

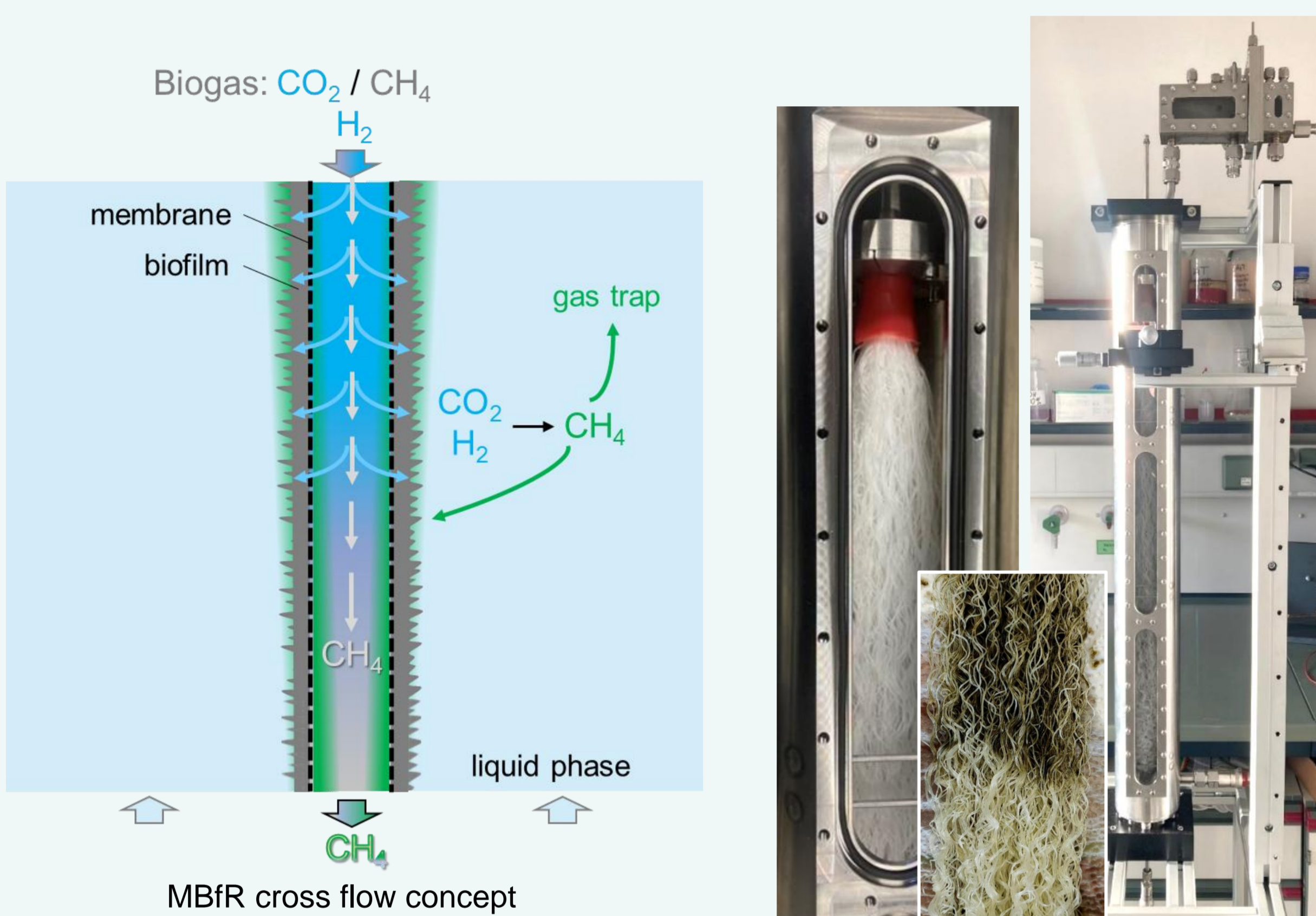
# MBfR-Skal – Scalability of biological biogas upgrading in membrane biofilm reactors

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## Motivation

- The growing demand for biogas requires practical solutions for the treatment of raw biogas or sewage gas in order to meet the grid quality standards (> 95 % methane content).
- Physical-chemical gas separation methods are energy intensive, produce methane losses, and 40 % CO<sub>2</sub> is lost as waste.
- Biological biogas upgrading offers the potential for equimolar methane production of the CO<sub>2</sub> share by providing green hydrogen and using hydrogenotrophic methanogenesis:  $\text{CH}_4 + \text{CO}_2 + 4 \text{H}_2 \longrightarrow \text{CH}_4 + \text{CH}_4 + 2 \text{H}_2\text{O}$
- Membrane biofilm reactors (MBfR) offer a means to overcome the bottleneck of low gas solubility by providing immobilization of a hydrogenotrophic biofilm of archaea on the gas delivering membranes.

## Concept of MBfR in biogas upgrading and impact of membrane material



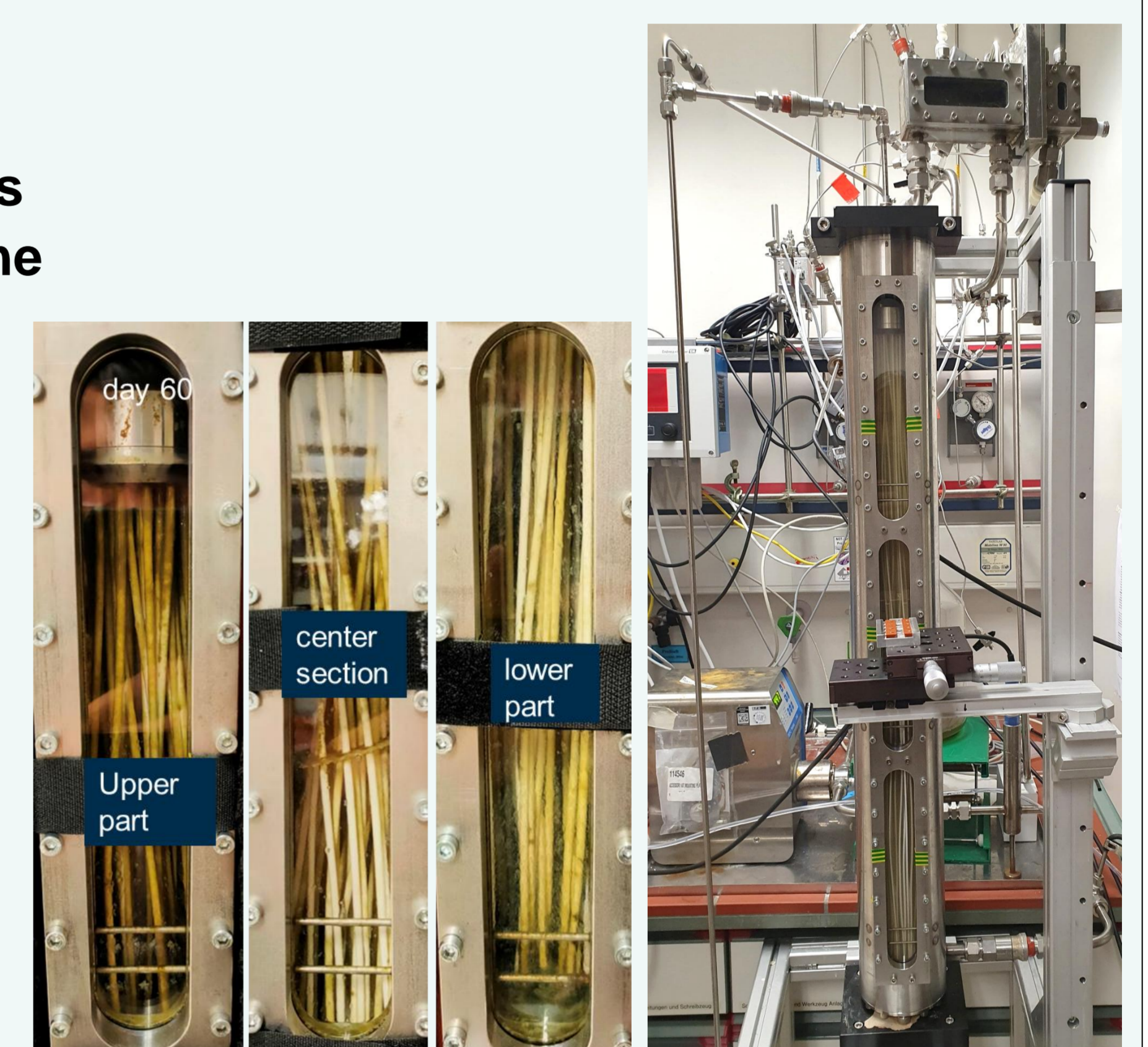
MBfR with dense silicone hollow-fibre membranes (left: bare, middle after months of cultivation)

dense silicone ↔ microporous polypropylene

max. methane production rates  
5.2 NL m<sup>-2</sup> d<sup>-1</sup> ↔ 25 NL m<sup>-2</sup> d<sup>-1</sup>

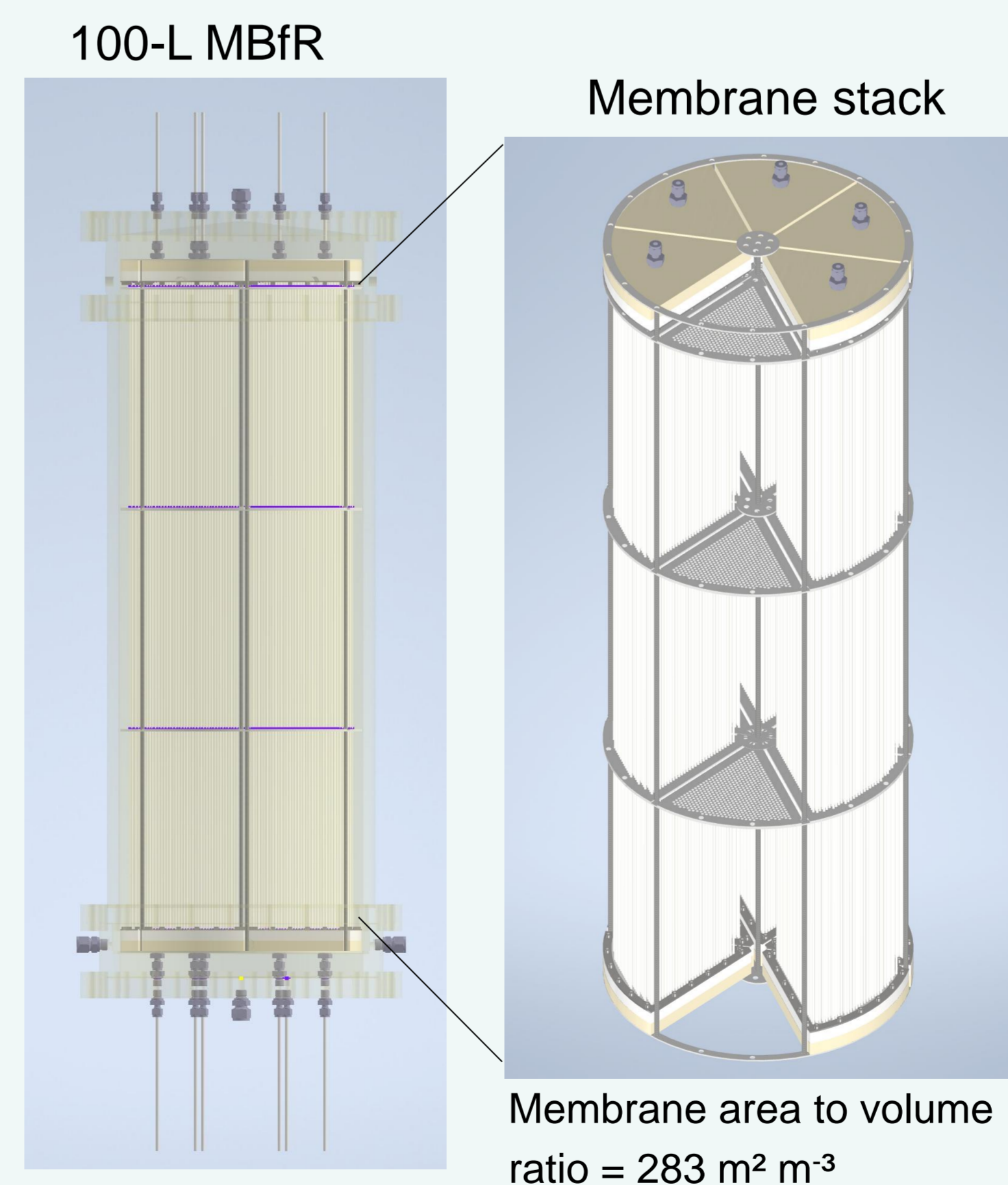
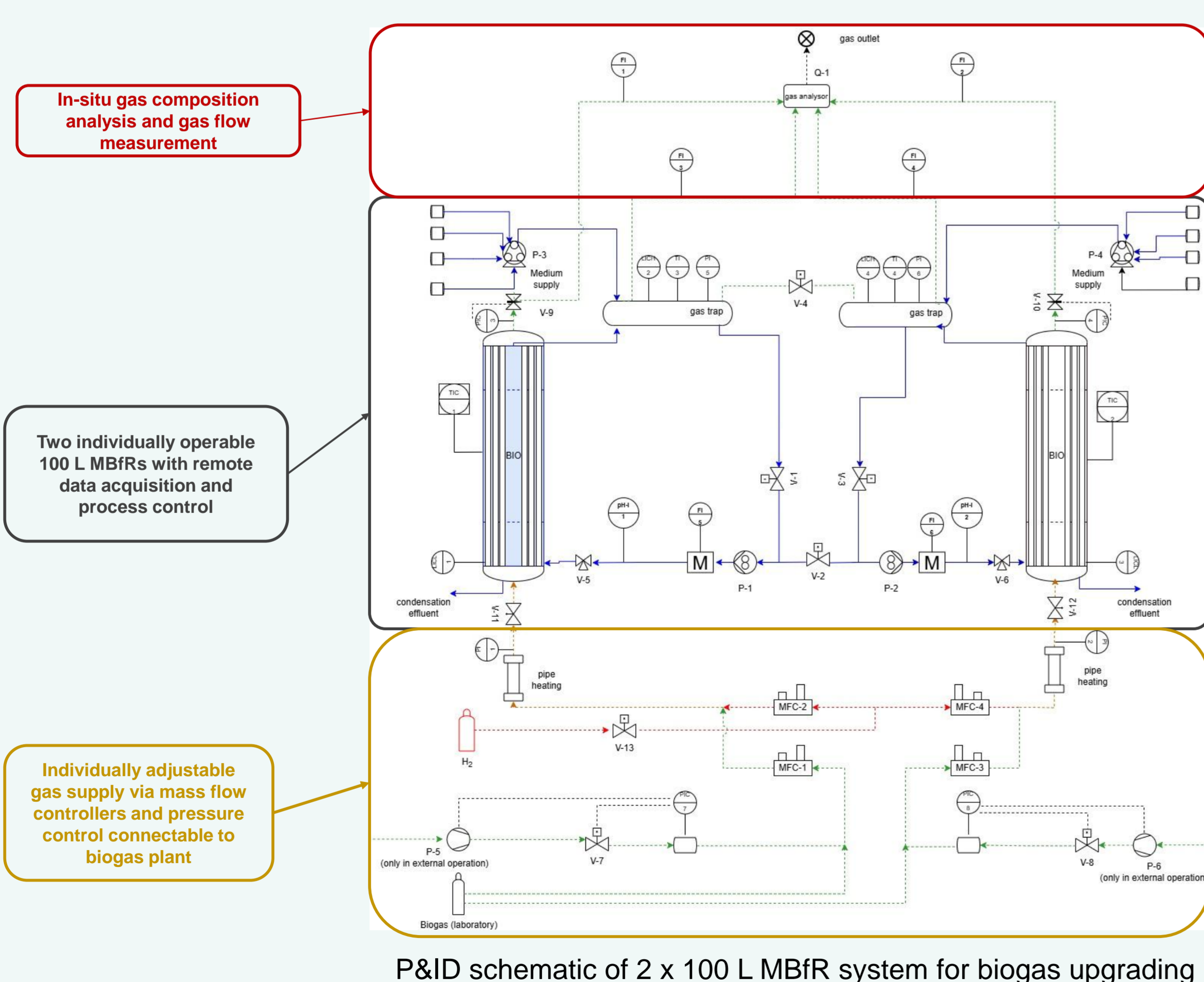
biofilm formation  
poor ↔ good

max. gas quality (CH<sub>4</sub>)  
80 - 85 % ↔ > 95 %

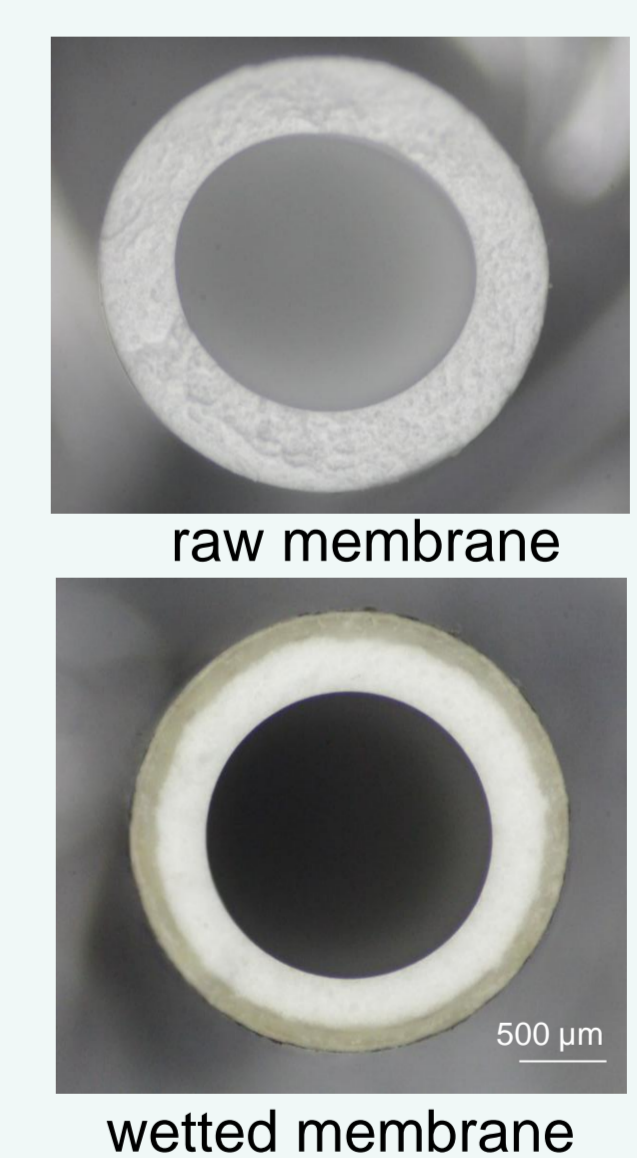


MBfR with microporous polypropylene capillary membranes (left: after 60 days of cultivation)

## MBfR upscale from 3.5 to 100 L



## Membrane wetting



mitigation strategies under investigation:

- membrane coating
- pressurized operation
- intermittent membrane drying

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