Phase Equilibrium Studies of the Ternary Mixtures (Methane + Propane + BTEX) at Temperatures from (213 to 323) K and Pressure to 12 MPa

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High-quality VLE data for LNG-related mixtures are essential for improving and examining the accuracy of existing equations of state (EOS) used in the design and simulation of the cryogenic distillation columns, also known as scrub columns. Data for the partitioning of BTEX (benzene, toluene, ethylbenzenes, and xylenes) compounds, which exist as minor components in both phases are particularly important given the freeze-out risk they pose for downstream cryogenic heat exchangers. In this work, the vapor-liquid equilibrium of a ternary methane + propane + methylbenzene (toluene) and methane + propane + 1,4-dimethylbenzene (p-xylene) mixtures were studied over a wide range of conditions, with toluene and p-xylene as the minor components in both the liquid and vapor phases. Measurements were conducted along different isochoric and isothermal paths at temperatures between (213 and 323 K) and at pressures up to 12 MPa. Two analytical VLE apparatus were used, with liquid and vapor phase samples being analyzed using a GC fitted either with a Flame Ionization Detector or a Barrier Ionization Detector. The measured VLE data were compared to values calculated with the Groupe European de Recherche Gaziere (GERG-2008) multiparameter EOS and the HYSYS Peng Robinson (PR) equation of state (EOS) used widely in the LNG industry. The amount of toluene and p-xylene in the vapor phase was under-predicted by both EOS, with the deviations increasing in magnitude at low temperatures. These VLE measurements demonstrate that current EOS substantially under-predict the possible BTEX content of saturated vapors that could be present in the overhead product stream of an LNG scrub column.