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Validation of a new method for flow measurement in cryogenic systems

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A new thermal method for flow measurement in cryogenic systems was recently published, featuring the capability for intrinsic calibration. The new method minimizes the differences between two physically exact evaluation functions for the flow rate, which are based on the same input parameters, i.e. the measurement readings of temperature differences and heater power of a heat exchanger. The minimization removes all systematic errors from the measurement, yielding uncertainties of typically less than ±1 % with regard to the actual flow rate. A proof-of-principle based both on experimental data and a closed analytical model was presented earlier, but comparative measurements against a second standard were not available at the time. This paper presents the results of room-temperature experiments taken with a first prototype sensor, designed with a tube diameter of 4 mm. The experiments were carried out with nitrogen flowing from gas cylinders against atmospheric pressure, and with flow rates ranging from 0.04 to 0.4 g/s. A gallery with 4 calibrated sonic nozzles was used as a reference, having measurement uncertainties of ±0.33 % with regard to their measurement range.

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