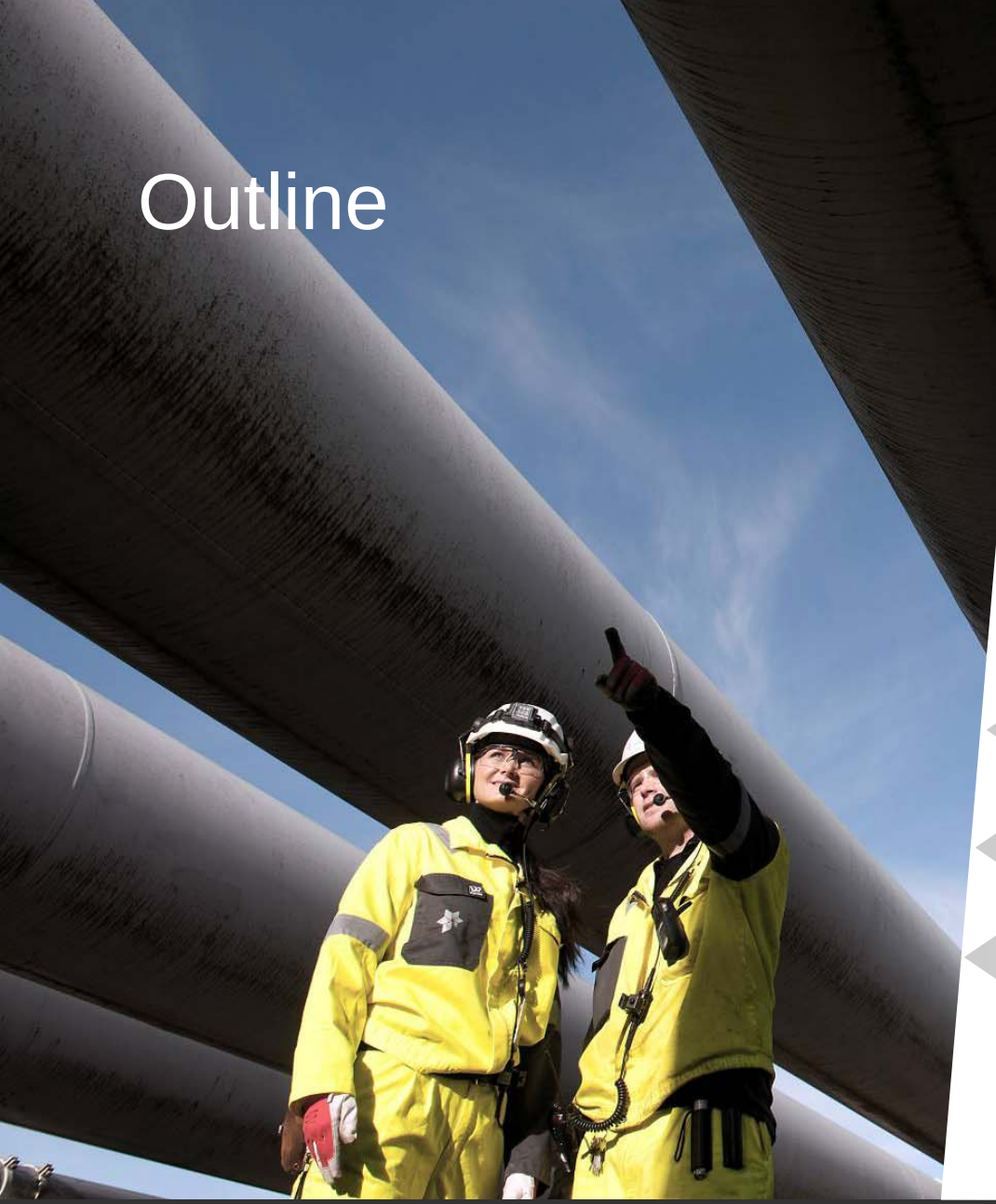
Water content of high pressure natural gas

Data, prediction and experience from field

Kjersti Omdahl Christensen, Torbjørn Vegard Løkken, Even Solbraa, Cecilie Fjeld Nygaard, Anita Bersås

Outline



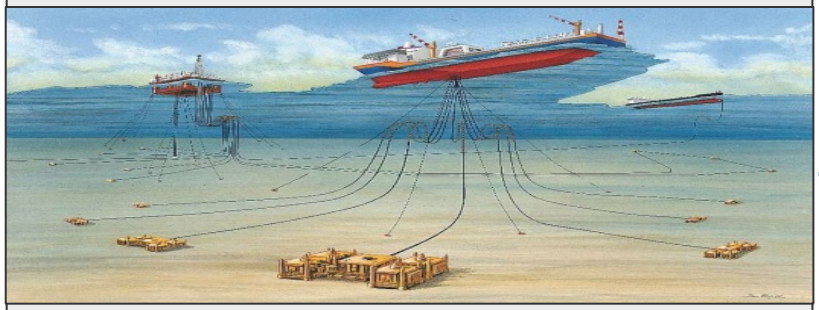
- Background
- Field experience
- Phase behaviour
- Experimental work
- Thermodynamic model
- Summary

Background

- Natural gas contains water in varying amounts dependent on upstream conditions
- Water in natural gas can create problems during transportation and processing
  - Gas hydrates
  - Ice formation
  - Increase corrosion potential
- Understanding of the phase behaviour of natural gas and it trace components is crucial for safe and efficient gas processing

Field experience

Platform process



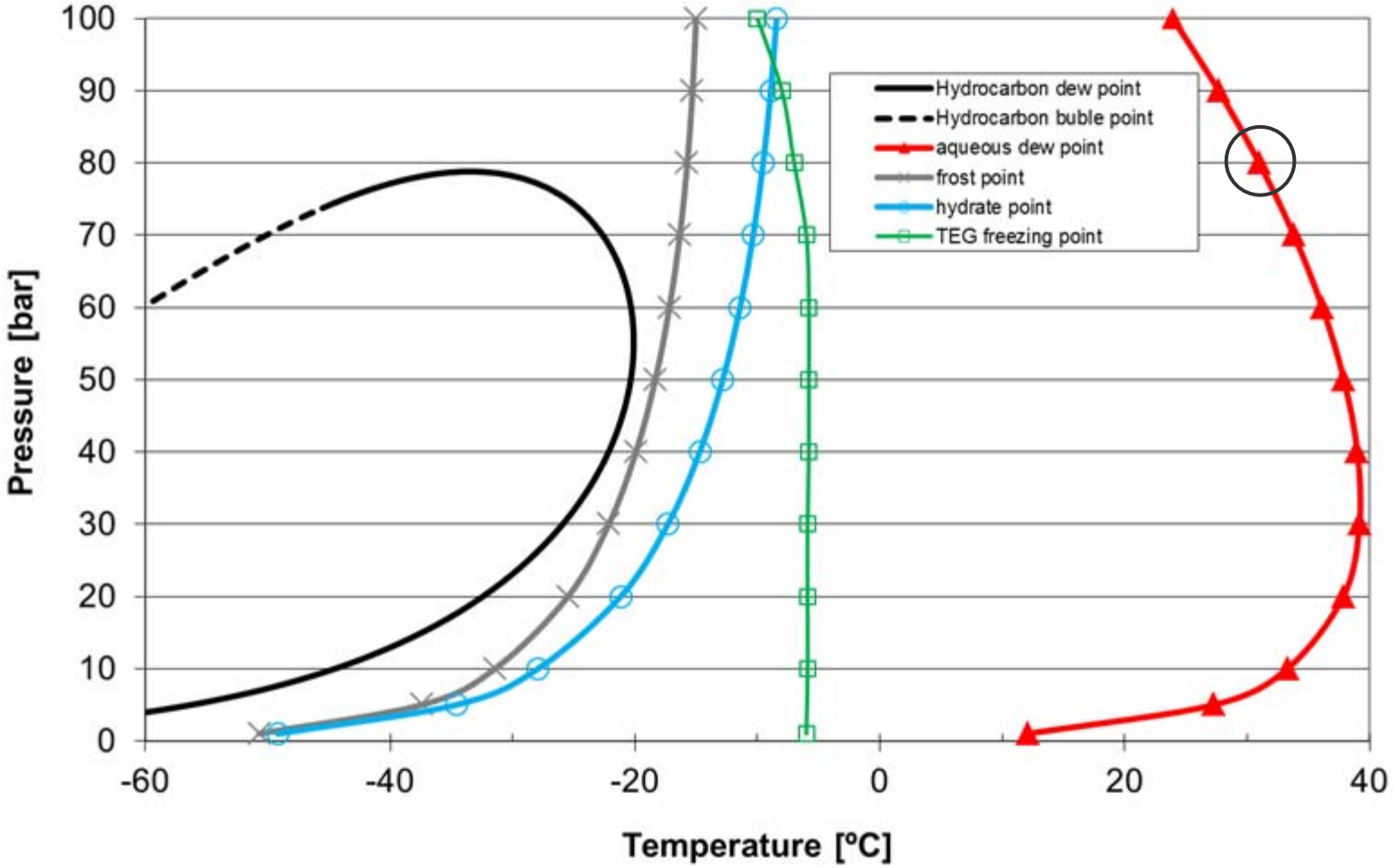
- Water spec: -18 ºC @ 69 barg
- Moderate dew point depression
- Triethylene glycol (TEG) used as water absorber
- Gas from TEG contactor contains TEG (g)

Rich gas flow

Onshore process

- Cold processes
- Freezing of hydrocarbon/glycol/water solutions
- Hydrate formation in hydrocarbon/glycol/water solutions

Phase behaviour of natural gas with traces of water and TEG



Operating point, TEG contactor

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CPA-EoS

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

Classic contribution (SRK)

Contribution from hydrogen bonding (association and solvation)

CPA-EoS is developed by CERE / DTU

CPA: Cubic plus association

EoS: equation of state

SRK: Soave-Redlich-Kwong

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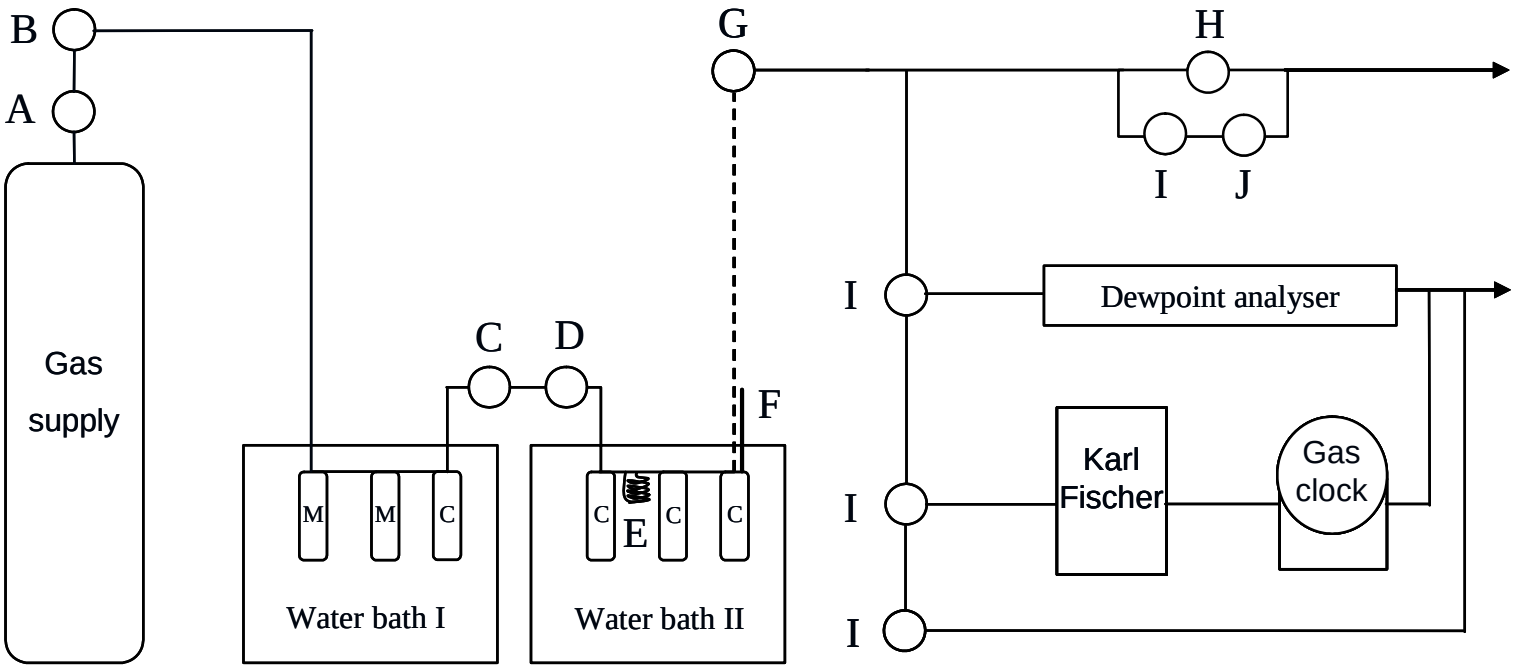
Experimental set-up



A: Gas regulator

B: Shutdown valve

C: Valve

D: Pressure transmitter

E: Coil

F: Thermo element

G: El. heated pressure regulator

H: Safety valve

I: Metering valve

J: Flow meter

--- Heat tracing

M: Moisturizer

C: Condenser

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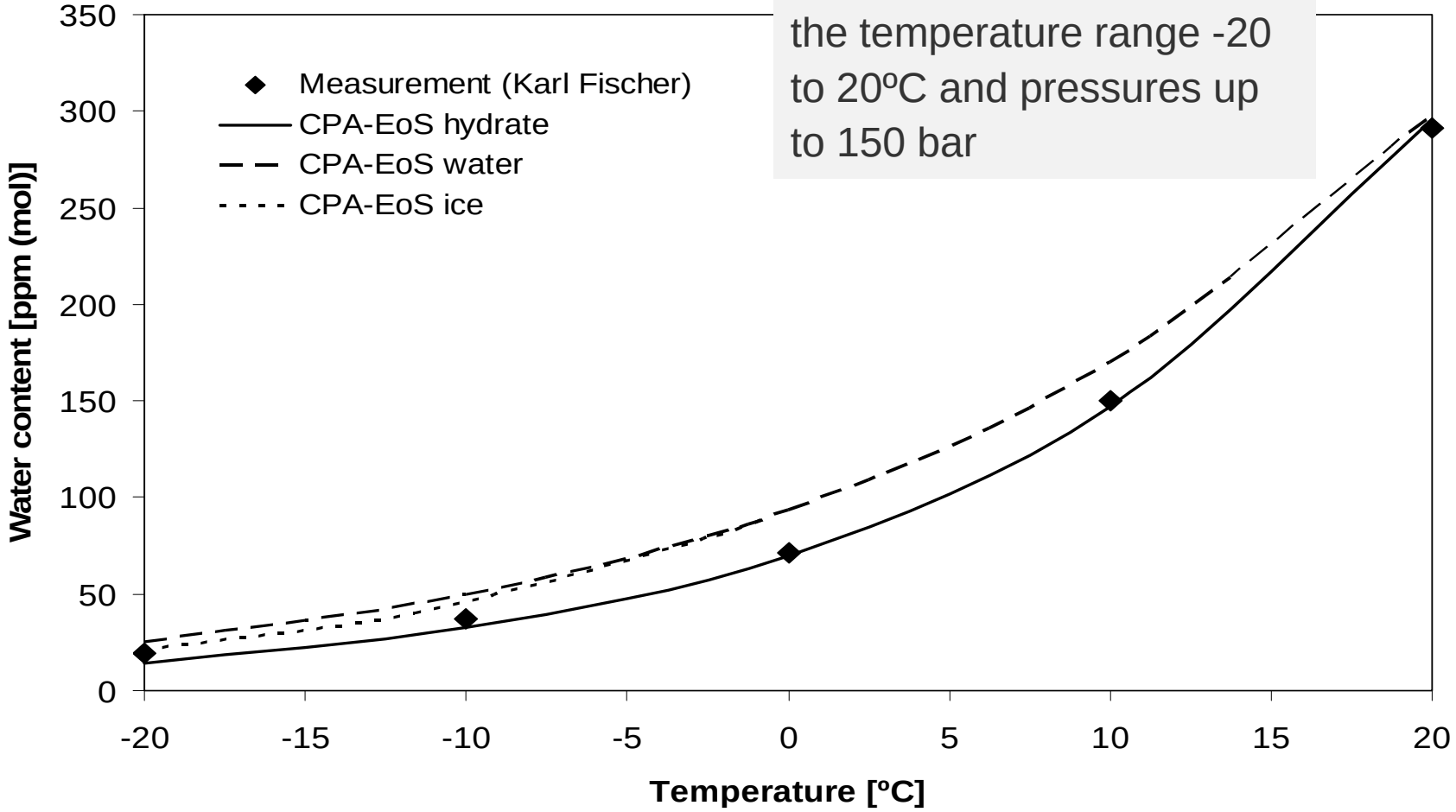
Results

Data for the equilibrium water content in methane and a natural is available in the temperature range -20 to 20ºC and pressures up to 150 bar



Comparison of experimental data for natural gas - water at 150 bar to stable and meta-stable phases predicted with the CPA-EoS

T. Løkken et al, Conference paper IGRC Paris (2008)

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Summary

- ✓ Knowledge of phase behaviour of natural gas an its trace components is crucial for a safe and efficient production.
- ✓ CPA-EoS combined with thermodynamic models for the ice and gas hydrate phases gives excellent results for calculation of:
  - Equilibrium water content of natural gas
  - Water dew point temperature
  - Natural gas hydrate temperature
  - Ice precipitation temperature
  - Aqueous dew points

Thank you

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Kjersti O. Christensen

Researcher

kchr@statoil.com, +47 99 48 76 84

www.statoil.com

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