Experimental Phase Envelopes for Two Synthetic Light Natural Gas-Like Mixtures

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Natural gas is an extremely important energy and feedstock source. Gas appears poised to become the fastest growing source of energy in the near future, and, from an environmental viewpoint, it is the least offensive fossil fuel. Our laboratory has conceived a research project for the systematic measurement of volumetric and phase equilibria properties of natural gas mixtures over wide temperature and pressure ranges that considers the effects of mixture components and composition. We report here preliminary results of experimental phase envelopes for two light, synthetic natural gas mixtures measured using a semi-automated isochoric apparatus. The reported multicomponent mixtures contain n-pentane as the heaviest component, and one of them also contains nitrogen and carbon dioxide.

The experimental technique utilizes pressure versus temperature measurements along nearly isochoric paths, and detects the phase boundaries by observing the slope change of the isochores. The equimolar binary system methane + ethane serves to establish the reliability of our apparatus, showing low deviations from experimental data in the literature.

The measured phase envelopes have significant deviations compared to the predictions of common equations of state, both cubic and molecular-based. The deviation for the sample without nitrogen and carbon dioxide is 2 to 3 MPa in the cricodenbar and 3 to 5 K in the cricodetherm, whereas the sample containing nitrogen and carbon dioxide have values closer to the predicted ones.

These results illustrate that models usually considered in the design of processes of natural gases have suspect phase equilibria, especially in the cricodenbar region. Thus, it is not prudent to use these equations of state for such systems, and a need exists for new, more accurate equations of state based upon a much broader set of data for multicomponent mixtures.