Concatenated Gas Saturation Method for Vapor Pressure Measurements: a New Design That Minimizes Measurement Uncertainty

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Gas saturation (also known as transpiration) methods for vapor pressure measurement are based on the saturation of a carrier gas stream with the vapor of a condensed phase. The vapor is stripped from a measured volume of the saturated carrier gas, the amount of vapor is determined, and the vapor pressure is calculated by assuming ideal gas behavior. Two important advantages are shared by all gas saturation methods: (1) no calibration is required and (2) impurities have a small, predictable effect on the measured vapor pressure. On the other hand, gas saturation methods are subject to a variety of potential systematic measurement errors, including non-ideal mixture behavior, insufficient equilibration time, leaks, pressure drop, temperature gradients and cold spots, sample decomposition, and insufficient sample compound. The "concatenated" gas saturation method (CGSM) was developed at NIST to facilitate the detection of systematic measurement errors. The basis of the instrument design is that the carrier gas stream flows through a series of saturator-adsorber pairs. In this way, multiple simultaneous vapor pressure measurements are made with the same carrier gas stream. The primary advantage of the CGSM is that it allows for simultaneous measurements on a control sample (with a well-known vapor pressure curve). If measured values for the control compound are the same as reference values, within experimental uncertainty, one has additional confidence in the data collected simultaneously for the other compounds. Another commonly implemented procedure is to use saturators of different lengths for each sample compound, which tests for sufficient equilibration time. The primary disadvantage of the CGSM is greater measurement uncertainty from temperature gradients and pressure drop. A new apparatus design that minimizes temperature gradients and pressure drop will be presented.