Accurately Measuring Volatile Organic Compounds (VOC's) Using Photo-Ionization Detection (PID) Technology

Technical Note #AQ-14-317

What Are Volatile Organic Compounds (VOC's)

VOCs are any variety of organic, carbon-containing chemical compounds that release gaseous molecules from their liquid or solid form at room temperature. While many VOCs are naturally occuring and important to environmental interactions, a large number are emitted in manmade processes and are hazardous to human health if inhaled at certain concentrations. The EPA has determined that concentration of VOCs are much higher indoors compared to outdoors (up to 10 times higher), and it is estimated that 50 to 300 different VOCs may be detected in the air of homes, schools, offices, and commercial buildings at any given time. The adverse health effects caused by breathing in these chemicals can range from temporary irritation of the eyes or throat, nausea, and headache, to long-term disease such as cancer or damage to liver, kidneys, or central nervous system.

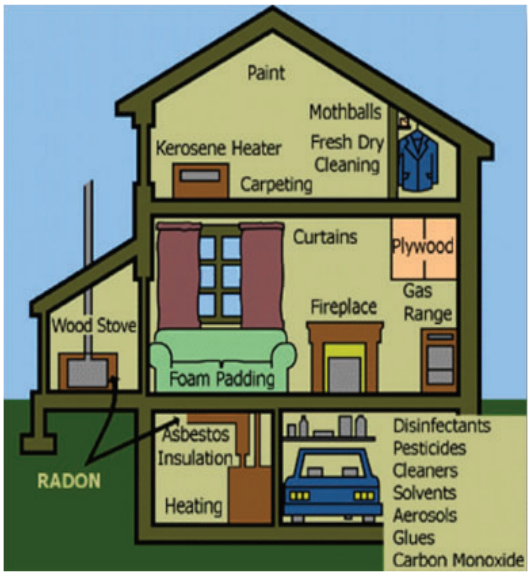


Image Courtesy of www.gethomeinspector.com

How Does PID Technology Work?

To accurately measure the most common VOC's found in homes or offices to concentrations of parts per billion (ppb), E Instruments' indoor air quality monitors use Photo-Ionization Detection (PID) technology. Each PID sensor is equipped with a UV lamp which emits high energy photons onto a sample of ambient air drawn into the sensor chamber (see diagram below). When hit with this UV light, most VOC molecules, with the exception of low molecular weight VOC's, will break up into free electrons and positively charged ions, a process called ionization. This ionized gas is electrically charged and produces an electric current. The ion current is collected by the sensor, amplified and converted to a reading either in ppb or µg/m^3. The greater the concentration of VOC's in the air sample, the greater the current that will be generated and detected by the PID sensor.

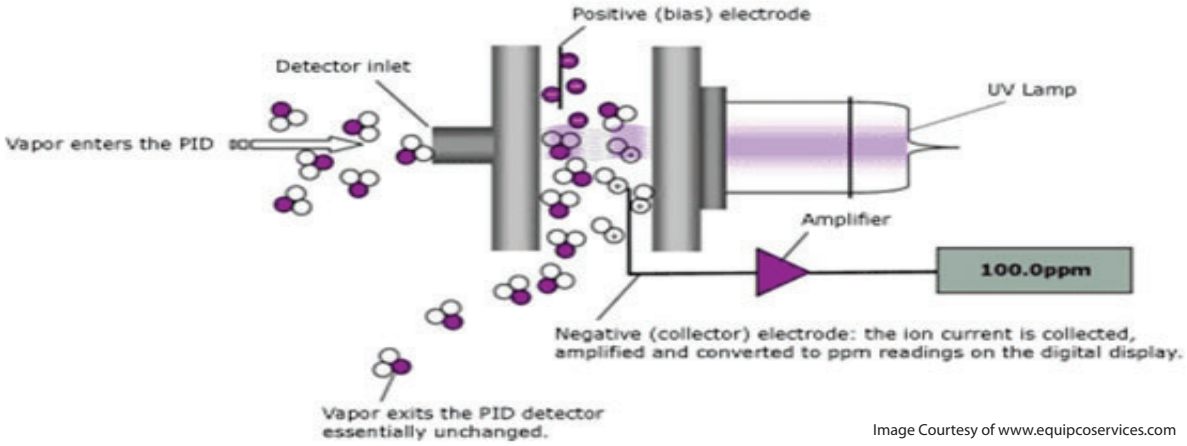


Image Courtesy of www.equipcoservices.com

Using Krypton (10.6 eV) Lamp to Optimize the PID Sensor

A VOC will be ionized and detected by the PID sensor if the energy it takes to break up the VOC molecules, or Ionization Potential, is lower than the energy emitted by the UV lamp in the sensor.

PID lamps are created containing a variety of gases including Krypton, Xenon, and Argon. Each gas emits a specific photon energy when heated, which would ionize a different subset of VOC molecules. E Instruments IAQ family of products uses a PID Krypton lamp, which emits a photon energy of 10.6 eV. Krypton lamps are optimum for their high sensitivity, long lamp life, and ability to target a wide range of common VOC's in residential and commercial settings.

E Instruments International **www.E-Inst.com**

P: 215-750-1212 F: 215-750-1399 A: 402 Middletown Blvd, Ste 216 Langhorne, PA 19047

Accurately Measuring Volatile Organic Compounds (VOC's) Using Photo-Ionization Detection (PID) Technology

Technical Note #AQ-14-317

Although Xenon lamps have a long life, they can ONLY detect VOC's with Ionization Potentials lower than the 9.6 eV's that it emits. This would exclude many of the most common VOC's found in homes and offices.

Argon lamps are able to detect a very wide range of VOC's as it emits 11.7 eV's of energy. However, the Argon lamp has a short life and would require frequent replacing.

With this in mind, E Instruments has chosen the Krypton lamp for its PID sensor which has the capability of detecting a wide variety of VOC's and also has a long lamp life making it the optimal choice for home, office, and field use.

Which VOC's can a Krypton (10.6 eV) Lamp Detect

Krypton lamps are able to detect hundreds of VOC's with a lower ionization potential then the 10.6 eV of energy that it emits. The following table gives guidance as to which VOC's the E Instruments PID sensor generally can detect:

	VOC's PID Detects	Exceptions
Hydrocarbons	All Chemicals with names that end in: -ane -ene -yne	Methane Ethane Propane Acetylene See Note Below*
Alcohols	All Chemicals with names that end in -ol	Methanol See Note Below*
Aldehydes	All Chemicals with names that end in -aldehyde	Formaldehyde See Note Below*
Ketones	All Chemicals with names that end in -one	See Note Below*
Esters	All Chemicals with names that end in -ate	See Note Below*
Amines	All	
Sulfides	All	

* Note: Chemical compounds with names containing: Chloro, Fluoro, and Bromo

For a list of common VOC's measured by a Krypton lamp (10.6 eV) PID sensor, please see Appendix A.

Courtesy of www.homeaircheck.com


Courtesy of www.epa.gov

Other Methods of Measuring VOC's: Older Technologies

Measuring VOC's with PID technology is the industry standard because these sensors
1) are highly sensitive down to parts per billion (ppb),
2) detect a wide range of VOC's, and
3) having a relatively long life requring relatively infrequent replacement

However, there are other methods of measuring VOC's including Flame Ionization Detection and Calorimetric Tubes.

E Instruments International **www.E-Inst.com**

P: 215-750-1212 F: 215-750-1399 A: 402 Middletown Blvd, Ste 216 Langhorne, PA 19047

Accurately Measuring Volatile Organic Compounds (VOC's) Using Photo-Ionization Detection (PID) Technology

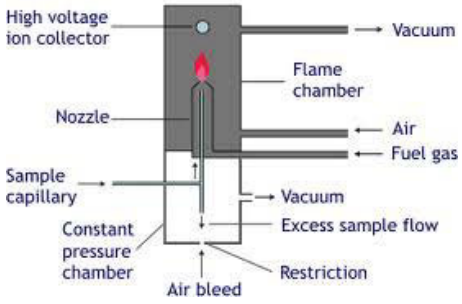
Technical Note #AQ-14-317

Flame Ionization Detectors (FID)

FID's are a historically reliable method of detecting a wide ranges of VOC's in fixed spaces and is a common technology used in laboratories. FID technology works by injecting a gas sample in a chamber which is then introduced to a hydrogen-air flame, where most carbon containing compounds will ionize. These ions produce a current which is detected, amplified, and converted into a quantity measurement such as ppm.

Limitations in the field: FID units require careful setup prior to each use due to the equipment size and delicate construction, as well as the explosive potential of the hydrogen gas. FID's are not optimal for portable applications of VOC measurement.

Flame Ionization Detector



Courtesy of www.dieselnet.com

Colorimetric Tubes

Courtesy of www.clareys.com

Colorimetric Tubes

Colorimetric Tubes can reliably detect individual gases and vapors, including many VOC's, at low cost. This technology works by manually injecting an air sample into a glass or plastic tube containing an indicator chemical which will react and change color in the presence of a particular VOC (e.g. benzene, formaldehyde, etc.).

Limitations in the field: Colorimetric tubes cannot be used for a collective measure of VOC's, which is the industry standard for VOC monitoring in IAQ assessments as well as for LEED or BREEAM certifications. Further, this technology can only support a single reading as opposed to PID sensors which are able to support continuous measurement. Colorimetric tubes are also slower to measure toxic gases, requiring many minutes as opposed to seconds.

VOC Monitoring Solution: AQ Expert and AQ VOC Indoor Air Quality Monitors

The measurement of the concentration of many VOCs commonly found in indoor environments can be performed using the E Instruments AQ Expert portable IAQ monitor and the AQ VOC Handheld VOC monitor. These specialized monitoring instruments utilize PID sensors that allow air quality analysts, environmental safety companies, laboratory technicians, etc., to quickly and accurately monitor the levels of dangerous VOCs present in the breathing environments of homes, office buildings, laboratories, or industrial facilities. These monitors include software with real-time continuous data logging, wireless Bluetooth compatibility, and can be customized to monitor up to 11 different parameters relevant to indoor air quality.

AQ VOC

AQ Expert

E Instruments International **www.E-Inst.com**

P: 215-750-1212 F: 215-750-1399 A: 402 Middletown Blvd, Ste 216 Langhorne, PA 19047