



MATHEMATICAL MODELLING OF OXYGEN MEMBRANE REACTORS

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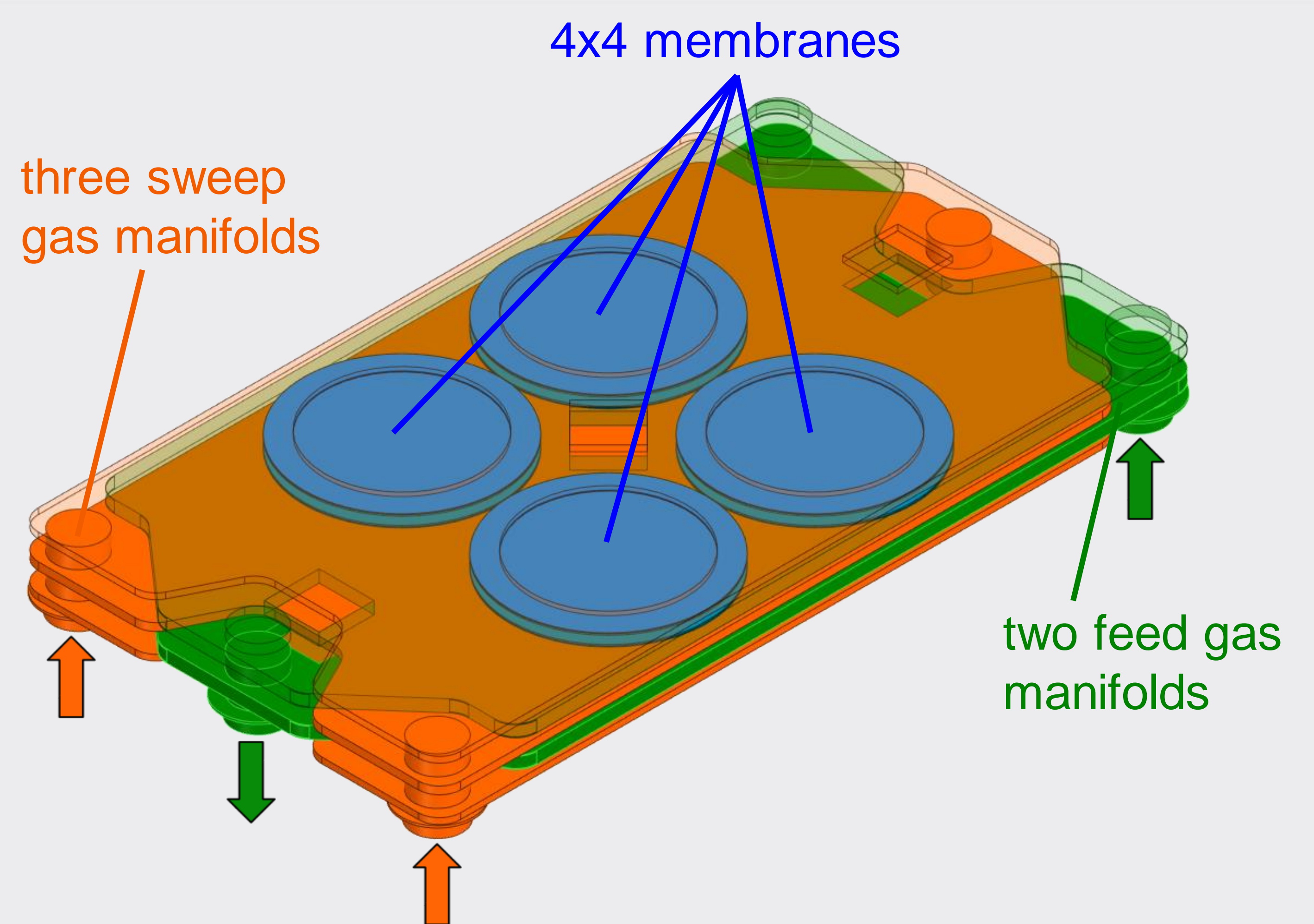
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DESCRIPTION

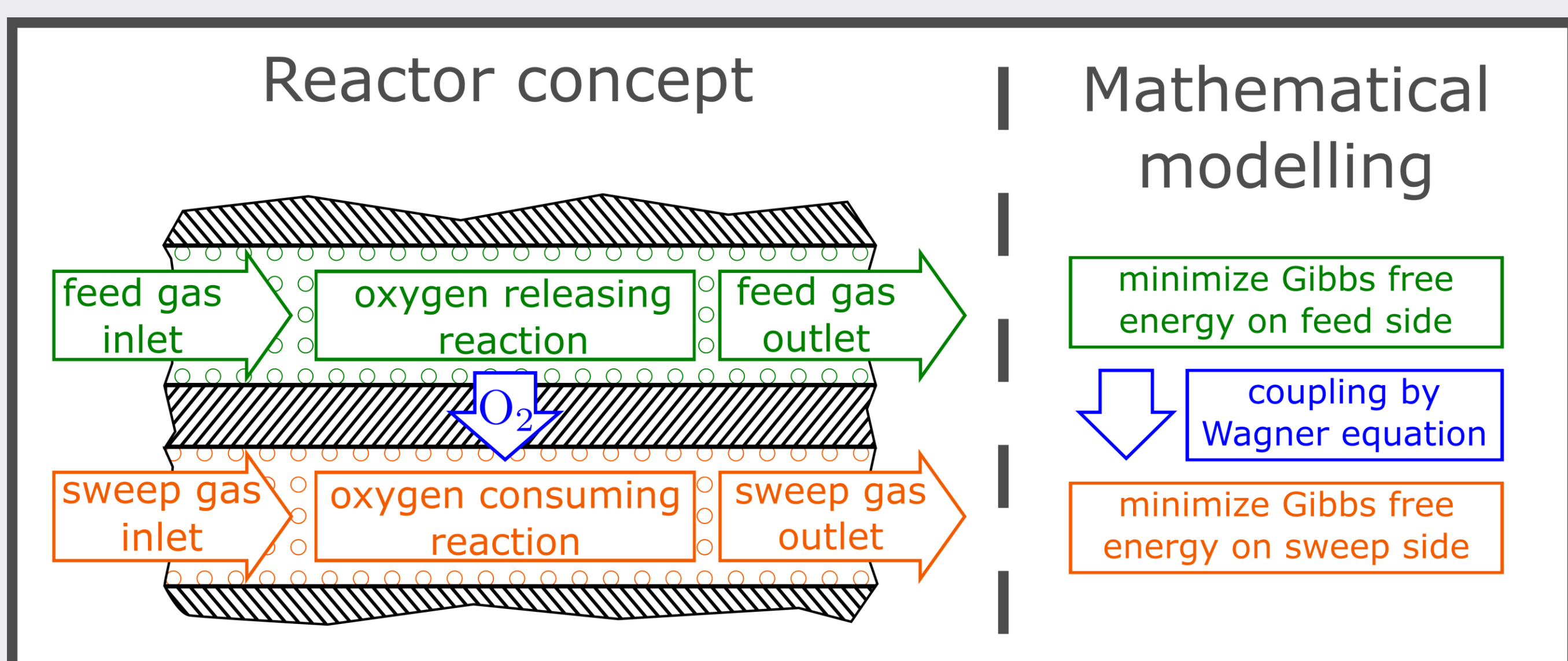
In oxygen membrane reactors, two gas chambers are separated by a semipermeable oxygen membrane, which allows **oxygen transport from the feed side**, where oxygen can be released by chemical reactions, to the **sweep side**, where oxygen can be consumed.

To assess the viability of **new chemical processes** based on this concept, a **generalized mathematical model** was **developed** and successfully **validated against experimental data** from the literature.

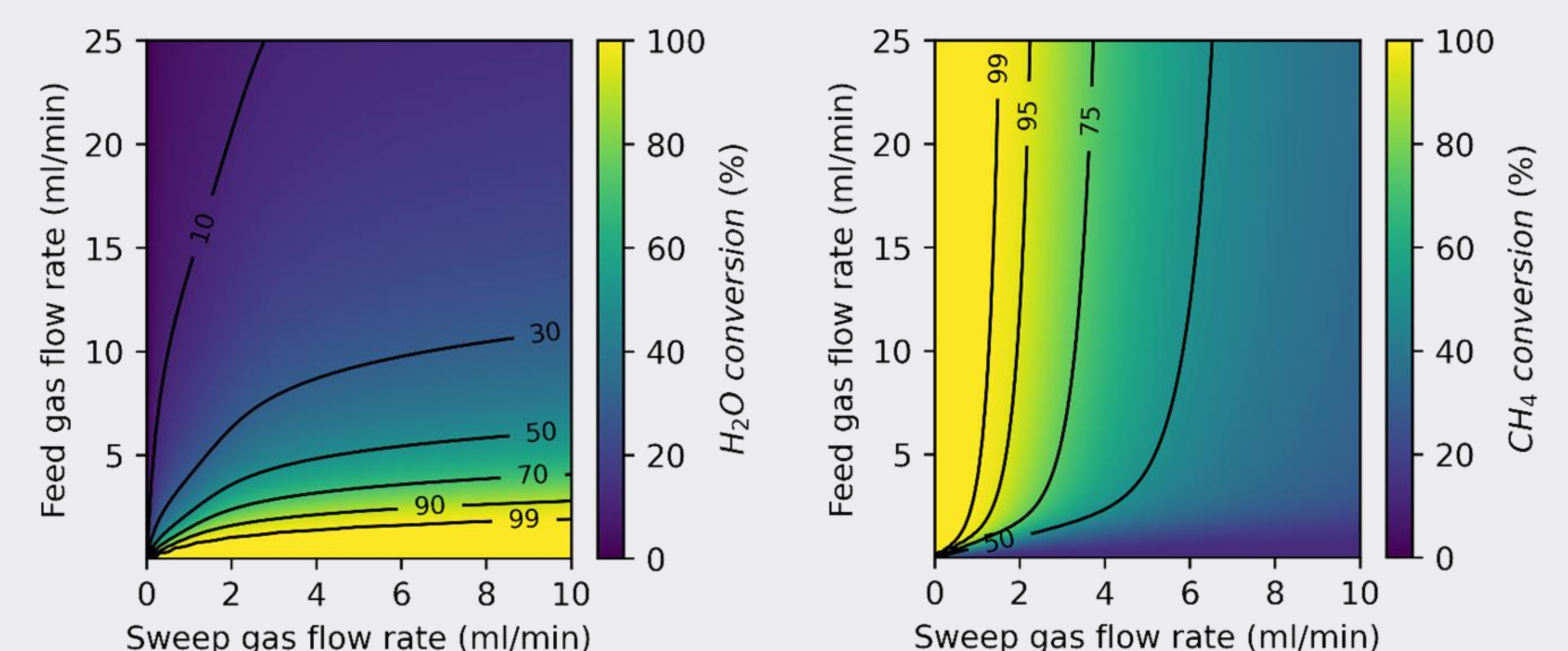
It is suitable for membrane reactor design where chemical reactions and diffusion in the gas chambers are fast compared to the oxygen transport through the membrane.



Gas manifolds of the membrane reactor prototype with about 160 cm² active membrane area



Generalized membrane reactor modelling approach

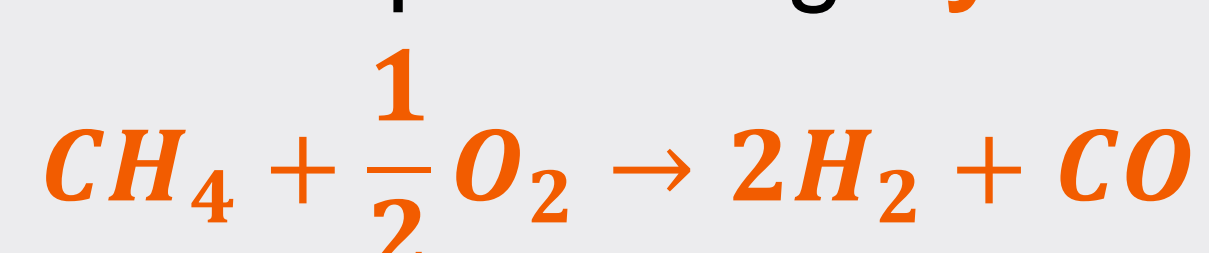


Steam and methane conversion for 1 cm² active membrane area at 850 °C

SIMULTANEOUS PRODUCTION OF HYDROGEN AND SYNTHESIS GAS

One exemplary process that can be implemented is the coupling of the **water splitting** with **partial oxidation of methane**.

On the **sweep side** of the membrane oxygen is consumed by methane producing **synthesis gas**:



The process was investigated in detail to define **suitable gas flow rates** for a reactor prototype using the developed model.

FUTURE OPPORTUNITIES

The developed model allows a **straight-forward assessment of new chemical processes**.

It is in particular suitable for **feasibility studies**, **first design iterations** as well as **sensitivity studies**.

The **scalability for industrial applications** of these new chemical processes can be validated experimentally using the designed prototype.

By developing a **computational fluid dynamics** model, the **geometry** of the prototype can be **optimized**.