Development of a State-of-ohe-Art Hydrostatic Weighing Apparatus for Determination of the Universal Gas Constant

Yohei Kayukawa [C, S]
NMIJ, AIST, Tsukuba, Ibaraki, Japan
kayukawa-y@aist.go.jp

One of the most important subjects in thermodynamic property research field is to determine the universal gas constant, R, or the Boltzmann constant, k, to contribute to the re-definition of the thermodynamic temperature. The most promising experimental approach is speed-of-sound measurement for gas, so called acoustic gas thermometry (AGT). Recent progress in AGT techniques remarks the relative uncertainty for the universal gas constant being less than 1 ppm. On the other hand, other experimental techniques such as dielectric constant gas thermometry (DCGT), Johnson noise thermometry (JNT), or Doppler broadening thermometry (DBT) are competitive for the moment. In this study, therefore, a completely different approach to determine the universal gas constant was proposed. Namely, the universal gas constant is determined from gas-phase PVT property measurements. Since density calibration techniques for solid sample are well established recently, it is possible to improve measurement performance in gas density measurements to ppm level. In the present study, apparatus for gas-density measurement using a hydrostatic weighing of 1 kg silicon sphere was designed. By measuring buoyancy force acting on the sphere, gas density can be measured with an uncertainty around 1 ppm. The gas pressure is measured by a dead weight piston-cylinder balance which is calibrated against the national pressure standard in NMIJ. The apparatus is thermostatted at 273.15 K with good temperature stability of less than 0.1 mK. The present status of this study, estimated measurement uncertainties, gas samples considered is presented.