Research Summary

Thermodynamic Modeling of Phase Behavior in Confinement

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Problem Statement

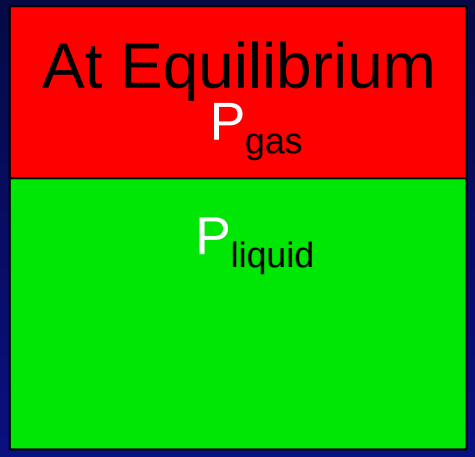
- In confined environments, the fluid behaves differently due to the proximity of the fluid molecules to the pore walls.
- This impact reveals itself as suppression of the bubble point pressure for oil systems.
- The impact of confinement in nano-pores needs to be understood for condensate systems.

Problem Statement

PVT cell vs. pore-confinement

PVT Cell (Bulk)

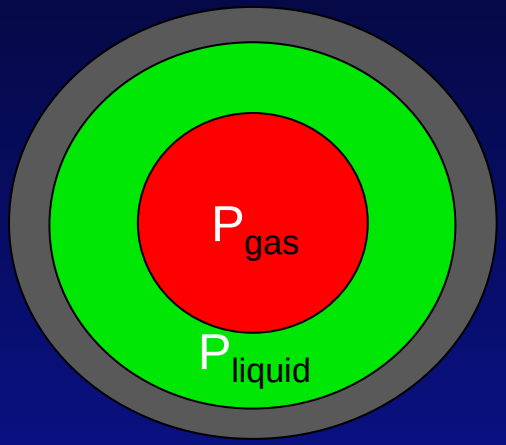
The interface is flat



$$p_{gas} = p_{liquid} = p_b$$

Confined Environment

The interface is curved



$$p_{gas} - p_{liquid} = p_c + \Pi$$

- $p_{bubble} = ?$
- $p_{dew} = ?$

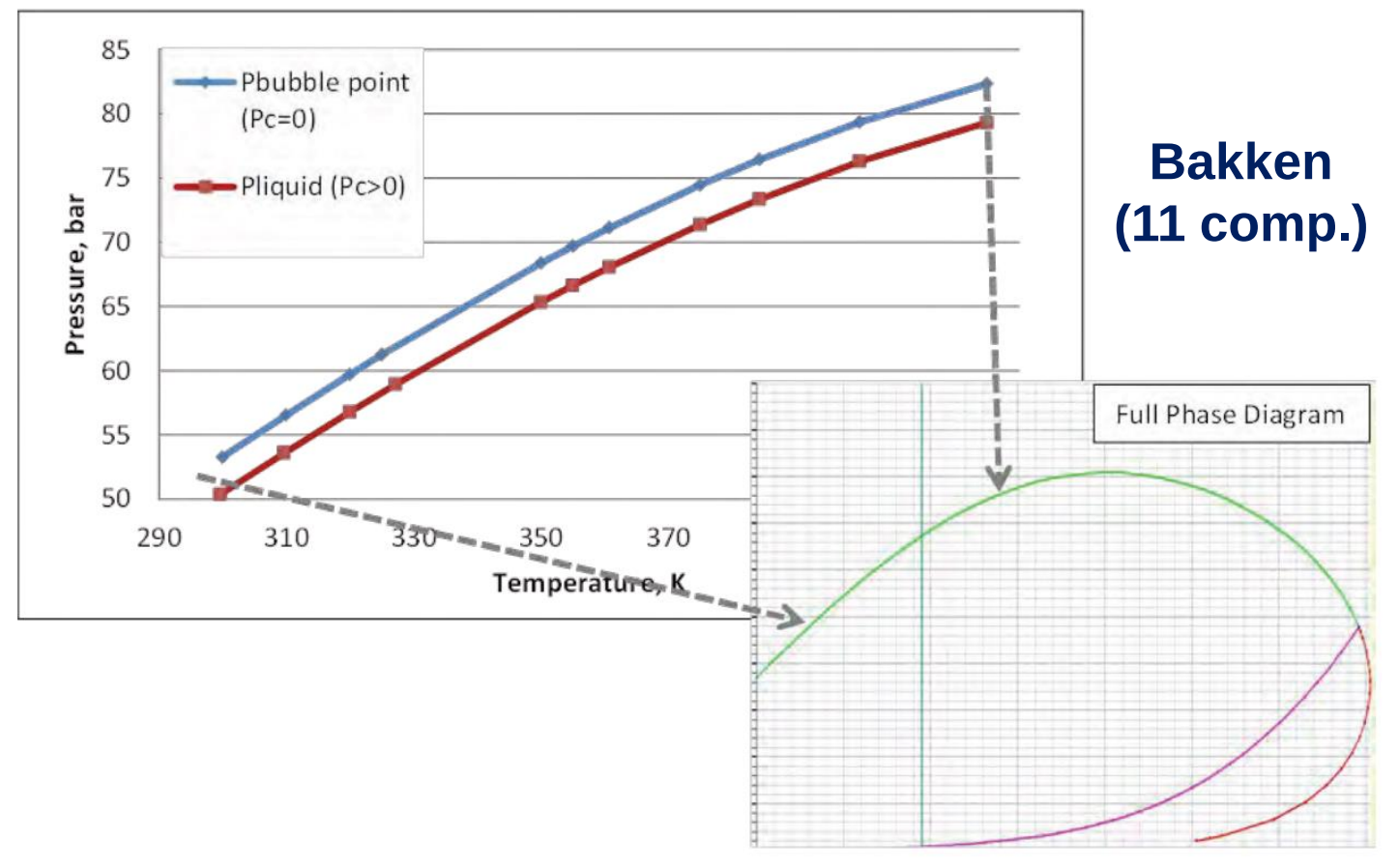
Scope of Research

- To investigate the impact of *p*ore size distribution on the phase behavior of gas condensate in unconventional reservoirs.

- To improve our understanding of fluid flow in unconventional reservoirs by focusing on the dew-point pressure behavior in nano-pores.

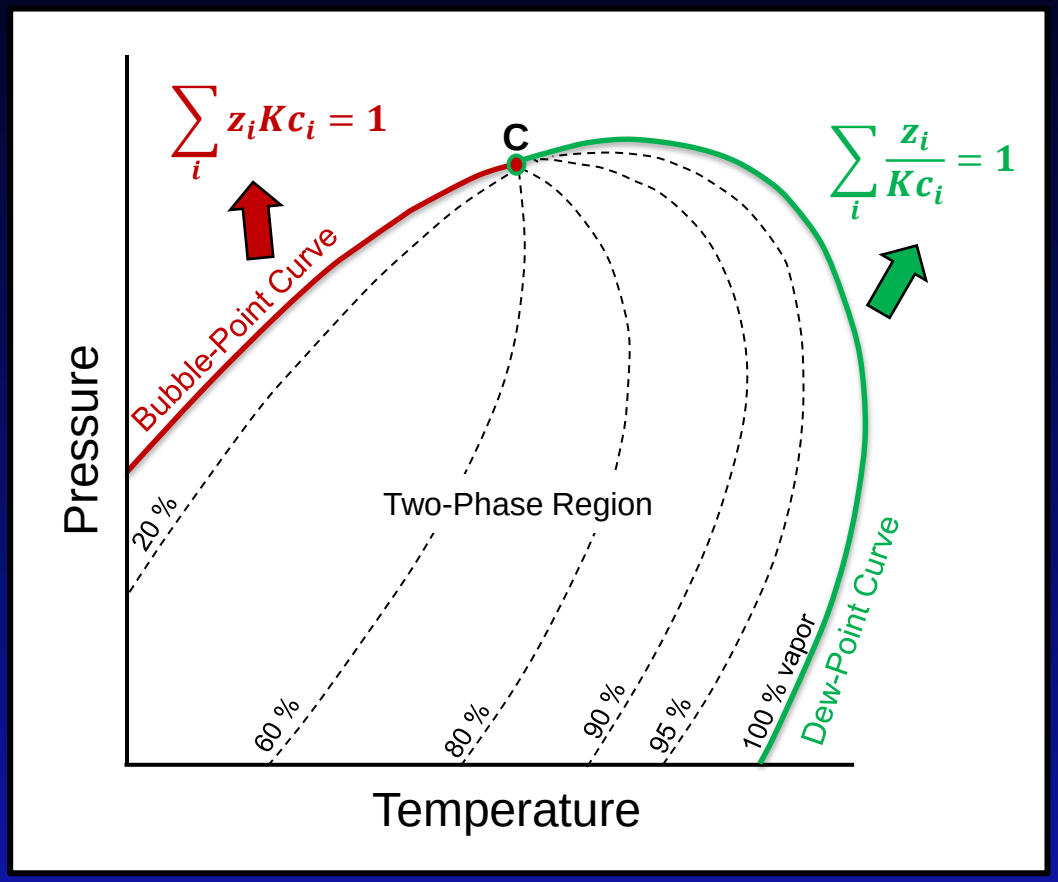
Approach

Firincioglu et al., 2013 (SPE 159869 and SPE 166459) :
the bubble-point suppression in nano-pores

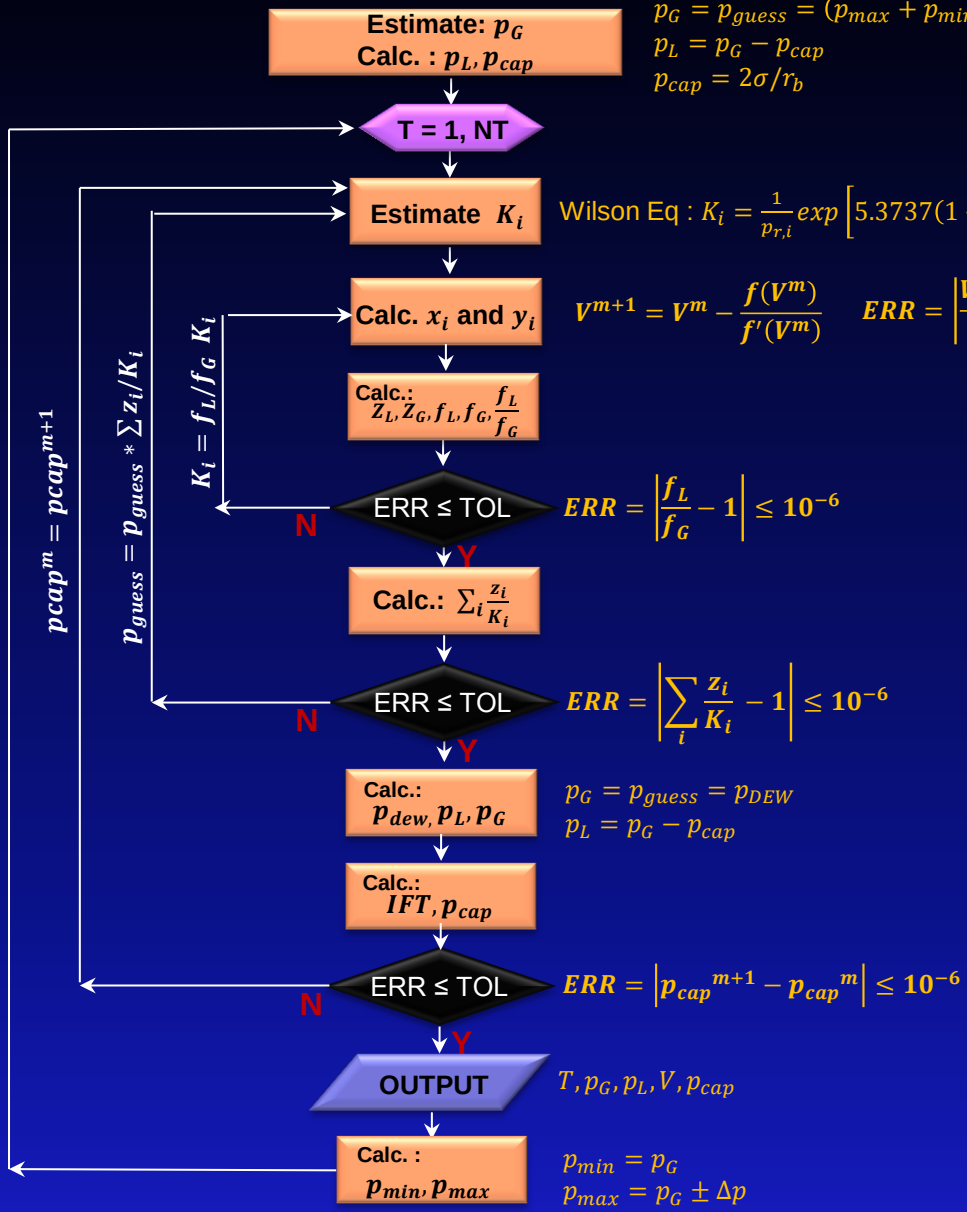


Approach

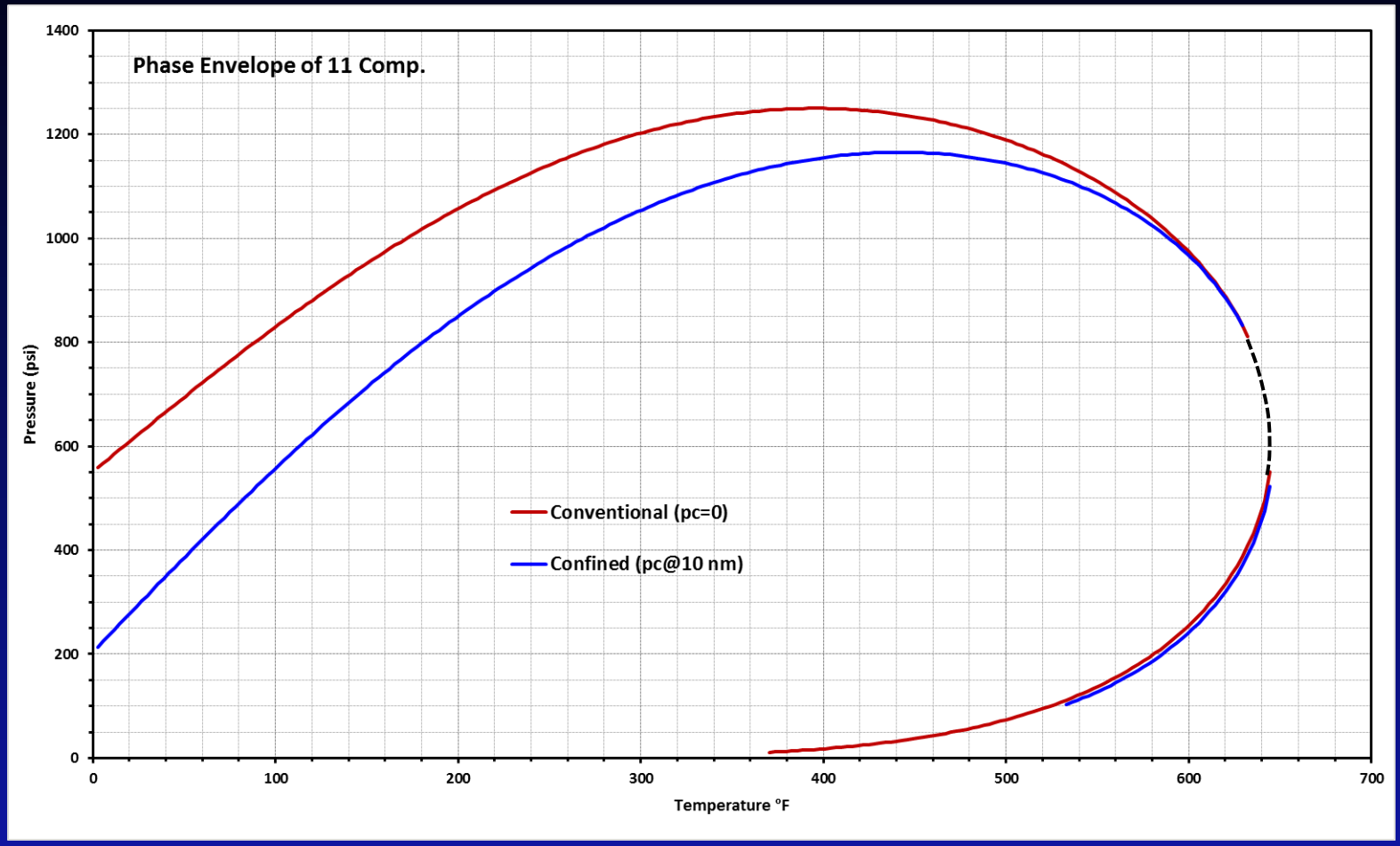
- VLE is solved for two pressures (P_L and P_G) for the two phases
- Capillary K value (K_c) definition is used
- PR EOS is utilized



Flow Diagram



Applications (Black Oil Sample)



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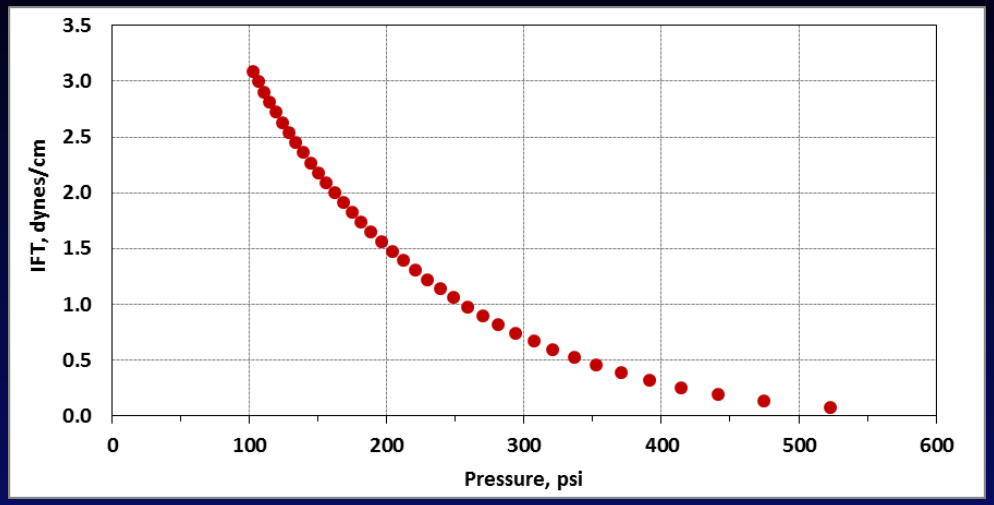

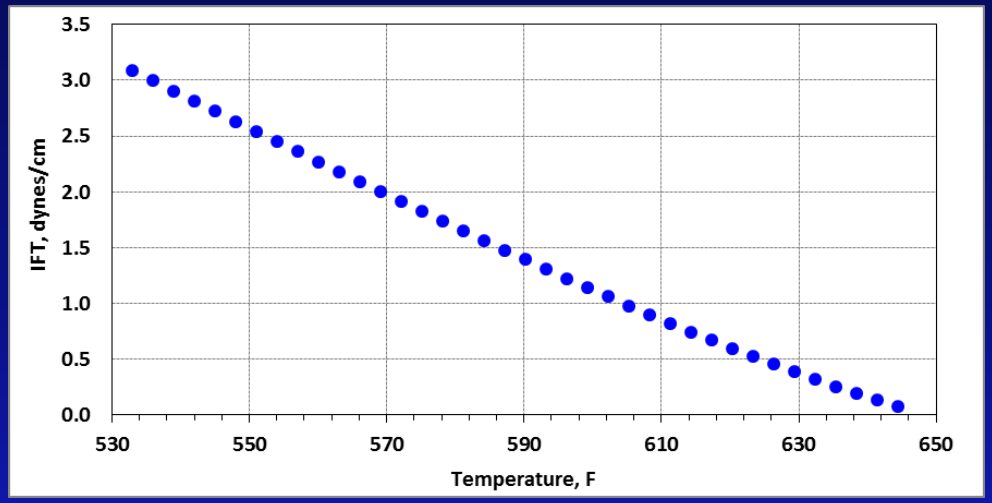

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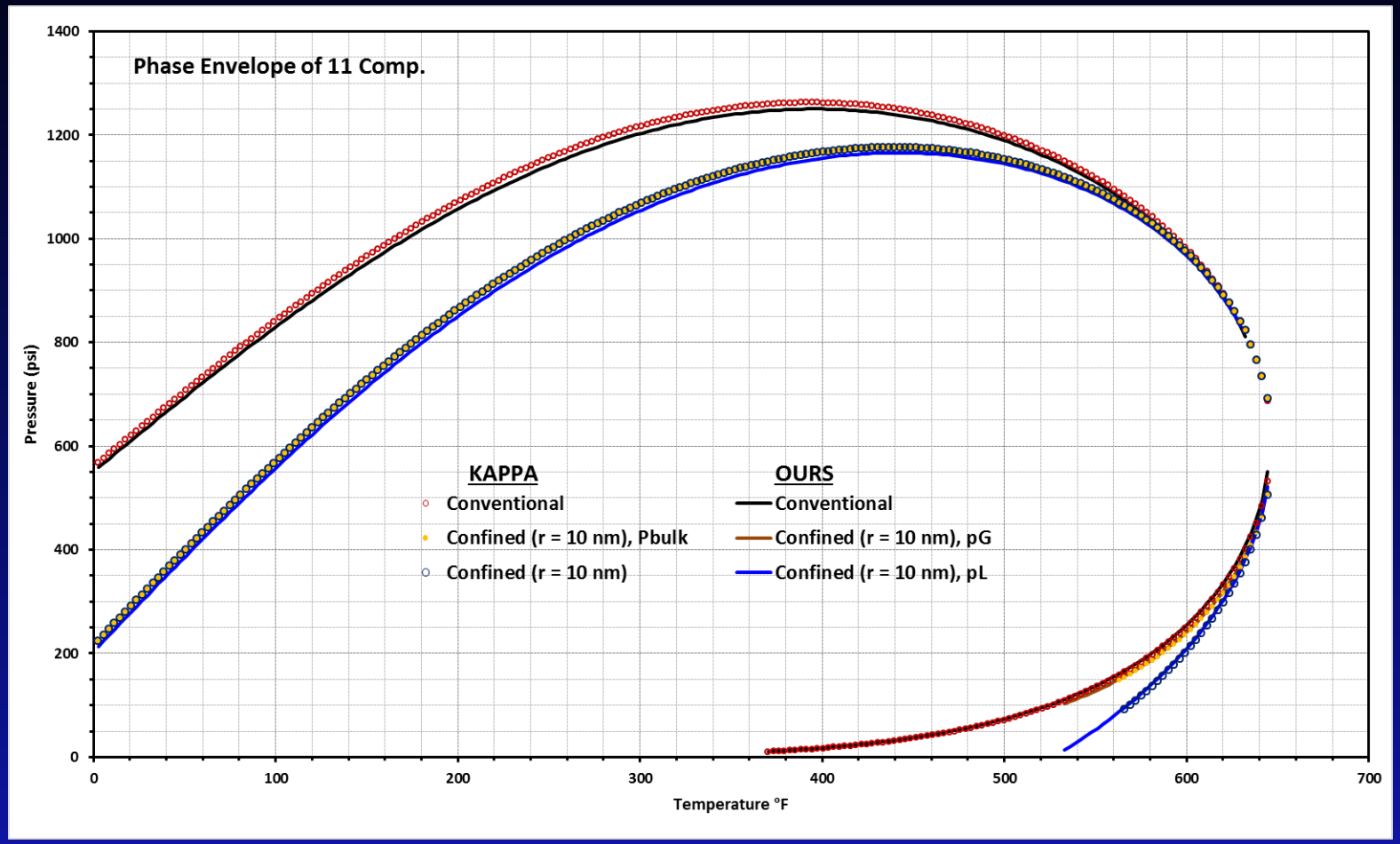
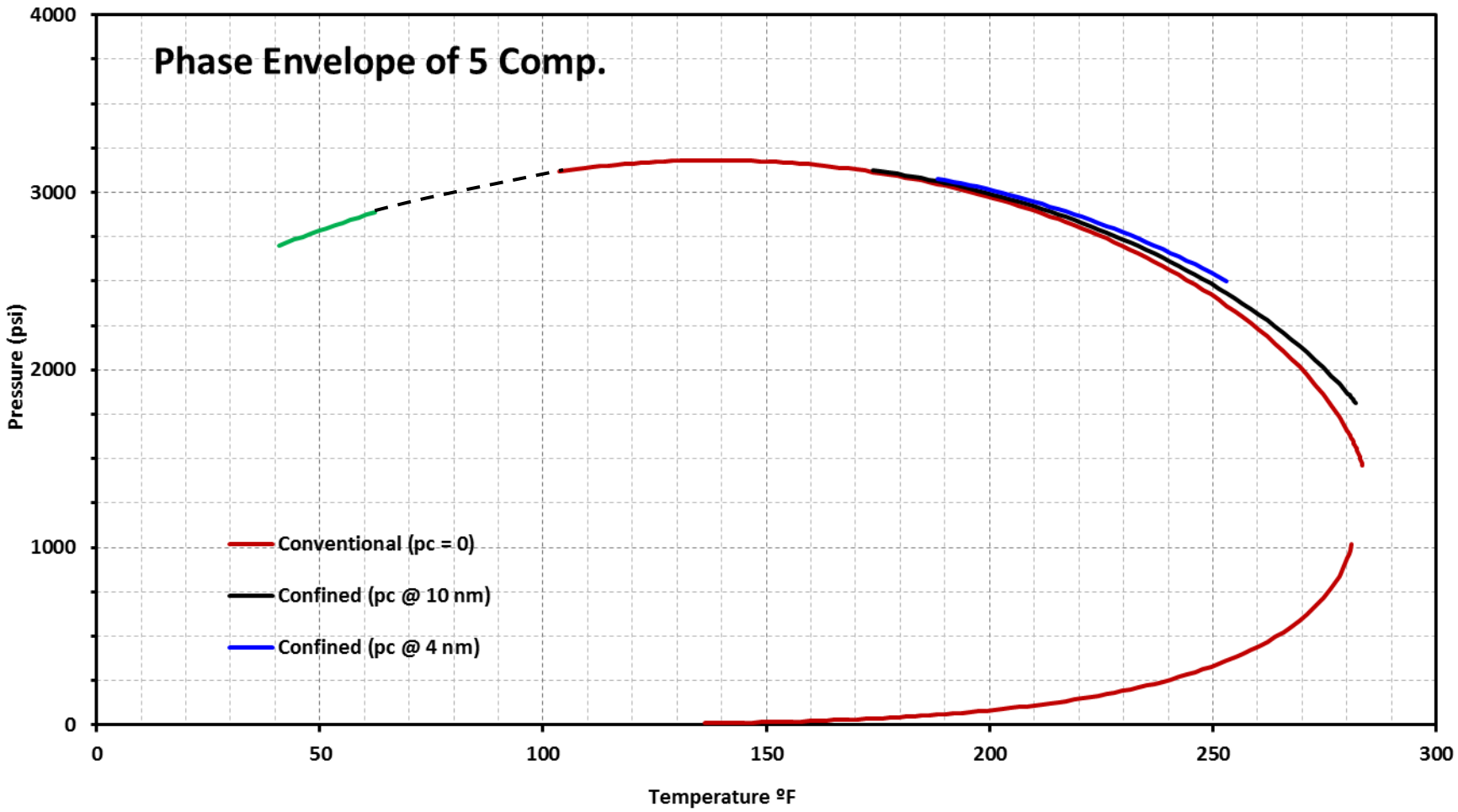


Applications (Condensate Sample)



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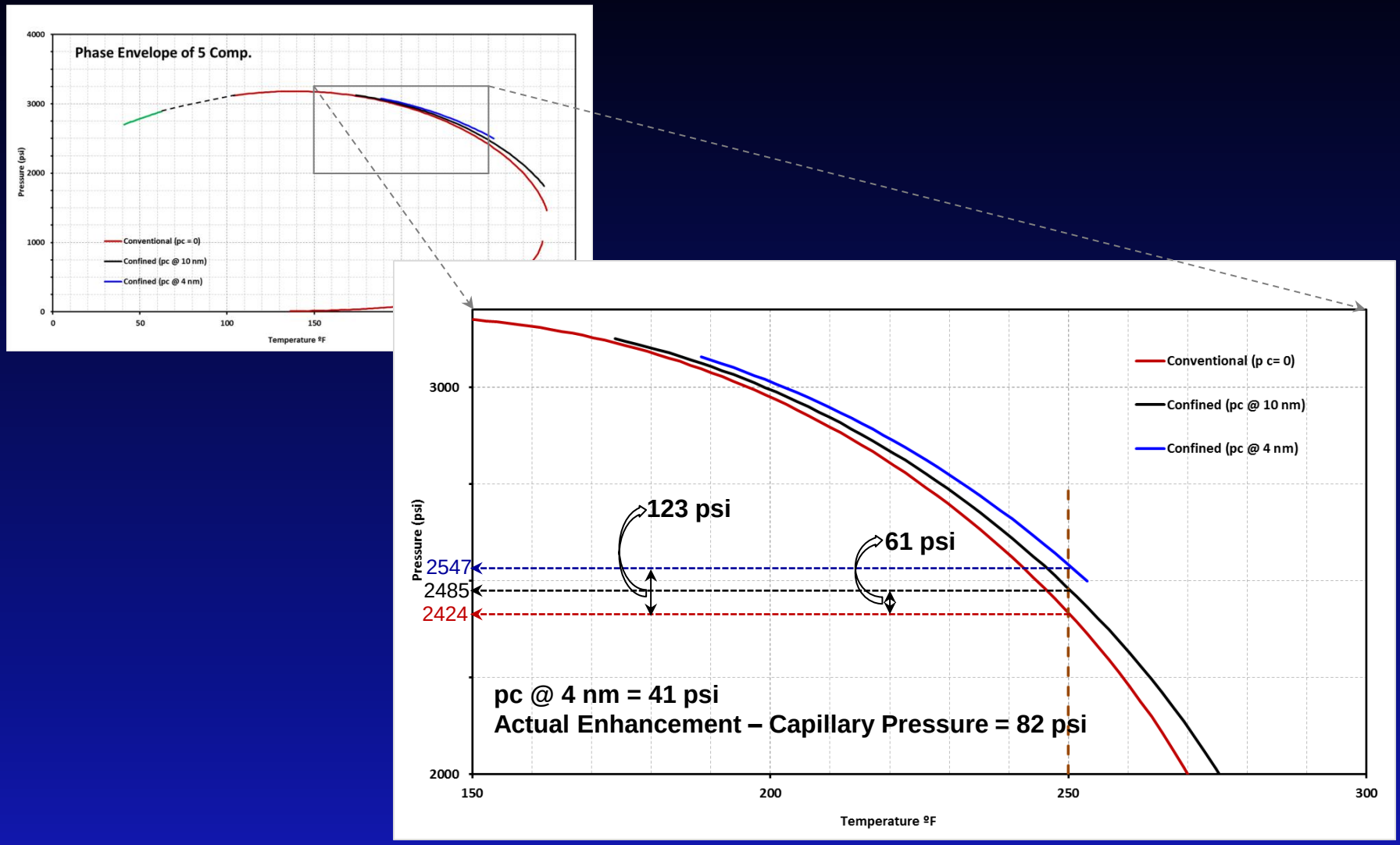


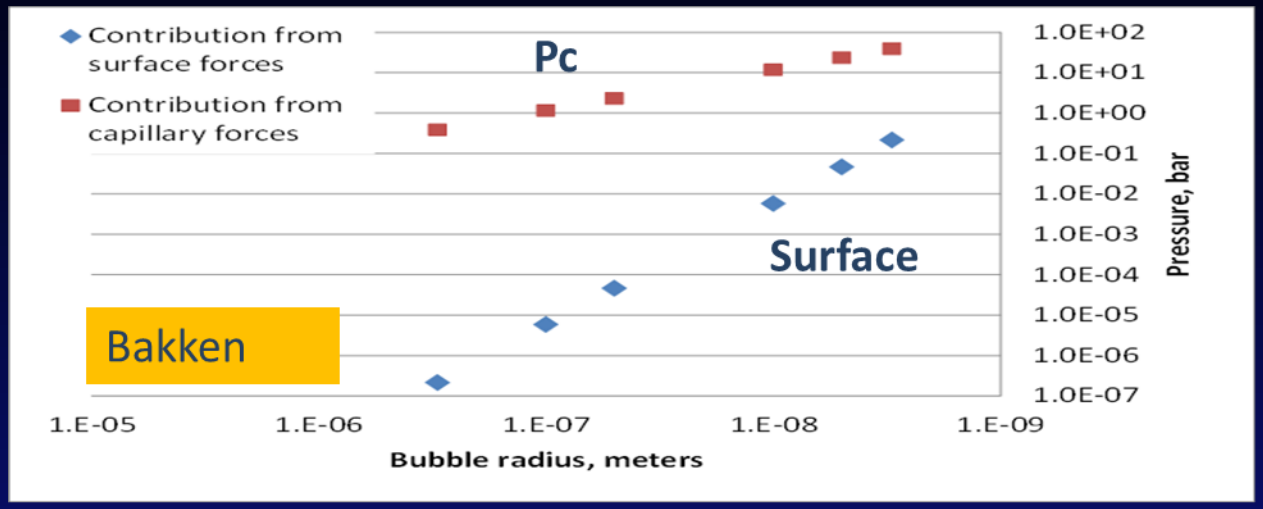
Future Work

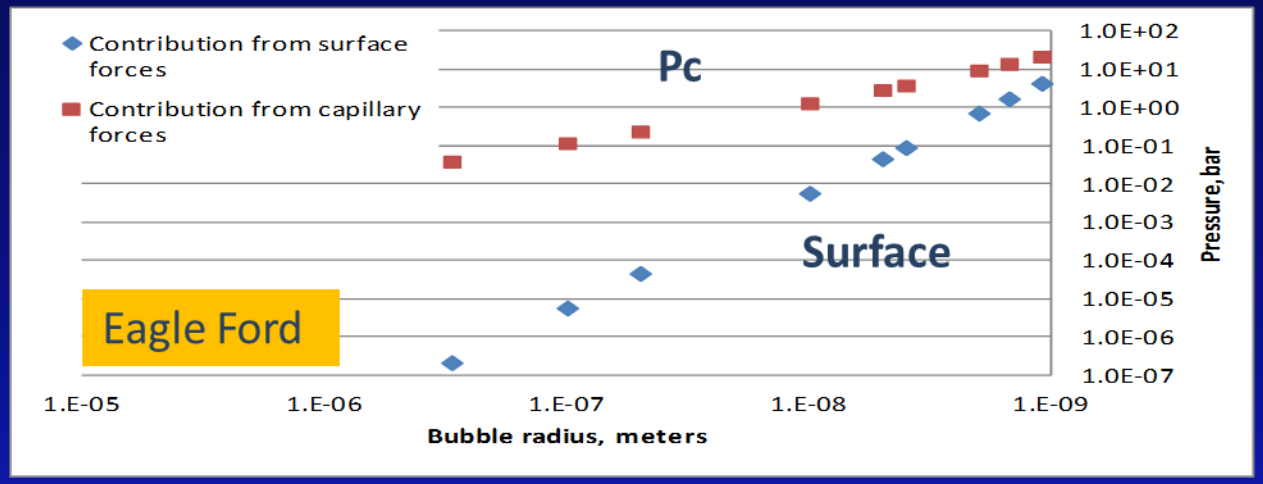
- The impact of confinement should be investigated using more condensate samples.

Future Work

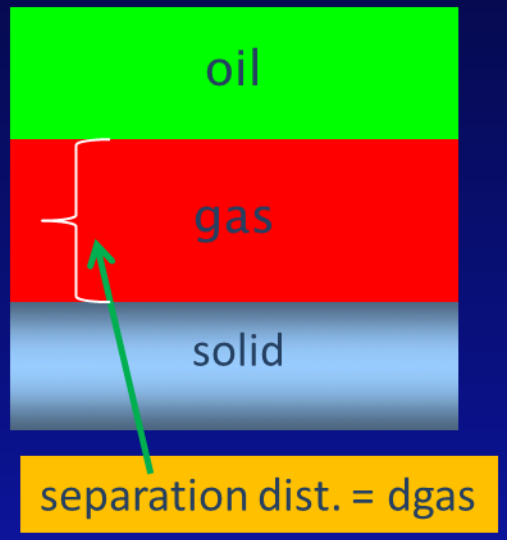
- $p_G - p_L = p_c + \Pi$
- **Surface forces**
  - *electrostatic*
  - ***Van der Waals***
  - ***adsorption***
- Firincioglu et al (2012) investigated the impact of the Van der Waals surface forces on bubble point suppression. They found that these forces are negligible compared to the capillary forces.

Future Work





$$P_g - P_l = \frac{2\sigma}{r} + \Pi$$



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