PHASE EQUILIBRIA VAPOR-LIQUID-SOLID BINARY AND MULTICOMPONENT IN CO₂-HC SYSTEM

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ABSTRACT

In this work, phase equilibria for carbon dioxide (CO₂) frost in CH₄/CO₂, CH₄/CO₂/C₂H₆, CH₄/CO₂/C₂H₆/C₃H₈, CH₄/CO₂/C₂H₆/C₃H₈/C₄H₁₀ system was investigated by using double pipe heat exchanger (DPHE) with 190 cm length where inner tube made of copper and the annulus made of stainless steel with 3/8 in and 5/8 in diameters, respectively. The blockage point location was predicted using Peng-Robinson equation of state. Nine resistance temperature detectors were installed as temperature sensors along DPHE with 0.25 m distance between two RTD. The mixed gas was flowed into annulus and cold nitrogen gas and it was flowed into tube in counterflow. The initial CO₂ frost formation was detected using pressure drop indicator installed in annulus side inlet and outlet and it was allowed until fully blockage occurred. After steady state condition was achieved, the gas composition flowed out from annulus was analyzed using gas chromatography. Experiment was carried out in (5% and 10% mole of concentration CO₂ in mixed gas (CH₄/CO₂)) and (3% and 7% mole of concentration CO₂ in mixed gas (CH₄/CO₂/C₂H₆/C₃H₈/C₄H₁₀)) with pressures of 1, 5, 10, and 20 bar. The result showed that Peng-Robinson equation of state was successfully employed to predict frost temperature of the gas mixtures. Frost temperature obtained from experiment was compared with those from predicted result using Peng-Robinson Equation of State and gave 1.7% average absolute deviation. The phase equilibria data obtained in this work are necessary for rational design for optimizing CO₂ removal process.

Keywords: double pipe heat exchanger, phase equilibria, CO₂ frost peng-robinson EoS