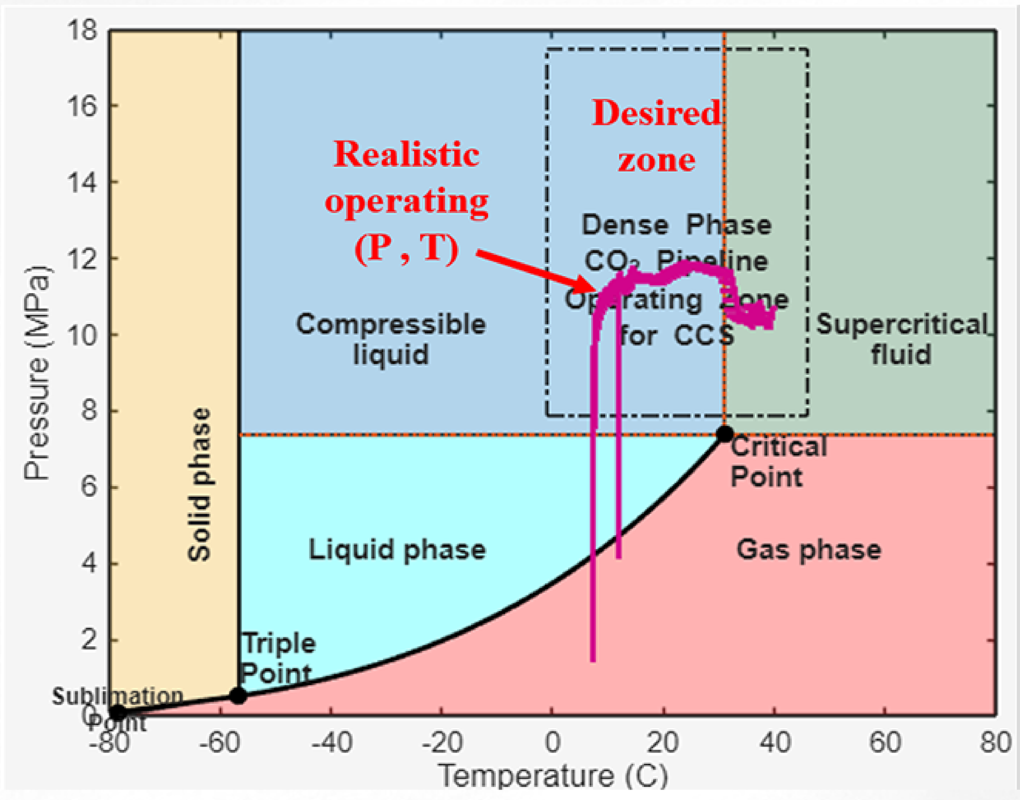
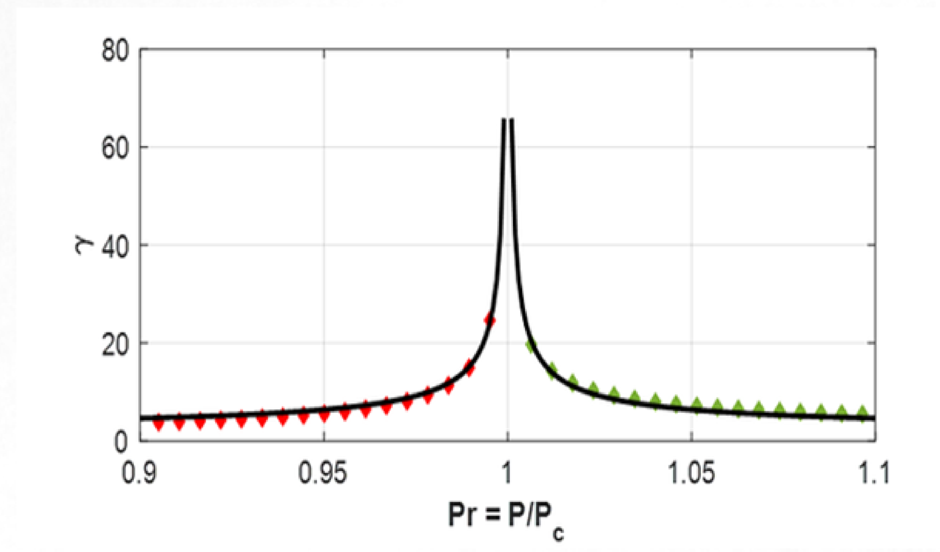
Vanmok Dense Phase Simulator for CO_2 Pipelines



Transporting CO_2 at pressures higher than its critical point is the most economically efficient method. A supercritical fluid has a higher density than a gas and a lower viscosity than a liquid, which allows for greater throughput with less pressure drop along the pipeline.

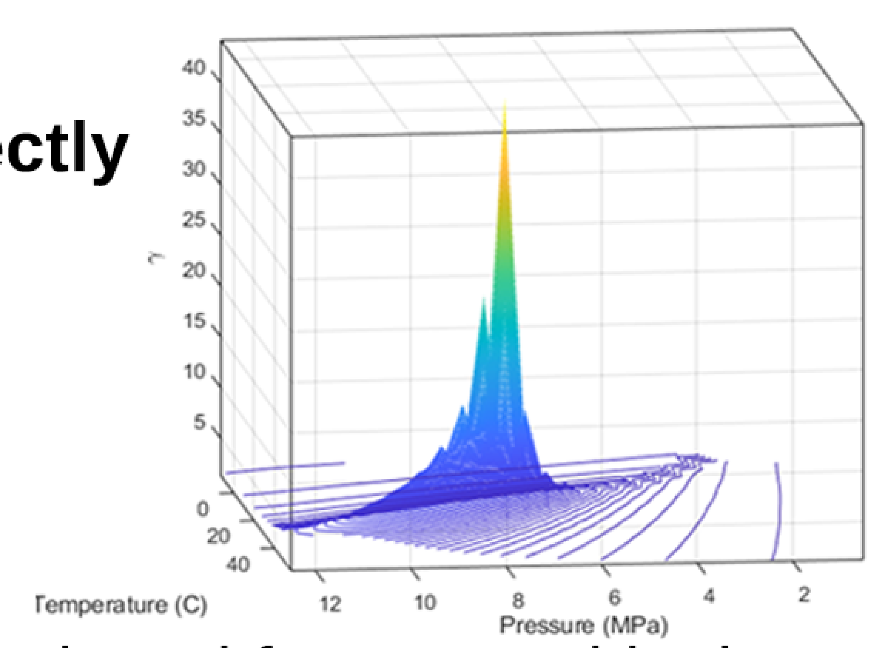
Equation of State – Challenges



CO2 pipeline design gets wrong if corrected EOS is not used.

- Industrial pipelines transport CO2 in dense and supercritical phase.
- Temperature changes and operational deviations can force phase transitions.
- Near the critical point where CO2 pipeline operates, small modeling shortcuts can create large errors.
- Density and heat-capacity ratio change sharply near critical conditions.
- Many conventional equations of state (EOS) smooth out this behavior, leading to 10–30% property errors.
- Those errors propagate directly into FEED design studies, and leak detection reliability.

CO2 pipeline design becomes unreliable if near-critical physics is not handled correctly



Need for a Simulator:

Why Existing Simulation Tools Fail Near Critical Region

Most pipeline simulation tools rely on equations of state or property tables that were not designed for near-critical operation. While these methods perform adequately for conventional gas and liquid regimes, they struggle in dense-phase CO2 where property curves change sharply near the critical point. Coarse tables and interpolation smooth out the very physics that governs this region, causing real-time models to use density and thermodynamic values that can be wrong by 10–30%. These inaccuracies directly undermine transient simulation fidelity and the reliability of leak detection systems.

- For a given pipeline design parameter (diameter, length, and elevation), what throughput can be achieved?
- Can the flow remain supercritical along the entire length of the pipeline?
- What is the effect of impurities?
- How do seasonal temperature variations affect throughput?

Scan the QR code to run what-if scenarios

Data driven actionable insights for design and operation of CO_2 Pipelines

Vanmok's unique solution to address near critical physics

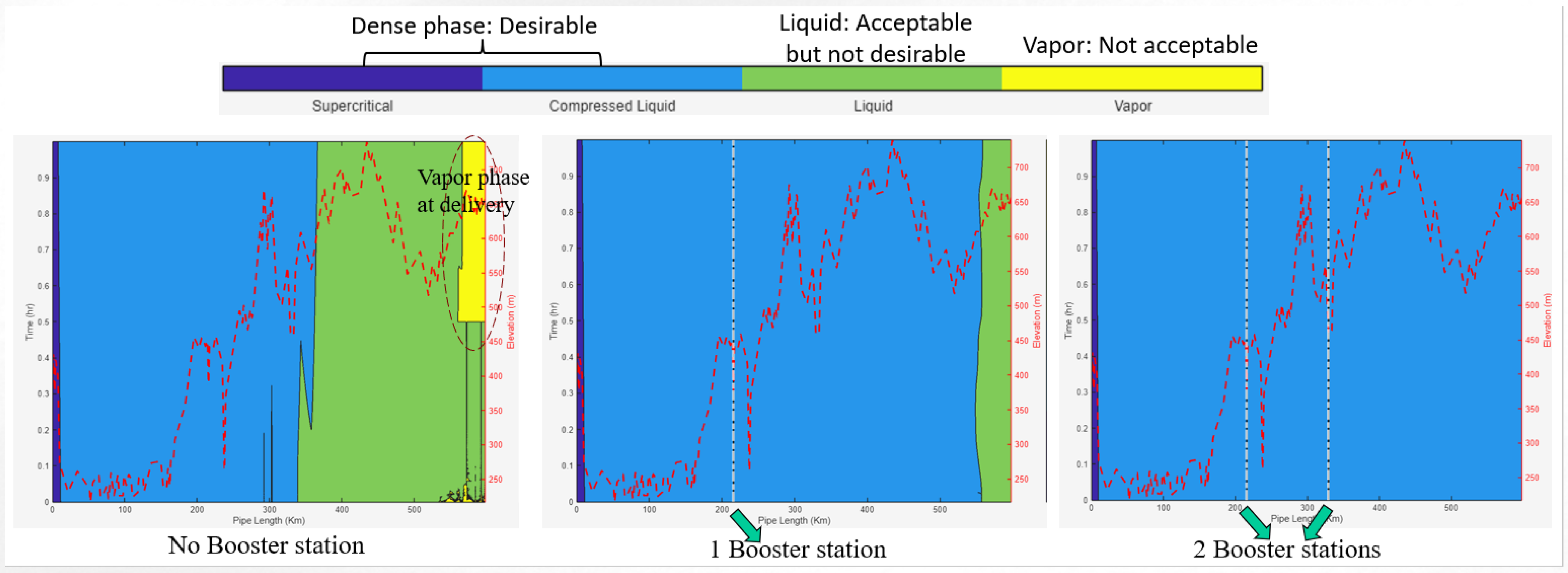
Vanmok's CO2 Simulator uses explicit, regularized thermodynamic correlations tailored for the critical region.

- Our simulator detects proximity to the critical point.
- Replaces property evaluation with analytical correlations for all thermodynamical properties.
- Correlations are directly embedded into the transient PDE solver.
- Continuous, numerically stable thermodynamic field across gas, liquid, critical, and supercritical regimes is produced.
- No property look up tables are used.
- Simulator is numerically stable (free of singularity) in real time transient simulation.

Why Choose Vanmok Dense Phase Simulator for CO2 Pipelines?

- **Precision and Accuracy:** Benefit from state-of-the-art thermodynamic and fluid dynamic models to predict CO2 behavior with exceptional accuracy.
- **Cost Optimization:** Identify the most cost-effective pipeline design and operational parameters, reducing both construction and long-term operational costs.
- **Real-Time Decision Making:** Leverage real-time data and simulations for proactive monitoring and operational adjustments, ensuring the system operates efficiently under all conditions.
- **Regulatory Compliance:** Stay ahead of regulatory requirements with compliance checks and detailed reporting, ensuring your pipeline operations meet the latest safety and environmental standards.

Operation Analysis



CO2 PIPELINE PHASE CHANGE DETECTION ALONG THE LENGTH AND OVER A DAY.

COMPRESSOR STATION SPACING EFFECT ON CO2 PHASES IN PIPELINE

Experience the Future of CO_2 Pipeline Transport

At Vanmok, we are committed to providing innovative solutions that enhance the efficiency, safety, and environmental sustainability of CO_2 transportation. Vanmok Dense Phase Simulator for CO_2 Pipelines is the ideal tool for designing, analyzing, and optimizing pipelines that transport CO_2 in the supercritical phase.