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Widom Line Prediction by the Soave-Redlich-Kwong and Peng-Robinson Equations of State

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Abstract

Using cubic equations of state for a single-component fluid, we compute pseudocritical loci where the isobaric heat capacity is a relative maximum at constant pressure, or at constant temperature. These two loci, called the Widom line and the characteristic isobaric inflection curve (CIIC), are quite different from each other, as we show using the van der Waals equation, where the two curves admit a closed-form representation in the (P, T) plane. Similarly, the Redlich-Kwong (RK) equation leads to a closed-form representation for the CIIC in the (T, v) plane. With the Soave-Redlich-Kwong (SRK) and the Peng-Robinson (PR) equations we find almost coincident predictions for the above-mentioned pseudocritical loci; furthermore, comparing our results with a correlation obtained by regression of experimental data for CO_2 and water shows that the increased complexity of the SRK and PR equations (as compared to RK) allows improved agreement with the experimental data.

Keywords: Characteristic curves; Cubic equations of state; Thermodynamics.

1. Introduction

As is well known, the physical properties of a pure substance that enters its supercritical region by heating or cooling are strong functions of temperature and pressure, which can greatly affect heat transfer rates in practical applications. For example, in a supercritical constant-pressure process, all physical

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