In this work we present a generalised virial equation of state for natural gas systems under custody transfer conditions, i.e. the intervals $270 \leq T/K \leq 330$ and $p/\text{MPa} \leq 12$. The model is based on corresponding states expressions for the second and third virial coefficients with argon as the reference fluid. The acentric factor of argon is calculated with the vapour-pressure ancillary equation by Tegeler et al. [1]. The correlations for the generalised second and third virial coefficients use 12 adjustable coefficients. By comparison, a generalised virial model based on the Tsonopoulos [2] and the Orbey-Vera [3] correlations for the second and third virial coefficients, respectively, would incorporate 17 adjustable coefficients.

For the extension to mixtures we propose a one-fluid mixture model with binary interaction parameters in the combining rules for the mixture critical temperature and density. With this device we intend to amend the unsatisfactory pairwise additivity approximation to the interaction third virial coefficient that is commonly used in generalised virial models [4] with formal mixing rules for the mixture virial coefficients. As a result, our model leads to successful approximations to multicomponent mixture properties; in the case of binary-mixture virial coefficients, the one-fluid mixture model is less accurate than formal mixture models that are quadratic in composition. However, the behaviour of the model is considered satisfactory within the objectives set up for this work: to reduce the number of adjustable coefficients while improving on the predictive capabilities of generalised virial models.

We obtained overall average absolute deviations (AAD) of 0.04 and 0.08 per cent in pure-fluid compression factors and speeds of sound, respectively. For binary mixtures, the AAD’s were 0.07 and 0.19 per cent in compression factors and speeds of sound, respectively. For natural gas systems, the AAD’s were 0.047; and 0.13 per cent in compression factors and speeds of sound, respectively. These results compare quite favourably with equivalent calculations with the generalised virial coefficient models of [2,3].