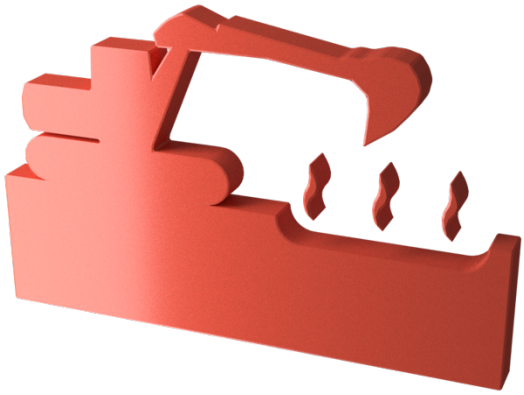
A buyer's guide to measuring VOCs in soil remediation

Typical photoionisation detectors measure volatile organic compounds and other gases in concentrations from sub parts per billion to 10 000 parts per million (ppm). The photoionisation detector is an efficient and inexpensive detector for many gas and vapour analytes.

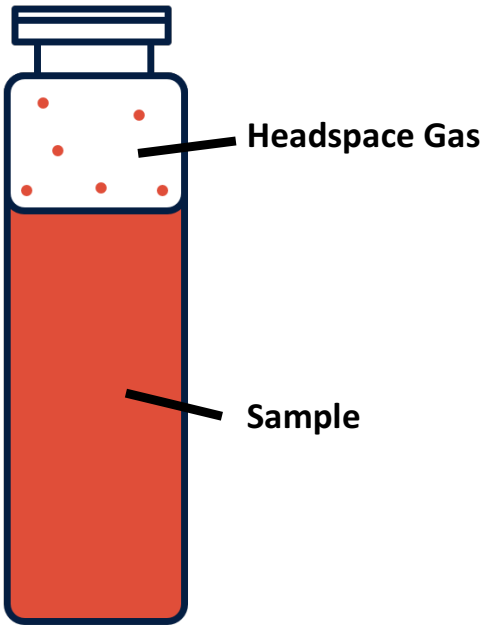
Source: Wikipedia



Detection technology

The photoionization detector (PID) has become a widely used tool used for the detection of volatile organic compounds (VOC) during site investigations because:-

- PIDs are quick, simple to use and accurate for the detection of a wide range of contaminants
- PIDs are very sensitive to commonly found solvents such as carbon tetrachloride but will detect hundreds of gasses and vapours in low concentration
- PIDs are battery powered and portable, ideal for field use



Although PIDs cannot be used to measure VOCs in soil (or water) directly, the VOC concentration can be determined indirectly using headspace analysis. Soil (or water) is collected in a part-filled, sealed jar and allowed to stabilise at room temperature. Any VOCs present will volatise (evaporate) and concentrate in the 'headspace' leading to a positive reading on the PID.

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Figure 1. Headspace sampling

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Choosing the right instrument

Manufacturers tend to offer variants of the same instrument differentiated by functionality and/or performance to suit different budgets but here are some important considerations:-

- Choice of UV lamps – 10eV required if benzene is a particular problem, otherwise choose the standard 10.6 eV.
- Battery life – look for at least a 24 hour run time.
- Battery type – look for rechargeable but is there a 'dry cell' backup?
- Sensitivity – look for a minimum 0.1 ppm (100 ppb) but ideally 1 ppb
- Fast response and clear down time – this should be around 2 seconds
- Upper range – 20,000 ppm is possible but 5000 ppm will suffice (and save money but look out for compromises that may otherwise be useful)
- Ease of calibration and maintenance
- How does the PID deal with humidity?

Effects of high humidity

Like many sensors and measurement instrumentation, traditional PIDs can be affected by the environmental conditions such as those found in the field, in particular dirt and humidity. Humidity is a naturally occurring phenomenon and is present in the atmosphere and gasses. The presence of humidity can disrupt PID measurements in two ways leading to false low or conversely high readings.

The cause of low readings is because water vapour absorbs the photons normally released by photoionisation as can be seen in the simplified cross section of a PID sensor (figure 2). The effect worsens with increasing humidity as shown by figure 3.

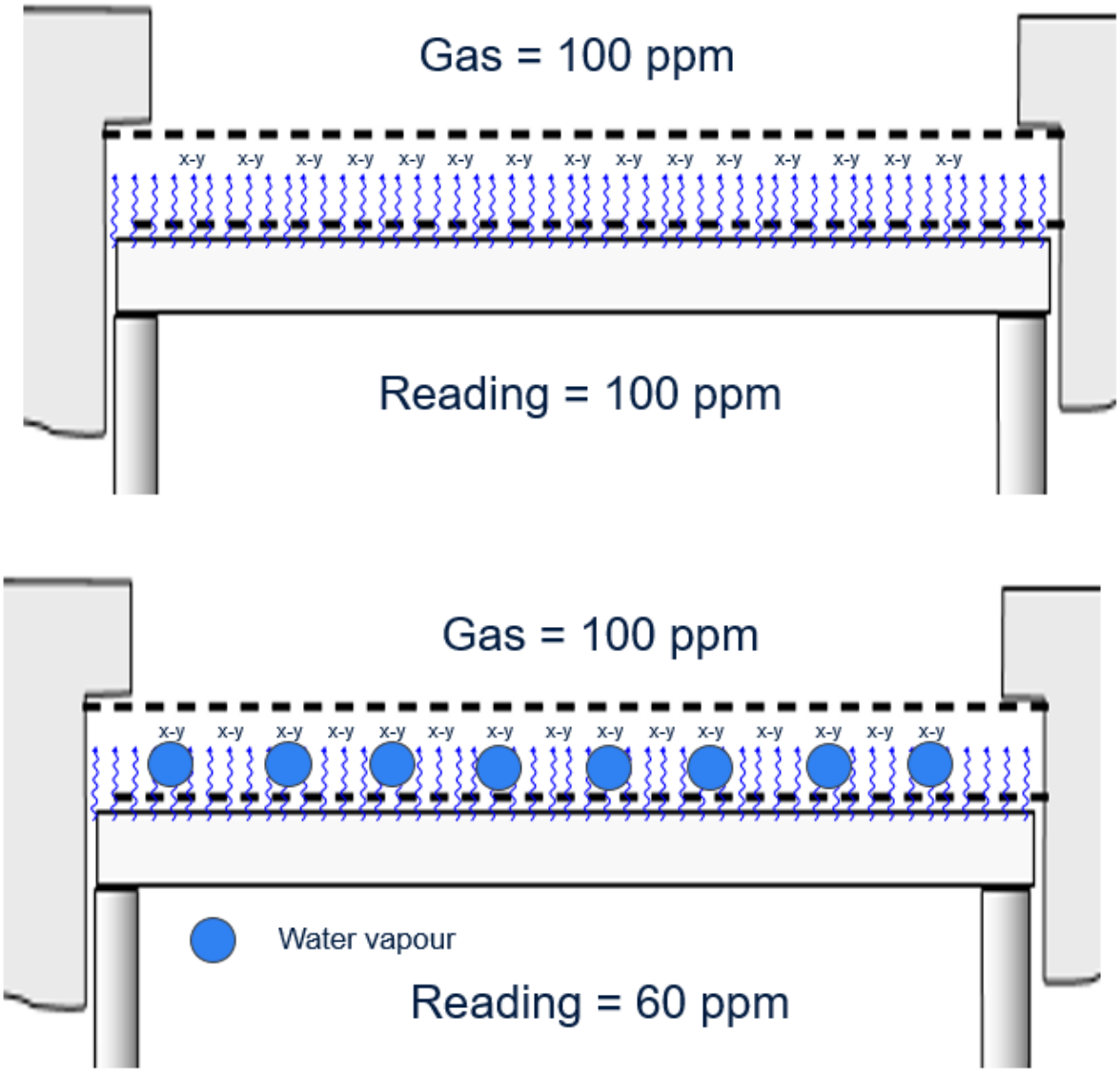


Figure 2: Cross section of a PID sensor with and without water vapour present

Water vapour absorption

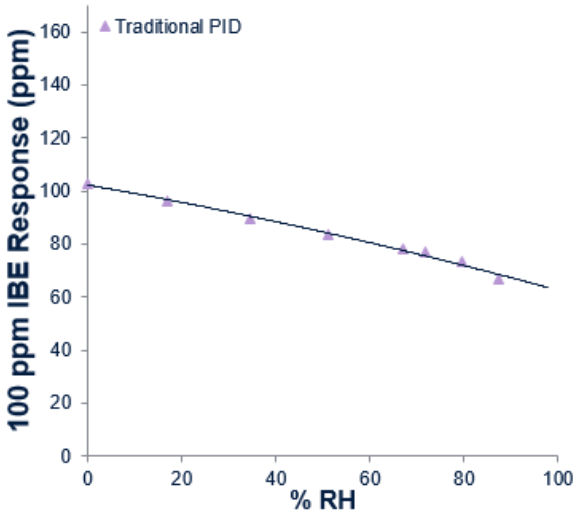


Figure 3: Effects of water vapour absorption

Contamination can also build up between the electrodes (shown as dotted lines in figure 2) effectively short circuiting them, leading to a high, 'false positive' reading at high humidity with no VOC present i.e. greater than 90% relative humidity. The dramatic effect can be seen in figure 4

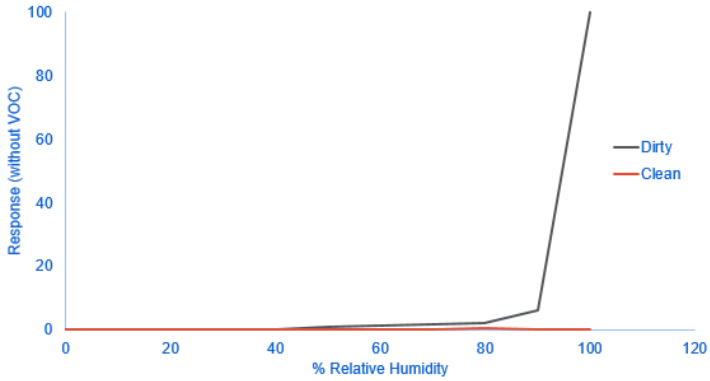


Figure 4: Effects of contamination

Solving the problem of humidity

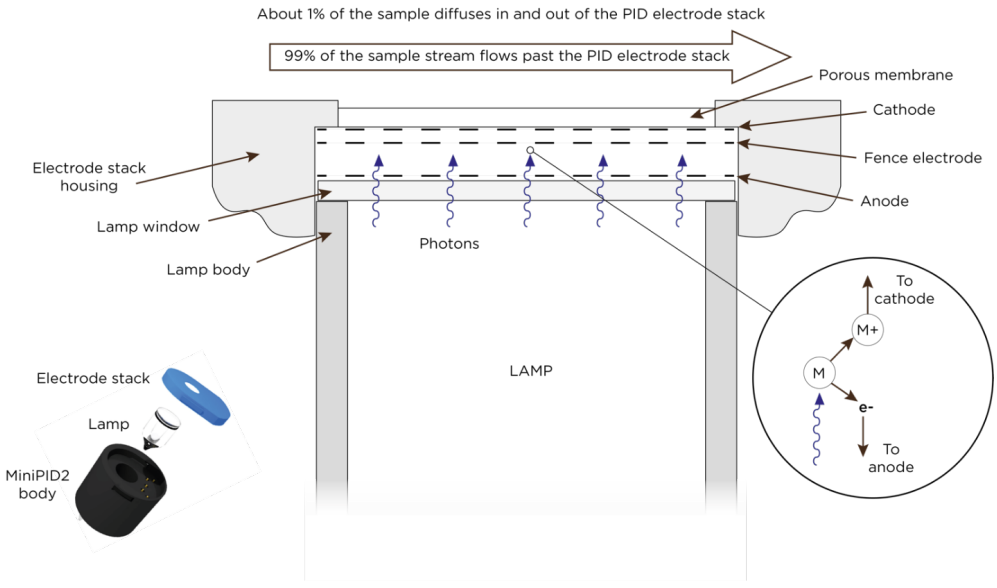
Conventional PIDs may use humidity suppression/compensation techniques but each of them has disadvantages:

- Humidity sensor – these typically have a slower response than the PID sensor itself which causes a drifting compensation
- Desiccant tube – these both slow the PID response and also reduce it by adsorption plus they need replacing from time to time which adds cost
- Humidify the calibration gas – this only works at one level of humidity and is no longer accurate when the humidity changes

Importantly none of these solutions solves a false positive at high humidity

Looking at a proprietary PID (figure 5), the presence of the porous membrane should be noted. In this design it is made from a hydrophobic material which means that it rejects the ingress of water vapour and mitigates the chance of low readings.

To deal with high humidity, the addition of a third, fence electrode overcomes the possibility of incorrect high readings since it behaves as a conductive break and stops the excess current flow caused by the presence of high humidity which would otherwise lead to a false positive.



Ease of calibration and maintainance

To prevent dirt from entering the instrument, which can contaminate the PID sensor's lamp, there should be an easily accessible filter which can be visually inspected and changed as required. During factory calibration and maintenance, the manufacturer should also clean the PID sensor lamp and the membrane should be changed prior to factory recalibration which will bring the instrument back to the manufacturer's original specification.

In daily use manufacturers recommend field calibration of their PIDs with Isobutylene, which is an excellent surrogate calibration gas because the response of most VOCs is reasonably close to, and consistent with this gas.

Summary

PIDs are an essential tool for Environmental Consultants and other professionals who undertake field investigations of contaminated land or during soil remediation. They are simple to use and provide quick, accurate results but care must be taken to ensure that they have ability to deal with humidity which would otherwise cause false readings. Portability and long battery life are other important considerations.

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About ION Science

Ion Science provide a portfolio of handheld, fixed and portable photoionisation (PID) detection instruments for the rapid, accurate detection of volatile organic compounds (VOCs). Find out more about our industry leading range of VOC detection solutions by clicking on the links below.

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