



Crude Oil Spot Sampling Methods and Their Impact on Thermophysical Properties

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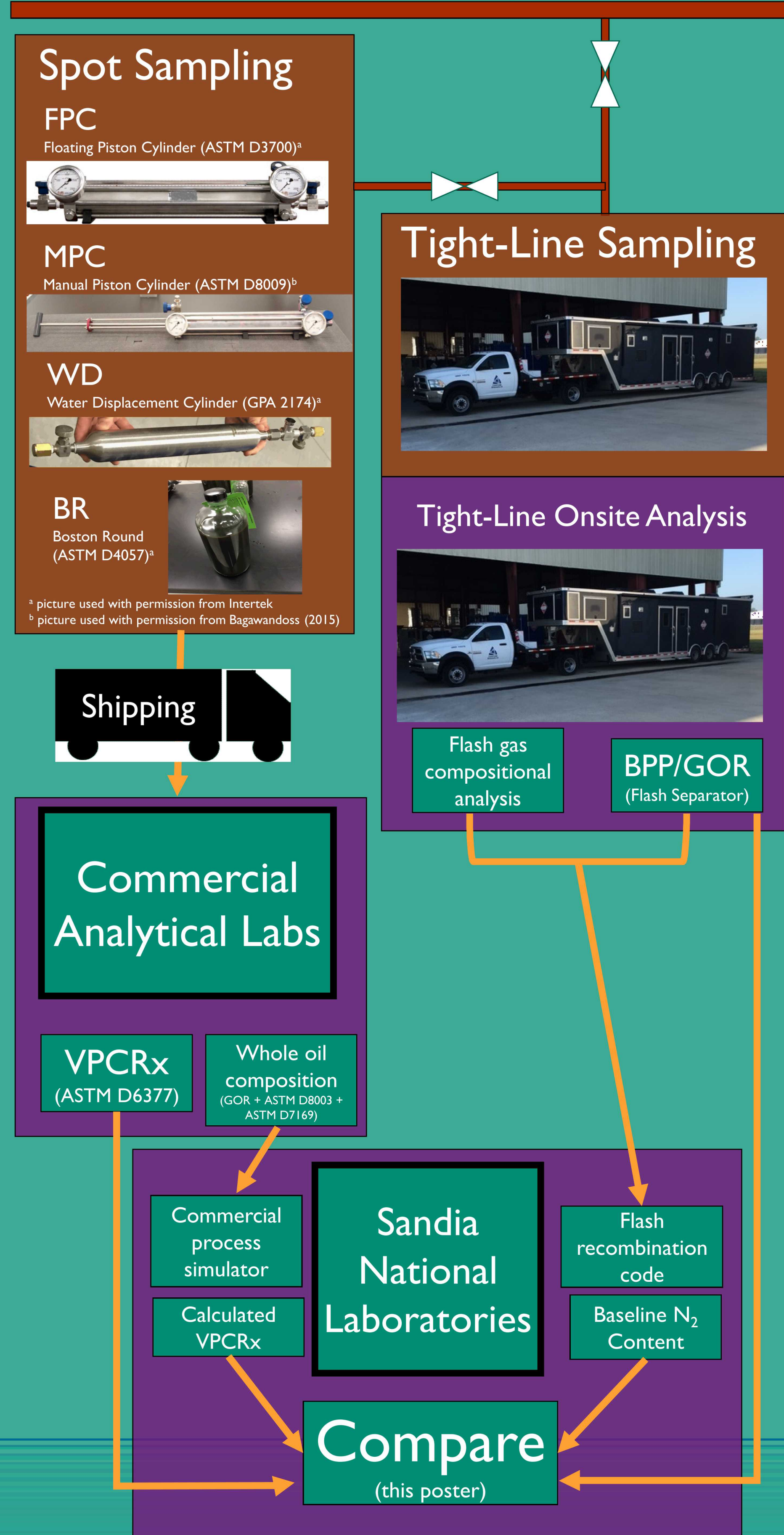
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Motivation

- In many situations, spot sampling provides an economic means by which aliquots of crude oil can be captured from various points in the supply chain for composition, bubble point pressure, density, and sulfur content property analysis offsite. However, inadvertent introduction of N_2 and other gases in sample handling systems during the sampling, transport, and analysis steps can cause difficulties when trying to assess the properties of the parent materials. Here, spot and tight-line sampling are compared for effects on composition and properties of crudes taken from the supply chain.
- There exists debate surrounding which spot sampling methods to use, especially for oils that contain high amounts of light ends
- An accurate representation of thermophysical properties is important for safe, efficient, and economical process design in many elements of the crude oil supply chain from the wellhead to the refinery.

Method

Conditioned shale oil stream (in ND or TX)



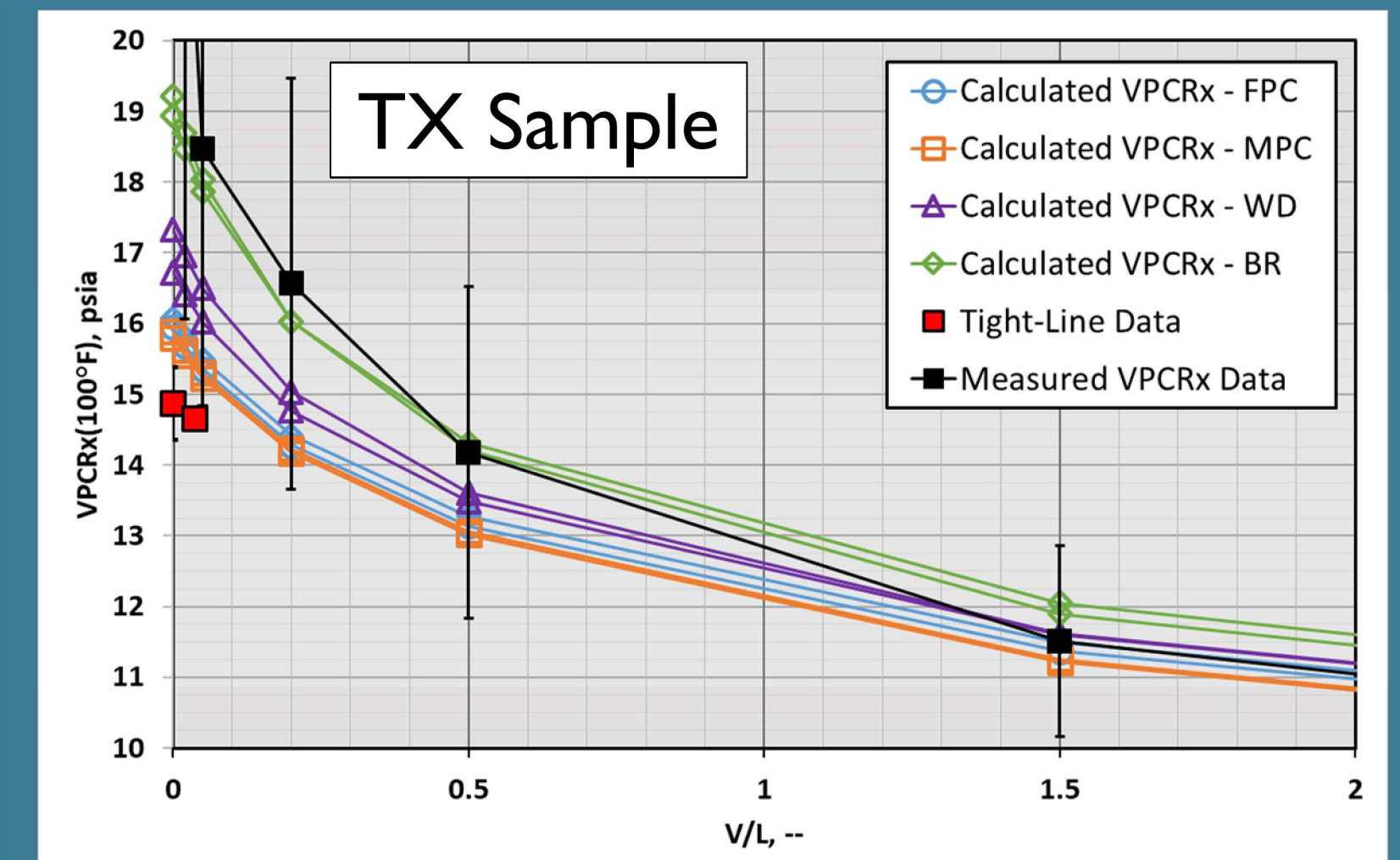
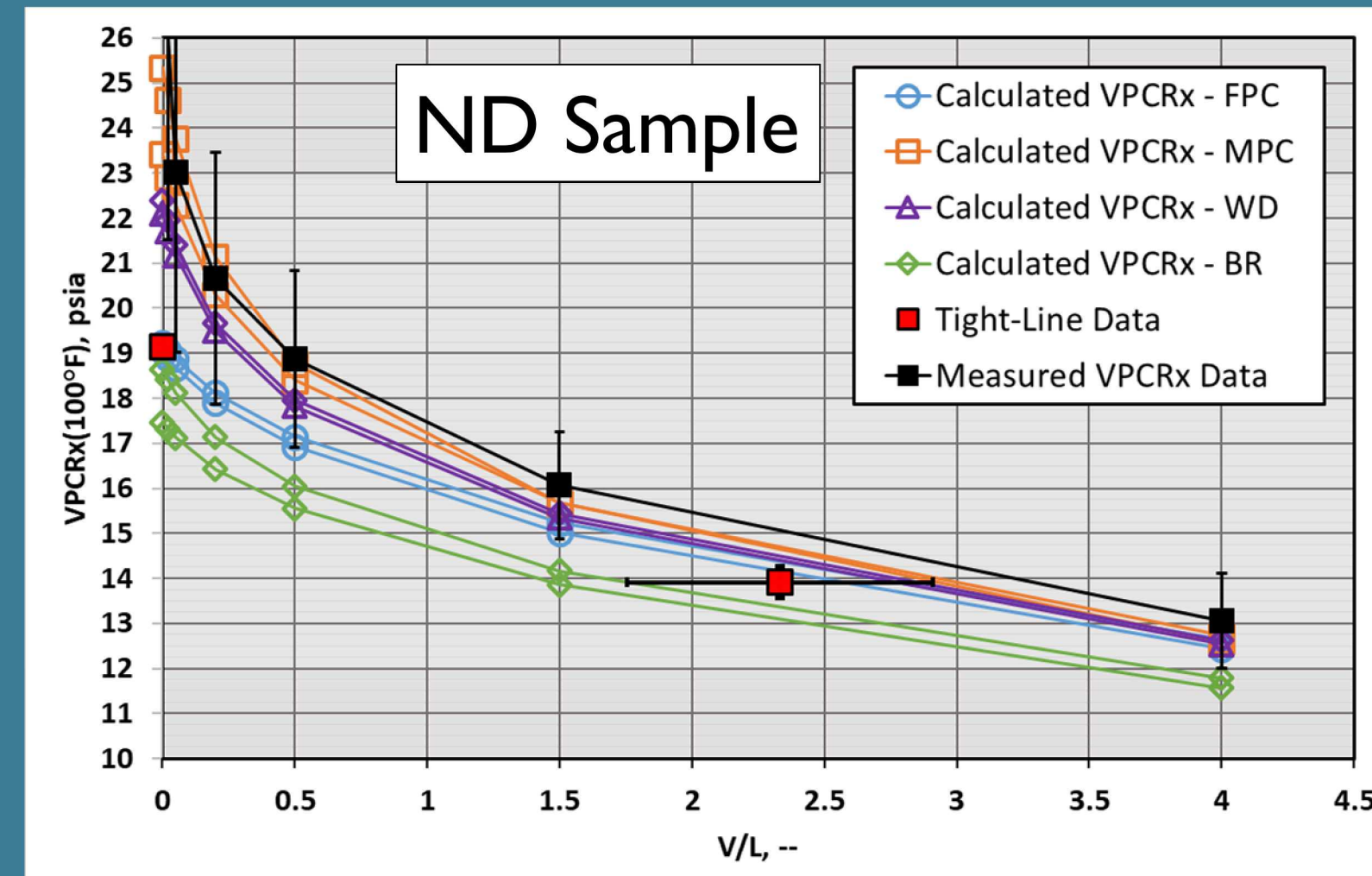
Notations/Acronyms

- BPP: Bubble point pressure
- BR: Boston Round glass jar
- FPC: fixed piston cylinder
- GOR: Gas-oil ratio
- MPC: manual piston cylinder
- ND: North Dakota
- TX: Texas
- V/L: vapor-to-liquid volumetric ratio
- VPCR_x: Vapor pressure of crude oil at $x = V/L$
- WD: water displacement (spun) cylinder

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Original Measured/Calculated VPCR_x (Vapor Pressure of Crude)



Observations

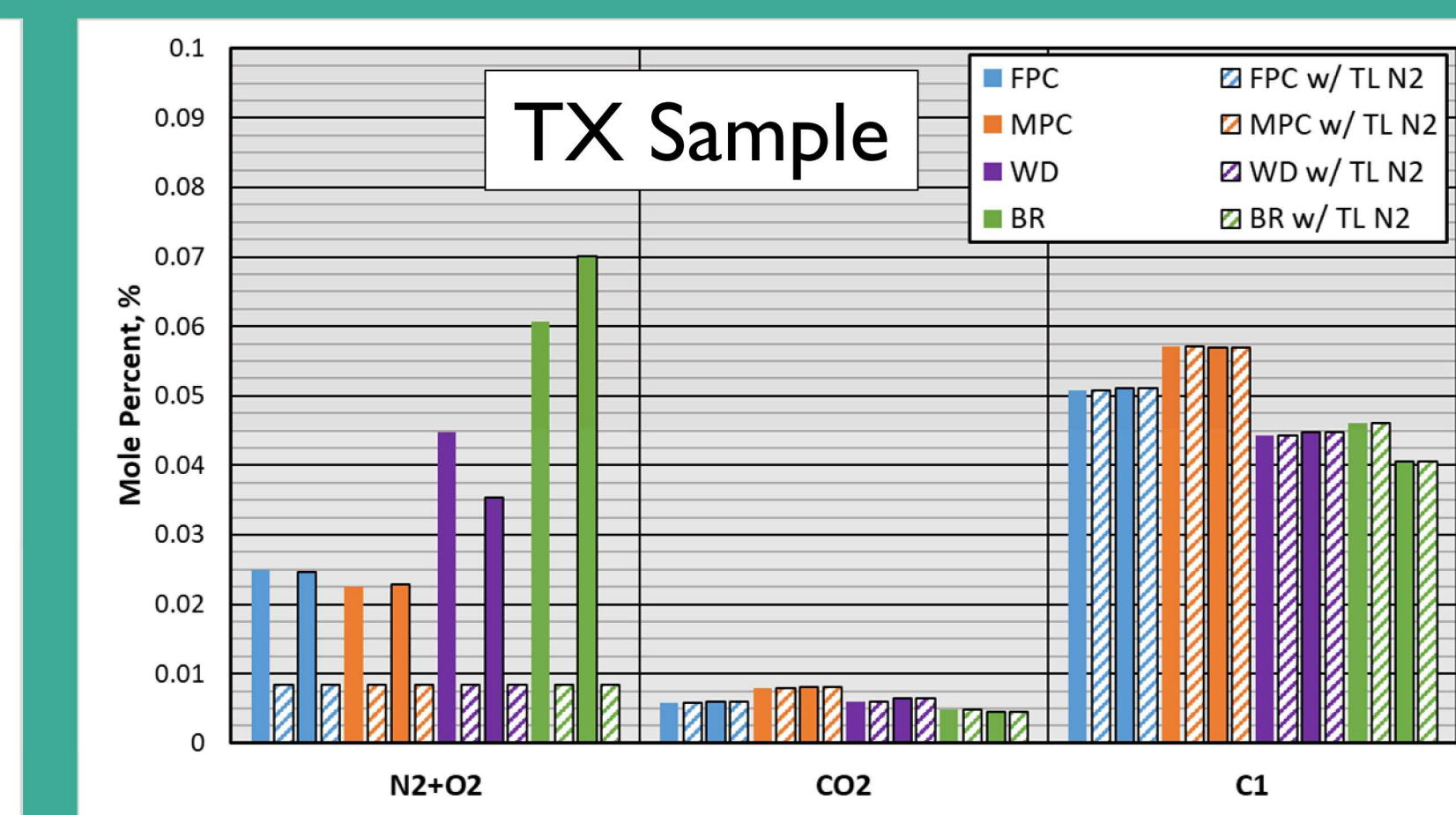
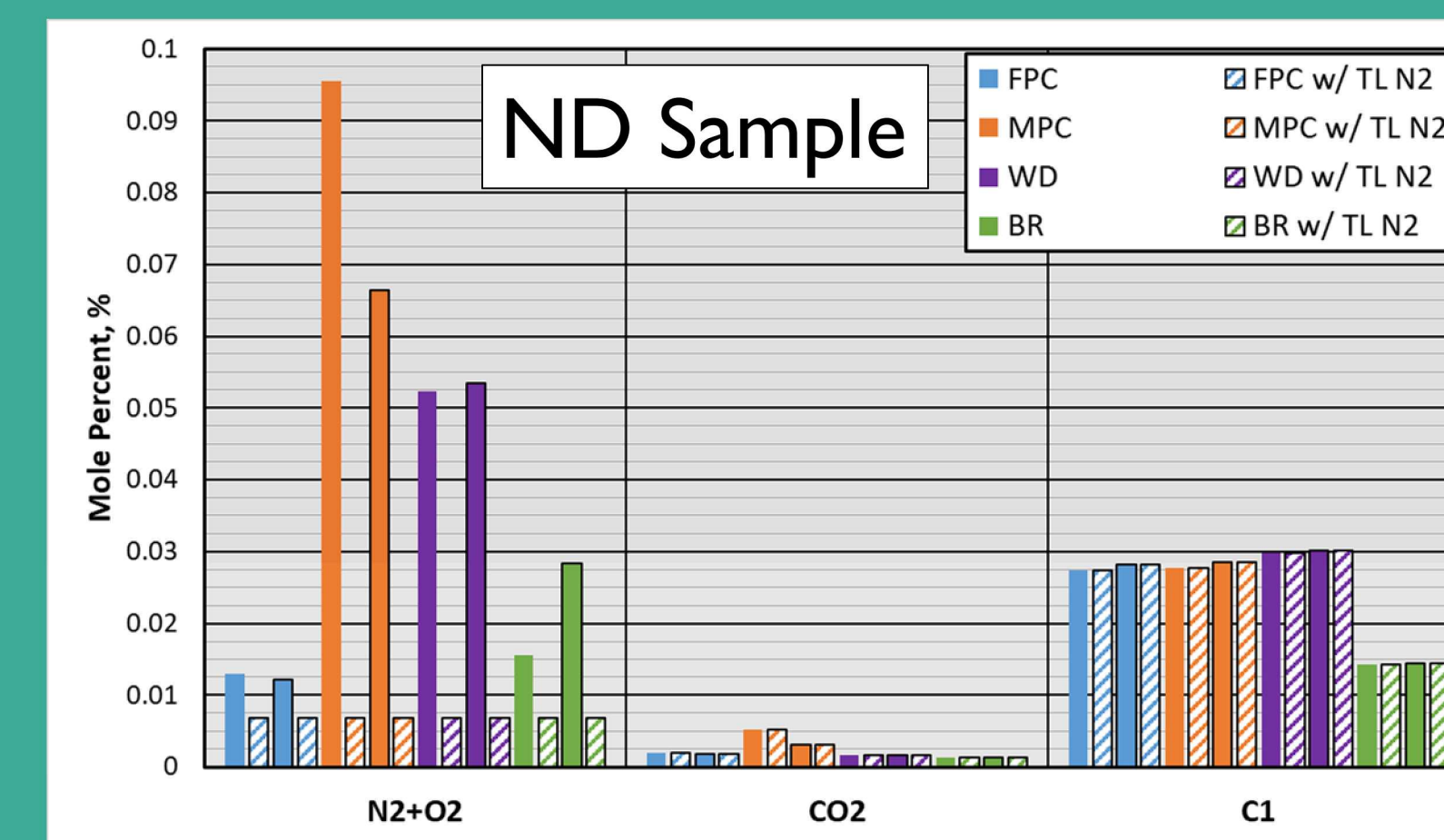
- Closed sampling measured and calculated VPCR_x overshoot tight-line (baseline) data at low V/L.
- Open sampling (BR) produced extreme calculated VPCR_x compared to closed sampling (FPC, MPC, WD)

Hypothesis

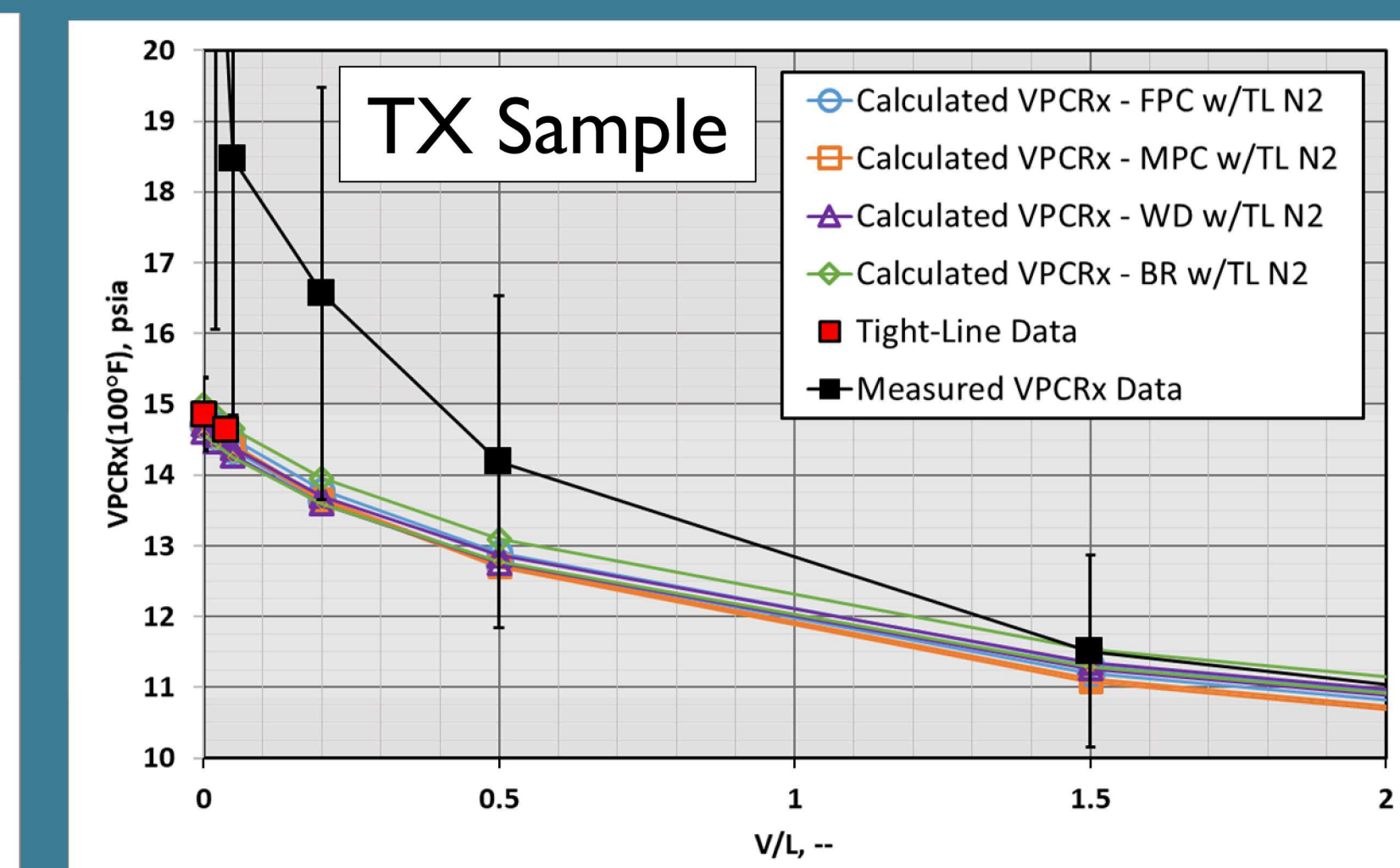
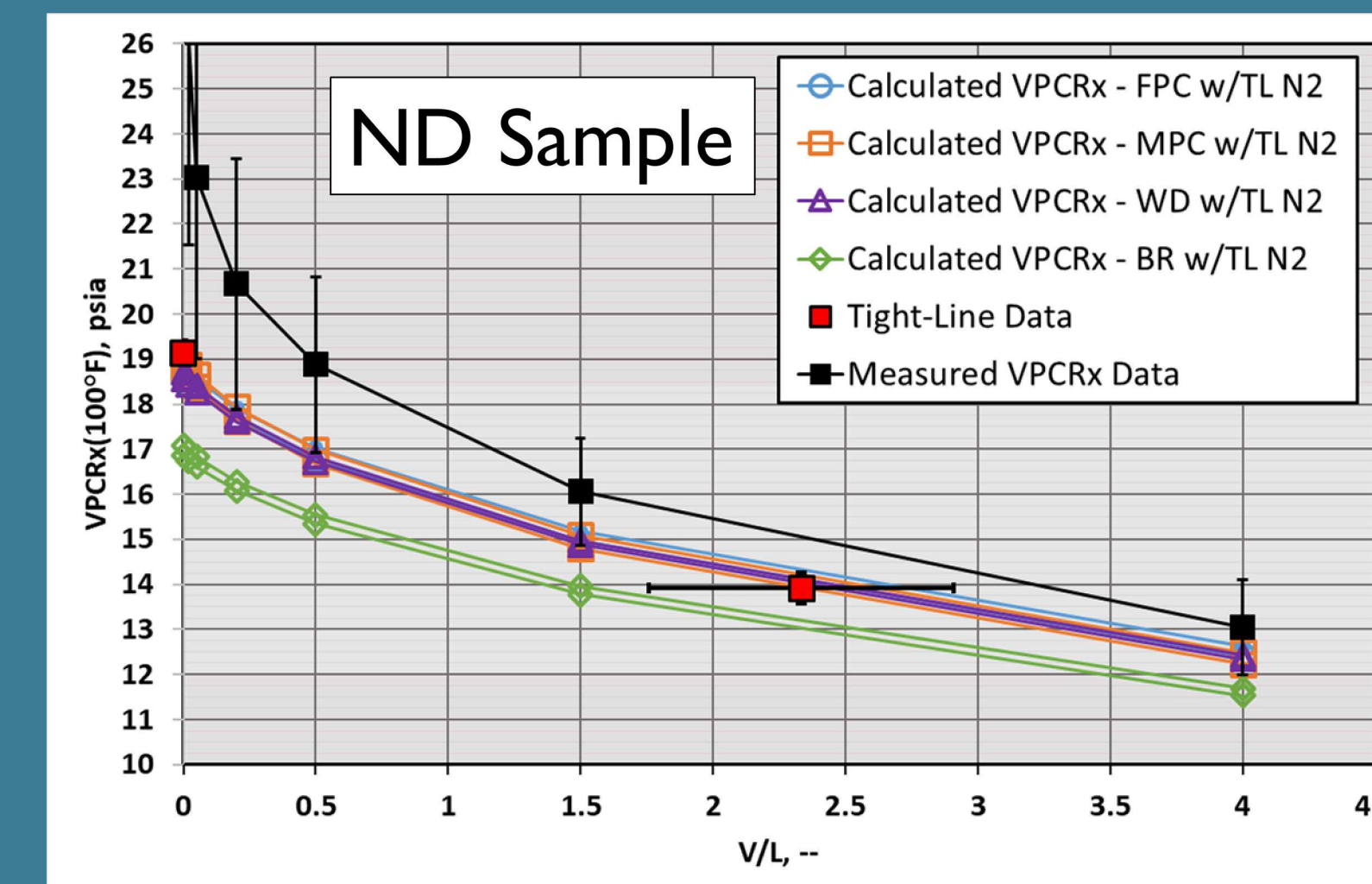
- Closed spot samples trap spurious nitrogen, causing artificially high VPCR_x at low V/L
- Open spot samples exchange light ends with atmosphere, causing VPCR_x change at low V/L

Test Method

- Numerically adjust N_2 for spot samples to match N_2 from tight line sample → renormalize



Recalculated VPCR_x



Observations

- Recalculated VPCR_x performed well compared to tight-line (baseline) data at low V/L
- Recalculated open sampling (BR) results depended on material volatility

Conclusions

- Closed spot samples accumulated extra N_2 relative to tight-line sampling
 - Using tight-line measured N_2 content in closed spot sample VPCR_x calculations **compared well** to tight-line measured VPCR_x, especially at low V/L
- Open spot samples exchanged light ends with atmosphere
 - More-volatile material (ND; BPP > 14.7 psia) lost light end hydrocarbons (C1) and gained extra air (N_2), artificially deflating VPCR_x
 - Less-volatile material (TX; BPP ~ 14.7 psia) ingested extra air (N_2), artificially inflating VPCR_x

Citations/Publications

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- Lord, D., A. Luketa, C. Wocken, S. Schlasner, R. Allen and D. Rudeen (2015). "Literature Survey of Crude Properties Relevant to Handling and Fire Safety in Transport." *Unclassified Unlimited Release SAND2015-1823*. Sandia National Laboratories, Albuquerque, NM 87185.
- Lord, D., R. Allen, D. Rudeen, C. Wocken and T. Aulich (2018). "DOE/DOT Crude Oil Characterization Research Study, Task 2 Test Report on Evaluating Crude Oil Sampling and Analysis methods, Revision 1 - Winter Sampling." *Unclassified Unlimited Release SAND2018-5909*. Sandia National Laboratories, Albuquerque, NM 87185.
- Hogge, J.W., D. Lord, R. Allen, and D. Rudeen, *Crude Oil Compositional Analysis Methods and Their Impact on Thermophysical Properties*, in *AIChE Annual Meetings*, 2019, Orlando, FL, 11/13/2019.