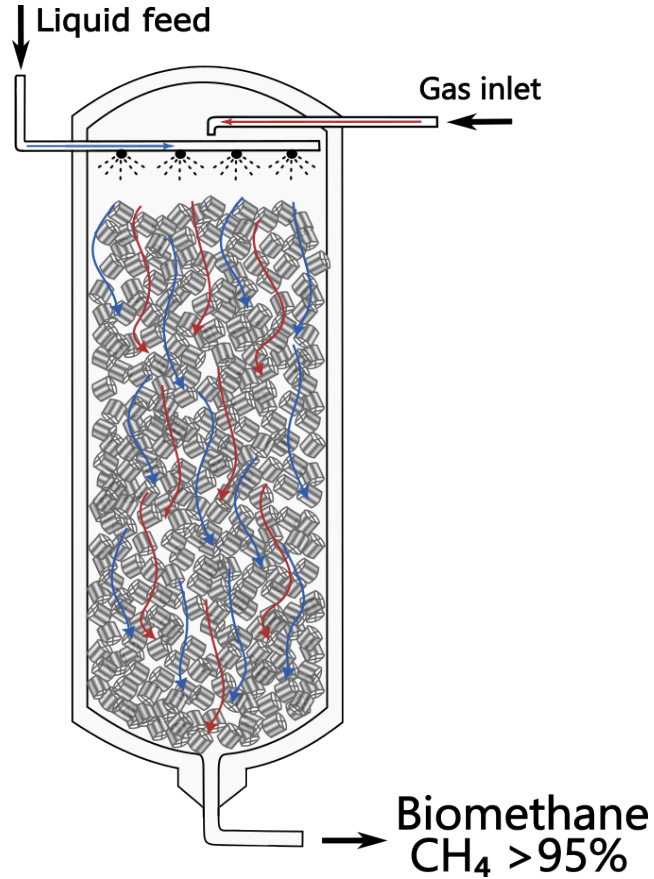




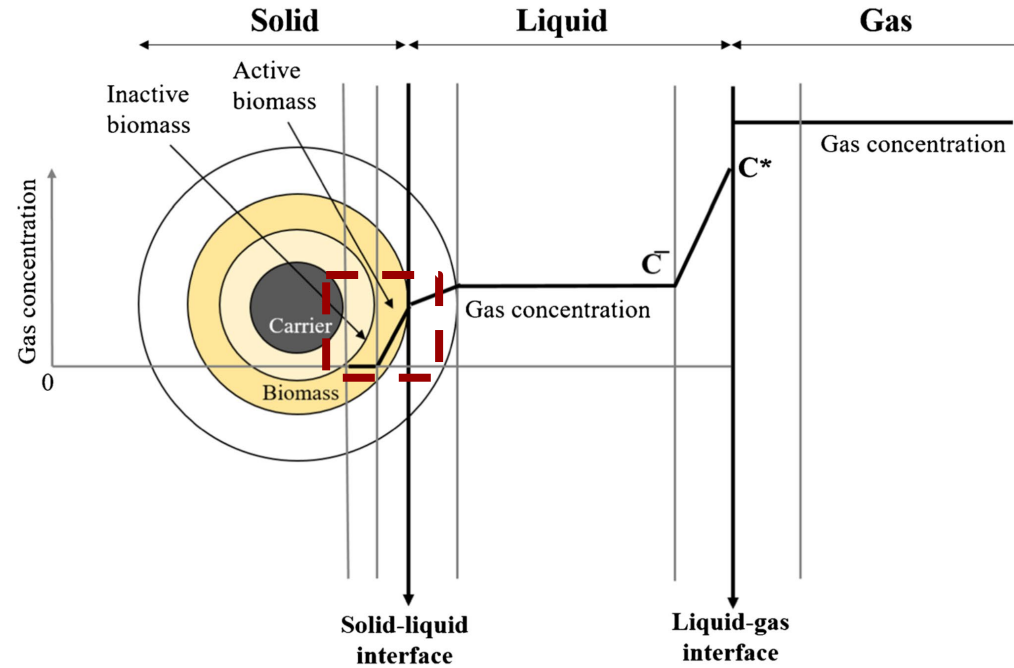
# Gas to liquid mass transfer

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Trickle Bed Reactor

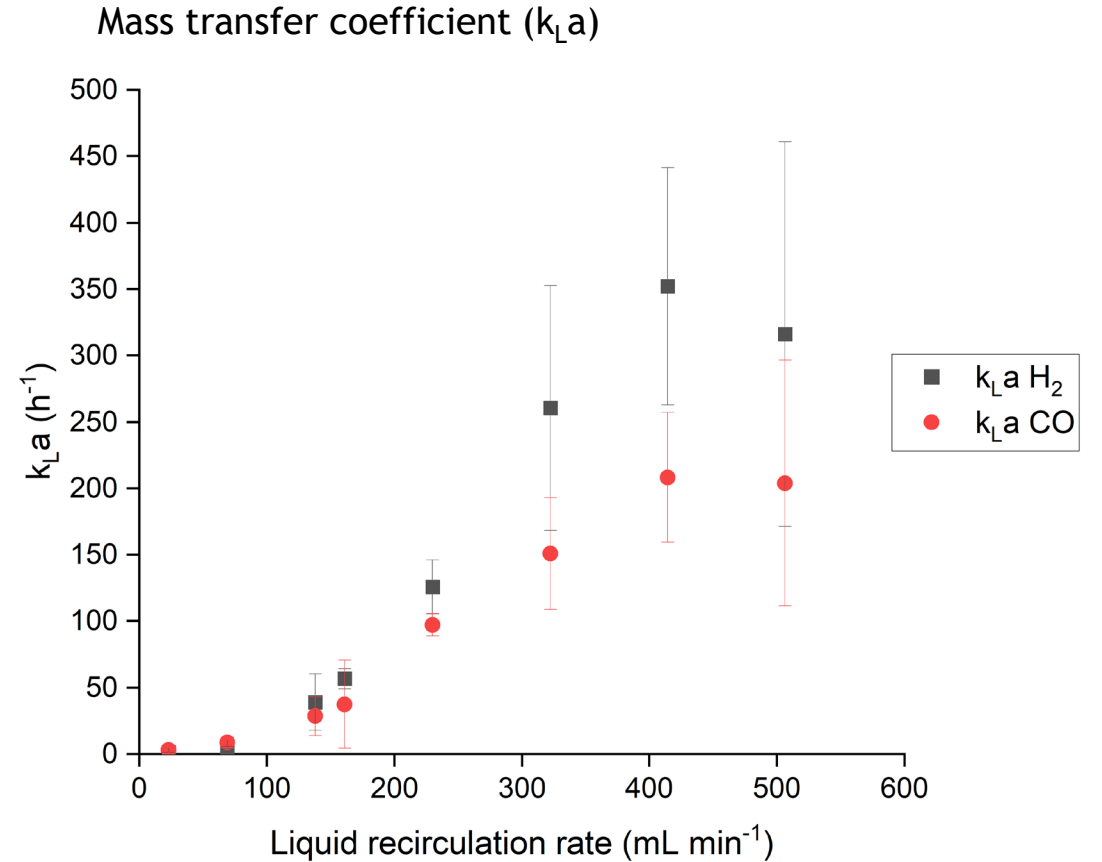
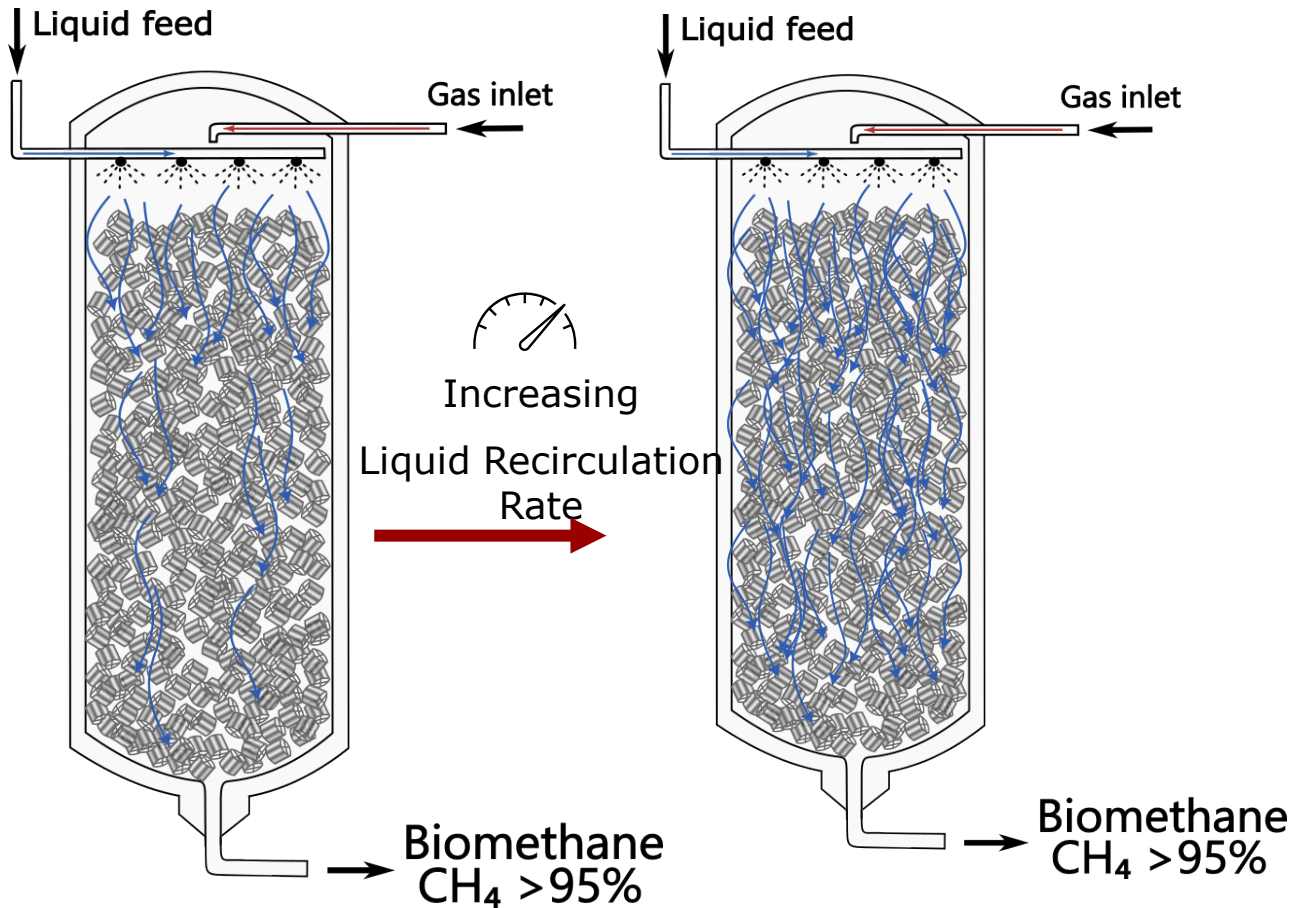


Three phase system: Gas-liquid-solid mass transfer



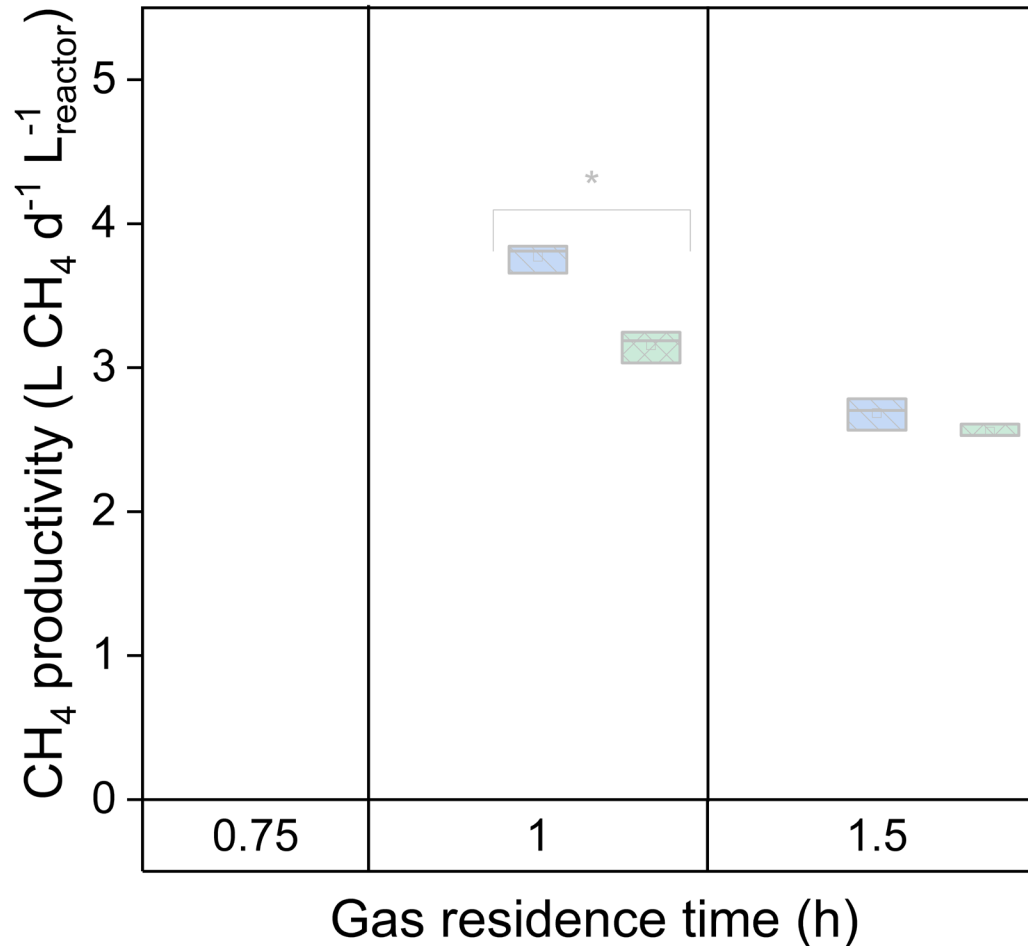
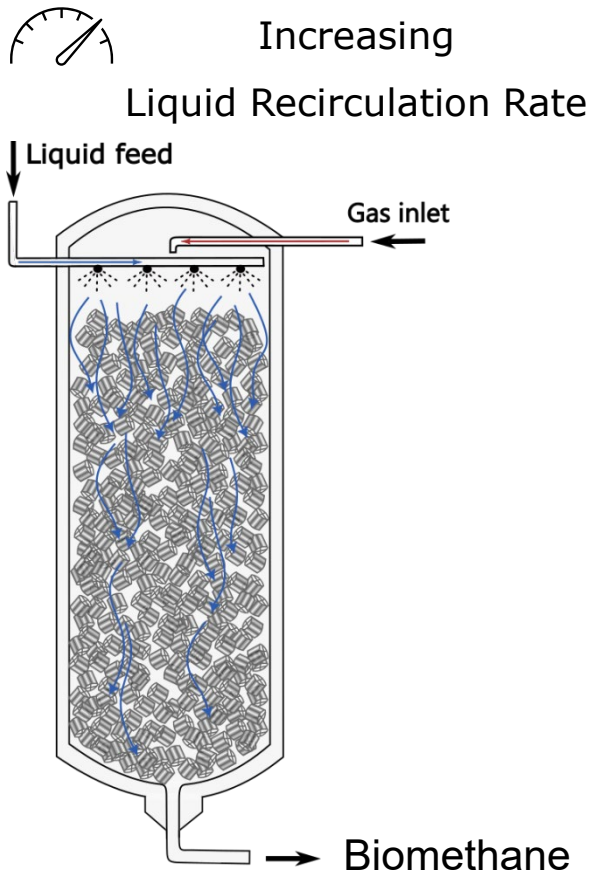
Sinharoy, Arindam & Pakshirajan, Kannan & Lens, P.N.L.. (2020). Biological Sulfate Reduction Using Gaseous Substrates To Treat Acid Mine Drainage. Current Pollution Reports. 6. 10.1007/s40726-020-00160-6.



# Channelling phenomena



Can increasing the liquid recirculation rate alleviate channelling (and increase productivity)?

# Channelling phenomena and gas to liquid mass transfer

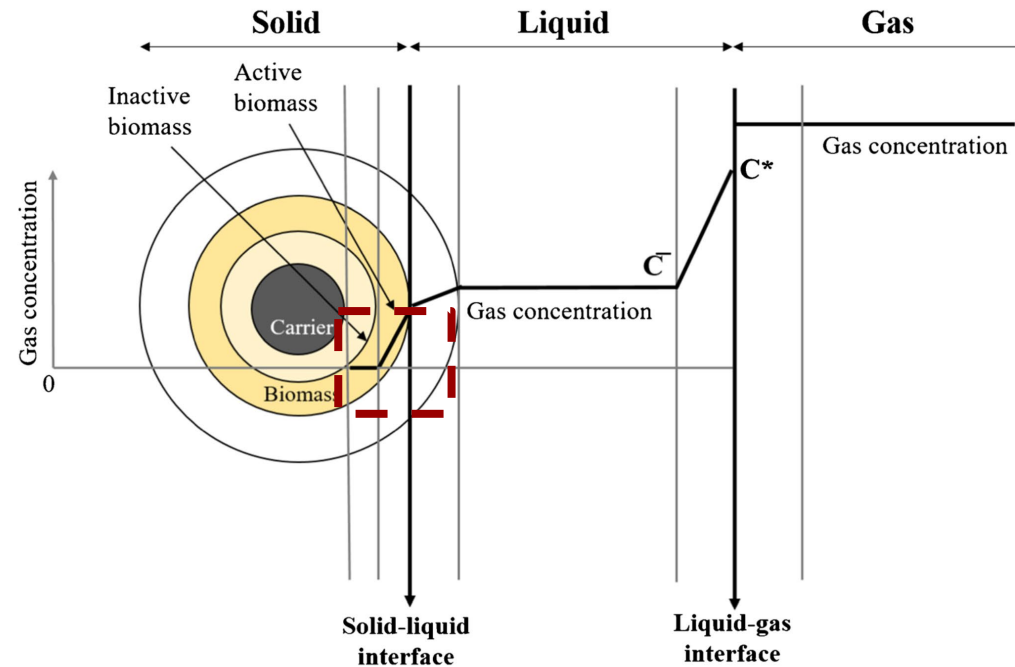


-  Liquid recirculation 20 mL min<sup>-1</sup>
-  Liquid recirculation 280 mL min<sup>-1</sup>

# Channelling phenomena and gas to liquid mass transfer

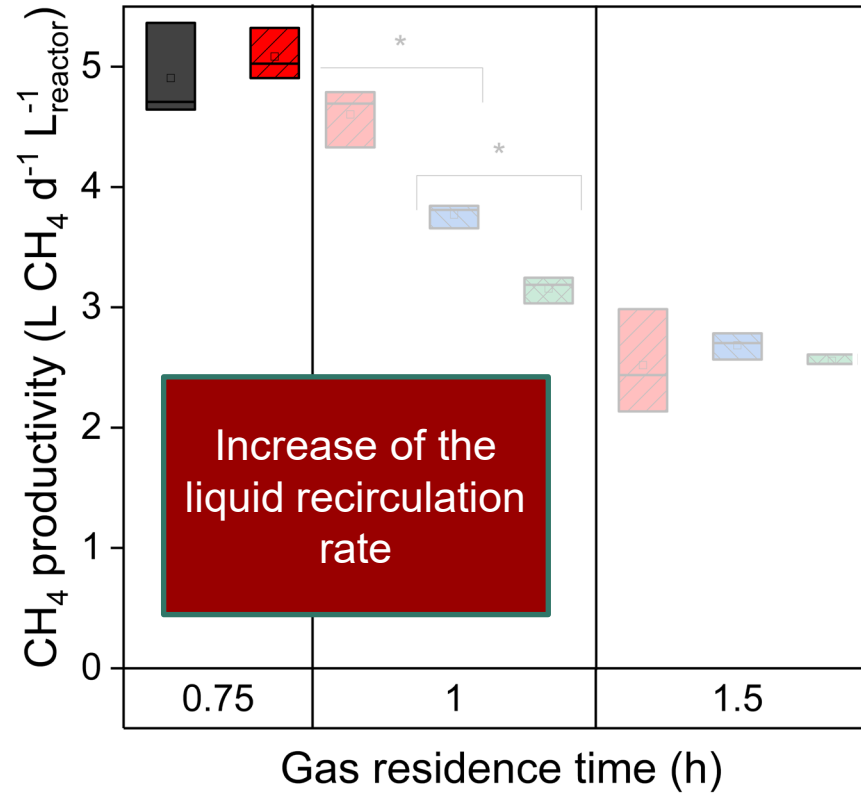
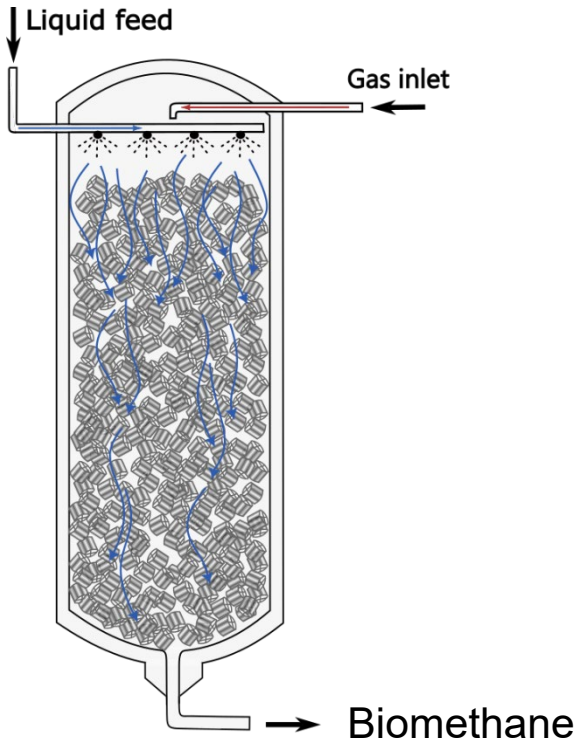
- Nutrient limitation
- Bottleneck other than gas-liquid mass transfer

Three phase system: Gas-liquid-solid mass transfer



Sinharoy, Arindam & Pakshirajan, Kannan & Lens, P.N.L.. (2020). Biological Sulfate Reduction Using Gaseous Substrates To Treat Acid Mine Drainage. Current Pollution Reports. 6. 10.1007/s40726-020-00160-6.

# Channelling phenomena and gas to liquid mass transfer



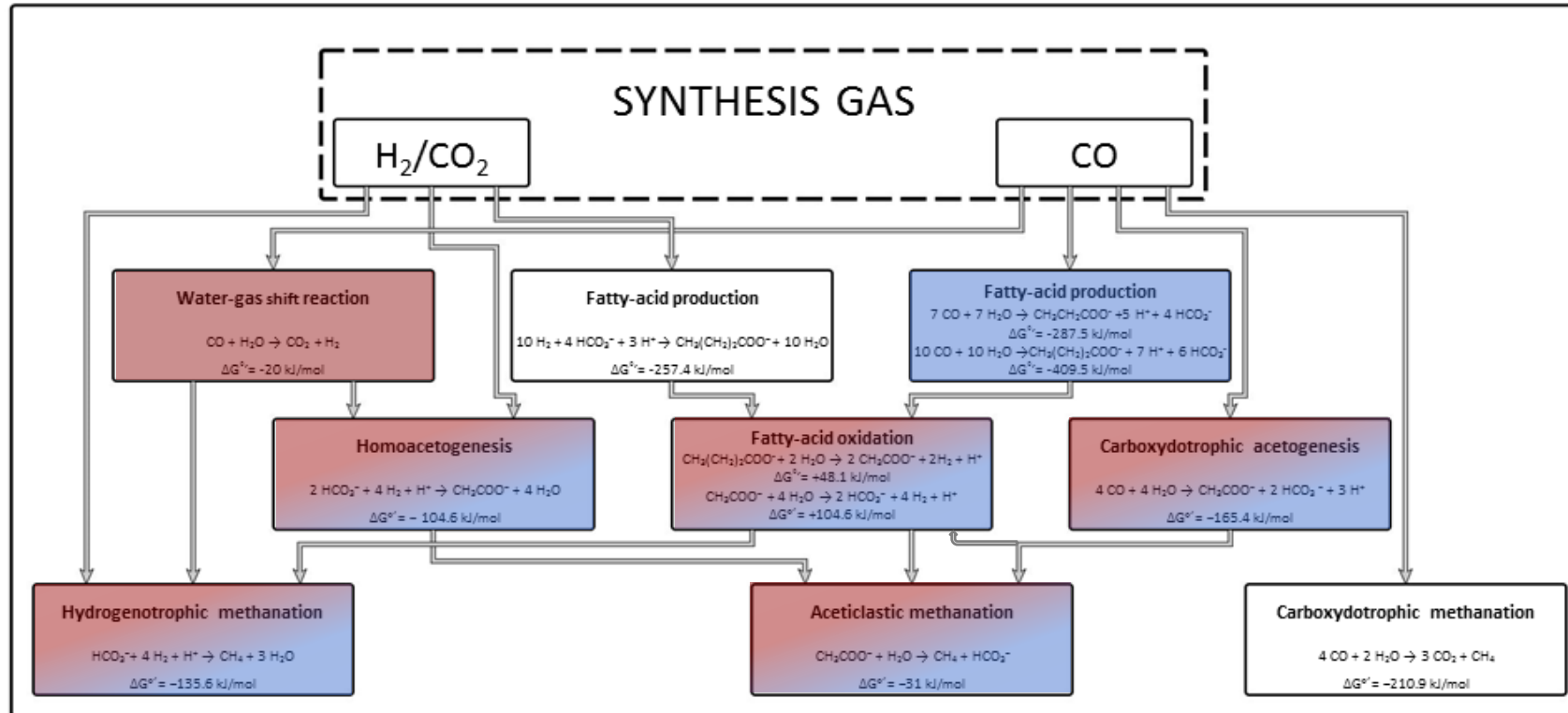
Diffusion may play a significant role

- Liquid recirculation 20 mL min<sup>-1</sup>, no trace elements
- Liquid recirculation 280 mL min<sup>-1</sup>, no trace elements
- Liquid recirculation 20 mL min<sup>-1</sup>, with trace elements
- Liquid recirculation 280 mL min<sup>-1</sup>, with trace elements



# Background

- Complex catabolic network
- Prevalent pathways modulated by operating conditions

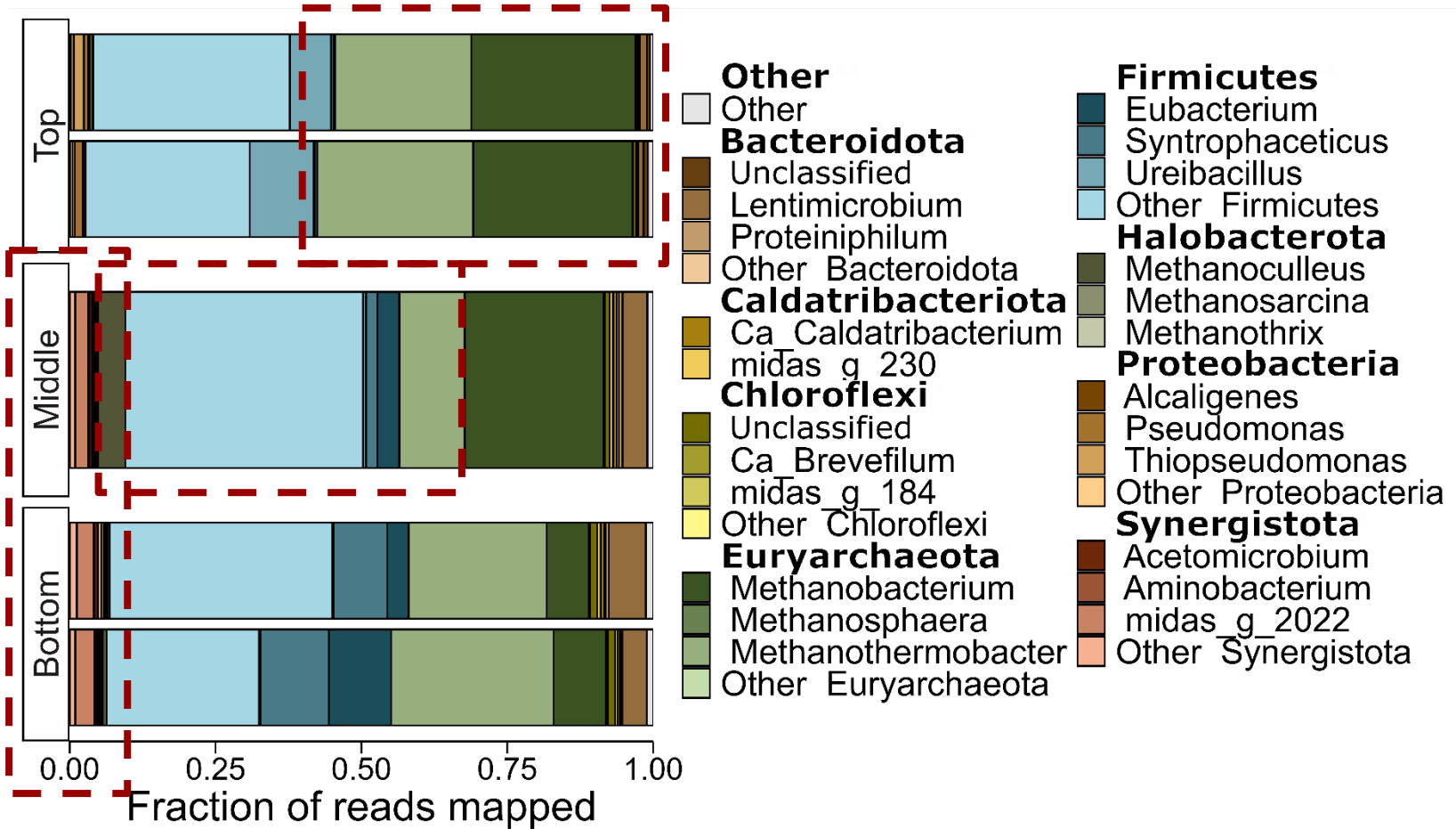
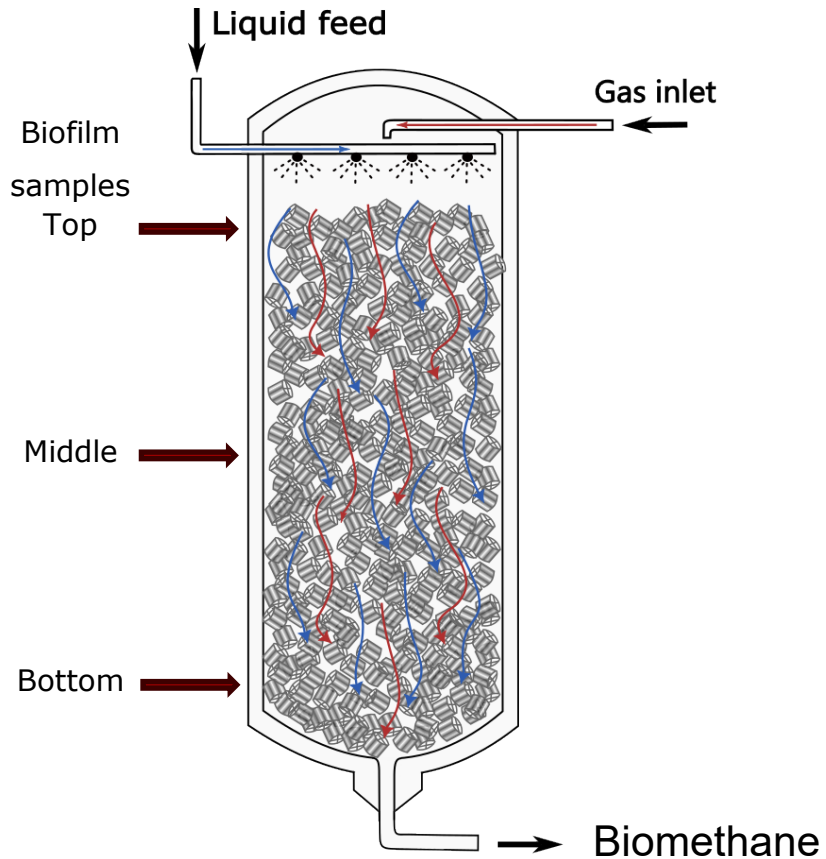


■ Mesophilic conditions  
■ Thermophilic conditions

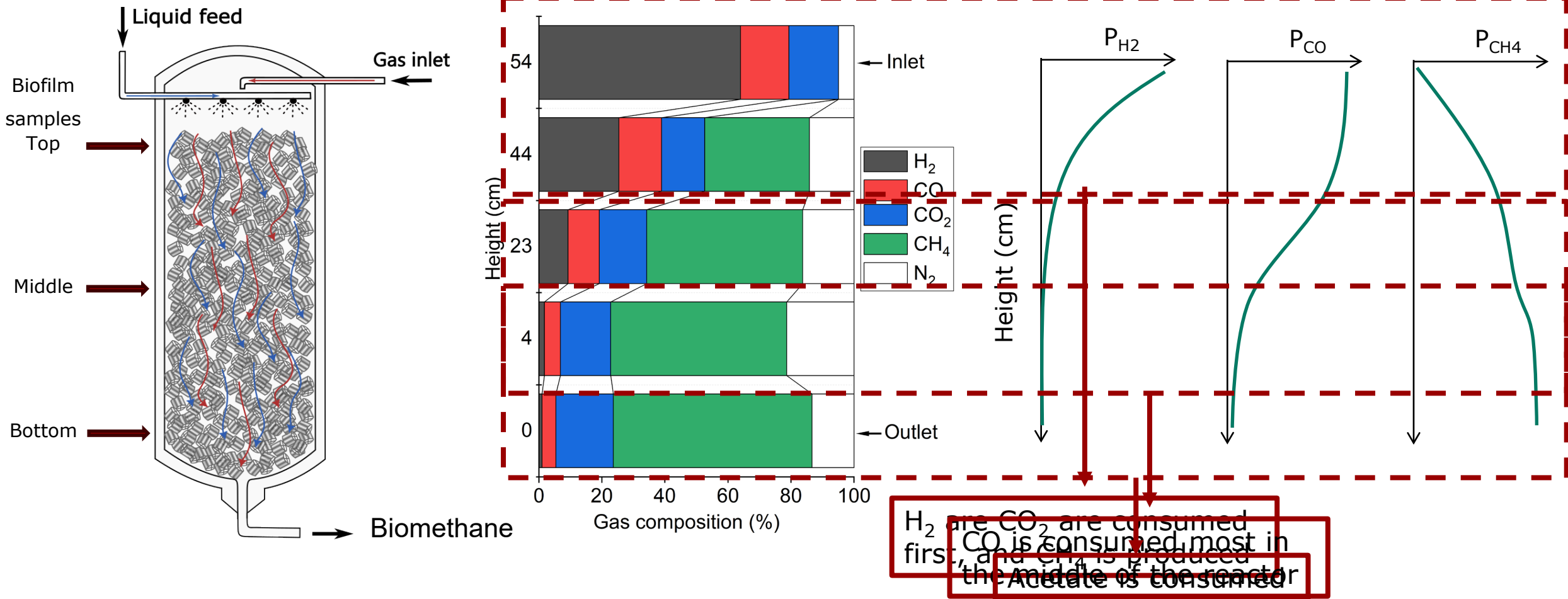


# Spatial distribution of syngas biomethanation reactions

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attention**