Conceptual Sensor Design for Hydrogen-Enriched Natural Gas Mixtures

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Increased usage of electrical energy from renewable sources suggests the electrolytic production of hydrogen. Storage and transportation of green hydrogen are enabled by the existing natural gas grid. However, due to the immense effect hydrogen exercises on gas quality parameters, its influence on end users, and their performance, as well as the adaption of end user devices to the altered gas compositions, are currently investigated. Thereby the effects of modified density, laminar flame velocity, methane number, and other parameters of natural gas are examined and evaluated. Nevertheless, the restrictions regarding the maximum hydrogen content in natural gas mixtures are set fairly low. Therefore, a measurement concept is developed to determine hydrogen concentrations in natural gas mixtures online with sufficient accuracy which results in a possible increase of limits on hydrogen concentration. The sensor concept is based on measuring thermal conductivity as well as the speed of sound of a multicomponent mixture in at least two different states, to take advantage of the impact of real gas effects factor and of the temperature gradient as a result of pressure reduction. With given operating temperature and pressure, the required concentrations can be calculated theoretically, mainly within tolerances predefined for technical applications. According to this calculation model, the characterization of the gas mixture can be performed successfully although the exact gas composition is not analyzed completely. To increase the accuracy of the analysis, an infrared absorption spectrum at specified wavelengths is going to be included in the measurement concept.

With the proposed iterative, correlative method, the hydrogen concentration can be determined accurately enough to calculate an approximate heating value as well as other relevant gas properties. To validate the theoretical approach, a test stand is in planning, which allows the application of different sensor types at various states.