As a companion to a new correlation for the thermodynamic properties of air in single-phase states, new values for the properties on the dew and bubble lines have been calculated. Phase equilibrium properties for air at low and moderate pressures were predicted from accurate equations of state for argon, nitrogen, and oxygen using extended corresponding-states (ECS) methods. For pressures near the critical pressure, property values were calculated using a modified Leung-Griffiths model for mixtures of argon, nitrogen, and oxygen. Available experimental data and newly predicted values have been used in developing new correlating functions for estimating density and pressure on the dew and bubble lines of air. Estimates of the accuracies of these correlations based upon comparisons of calculated properties to data from other sources are also included.

KEY WORDS: air; bubble point; dew point; phase equilibrium; thermodynamic properties.

1. INTRODUCTION

This paper is a companion to the preceding paper [1], which presents a revised wide-range model for the thermodynamic surface of state of air. For the wide-range model of Jacobsen et al. [1], dry air was considered to
be a ternary mixture, with mole fractions of 0.7812 N\textsubscript{2}, 0.2096 O\textsubscript{2}, and 0.0092 Ar, and was treated as a pseudopure substance over the range of single-phase liquid and vapor states where composition remains constant. The correlations for dew- and bubble-line properties of air presented in this work were developed in conjunction with the wide-range model of Ref. 1.

There is considerable uncertainty about the correct shapes of the dew and bubble lines of air in the vicinity of the critical point because this region has not been defined by experiment. Consequently, the theoretical model from Ref. 2 has been extended to ternary mixtures and applied to the nitrogen–argon–oxygen system for the purpose of calculating vapor–liquid equilibrium (VLE) in the critical region of air. Dew- and bubble-line properties for air based on the ternary Leung–Griffiths model are presented in Section 2 and supersede those published in the previous work of Ref. 2, where air was treated as a binary mixture of oxygen and nitrogen. The inclusion of argon in the model has made a small but significant difference in the dew- and bubble-line properties for air.

Another mixture property formulation for the coexistence states of air is the extended corresponding-states model given by Rousseau [3]. This model exhibits significant deviations from the experimental data of Blanke [4] and is used in this work for comparison purposes only.

2. THE MODIFIED LEUNG–GRIFFITHS MODEL FOR AIR

The Leung–Griffiths model [5] as modified by Moldover, Rainwater, and co-workers [6–11] has provided accurate VLE correlations in the critical regions of many binary mixtures. In a previous application, Rainwater and Jacobsen [2] estimated the coexistence properties of air at temperatures above 120 K using a correlation for nitrogen–oxygen mixtures based on the modified Leung–Griffiths model. In this prior work, air was considered to be a mixture with mole fractions of 0.7814 N\textsubscript{2} and 0.2186 O\textsubscript{2}. Pressure, density, and temperature values corresponding to state points on the dew and bubble lines were calculated from the model and used as estimates of the coexistence properties of air. Errors in these calculated coexistence properties caused by neglecting the presence of argon and other constituents were ignored.

Rainwater recently extended the formalism of the Leung–Griffiths model to ternary mixtures. In this work, the ternary model was applied to mixtures in the nitrogen–argon–oxygen system using an interpolation scheme developed by Van Poolen. Data of Wilson et al. [12], Jones and Rowlinson [13], and Israel et al. [14] were employed in developing this model. New estimates for coexistence properties of air above 120 K, including estimates of the critical point, maxcondentherm, and maxconden-