*Gas Sensor Calibration and Stability Testing*

John E. Sohl, Jeffrey D. Page, Hugo E. Valle

Weber State University, Ogden, UT 84408

Abstract (Air Quality: Science for Solutions, 2020)

Portable air measurement systems often rely on commercially available off-the-shelf gas sensors. Three of the more common systems use either metal oxide grids (mox), electrochemical cells (EC), or nondispersive infrared (NDIR). A primary market for these sensors is domestic and occupational safety and the detection of high levels of the target gas. For example, home carbon monoxide detectors can be readily purchased at most hardware stores. For atmospheric research and long-term air quality monitoring, the systems must be stable, easy to calibrate, and able to detect background levels of the target gas. The manufacturer datasheets might indicate a resolution of ±300 ppb, but research applications require resolutions that are at least an order of magnitude higher.

We have tested multiple sensors for O3, NO2, SO2, CO, CO2, and NH3. With careful circuit design and calibration, many of these sensors can be made to operate with precisions closer to ±10 to 30 ppb. While not research instrument precision, the accuracy is good enough for portable applications such as the Weber State University’s AtmoSniffer. We deployed two sets of sensors in a uniform air stream at the Utah Division of Air Quality’s Hawthorne air monitoring station. Those sensors were operated continuously for several weeks at a time and over an interval of six months, both in the lab and at Hawthorne.

Sensors that lacked the required precision were discarded. The EC sensors were the easiest to use, but comparatively expensive and have a shorter lifetime (typically rated at six to eighteen months by the manufacturers). The metal oxide sensors are the hardest to analyze and calibrate, and are generally more sensitive to humidity. The NDIR CO2 sensor was easy to use and had minimal cross-species sensitivity, but some models are effectively impossible to calibrate.

We will discuss the low-level sensitivity, zero-level drift, and precision along with some of the techniques we used to make the data more stable and how the calibration was done using Hawthorne field data.