Density and Speed of Sound Measurements in (H2 + n-Butane) for Decarbonizing the Gas Grid

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European energy is markedly dependent on natural gas, which is especially used for heat and power generation. It produces mainly carbon dioxide when combusted contributing to global warming. Hence, energy policy aims to reduce carbon dioxide emissions by electrification and decarbonizing the gas grid using the injection of biomethane or blending of hydrogen. The latter could be produced in electrolysers powered with renewable electricity (Power-to-Gas), rendering an energy storage capacity option to seamlessly harmonise uncoupled demand and supply of renewable electricity.

GERG 2008 is the reference Helmholtz-energy equation of state for natural gases and currently serves as the ISO standard (ISO 20765-2). It estimates the thermophysical properties in the entire fluid region for natural gases and related mixtures of up to 21 components. However, it has only been validated using limited test conditions for hydrogen enriched natural gas, and the results so far show deviations from the expected results. New data and interaction parameters need to be developed to predict the physical properties for hydrogen enriched natural gas.

In this work, new accurate density and speed of sound data in the gas phase of binary systems (hydrogen + n-butane) at three H_2-enriched compositions will be presented. They are measured with a single sinker densimeter with magnetic suspension coupling and a spherical acoustic resonator, respectively. The experiments will be carried out in the temperature range from 250 K to 330 K and pressures up to the minimum between 20 MPa and the vicinity of the dew point loci. The overall expanded (k = 2) relative uncertainty in speed of sound is 0.04 % and between 0.02 % and 0.4 % in density. These new accurate data will contribute to a better understanding of the binary functions associated to molecular pairs, which in turn will improve the thermodynamic equations.

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