Photo-Ionization Detector (PID)

1. Brief description

This gas sensor applies ultraviolet light to the detectable gas to ionize it. This causes an ion current to be generated. The sensor measures this current to determine the gas concentration. It detects a wide range of gases, irrespective of whether they are organic or inorganic. It is generally used to measure ppb to ppm levels of concentration of volatile organic compounds (VOCs).

Category	Detectable gas
Other methods	Toxic

2. Structure and principles

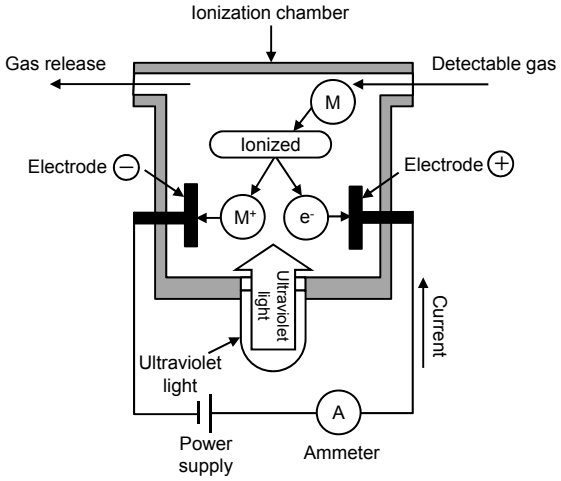
[Structure]

The sensor consists of an ionization chamber for letting in the detectable gas, a ultraviolet lamp for applying light, and positive and negative electrodes for detecting ion currents.

[Principles]

The detectable gas enters the ionization chamber and is exposed to ultraviolet light from the light source (ultraviolet lamp). This causes the gas to release electrons, generating cations. The generated cations and electrons are drawn by the positive and negative electrodes, which causes a current to be generated. Since this current is proportional to the gas concentration, the sensor measures the current value to determine the concentration of the detectable gas. Ionizing a detectable gas requires application of photon energy larger than the ionization energy specific to that gas. Photon energy is expressed in the unit electron volt (eV). This sensor uses a lamp having photon energies such as 10.6 eV and 11.7 eV. The larger the photon energy is, the larger amount of detectable gas the sensor can ionize.

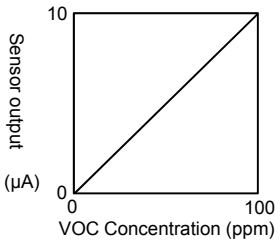
[Structure and principles]



3. Features

○ Output characteristics

For a gas with a low concentration of a few hundred ppm, the sensor output is almost proportional to the gas concentration, increasing linearly with the gas concentration.



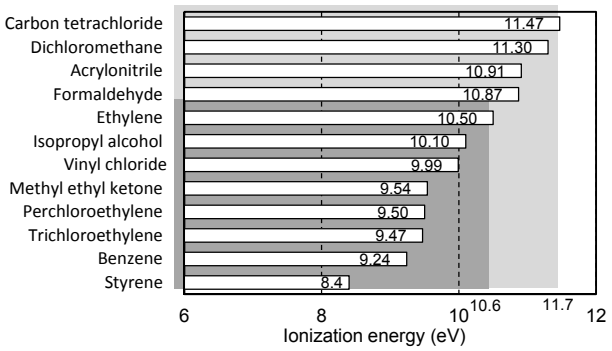
○ Ultraviolet lamp

The photon energy (eV) of a ultraviolet lamp is determined by the combination of the gas contained in the lamp and the material of the lamp window.

Gas contained	Window material	Photon energy (eV)
Xenon	Sapphire	8.4
Krypton	Magnesium fluoride	10.6
Argon	Lithium fluoride	11.7

○ Ionization energies of typical substances

By applying photon energy larger than the gas-specific ionization energy to each gas, the sensor ionizes the gas to determine the gas concentration. The sensor typically uses a lamp of 10.6 eV or 11.7 eV.



4. Detectable gas and molecular formula (examples)

Detectable gas (for 10.6-eV lamp)	Molecular formula
Ethylene	C_2H_4
Isopropyl alcohol	C_3H_8O
Vinyl chloride	C_2H_3Cl
Methyl ethyl ketone	C_4H_8O
Perchloroethylene	C_2Cl_4
Trichloroethylene	C_2HCl_3
Benzene	C_6H_6
Styrene	C_8H_8

Detectable gas (for 11.7-eV lamp)	Molecular formula
Carbon tetrachloride	CCl_4
Dichloromethane	CH_2Cl_2
Acrylonitrile	C_3H_3N
Formaldehyde	HCHO
Acetylene	C_2H_2
Chloroform	$CHCl_3$
Carbonyl sulfide	COS
Chlorine	Cl_2

5. Products of this type (examples)

○ Stationary products

... TVOC

○ Portable products

... GX-6000, Tiger, Tiger Select

Tiger