



Measuring PID Correction Factors For Volatile Compounds With Rae Systems Instruments

This Technical Notes details how to measure Correction Factors (CFs) for new compounds measured by MiniRAE 2000, ppbRAE Plus, ToxiRAE II and other RAE Systems photoionization detectors (PIDs). Correction Factors are used to allow measurement of a large variety of compounds while calibrating with only a single standard gas, commonly isobutylene.

In general, CFs are independent of the type of instrument and lamp size, as long as the lamp energy is the same. Therefore, any RAE Systems PID can be used to measure CFs, but it is often easiest to use a MiniRAE or ppbRAE because of their strong sampling pumps and fast response.

The matrix of the gas has important effects on the PID response. CFs listed in Technical Note TN-106 are measured in dry air and apply only to this condition. High humidity generally decreases the response by 30 to 50%. Measurements in pure nitrogen are the same as in air for a 10.6 eV or 9.8 eV lamp, but may give roughly a 10 to 30% increase in signal over dry air when using an 11.7 eV lamp. A correction factor measured with room air may be more representative of the actual use conditions, but is a less convenient reference point.

Correction Factor Definition

The correction factor is defined as the response of the isobutylene (IBE) calibrated PID to an equal concentration (ppmv) of the compound of interest (Gas Y):

$$CF = \frac{\text{Instrument's IBE Reading} * \text{Gas Y Concentration (ppmv)}}{\text{IBE Concentration (ppmv)} * \text{Gas Y Instrument Response}}$$

Thus, the higher the correction factor, the lower the sensitivity to the compound of interest. To account for any drift during the measurements, one can make isobutylene measurements before and after the sample measurements and take the average response to the isobutylene standard. It is preferable to use a gas standard of at least 50 to 100 ppmv for a MiniRAE or at least 5 to 10 ppmv for a ppbRAE in order to be well above the noise level of the instruments.

CF Measurement Using Gas Standards

If a cylinder of standard gas in dry air is available, simply calibrate the instrument with isobutylene measure the gas standard in the same way, and calculate the CF as above.

CF Measurement For Liquid Samples

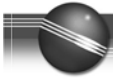
If the gas standard is to be prepared from a liquid sample, proceed as follows:

- Obtain a large vessel such as a 5-gallon glass water jug or a 3-liter Tedlar gas bag.
 - If using a glass bottle, calibrate its volume. One simple way to do this is to fill the bottle with water and measure the difference in weight with an accurate balance (each kg of water equals 1 liter of volume).
Place some small inert objects (e.g., PTFE pieces) inside or use a magnetic stirrer to aid in mixing. Bore two holes in the cap to insert the instrument influent and effluent sample lines. Use PTFE tubing for these lines to minimize losses due to adsorption. For a ToxiRAE II, provide a large opening for the instrument sensor head, and seal this with a gasket or PTFE tape. Flush the sample vessel with clean, dry air.
 - If using a Tedlar bag, fill the bag with a known volume of clean, dry air using a large-volume (e.g. 1.5-L) syringe.
- Calibrate the PID instrument with standard isobutylene gas.
- Using a microliter syringe, inject a volume of liquid calculated to give the desired concentration:

$$\text{Concentration (ppmv)} =$$

$$\frac{24.4 \text{ (L/mol)} * \text{Volume injected (}\mu\text{L)} * \text{Liquid density (g/mL)} * 10^6}{1000 \text{ (mg/g)} * \text{Molecular weight (g/mol)} * \text{Vessel volume (L)}}$$

The amount injected typically ranges from 0.2 to 1.0 μL per liter of air. Allow time for the liquid to evaporate and mix. Assist mixing with magnetic stirring or agitation of the inert objects inside the closed vessel. Tedlar bags can be massaged to move the air inside. If the compound is high boiling, it may help to



apply heat (e.g., using a heat gun) to the vessel wall to speed evaporation. However, never heat a Tedlar bag, because this often releases compounds into the air giving a background PID response.

- Uncap the vessel and quickly insert the MiniRAE 2000 influent and effluent lines or the ToxiRAE II head. Recap or reseal as quickly as possible.
- Allow a minute or more for equilibration, record the sample measurement, and remove the instrument. Calculate the CF using the equation above.
- Repeat the process a few more times to obtain a calibration curve and several CF values to average.

If desired, a known volume of liquid water can also be injected to achieve a desired relative humidity and CF under humid conditions. For such measurements, the sensor must be very clean, or else the readings may drift upward.