A Generalized Virial Equation of State for Natural Gas Systems

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The use of a generalized virial equation of state for natural gas systems [1] is an interesting alternative to other more complex models [2,3,4].

We propose 6-coefficient generalized correlations for the second and third virial coefficients, instead of the 17 coefficients that a generalized EoS would need if it were based on the well-known Tsonopoulos [5] and Orbey-Vera [6] correlations. For the extension to mixtures, the standard method is to calculate the mixture virial coefficients from formal mixing rules using interaction virial coefficients calculated at pseudo-reduced conditions for each binary interaction. Also, a pairwise-additive approximation is needed for the interaction third virial coefficient. This is an important source of inaccuracy in the case of complex multicomponent mixtures, such as natural gas systems. Instead, we propose a much simpler method by which the mixture virial coefficients are calculated at the mixture pseudo-reduced conditions obtained by means of standard van der Waals one-fluid mixing rules. Although this is an approximation as well, it avoids a need for cumulative approximations to the third interaction virial coefficient.

The application to natural gas systems in the intervals from 270 to 330 K and pressures up to 12 MPa gave the following results. The overall AAD was 0.047 % for densities and 0.080 % for speeds of sound. For binary mixtures of the primary components of natural gas systems, the AAD in densities was 0.070 % and in speeds of sound was 0.19 %. For the pure components of natural gas systems, the AAD in densities was 0.040 % and in speeds of sound was 0.080 %.

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