High Pressure Vapor Liquid Equilibrium Measurements of Binary Hydrocarbon and Water Mixtures Using Nuclear Magnetic Resonance (NMR) Spectroscopy

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Understanding the variability of natural gas composition is crucial to optimizing operating conditions along pipeline infrastructure. The associated compressor stations must effectively repressurize the gas to ensure steady delivery and will suffer damage to the intake and discharge valves with the ingestion of liquid slugs. Current maintenance of gas pipelines utilizes prediction software such as NIST-REFPROP to choose operation conditions that will protect equipment. NIST-REFPROP relies on vapor-liquid equilibrium (VLE) data of natural gas mixtures to predict phase behavior. Currently, it suffers from predictive errors under non-ideal conditions (*e.g.,* the presence of water) and at low temperatures (0 – 100 °C/ 32-212 °F) and pressures (0 – 13.79 MPa/ 0-2000 psi) because of extrapolation where experimental conditions have not been explicitly replicated.

Here, we present a study that replicates such conditions to measure more accurate compositions, ensuring that operating conditions are appropriately selected. The mixtures we present consist of methane and water, ethane and water, and propane and water. By incorporating the presence of water in the mixtures studied here, we account for the deviation from ideality not captured by current models. Nuclear magnetic resonance (NMR) spectroscopy offers a high-accuracy, low-uncertainty, quantitative approach to collecting VLE data over a range of temperatures and pressures. These measurements will improve the thermodynamic calculations done by NIST-REFPROP and provide the natural gas industry with fundamentally improved models for pipeline maintenance and operation. Furthermore, the experimental methodology we detail is readily adaptable to more complex, ternary mixtures for future application.