



MEMBRANE AND MEMBRANE ASSISTED LIQUEFACTION PROCESSES FOR CO₂ CAPTURE FROM CEMENT PLANTS



Melbourne, Australia

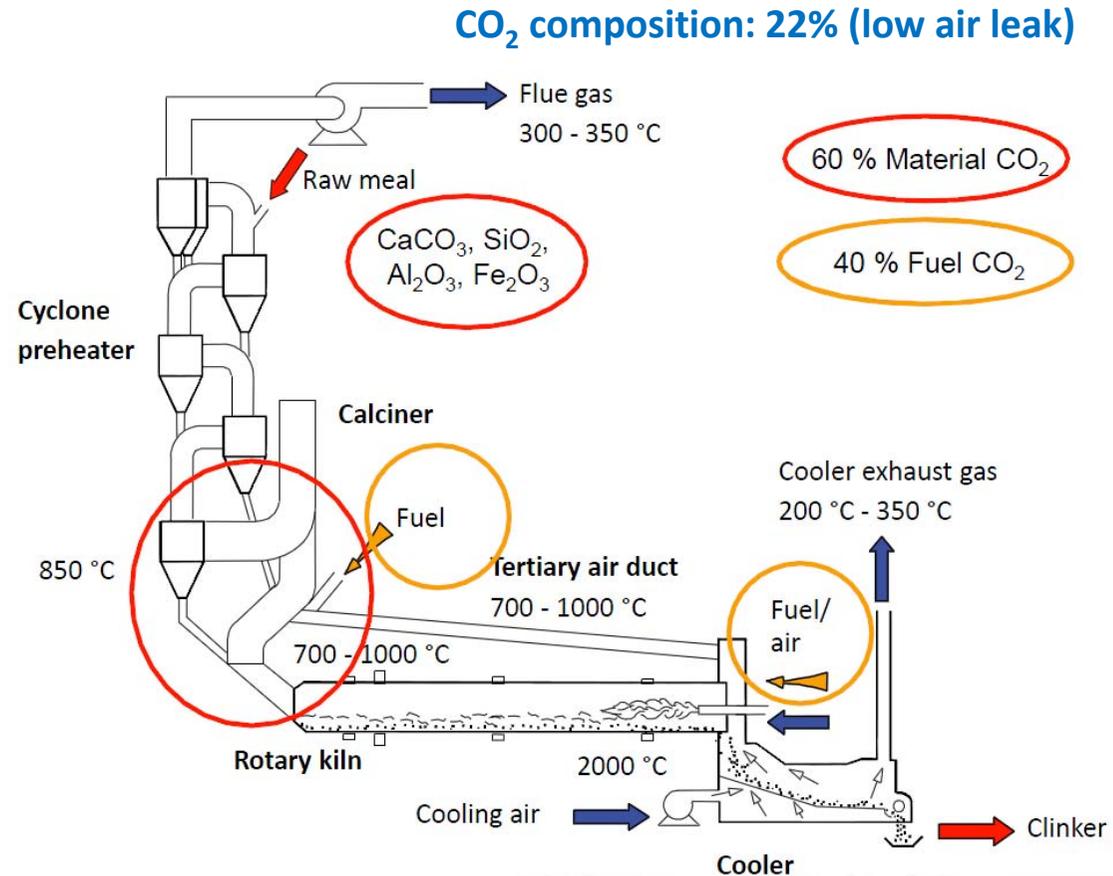
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Rahul Anantharaman and David Berstad

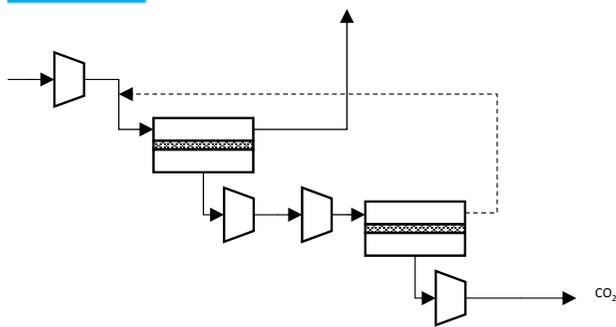
SINTEF Energy Research

Background

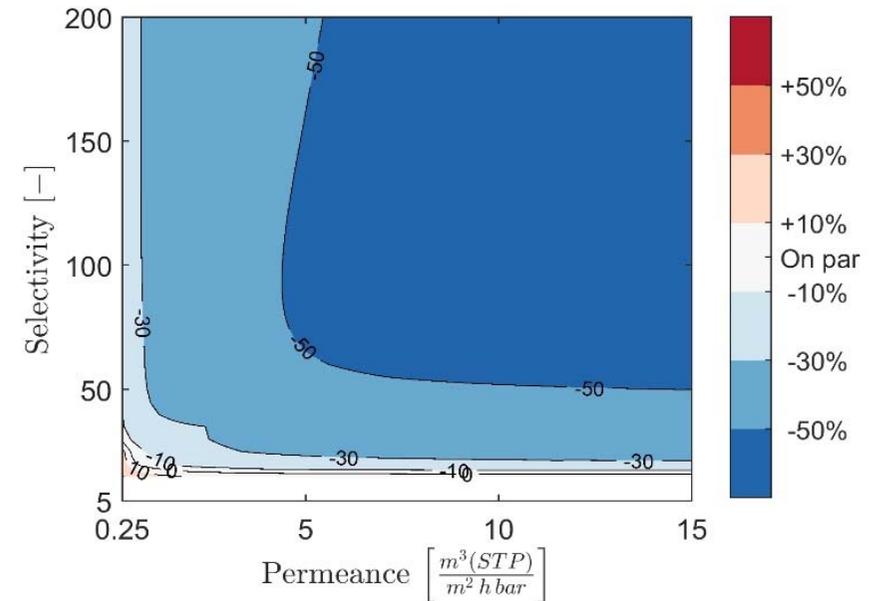
- 6-7% of global anthropogenic CO₂ emissions from the cement industry
- CO₂ emissions an inherent part of the cement production process



Membranes processes and their applicability in cement plants



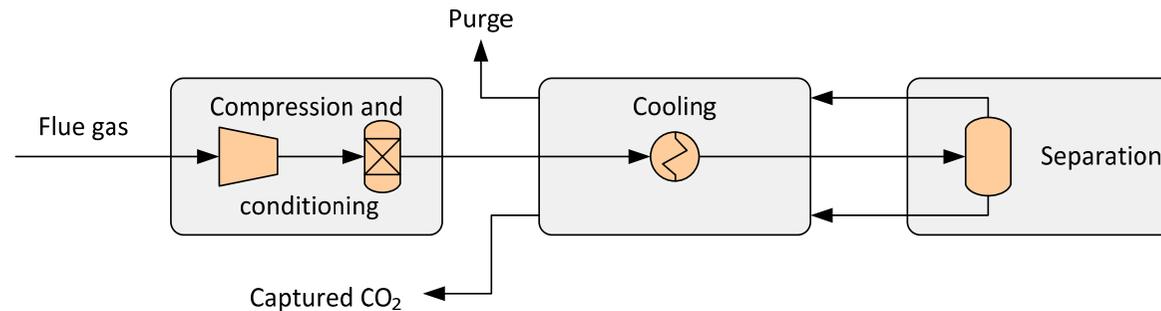
- Low environmental impact
- Ease of integration (no steam required in the process)
- Compact process
- Membrane separation processes favour high CO₂ partial pressure



Cost of membrane-based CO₂ capture compared to post-combustion MEA-based capture at a 90% CCR depending on the membrane properties for cement plant

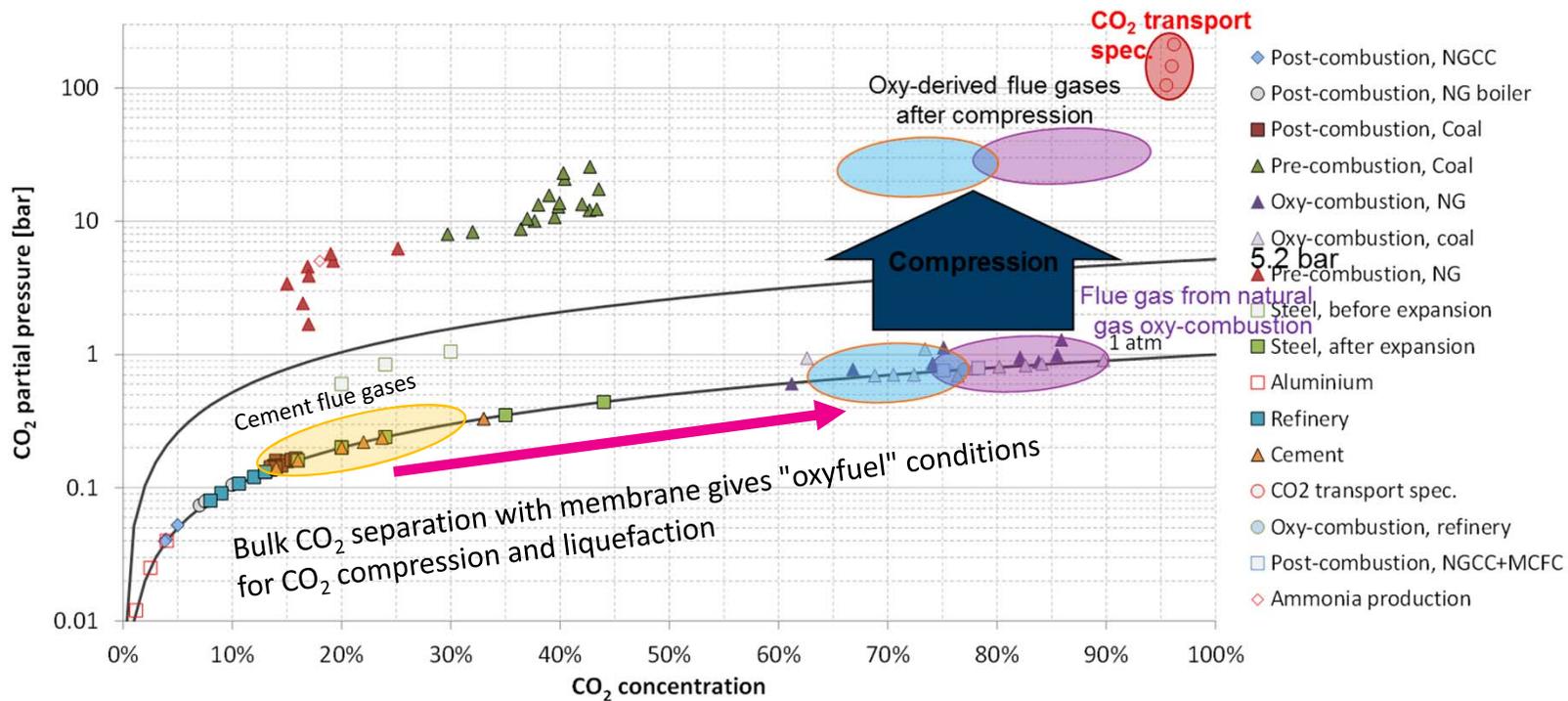
Roussanaly, S. *et al.* (2018) 'A new approach to the identification of high-potential materials for cost-efficient membrane-based post-combustion CO₂ capture', *Sustainable Energy & Fuels*.

CO₂ liquefaction process

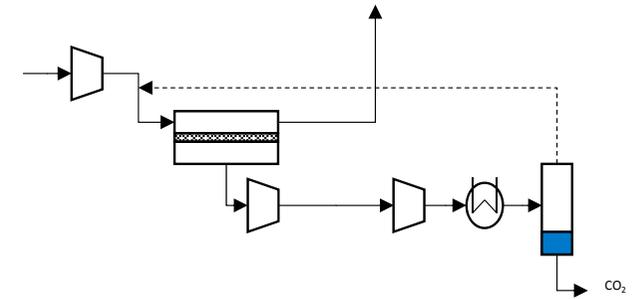
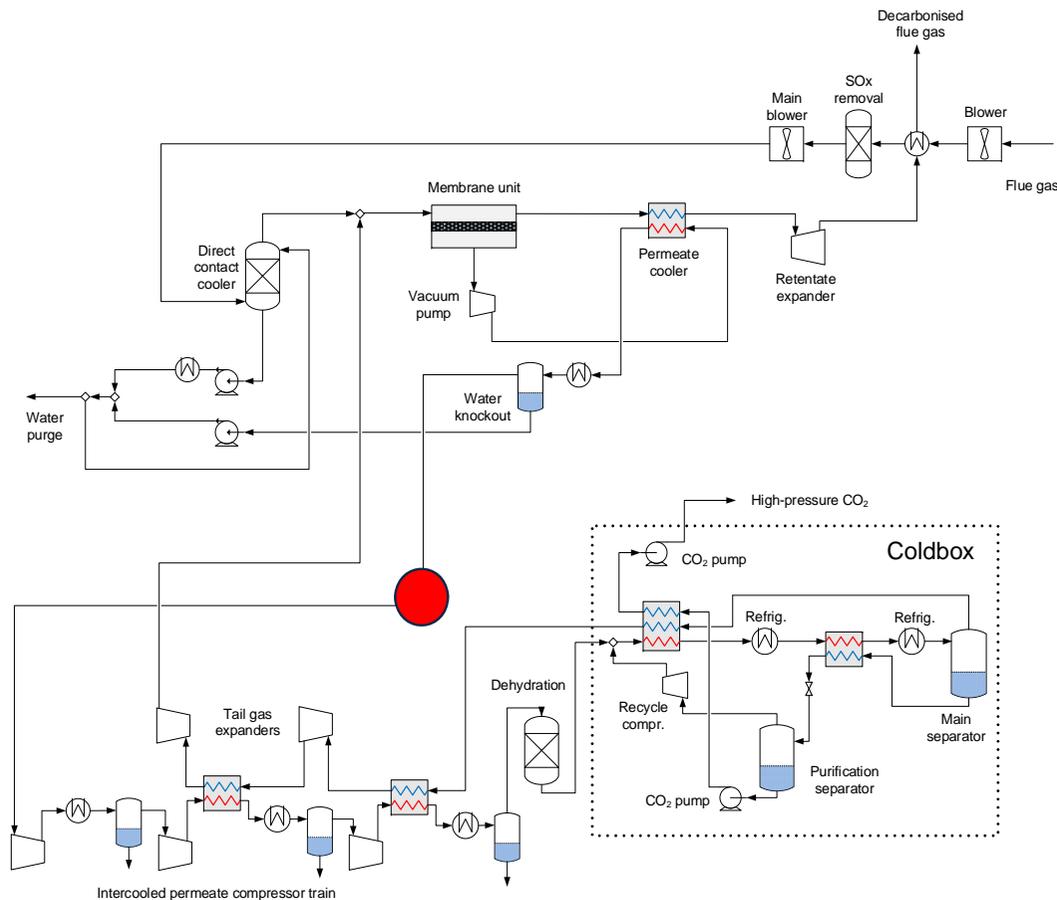


- No chemicals
 - Separation by phase change
- Flexible process
 - CO₂ product at conditions suitable for ship or pipeline transport
- Compact
 - CO₂ capture at high pressure
- Used as standard for oxy-combustion processes

Is there a role for CO₂ liquefaction in post-combustion capture from cement?



Membrane assisted liquefaction



CO₂ concentration at the interface is important

- Affects CO₂ capture ratio
- Affects amount of recycle to membrane
- Membrane area
- Vacuum pump size and work

CO₂ concentration at interface depends on

- Membrane type
- Pressure differential across membrane
- Membrane area

Membrane assisted liquefaction

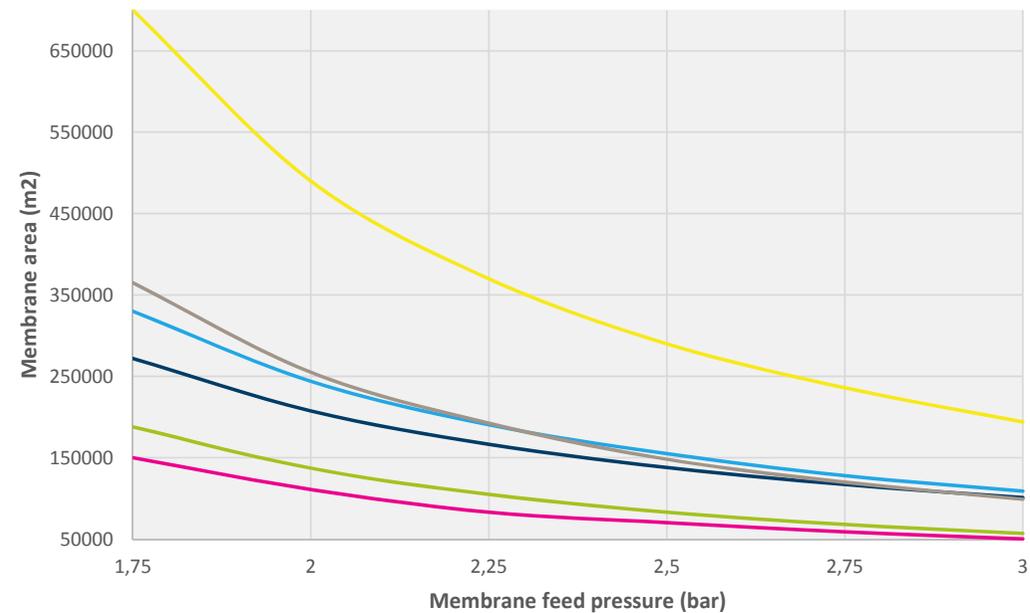
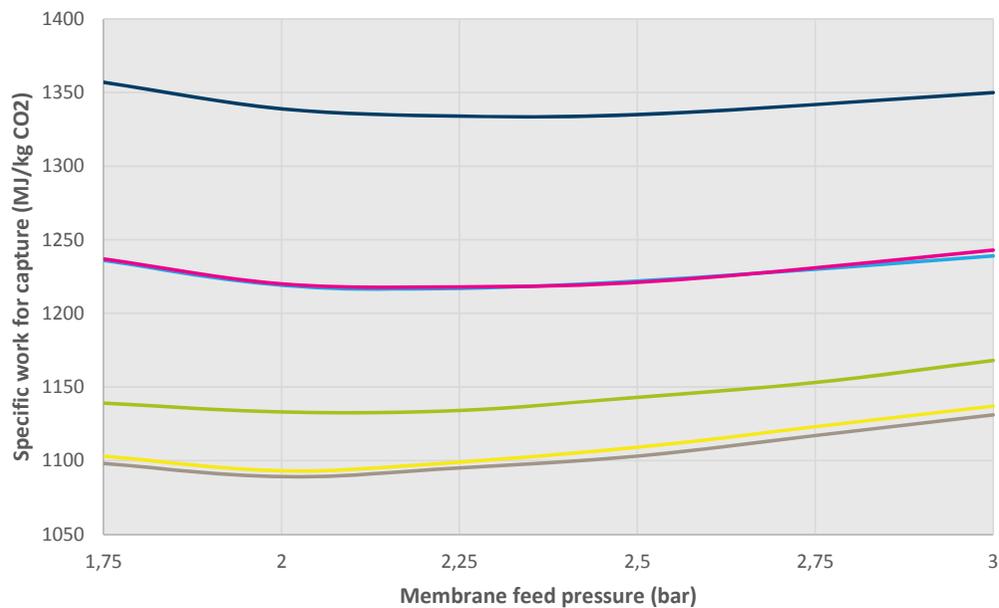
From CEMCAP cost estimation

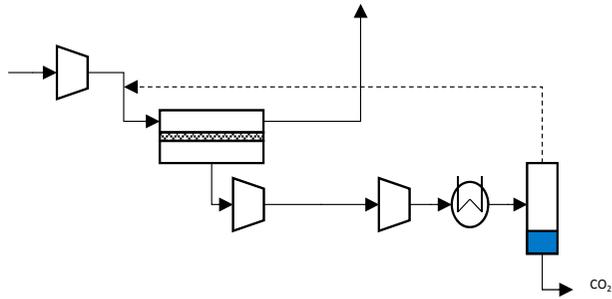
- Around 60% of total direct cost of the MAL process is due to the membrane process
- Membrane itself, the vacuum pump and the flue gas compressor stand out as the most expensive pieces of equipment
- These three together account for around 80% of the membrane part costs, or 46% of the total direct costs
- Membrane accounts for 9% of the total direct cost

Membranes considered

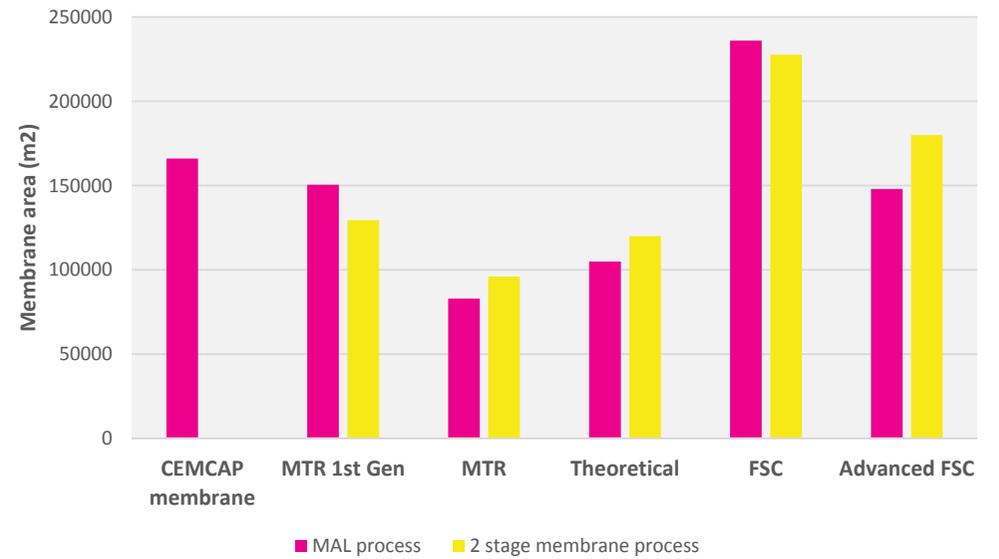
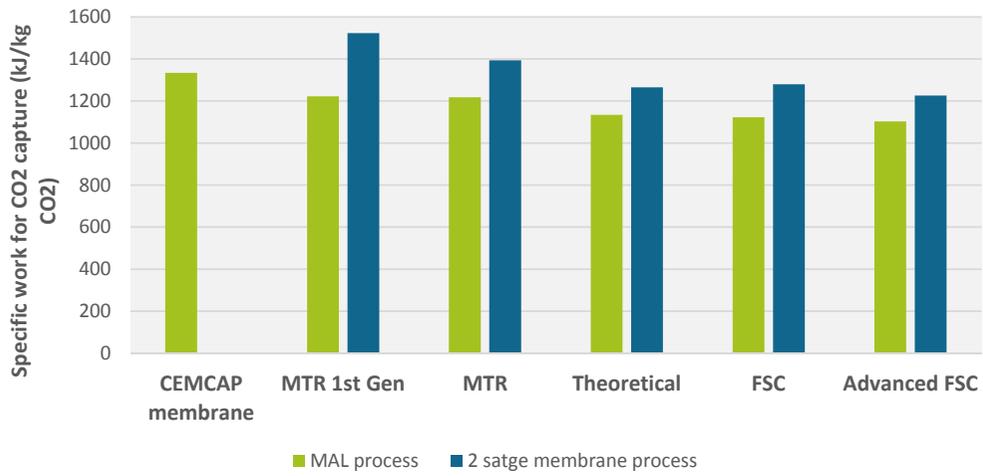
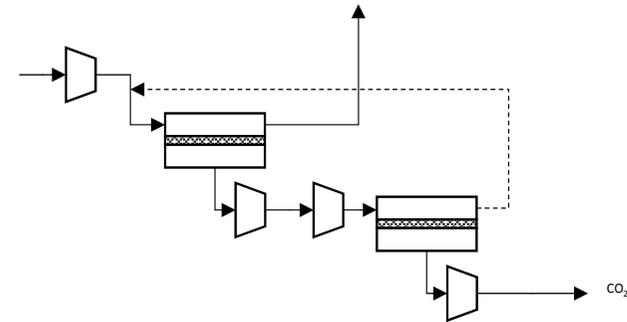
	Membrane in CEMCAP work
CO ₂ permeance (Sm ³ /m ² .bar.h)	2.7
N ₂ selectivity	20
O ₂ selectivity	26
H ₂ O selectivity	20

Membrane assisted liquefaction process performance





VS



Summary

- Membrane assisted liquefaction process performance and cost is will vary significantly with membrane performance
- Critical to identify suitable membrane properties for the process for a given flue gas composition
- Membrane assisted liquefaction outperforms the 2 stage membrane process for post-combustion CO₂ capture
 - Thermodynamic proof irrespective of membrane type or performance (not included in this presentation)
- Techno-economic analysis of membrane processes presented in this work will be performed and compared

Acknowledgements

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