Accurate Experimental Speed of Sound Data of Natural Gas and Hydrogen-Enriched Natural Gas Mixtures

Daniel Lozano-Martín and César R. Chamorro
TERMOCAL Research Group, University of Valladolid, Valladolid, Spain

Dirk Tuma
BAM, Berlin, Germany

David Vega-Maza [S] and José J. Segovia [C]
TERMOCAL Research Group, University of Valladolid, Valladolid, Spain
jose.segovia@eii.uva.es

Nowadays, a lot of efforts focus on the search of sustainable and carbon dioxide free energy systems. One of the measures with high potential in this cost-effective transition from our current highly dependent energy model is the, so called, Power-to-Gas.

This work aims to address the technical aspects related to the thermodynamic characterization of natural gas mixtures blended with hydrogen for the introduction of alternative energy sources within the Power-to-Gas framework. For that purpose, new experimental speed of sound data are presented in the pressure range between (0.1 up to 13) MPa and at temperatures of (260, 273.16, 300, 325, and 350) K for two mixtures qualified as primary calibration standards: a 11 component synthetic natural gas mixture and a hydrogen-enriched synthetic natural gas mixture with a nominal molar fraction of hydrogen 0.3. The measurements were performed using a spherical acoustic resonator with an experimental expanded (k = 2) uncertainty better than 200 parts in 106 (0.02 %) in the speed of sound. The heat capacity ratio as perfect-gas, the molar heat capacity as perfect-gas and the second and third acoustic virial coefficients are derived from the speed of sound values. All the results are compared with the reference models for natural gas-like mixtures, the AGA8-DC92 EoS [1] and the GERG-2008 EoS [2], paying attention to the impact of the hydrogen on these properties. The data are found mostly consistent within the model uncertainty for the 11 M synthetic mixture, as expected, but, in the limit of the model uncertainty, at the highest measuring pressures for the hydrogen-enriched mixture.

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References

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