Glycols in natural gas – Experiments, modelling and tracking

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Rationale for this work

- Glycols are used for hydrate inhibition and drying of the natural gas
- Very limited amount of solubility data available in the literature
- Need experimental results to adjust and validate simulation models
- Good simulation models are important to:
  - Avoid operational difficulties and contamination in downstream processes
  - Minimize chemical loss
  - Reduce operational costs

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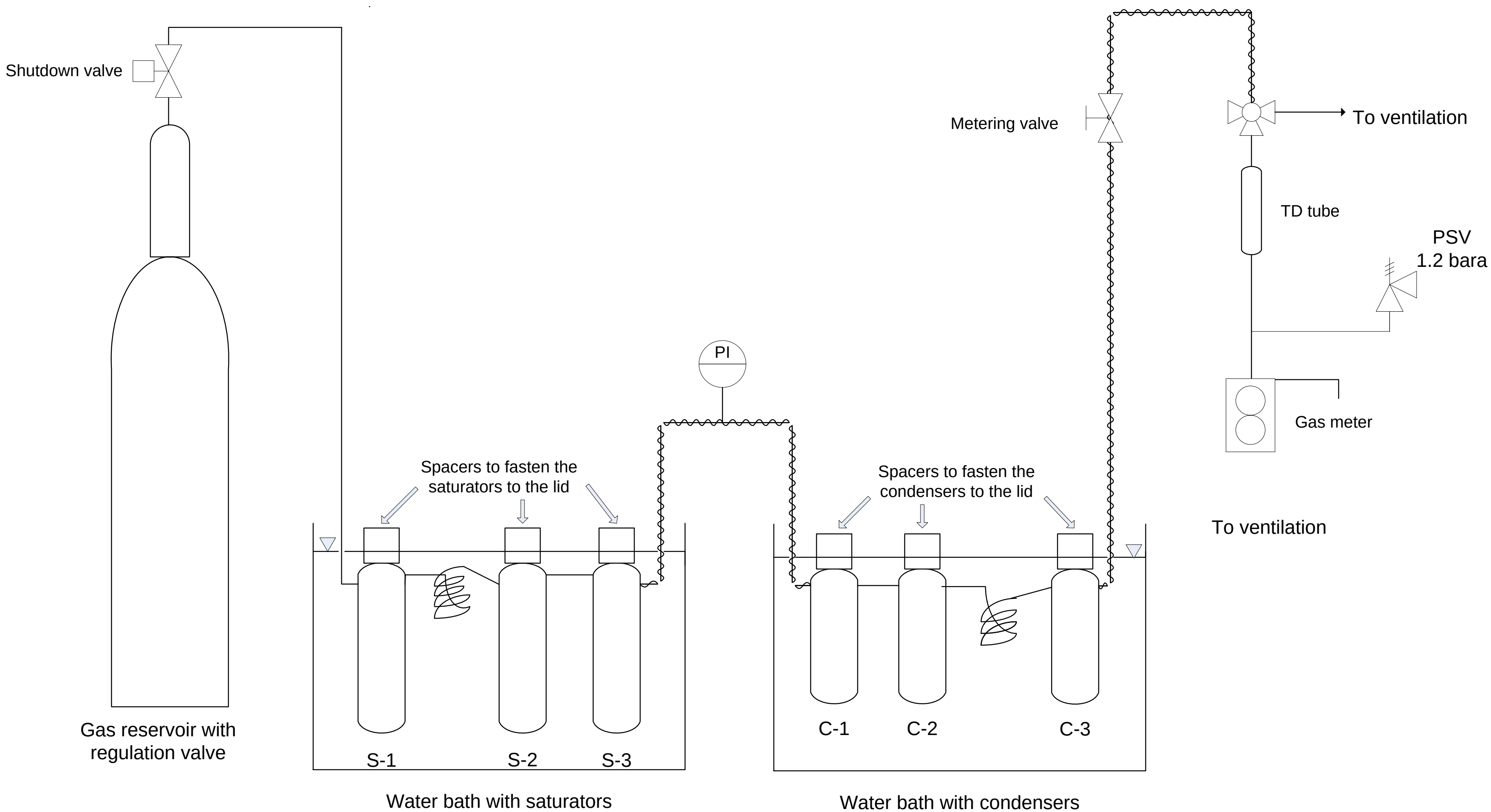
Experimental equipment



Experimental matrix

Measurement of solubility of MEG in natural gas

Gas composition	Pressure [bara]	Temperature [°C]	Intention of the experiment
Methane	25*, 50, 100, 150	0, 10, 20, 25	Increase repeatability and decrease uncertainty
85 mol% methane, 15 mol% ethane	50, 100	0, 10, 20	Ethane might effect the glycol solubility, and no data are available in the literature
CO_2	10**, 25, 50***	0, 20	CO_2 has high effect on glycol solubility, and no data are available in literature

*Only measured at 20°C

**Only measured at 0°C

***Only measured at 20°C

Thermodynamic modelling

The Cubic-Plus-Association equation of state (CPA-EoS):

- Developed in cooperation with DTU (Technical University of Denmark)
- Adds a hydrogen bonding contribution (association) to the SRK-EoS
- Is able to handle polar components (glycols, inhibitors) and water
- Reduces to SRK-EoS for hydrocarbon mixtures

$$Z = \frac{V_m}{V_m - b} - \frac{a(T)}{RT(V_m + b)} - \frac{1}{2}\left(1 + \rho \frac{\partial \ln g}{\partial \rho}\right) \sum_i x_i \sum_{A_i} (1 - X_{A_i})$$

$$Z_{CPA} = Z_{SRK} + Z_{association}$$

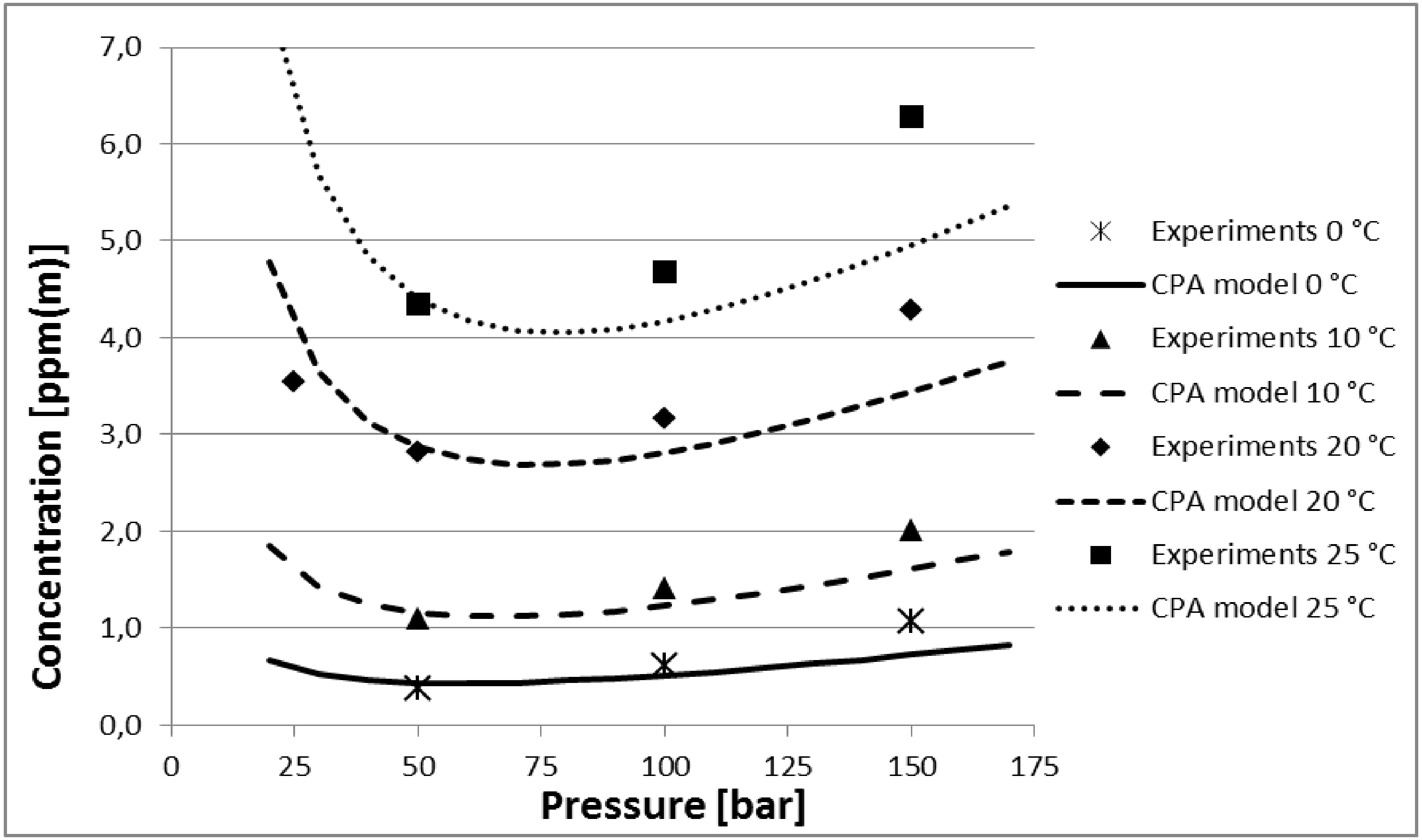
Physical (SRK) term

Classic contribution (SRK)

Association term

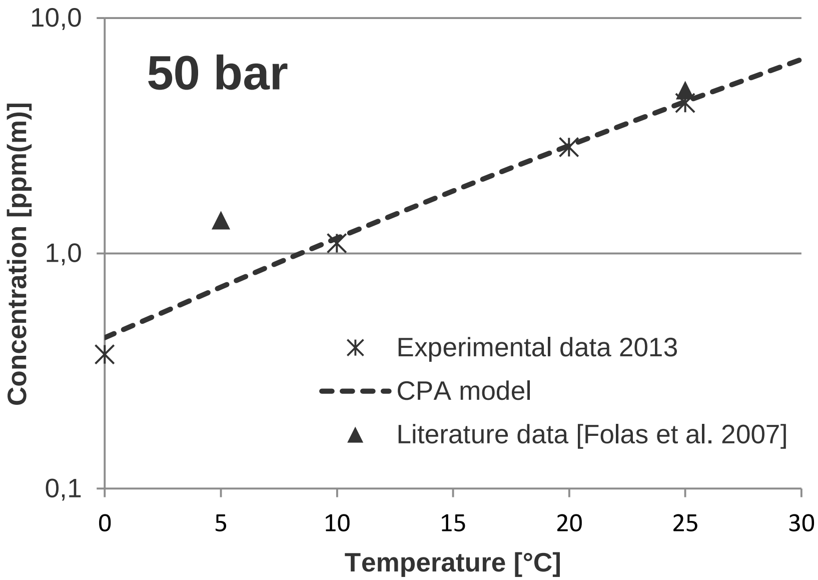
Contribution from hydrogen bonding (association and solvation)

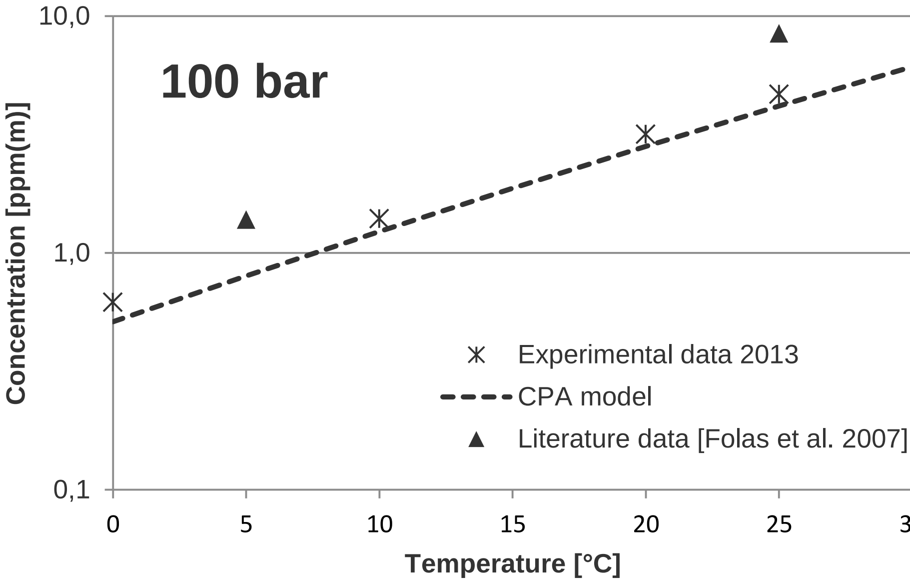
Solubility of MEG in methane



Comparison of literature and exp. data

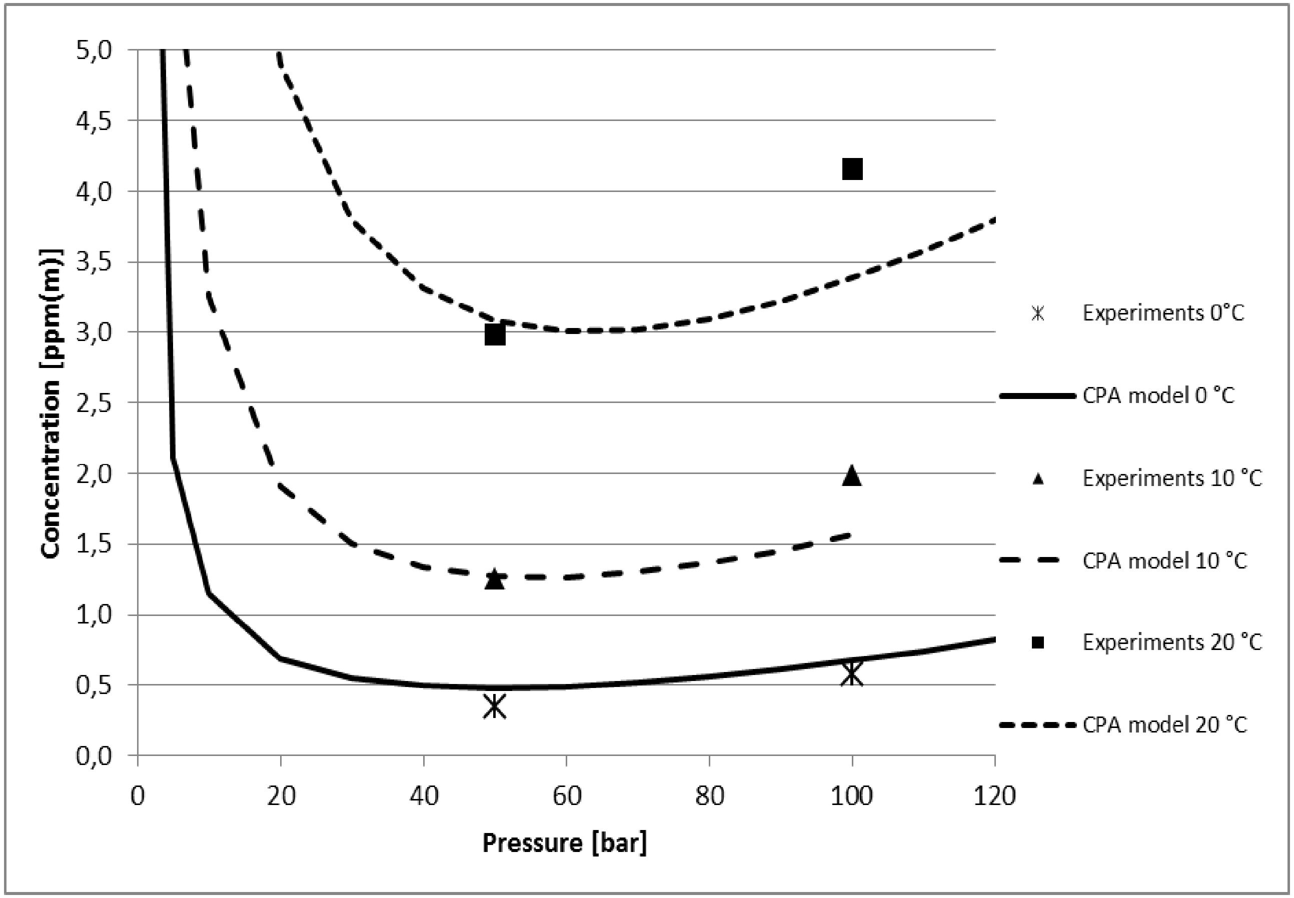
MEG in methane



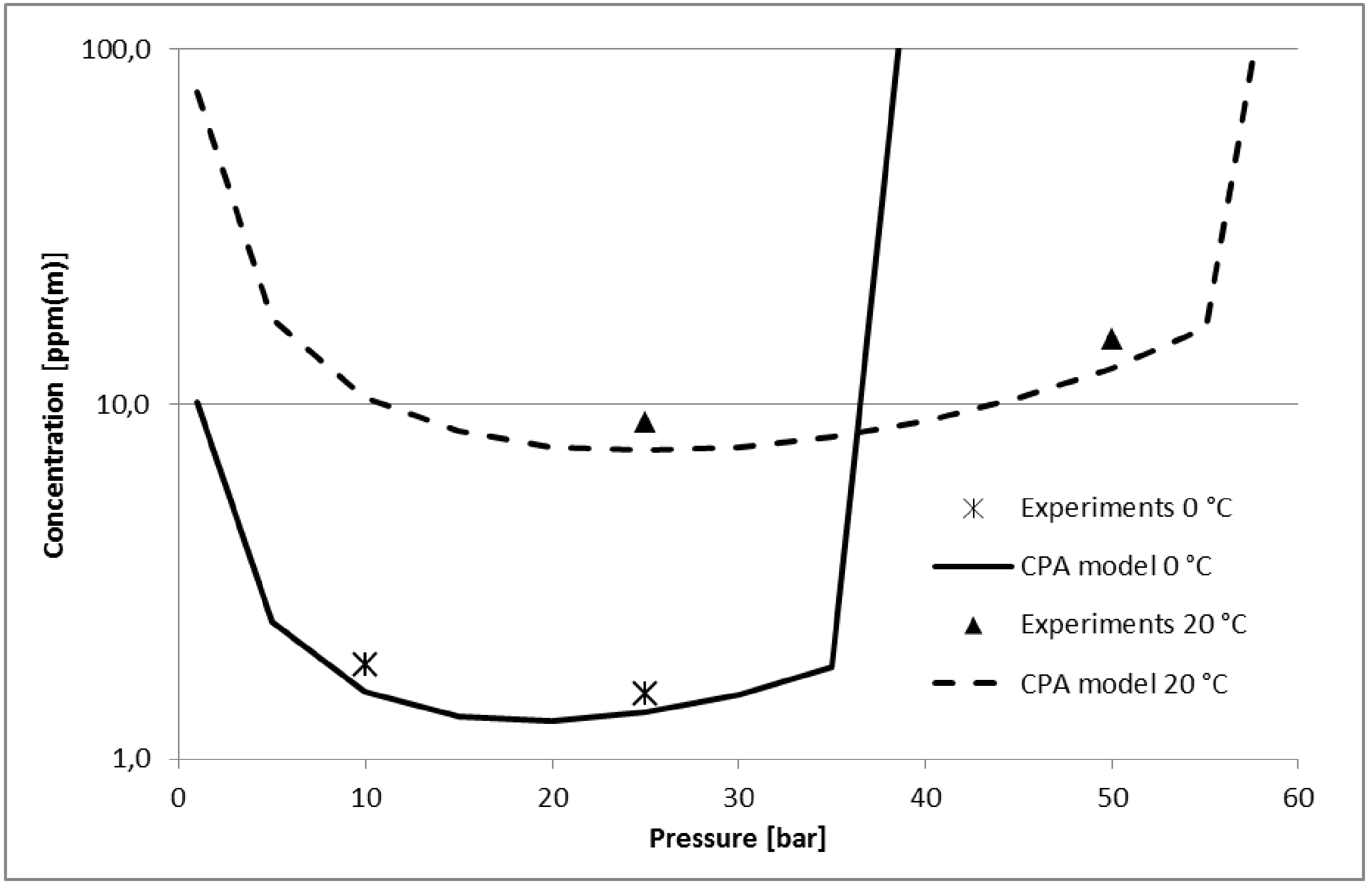


[Folas et al. 2007] Folas, G.K., Berg, O.J., Solbraa, E., Fredheim, A.O., Kontogeorgis, G.M., Michelsen, M.L. and Stenby, E.H. (2007). High pressure vapor-liquid equilibria of systems containing ethylene glycol, water and methane: Experimental measurements and modeling. Fluid Phase Equilibria, (251): 52-58.

Solubility of MEG in methane/ethane (85/15)



Solubility of MEG in CO_2



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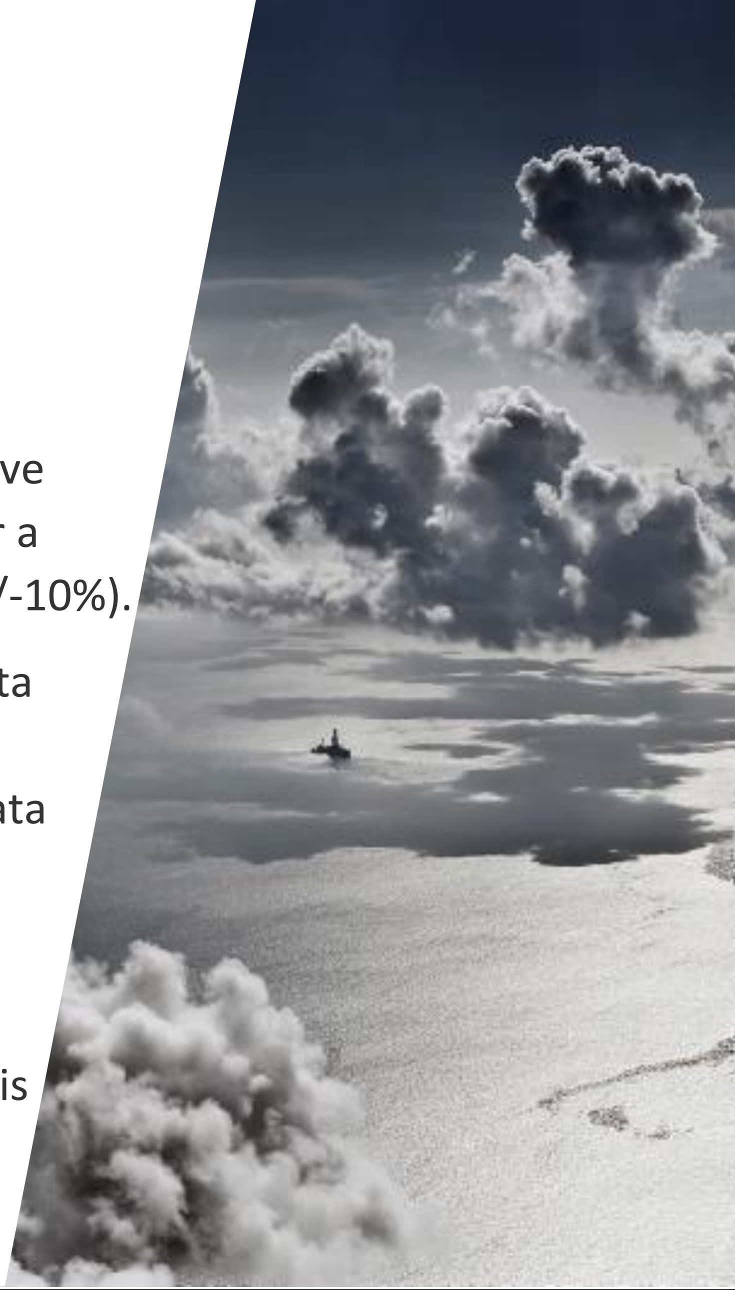
Concluding remarks

- Improved predictions of MEG solubility in methane, methane/ethane and CO_2: Challenging experiments have resulted in accurate measurement of MEG solubility for a wide range of P and T. High accuracy in experiments (+/-10%).
- Predictions with the CPA-EoS matches experimental data with good accuracy at 50 bar. At higher pressures, the deviations between the model and the experimental data increases. MEG solubility in gaseous CO_2 was predicted with good accuracy for all measured points.
- The experimental results are use to improve CPA-EoS which is being used to perform process calculations. This improves the quality of evaluations of glycol content in the gas – both during design and operational support.



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Thank you

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