Nuclear Magnetic Resonance Spectroscopy Techniques for the *in-situ* Composition Measurement in Fluid Mixture Vapor-Liquid Equilibria Experiments

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In this work, we demonstrate the use of nuclear magnetic resonance (NMR) spectroscopy for the determination of the liquid and vapor phase compositions in a vapor-liquid equilibrium (VLE) experiment. Appropriately designed NMR experiments yield quantitative compositions because the area of a NMR signal is proportional to the number of nuclei it represents. The conditions necessary for achieving quantitative results for NMR of liquids, and more recently gases, has been established and presents an opportunity for these techniques to be applied to two-phase mixtures. Here, we prepare a quantity of a binary mixture, sufficient to establish separate liquid and vapor phases, and fill it into a commercially available high-pressure NMR tube, which is then loaded into the NMR magnet. Next, we conduct a suite of NMR experiments, and the corresponding processing and analysis techniques, to determine the composition of each phase *in situ*. While the differing densities of the liquid and vapor phases—and resulting shift in their respective spectra—would allow, in principle, a simultaneous composition determination of both phases, the step change in the magnetic permeability at the liquid-vapor interface presents complications. Additional challenges related to both sample preparation and experimentation are also discussed. We present several strategies to overcome these issues and provide proof-of-concept measurements on a binary mixture. Finally, we discuss the prospects for further improvement as well as the limitations of the technique.