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# *Predicting solvent loss in a membrane contactor for CO2 capture*

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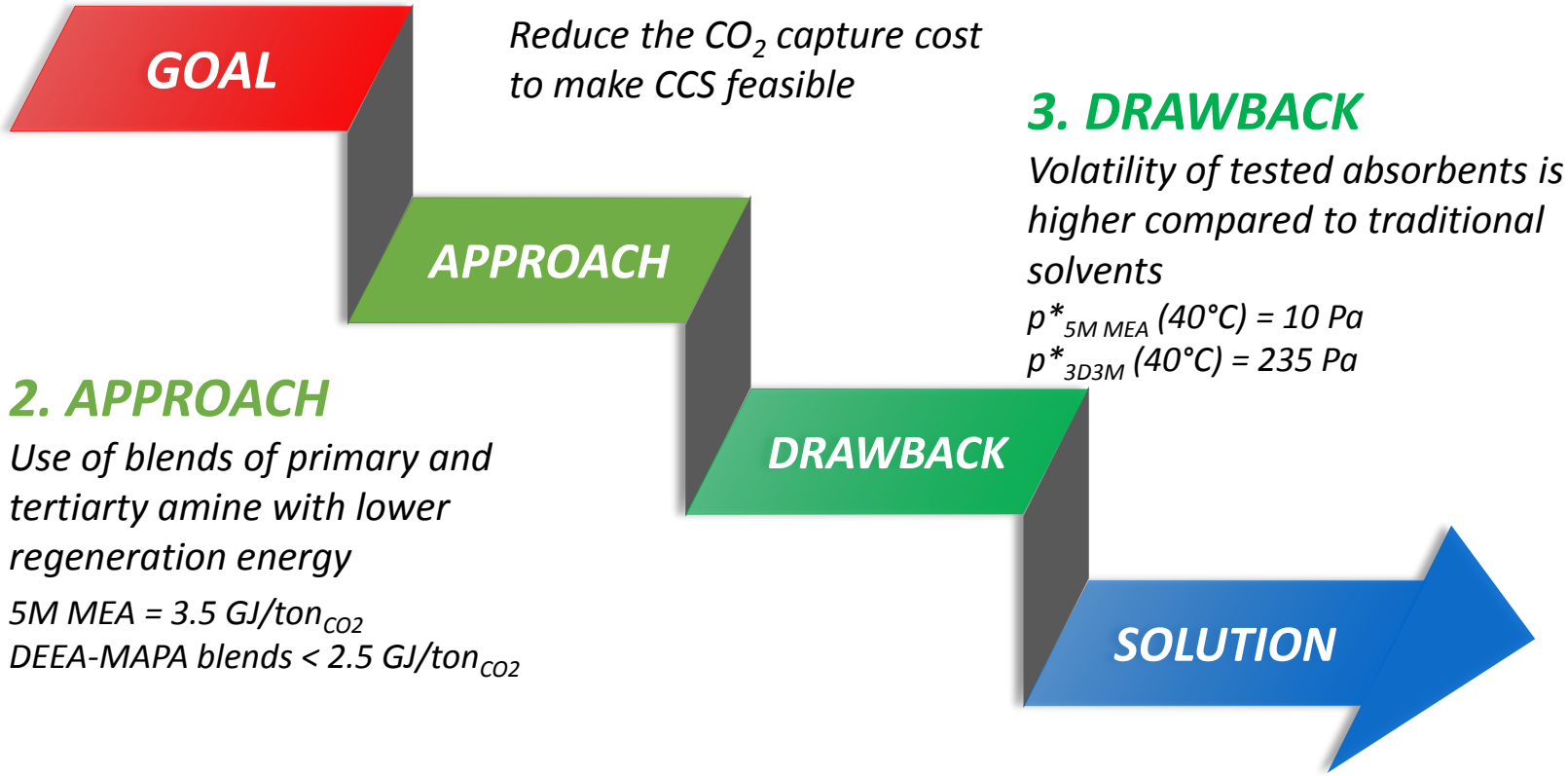
The Research Council of Norway

CLIMIT
NEW CONCEPTS FOR $CO_2$ CAPTURE

# Outline

- 3GMC Project
- Membrane contactor basics
- Model description
- Model results
- Conclusion

# 3GMC Project




### 1. GOAL

*Reduce the $CO_2$ capture cost to make CCS feasible*

### 2. APPROACH

*Use of blends of primary and tertiarty amine with lower regeneration energy*

*5M MEA = 3.5 GJ/ton$_{CO2}$*
*DEEA-MAPA blends < 2.5 GJ/ton$_{CO2}$*

### 3. DRAWBACK

*Volatility of tested absorbents is higher compared to traditional solvents*

*$p^*_{5M\ MEA}$ (40°C) = 10 Pa*
*$p^*_{3D3M}$ (40°C) = 235 Pa*

### 4. SOLUTION

*Use of **MEMBRANE CONTACTOR** technology using **NON-POROUS MEMBRANE***

# Membrane contactor basics

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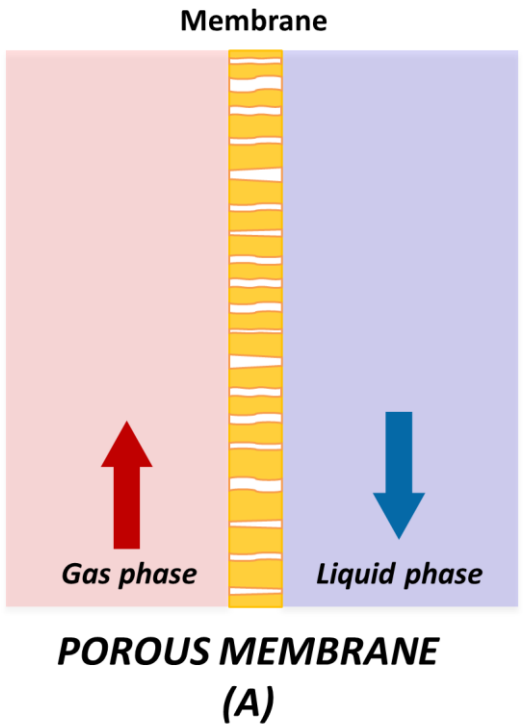
A membrane contactor is a system where a membrane is used as interface between the gas and the liquid phase, increasing the interface area, which becomes also independent from the operating conditions.



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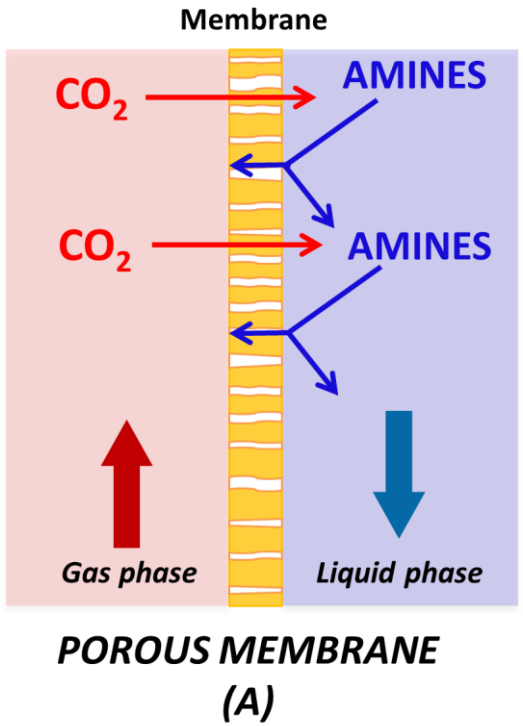

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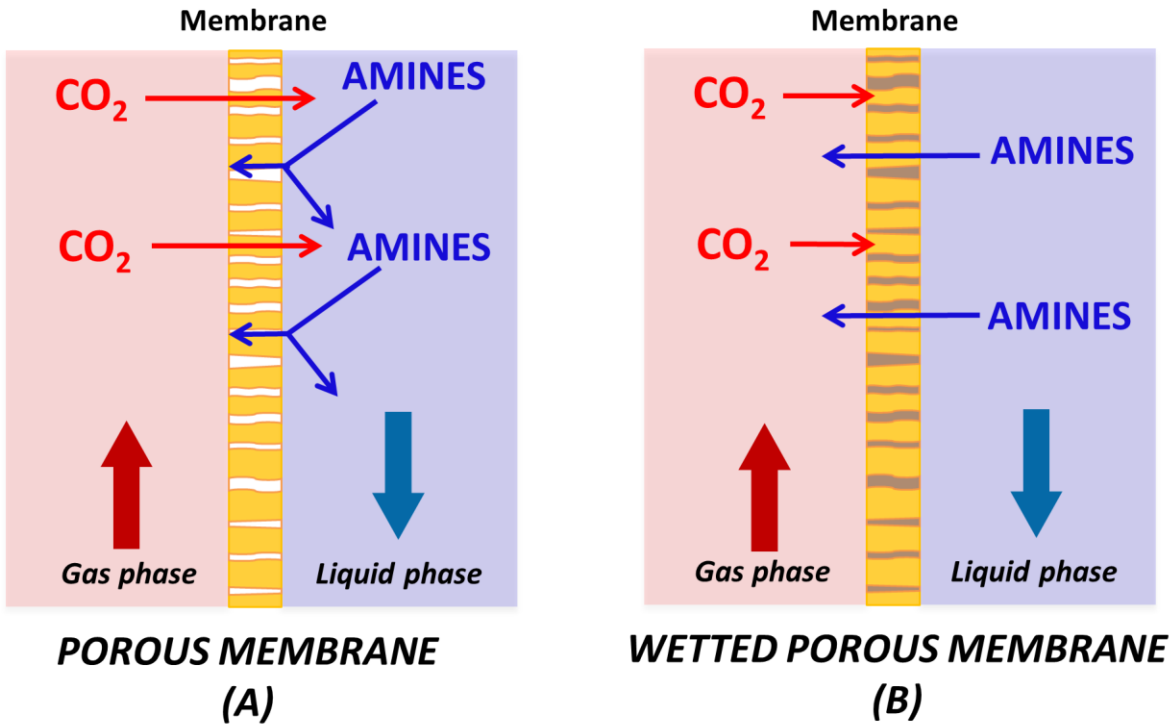

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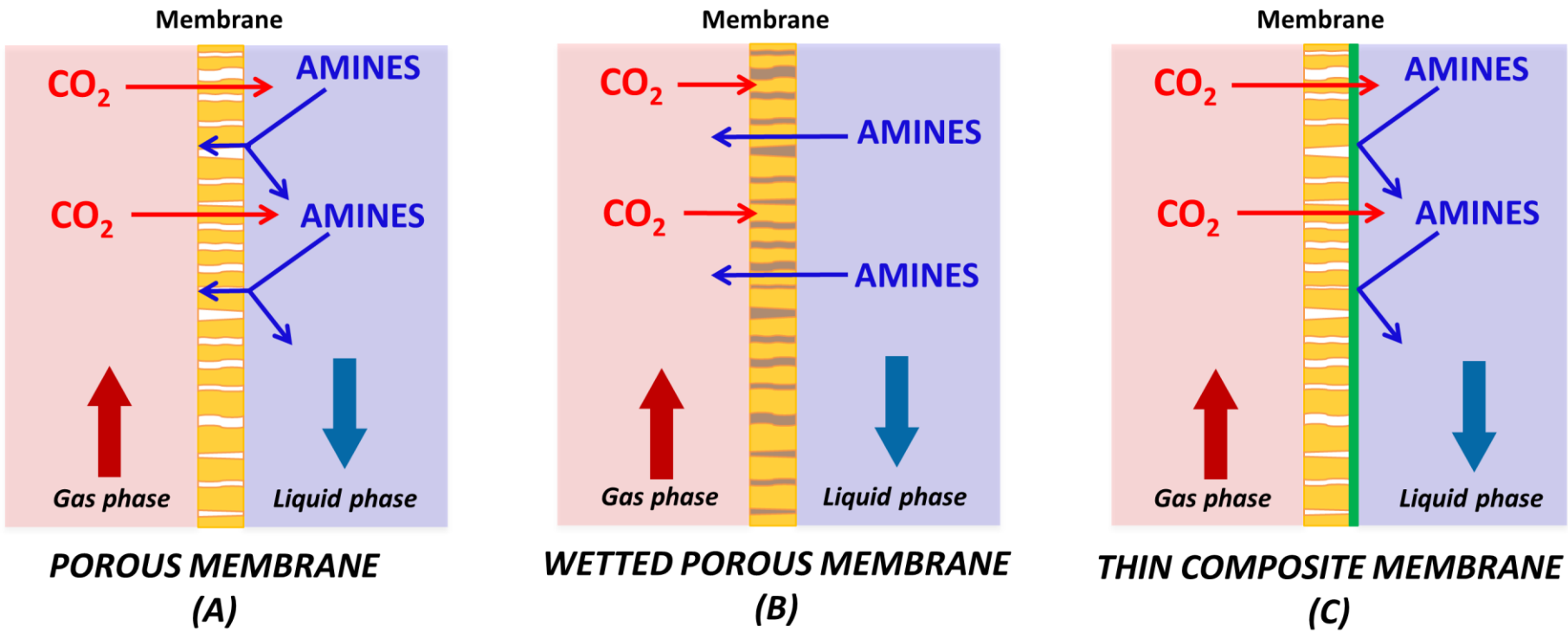


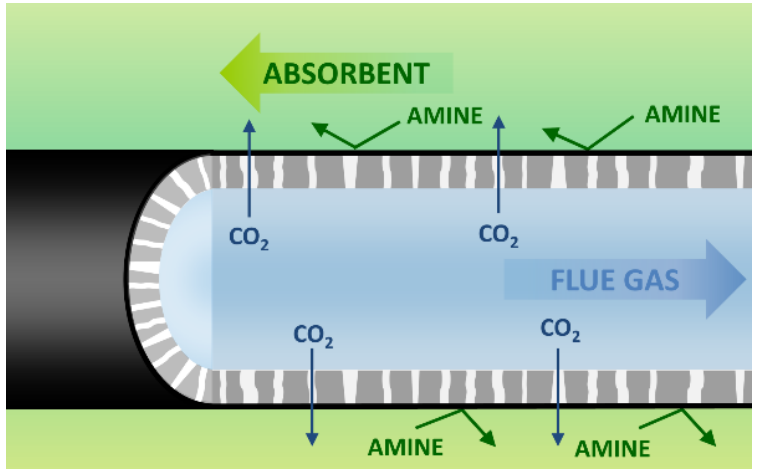
# Membrane contactor basics

## *NON-POROUS MEMBRANE CONTACTOR*

***THIN COMPOSITE MEMBRANE***

- *Chemically stable to solvent*
- *Ensure high $CO_2$ flux*
- *Barrier for the amines*

*Patent WO 2017055615 A1*




## ***POSITIVE IMPACTS*** *(compared to traditional technologies)*

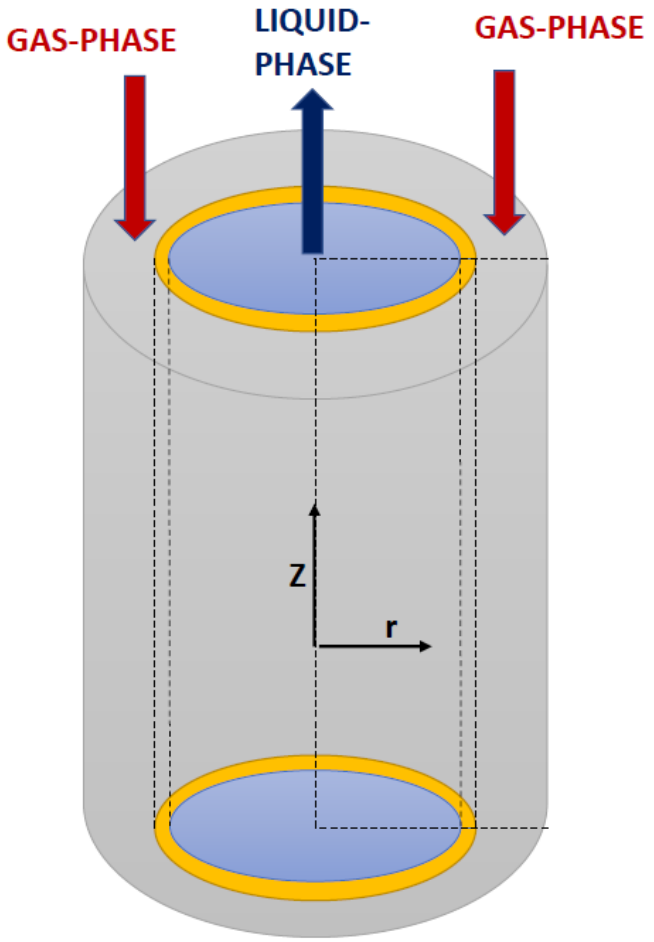
1. ***Prevention of liquid penetration in the pores***
2. ***Reduction of amine emissions (evaporation and mist)***
3. ***Larger packing density, easier process scalability, simpler operability***

# Model development

# Case: 5M MEA – 800MWe

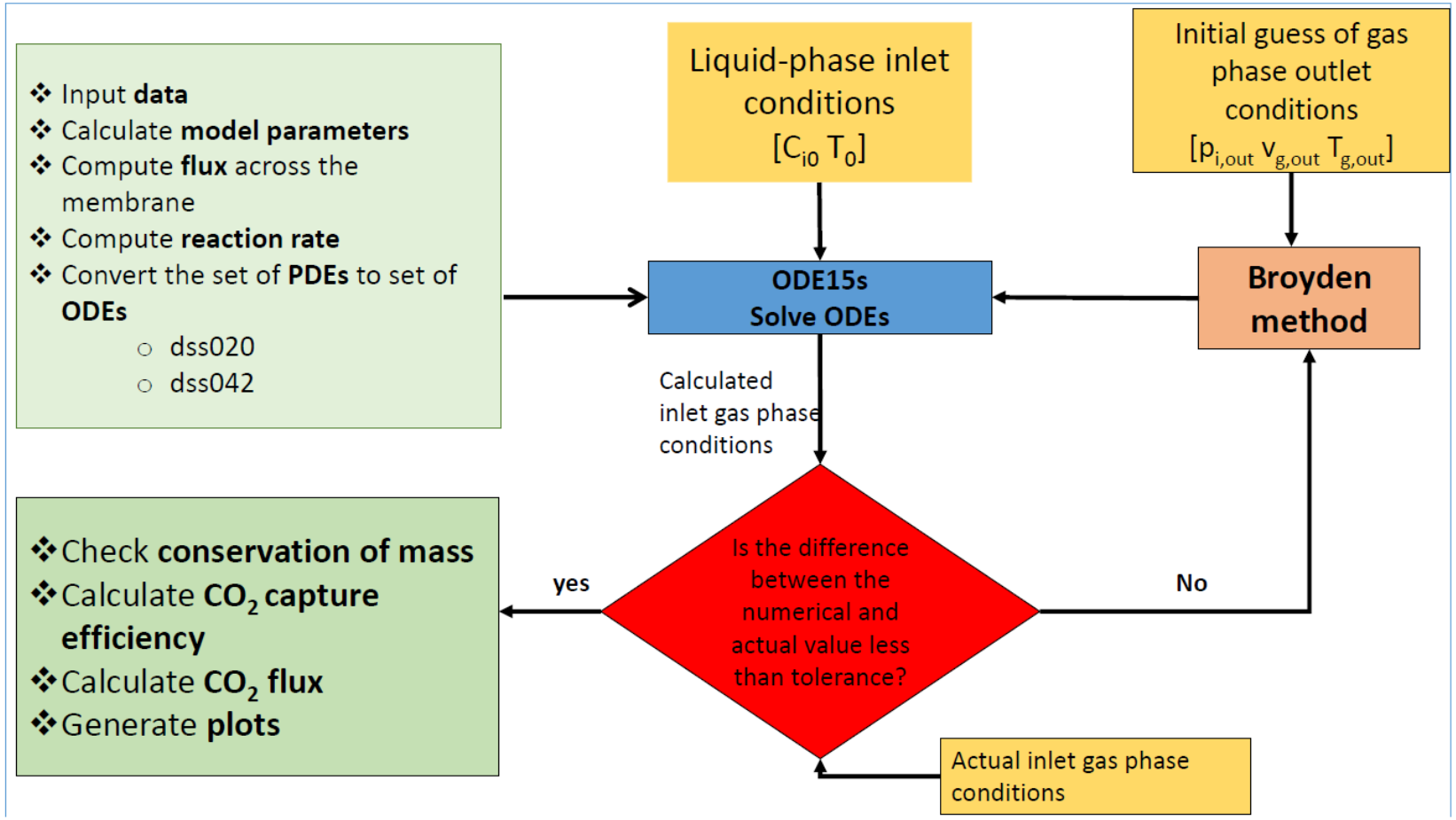
| Gas composition | Partial pressure [kPa] |
|---|---|
| $CO_2$ | 13.61 |
| $H_2O$ | 12.09 |
| $N_2$ | 72.24 |
| $O_2$ | 3.66 |

| | |
|---|---|
| **Total pressure** | **101.6 [kPa]** |
| **Gas flow** | **680 $m^3/s$ [kPa]** |
| **Liquid flow** | **3.46 $m^3/s$ [kPa]** |




Case from Kimball et al. (2014)

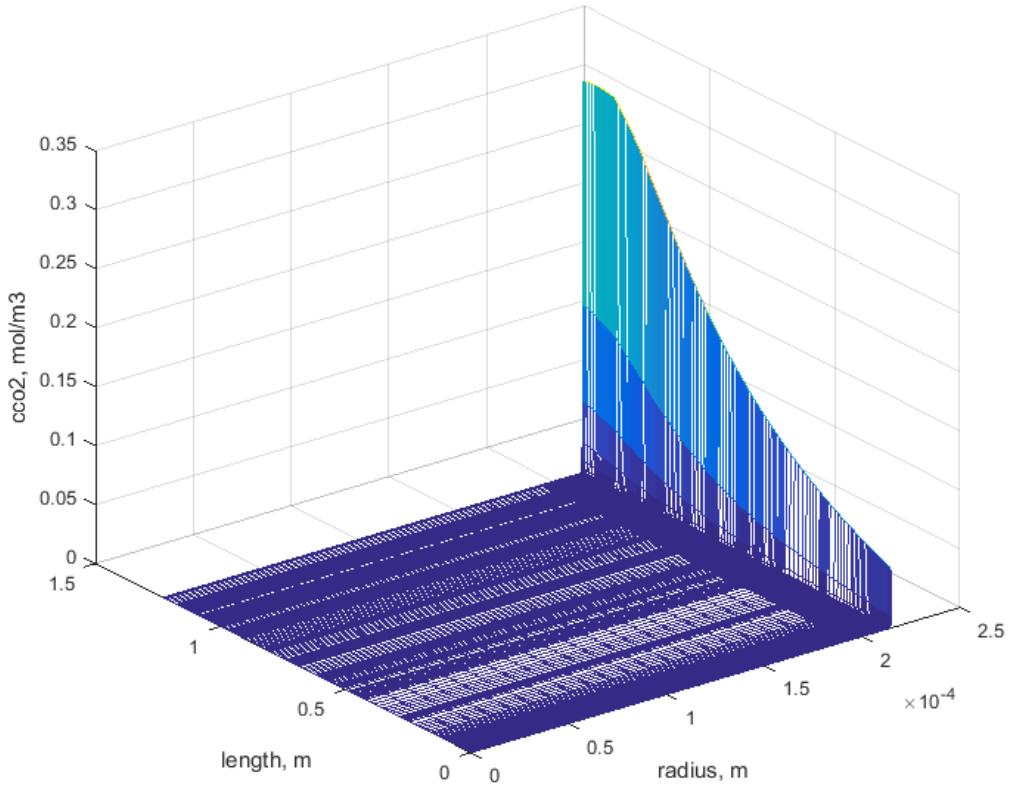
# Model description

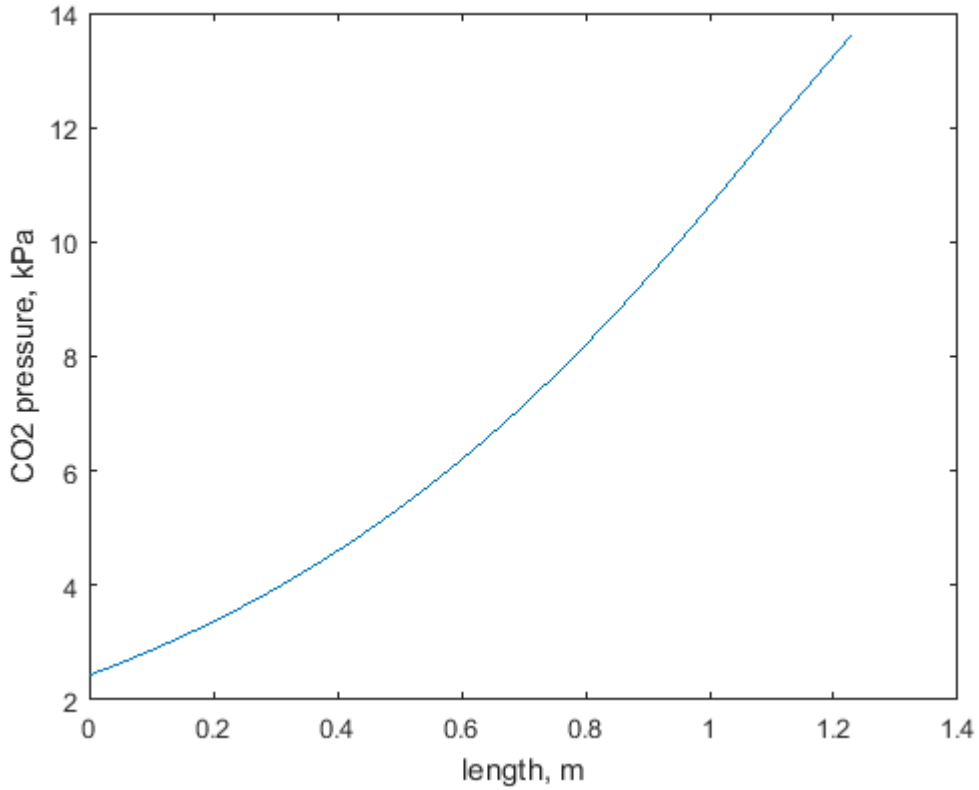



Adapted from Gebremariam, Solomon Kahsay , Msc. thesis.

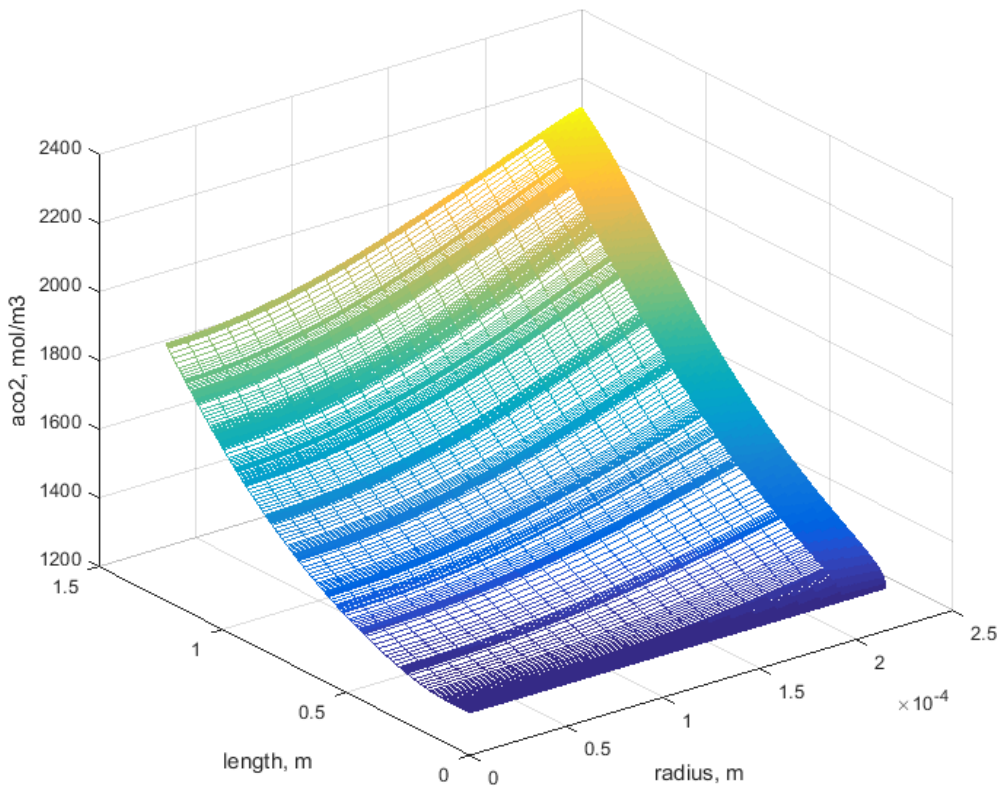
# Results

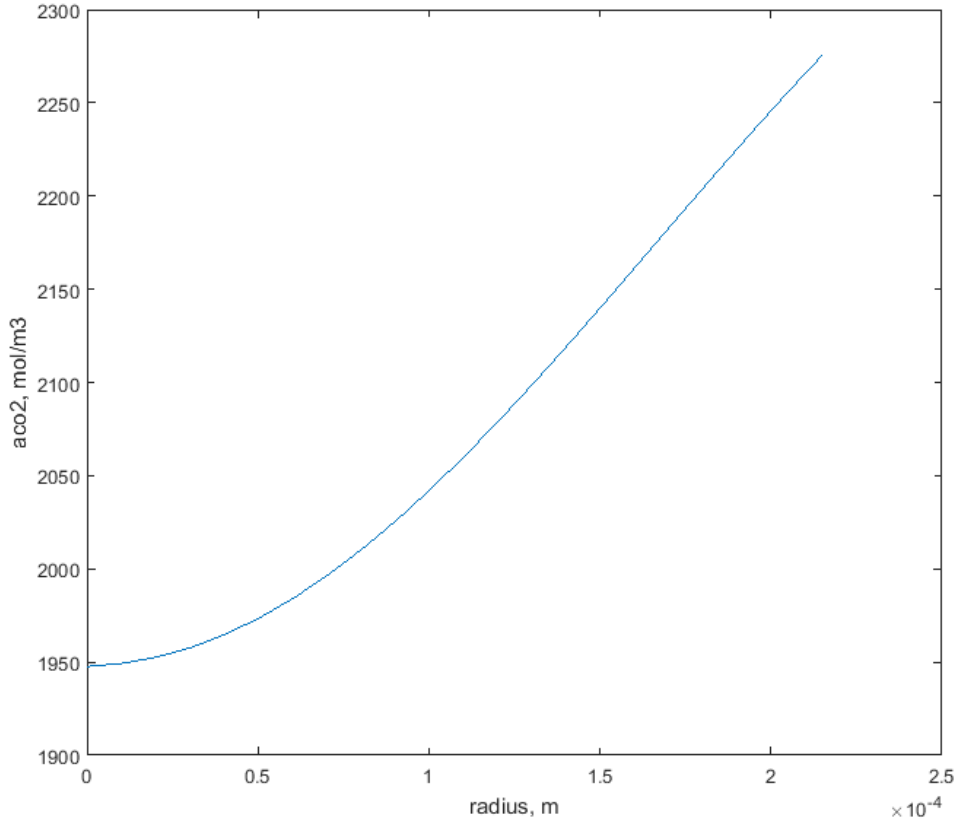
# Free $CO_2$ concentration liquid and gas phase



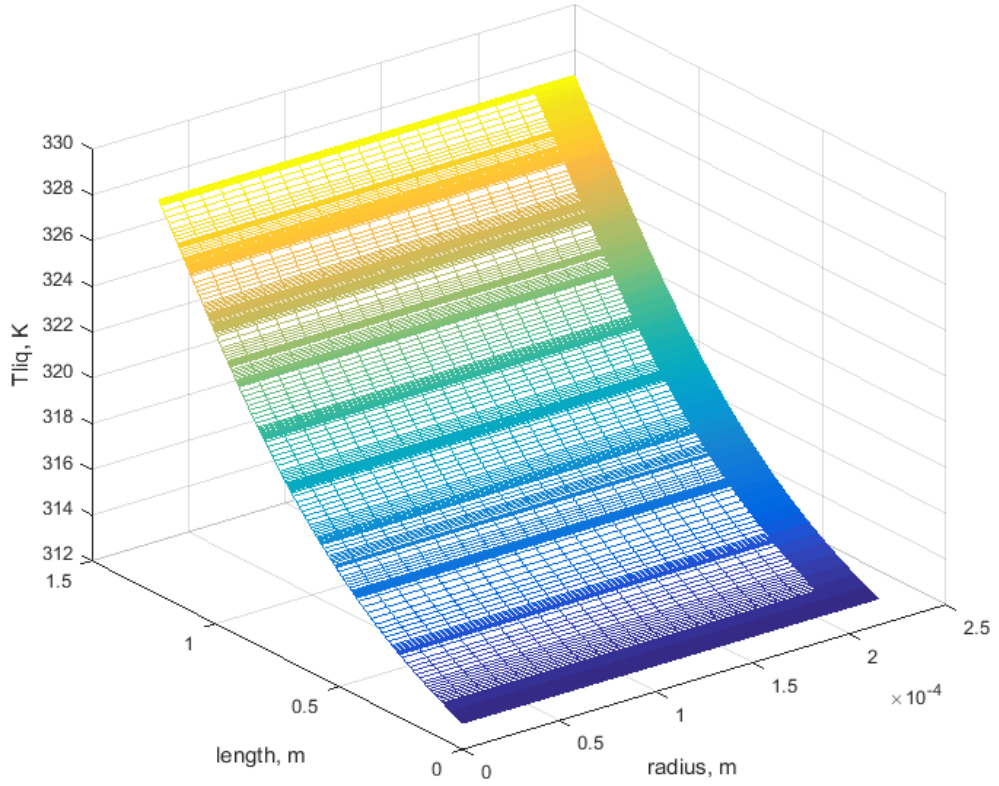



# Absorbed $CO_2$ concentration in the liquid phase

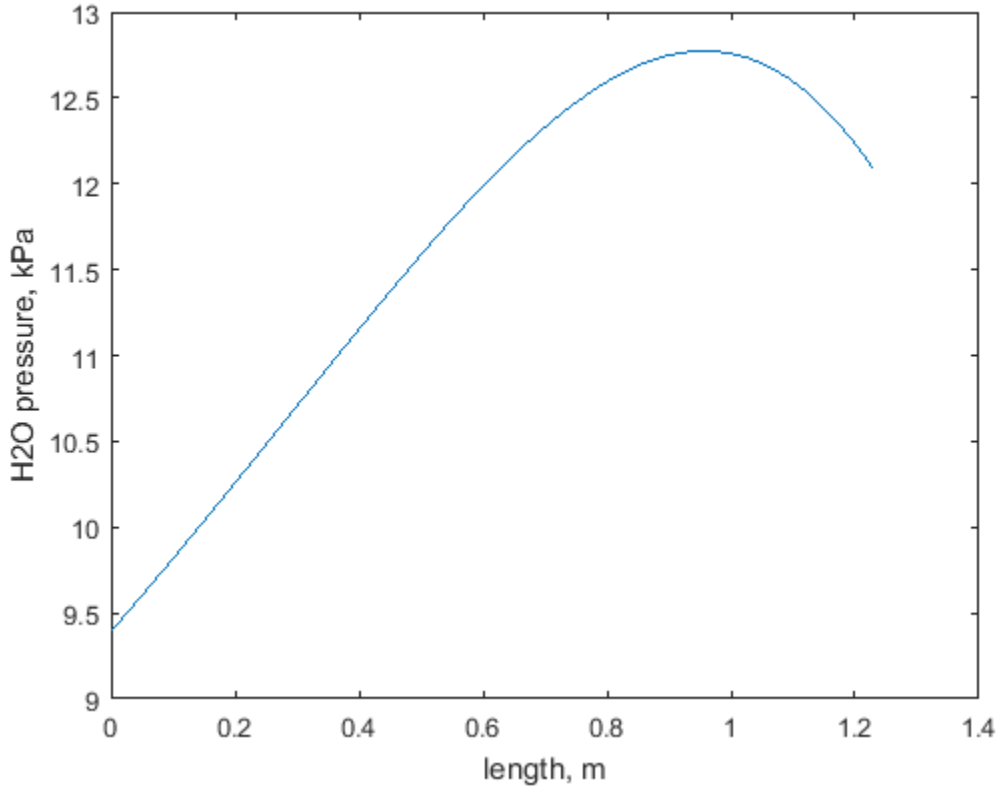


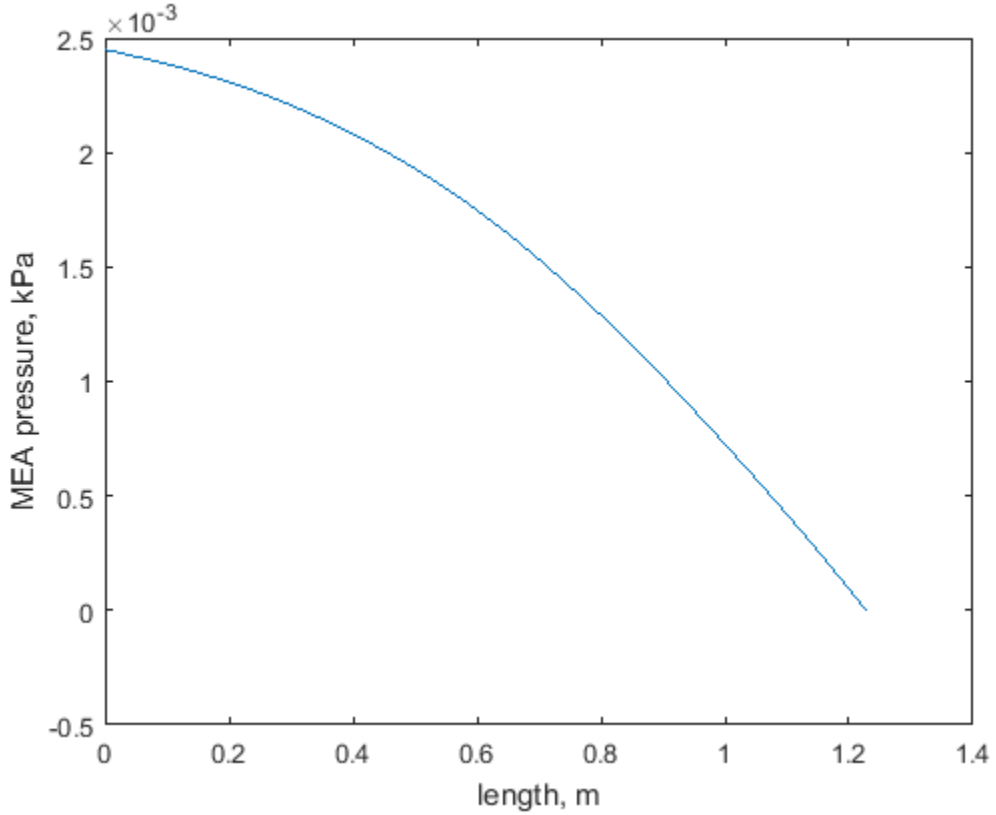
# Temperature profile in liquid phase

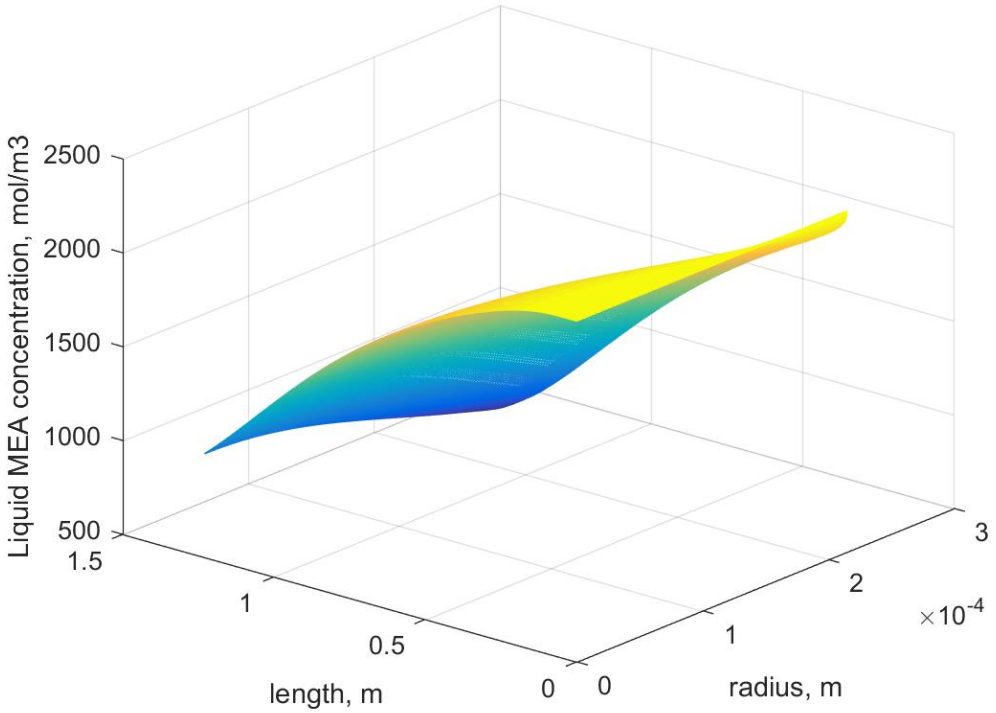


# $H_2O$ pressure over the length of the membrane



# MEA pressure over the length of the membrane

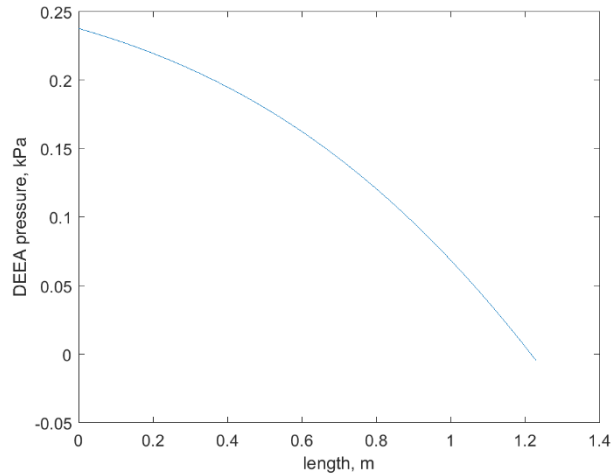


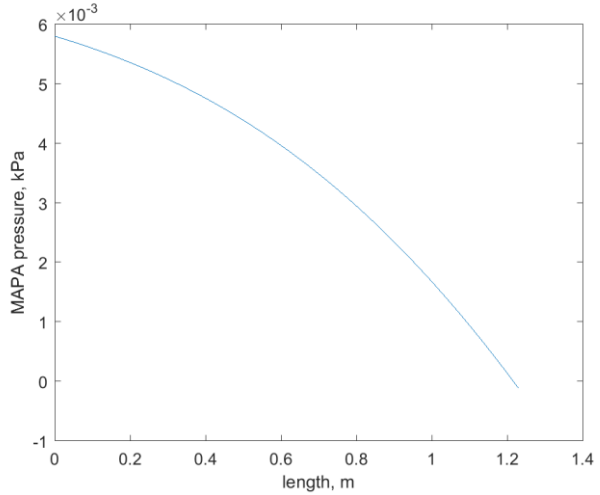



# Conclusions and future work

- The model show that only small amounts of MEA enters the gas on the shell side

- DEEA-MAPA model is under construction.



# Acknowledgements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