Compensating for Altitude With NDIR CO_2 Sensors

Application Note ITI-091

TSI's IAQ-CALC™ Indoor Air Quality Meters measure carbon dioxide concentration by relying on one of the natural properties of CO_2 molecules: CO_2 molecules absorb light at a specific wavelength of 4.26 µm, which is within the infrared (IR) range. High concentrations of CO_2 molecules absorb more light than low concentrations. This technique is called non-dispersive infrared (NDIR) detection.

As altitude increases, air density is reduced due to the molecules spreading apart under less atmospheric pressure. The size of the sensor probe on the IAQ-CALC meter, however, is fixed. So, as altitude increases, the number of air molecules within the effective measurement volume of the probe, decreases. This method of measuring CO_2 concentration is based on an absolute ratio, molecules of CO_2 per million molecules of air or ppm. So for accurate results, the measurement must compensate for the decrease in air density based on altitude.

As altitude increases, correction can easily be made in the instrument so that the proper concentration of gas is displayed and recorded. The instruments are factory calibrated at sea level atmospheric pressure: 29.92 in. Hg or 1 atm. There are two ways to help ensure accurate CO_2 measurements at different altitudes:

- Field calibrate the CO_2 sensor at the elevation that it is being used.
- Enter the correct local barometric pressure expressed in inches of mercury (Hg) during the start-up cycle as follows:
  1. Turn the instrument on.
  2. The first item displayed is battery life expressed in [− +] %.
  3. The next screen shows data logging memory available expressed as **% Log**.
  4. Next, the communication baud rate is shown in 1000's. You have an opportunity to change this value by pressing the up and down arrow keys "▲" "▼" on the right side of the key pad. Once a selection is made, press the "**ENTER**" key to save the setting.

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5. The next screen reflects time and date information expressed as “**tinE”.** Again, as soon as this is displayed, you may use the up and down arrow keys “▲” “▼” on the right side of the key pad to change time in minutes and the hour as well as setting the day, month and year. Once changes are made, press the “**ENTER**” key to save the setting.

6. **This is the key step:** Barometric pressure is shown in inches of mercury. As soon as this is displayed, you may use the up and down arrow keys “▲” “▼” on the right side of the key pad to alter the barometric pressure setting to the local value. Once changes are made, press the “**ENTER**” key to save the setting. **Note:** Local pressure can be found using a barometer. However, local TV weather channels, web sites and other sources that report local barometric pressure are **NOT** always reliable sources for true barometric pressure conditions. The values these sources report are often corrected to sea level conditions and therefore do not represent the actual pressure. Sea level pressure typically range from about 29.3 to 30.5 in. Hg. If the local barometric pressure is reported in this range and you are more than 300 feet (100 m) above sea level, then the actual pressure has probably been adjusted to sea level conditions. This is NOT the value you should enter into the IAQ-CALC meter during start-up. Actual local barometric pressure can be calculated by reducing the reported “sea level” corrected pressure by 1% for every 300 ft. (100 m) that you are above sea level. For example, if the barometric pressure is reported as 29.85 in. Hg and you are at an elevation of 1000 ft. (330 m), reduce the reported pressure by 3.3% (29.85/1.033 or 28.9 in. Hg). This is the value to enter in the IAQ-CALC meter.

7. Finally, the test ID number is shown and you may toggle through previous tests taken using the up and down arrow keys “▲” “▼”.

8. All changes are kept when the instrument is turned off.

9. The instrument now goes to the survey mode and is making real-time measurements.

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