

## **Helmholtz Energy and Extended Corresponding Models for Non-Polar Fluids and Natural Gases**

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This work presents an overview of the results obtained with Helmholtz energy and extended corresponding (ECS) models for non-polar fluids, mixtures of those fluids and natural gas and related systems. In the proposed model, the mixture Helmholtz energy is represented by a term from an ECS model plus a correction term. The ECS term is based on temperature- and density-dependent shape factors relative to the Setzmann-Wagner reference equation of state for methane and the correction term is a mixing rule, in terms of local compositions, depending on reduced temperature and density; with the local compositions calculated by a coordination number model for square-well fluids. The model was applied to 18 non-polar fluids; 46 binary, ternary and quaternary mixtures of those components and 388 distinct-composition samples of natural gases. The model was tested against a total amount slightly exceeding 91,000 data and representative results, in terms of overall percentage average absolute deviations, were: for pure fluids: 0.175 in densities, 0.279 in vapour pressures and 0.638 in speeds of sound; for binary mixtures: 0.169 in densities, 1.233 in bubble-point vapour pressures and 0.108 in speeds of sound; and for natural gases: 0.060 in densities of pipeline-quality gases, 0.099 in densities of unusual-composition samples, 0.249 in densities of rich natural gases, 0.146 in saturated-liquid densities of liquefied natural gases and 0.220 in speeds of sound. Compared to the equations of state for technical applications, these results are satisfactory and allow concluding that the proposed models are alternatives in the context of technical applications.