EOS-LNG: A New Fundamental Equation of State for the Calculation of Thermodynamic Properties of Liquefied Natural Gases

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The knowledge of thermodynamic properties is important for a safe and efficient design of any process in natural gas production and distribution. For example, in natural gas trade, the transferred energy depends on volume or volume flow, calorific value and density. Thus, the accurate knowledge of the density at given temperature, pressure, and composition of the natural gas mixture is an essential element of the value chain. Since no robust and sufficiently accurate device for *in situ* density measurements at any process step is available, equations of state are currently used to provide this information based on measurements of the pressure, temperature, and composition.

Over the last decades, the transport of natural gas in liquefied form (LNG) has become more important; it is usually shipped between different continents over large distances. Since existing thermodynamic property standards for natural gas focus mainly on gaseous pipeline conditions, new equations have to be developed that enable accurate calculations of thermodynamic properties in the cryogenic region at approximately 90 K to 180 K with pressures up to 10 MPa. Recent density measurements show that the GERG-2008 equation of Kunz and Wagner [1], which is the current standard for natural gas properties in a wide range of compositions and conditions, does not reproduce these data within their experimental uncertainty of 0.05 % or less. Therefore, a new mixture model in terms of the Helmholtz energy is presented here. The new model can be used to consistently calculate all thermodynamic properties from combinations of derivatives with respect to its natural variables. Although special focus was given to the LNG region, the reproduction of all other available data was simultaneously monitored so that the uncertainty of the EOS-LNG is smaller or at least similar to the GERG-2008 equation outside of the LNG-typical range as well.

References:

[1]. Kunz and Wagner (2012), "The GERG-2008 Wide-Range Equation of State for Natural Gases and Other Mixtures", J. Chem. Eng. Data 57, 3032