

# CARBON DIOXIDE ABSORPTION IN WATER

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Machinery

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# Goal of the research

- Reduce the CO<sub>2</sub> content in the mixed gas
- The mixed gas is wood gas
- Make sensitivity analysis with ChemCAD process simulation software
- Investigate the modification of the temperature, pressure, mass flow of the water and the number of stages in the column.

# The investigated mixed gas

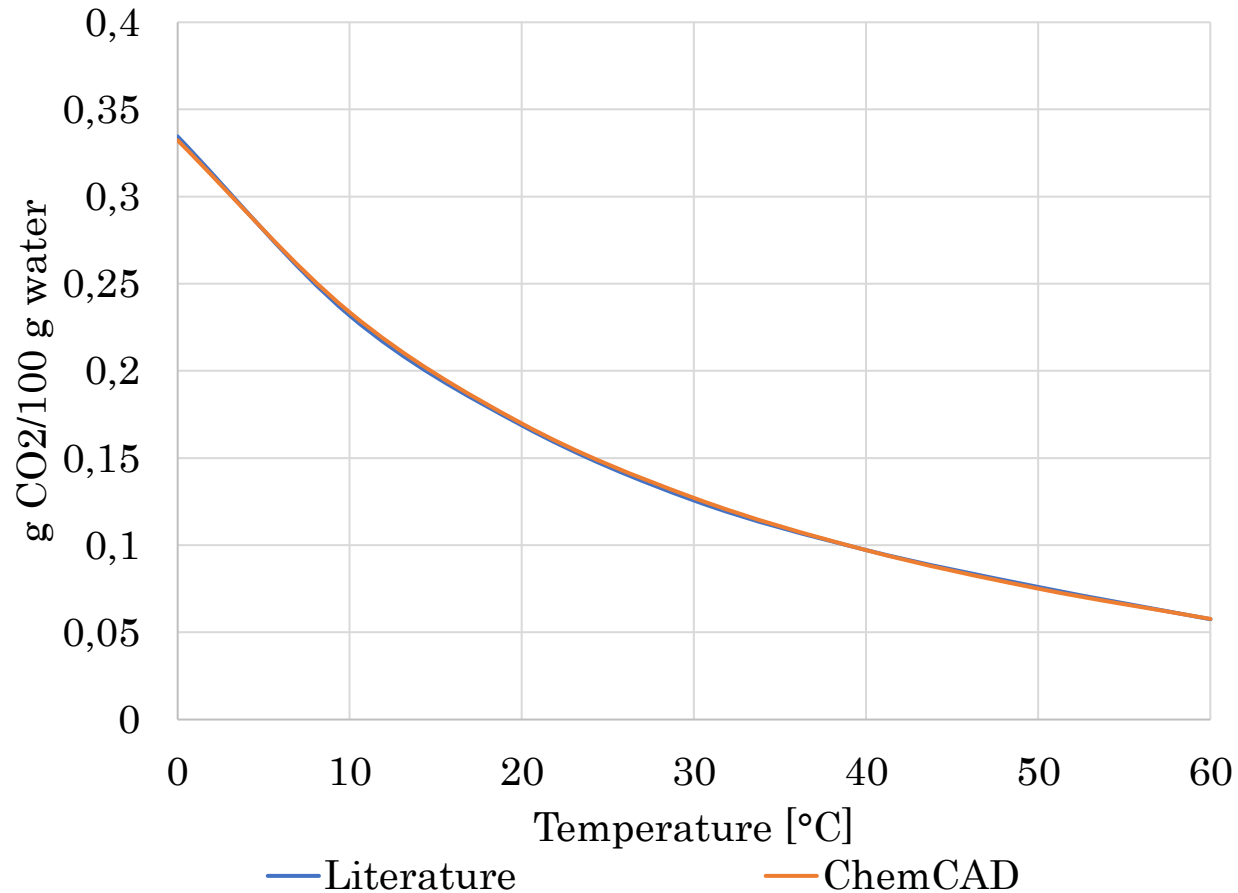
Sampling	Content of the mixed gas [V/V %]									Total
	CO <sub>2</sub>	C <sub>2</sub> H <sub>6</sub>	C <sub>2</sub> H <sub>4</sub>	H <sub>2</sub> S	H <sub>2</sub>	O <sub>2</sub>	N <sub>2</sub>	CH <sub>4</sub>	CO	
1	51,1	0,2	0,8	0	0	0,7	4,7	1	33,5	92
2	50,6	0,2	1,2	0	12,6	0,2	1,3	1,7	31,4	99,2
Average	50,84	0,2	1	0	6,3	0,45	3	1,35	32,46	95,63
Supplemented	53,16	0,21	1,05	0	6,59	0,47	3,14	1,41	33,94	100

# Carbon-dioxide solubility in water

- Based on literature<sup>1</sup> the Henry law describes the solubility of carbon dioxide in water.
- With lower temperature and higher pressure, the solubility of gas is growing in water.
- In the Perry's Chemical Engineers' Handbook there are some data for the solubility of CO<sub>2</sub> gas in water in 1 atm pressure and between 0 and 60 degrees of Celsius.
- In ChemCAD we used the electrolyte Henry law thermodynamic model
- There is app. 1% differences between the results of the literature and the simulation.

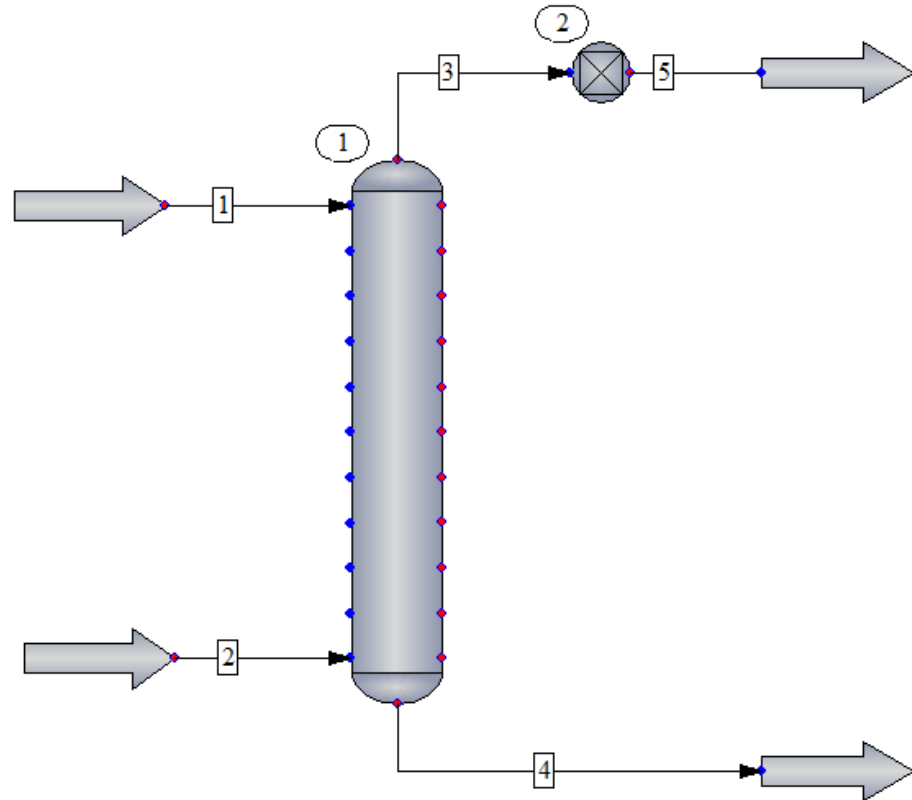
<sup>1</sup>W. Knoche: Chemical reactions of CO<sub>2</sub> in water, Springer-Verlag Berlin Heidelberg, 1980

# Carbon-dioxide solubility in water



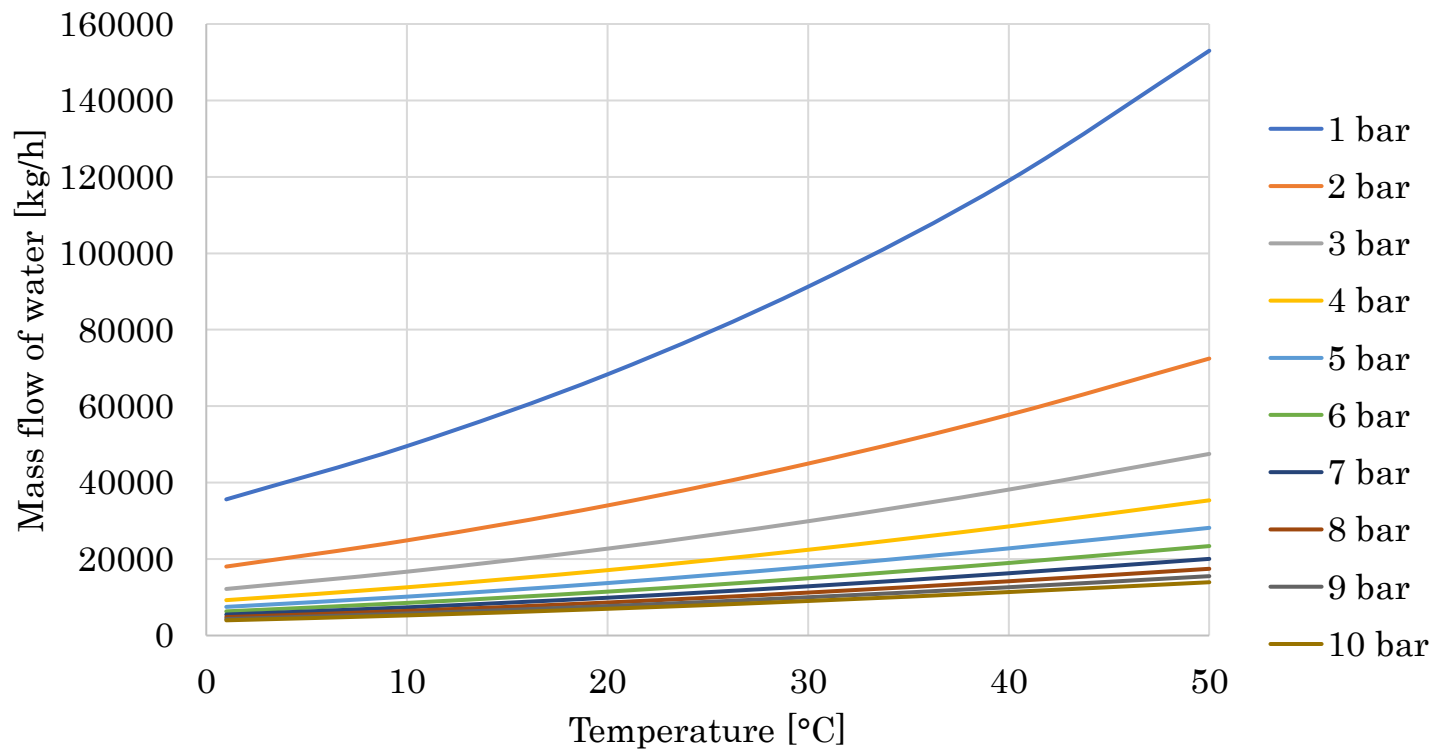
# The model

- ChemCAD 8 process simulation software
- Electrolyte Henry law thermodynamic model
- Mass flow of the mixed gas: 100 kg/h
- Six stages in the column



# Sensitivity analysis

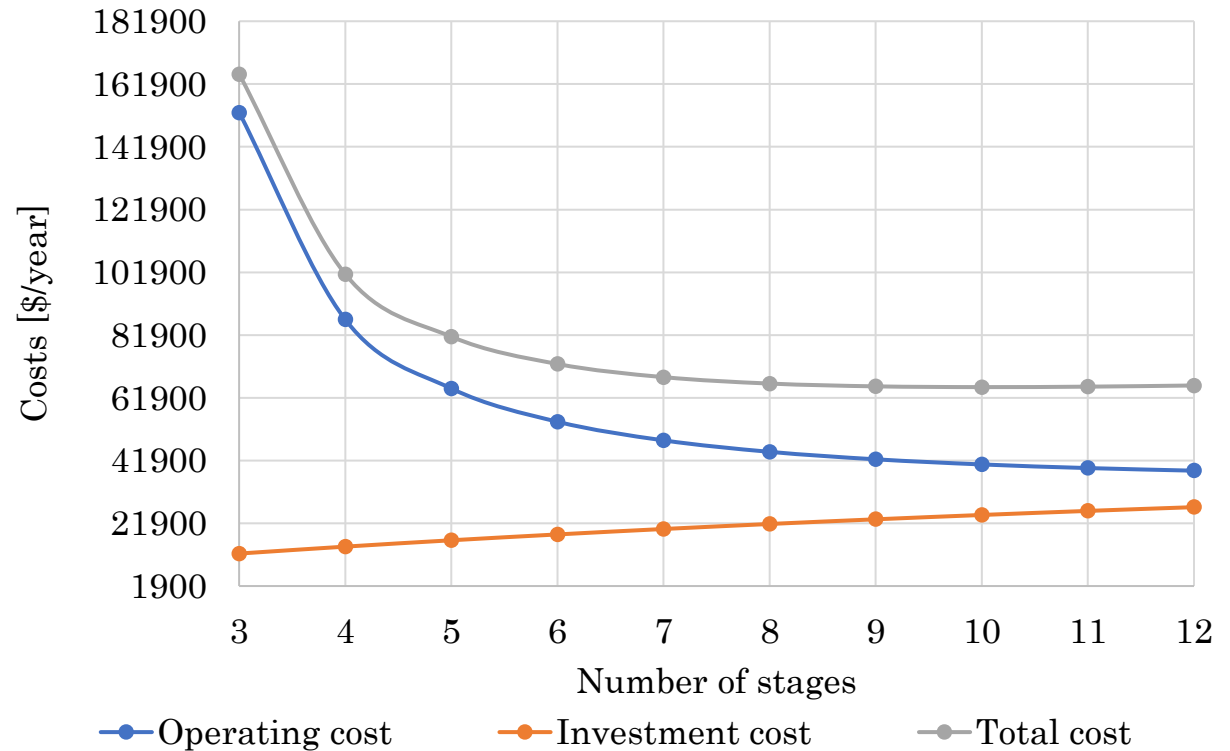
- Pressure is modified between 1 and 10 bar
- Temperature is modified between 1 and 50°C





# Cost estimation

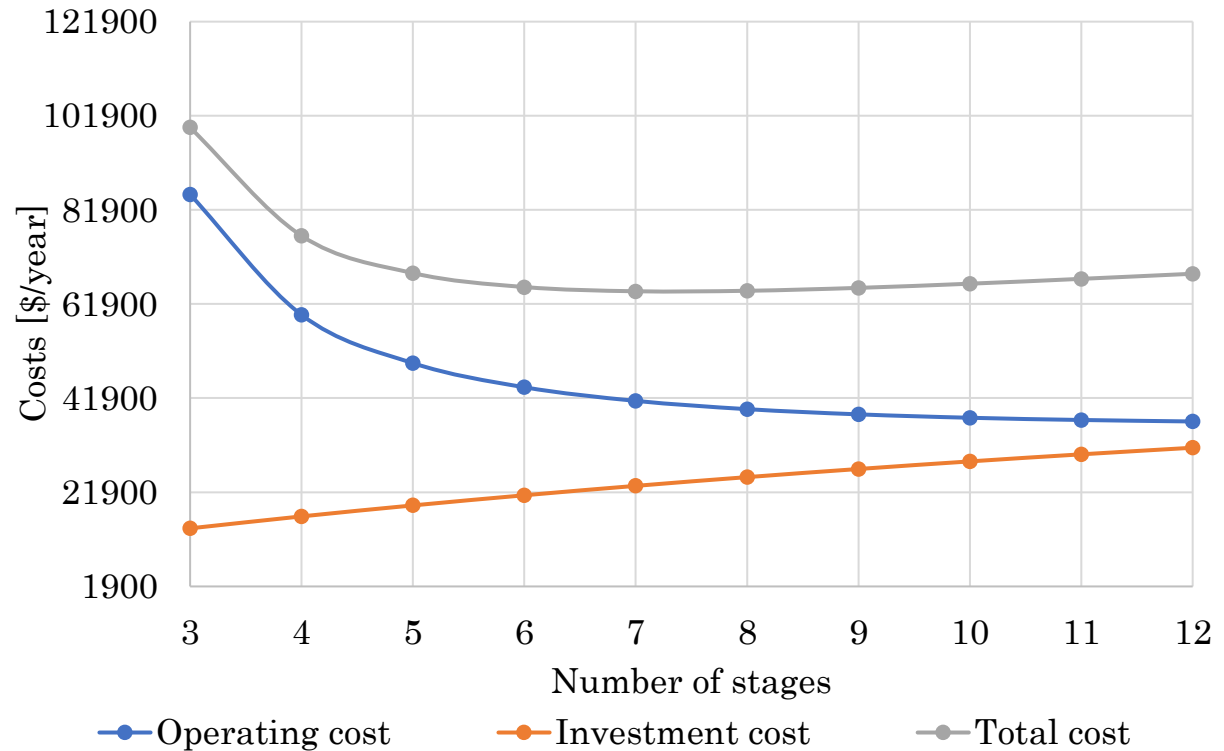
- Column diameter: 0.6 m
- Sieve trays
- Number of trays: 3-12
- Pressure: 6 bar
- Temperature: 10°C
- Install factor: 3
- Amortization: 5
- Operating hours in 1 year: 8000
- Cost of the water<sup>2</sup>: 0.54 \$/t
- Minimum of the total cost function: 10 stages



<sup>2</sup><https://vizmuvek.hu/hu/kezdolap/informacio/k/dijszabasok/dijszabasok>

# Cost estimation

- Column diameter: 0.8 m
- Sieve trays
- Number of trays: 3-12
- Pressure: 6 bar
- Temperature: 10°C
- Install factor: 3
- Amortization: 5
- Operating hours in 1 year: 8000
- Cost of the water<sup>2</sup>: 0.54 \$/t
- Minimum of the total cost function: 7 stages



<sup>2</sup><https://vizmuvek.hu/hu/kezdolap/informacio/k/dijszabasok/dijszabasok>

# Results

- It is necessary to use higher pressure and lower temperature.
- There is lower differences between the necessary mass flow of the water in case of higher pressure.
- With a cost estimation it is determined, that there is an optimal number of stages. In this case the total cost function has a minimum point.
- In the future we would like to make measurements to compare the results of the measurements and simulations.

**THANK YOU FOR YOUR  
KIND ATTENTION!**