Numerical and Experimental Study of the Hydrostatic Pressure Correction in Gas Thermometry: A Case in the SPRIGT

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Single-pressure refractive index gas thermometry (SPRIGT) is a new type of primary thermometry, which needs an extremely stable working pressure (stability 4 ppm). In practice, the pressure control system at room temperature is located above the cold resonator at 5 K to 25 K, and a long pressure tube is used to connect them, which entails a hydrostatic pressure correction (HPC). To this end, a threedimensional(3D) Computational Fluid Dynamics (CFD) simulation model of the pressure tube has been developed and compared with experimental results. First, to verify the simulation results, the helium-4 gas pressure in the center of the resonator was measured using a determination of the refractive index by microwave resonance coupled with the knowledge of the temperature. Results of simulation and experiment showed good agreement. Thereafter, based on this CFD simulation, the non-linear temperature distribution in the vertical pressure tube and the uncertainty caused by this non-linear phenomenon were calculated. After this, the validity of the isothermal assumption to simplify the calculation of the HPC was verified. Finally, the effect of heating on the pressure was studied and its impact found to be negligible.To the best of our knowledge, this is the first time experimental and simulation results have been compared for the HPC. The results are expected to be more generally applicable to the accurate determination of pressure in cryostats.