More Sensing, Fewer Sensors™

TVOC SENSING

DESCRIPTION

The Sensor Pack monitors multiple air quality parameters across 16 zones, independently reporting on each. Each sensor pack contains sensors for air velocity, temperature, humidity, and pressure. With a reference to clean air, it cancels sensor drift, ensuring more accurate and consistent data compared to standard wall-mounted solutions. All required sensors for a specific application are pre-installed in one sensor pack, making calibration effortless through a tool-free replacement process.

WHY

There are various technologies available for VOC detection. The Antrum platform allows for the identification of some specific gases using the appropriate sensors, however, for a broader view and increased flexibility, multi-point TVOC sensing is offered by employing both ElectroChemical (EChem) and Photoionization Detector (PID) sensors.

Monitoring TVOC levels to optimize ventilation is essential for maintaining a healthy building, ensuring occupant comfort, and improving energy efficiency. It allows for targeted adjustments in ventilation systems to mitigate health risks associated with VOC exposure and create a more pleasant and conducive indoor environment.

Health and Safety: VOCs can have adverse health effects, especially in high concentrations. Monitoring these compounds helps ensure that ventilation systems effectively remove or dilute VOCs, minimizing health risks and maintaining a healthier indoor environment.

Indoor Air Quality (IAQ): VOCs contribute to indoor air pollution. Monitoring levels allows for adjustments in ventilation to control and improve overall indoor air quality, reducing the risk of respiratory issues and other health problems caused by prolonged exposure to these compounds.

Optimizing Ventilation: Monitoring VOC levels provides data that can inform ventilation system operation. When levels are elevated, ventilation systems can be adjusted to increase the supply of fresh outdoor air, optimizing ventilation efficiency.

Energy Efficiency: According to the 2023 version of the ASHRAE Handbook, specific to laboratories, with fixed ventilation rates, engineers are forced to “design for the 2% of the time when high flow is needed; dynamic ventilation takes advantage of the 98% of the time that it is not.” As opposed to a fixed air change rate, by adjusting ventilation based on actual VOC measurements, energy consumption can be optimized while ensuring adequate air quality.

HOW IT WORKS

EChem

Antrum's sensor pack uses a solid polymer electrochemical technology. This technology is based on the principle of electrochemical catalytic reaction, detecting the output signals of the electrochemical reactions of different gases, and accurately measuring the gas concentration through the signal. The advantages are high sensitivity for both TVOC and individual VOCs, and small mechanical size. The sensor outputs ppm isobutylene which provides an overview of TVOCs in the space. If you have a known mixture of VOCs you can convert the output of the sensor to a particular VOC using Table 1 below.

Table 1: Concentration Conversion for Typical VOC

VOC Name	Chemical Formula	Response Factor[2]
Isobutene	C_4H_8	1
Ethylene	C_2H_4	0.632
Formaldehyde[1]	CH_2O	1.2
Methyl mercaptan	CH_4S	1.4
Ethylene oxide	C_2H_4O	0.766
Ethanol	C_2H_6O	0.366
Carbon disulfide	CS_2	0.246
Dimethyl Disulfide	$C_2H_6S_2$	1.36
Methanol[1]	CH_4O	1.19
Methyl sulfide	C_2H_6S	1.794
Styrene	C_8H_8	1.5
Benzene	C_6H_6	0.22
Toluene	C_7H_8	0.162
O-xylene	C_8H_{10}	0.116
Formic acid[1]	CH_2O_2	1.072
Acetic acid	$C_2H_4O_2$	0.22
Carbon monoxide[1]	CO	0.676
Hydrogen chloride[1]	HCl	0.054
Hydrogen cyanide[1]	HCN	0.072
Ammonia	NH_3	0.3
Hydrogen[1]	H_2	0.23
Trimethylamine	C_3H_9N	0.13
Nitrogen dioxide	NO_2	0.372

1. These VOCs are not detected by the PID sensor
2. Concentration of target VOC = sensor output multiplied by response factor

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SPECIFICATIONS

Parameter	Value	Units
Technology	ElectroChemical	
Range	0–10	ppm
Humidity Range	15–95	%
Resolution	0.01	ppm
Accuracy	± 5	% (FS)
Response[1]	20	s
Recovery[1]	80	s
Overload	10	ppm
Calibration	1	Year(s)

1. T90

HOW IT WORKS

PID

The sensor uses an ultraviolet (UV) light source to break down VOCs in the air into positive and negative ions. The PID then detects or measures the charge of the ionized gas, with the charge being a function of the concentration of VOCs in the air. These sensors work over a wide range of gas concentrations and although alone it cannot distinguish between different VOCs, it does have the ability to measure low levels of VOCs quickly, making it an ideal sensing instrument for critical environments.

SPECIFICATIONS

Parameter	Value	Units
Technology	Photoionization	10.6 eV
Range	0–5	ppm
Resolution	.001	ppm
Accuracy	± 0.1	ppm
Response[1]	5	s
Recovery[1]	5	s
Calibration	6	Month(s)

1. T90

PID Response Factor Table

Response factors (RF) for important chemicals are identified below. Chemicals are listed according to their most common name, but the CAS number should be used to more precisely identify each chemical. All RFs are subject to some variation due to differences in PID electrode stack design, UV light intensity and operating conditions.

The sensor will respond to all detectable volatiles present, and it is not possible to measure the concentration of each individual component. However, if it is known that only a particular VOC is present, the concentration of that VOC can be found using equation 1. If the formulation of a mixture of VOCs is known, the RF can be calculated using equation 2.

Concentration of known VOC = sensor output x RF (Equation 1)

$RFmix = 1/(VOC_1/RF_1 + VOC_2/RF_2 + VOC_3/RF_3 +\dots VOC_i/RF_i)$ (Equation 2)

*Where VOC_n and RF_n are the mole fraction and correction factor for the respective component 'n'.

Table 2: PID Response Factor Table

Compound Name	Formula	CAS Number	RF at 10.6 eV
Acetaldehyde	C2H4O	75-07-0	6.0
Acetic acid Ethanoic Acid	C2H4O2	64-19-7	22
Acetic anhydride	C4H6O3	108-24-7	6.00
Acetone	C3H6O	67-64-1	1.10
Acrolein	C3H4O	107-02-8	3.90
Acrylic acid	C3H4O2	79-10-7	12.00
Allyl alcohol	C3H6O	107-18-6	2.40
Allyl chloride	C3H5C	107-05-1	4.30
Aniline	C6H7N	62-53-3	0.48
Anisole	C7H8O	100-66-3	0.58
Arsine	AsH3	7784-42-1	2.00
Ammonia	7664-41-7	5.8	10.16
Benzaldehyde	C7H6O	100-52-7	0.70
Benzene	C6H6	71-43-2	0.50
Benzonitrile	C7H5N	100-47-0	1.60
Benzyl alcohol	C7H8O	100-51-6	1.10
Benzyl chloride	C7H7Cl	100-44-7	0.60
Bromine	Br2	7726-95-6	1.30
Bromobenzene	C6H5Br	108-86-1	0.60
Bromine	CH3Br	75-25-2	2.60
Bromopropane,1-	C3H7Br	106-94-5	1.50
Butadiene	C4H6	106-99-0	0.60
Butane	C4H10	106-97-8	60.00
Butanol, 1-	C4H10O	71-36-3	4.70
Butanol, t-	C4H10O	75-65-0	2.90
Butoxyethanol, 2-	C6H14O2	111-76-2	1.20
Butoxyethyl Acetate, 2-	C8H16O3	112-07-2	1.30
Butyl acetate, n-	C6H12O2	123-86-4	2.60
Butyl acrylate, n-	C7H12O2	141-32-2	1.60
Butylamine, n-	C4H11N	109-73-9	1.10
Butyl mercaptan	C4H10S	109-79-5	0.50
Butyraldehyde	C4H8O	123-72-8	1.80
Carbon disulfide	CS2	75-15-0	1.20
Chlorobenzene	C6H5C	108-90-7	0.50
Chloro-1,3-butadiene, 2-	C4H5C	126-99-8	2.00
Chloroethyl methyl ether 2-	C3H7ClO	627-42-9	3.00
Chlorotoluene, o-	C7H7Cl	95-49-8	0.50
Cresol, m-	C7H8O	108-39-4	0.50
Cresol, o	C7H8O	95-48-7	1.10
Cresol, p	C7H8O	106-44-5	1.20
Cumene	C9H12	98-82-8	0.55
Cyclohexane	C6H12	110-82-7	1.40
Cyclohexanol	C6H12O	108-93-0	0.92
Cyclohexanone	C6H10O	108-94-1	0.90
Cyclohexene	C6H10	110-83-8	0.80
Cyclohexylamine	C6H13N	108-91-8	1.20

Decane	C10H22	124-18-5	1.40
Diacetone alcohol	C6H12O2	123-42-2	0.80
Dibromo-3- chloropropane 1-2	C3H5Br2Cl	96-12-8	1.70
Dibromoethane, 1,2-	C2H4Br2	106-93-4	1.70
Dichlorobenzene, o-	C6H4Cl2	95-50-1	0.60
Dichloroethene, 1,1-	C2H2Cl2	75-35-4	0.90
Dichloroethene, c-1,2-	C2H2Cl2	156-59-2	0.80
Dichloroethene, t-1,2-	C2H2Cl2	156-60-5	0.45
Dichloro-1-propene, 2,3-	C3H4Cl2	78-88-6	1.30
Dicyclopentadiene	C10H12	77-73-6	0.48
Diesel Fuel	m.w. 226	68334-30-5	0.80
Diesel Fuel #2	m.w. 216	68334-30-5	0.70
Diethylamine	C4H11N	109-89-7	1.00
Diethylaminopropylamine, 3-	C7H18N2	104-78-9	2.50
Diethyl ether	C4H10O	60-29-7	1.20
Diketene	C4H4O2	674-82-8	2.00
Dimethylamine	C2H7N	124-40-3	1.50
Dimethyl disulfide	C2H6S2	624-92-0	0.20
Dimethylformamide, N,N	C3H7NO	68-12-2	0.80
Dimethylhydrazine, 1,1-	C2H8N2	57-14-7	0.80
Dioxane, 1,4-	C4H8O2	123-91-1	1.30
Epichlorohydrin	C2H5ClO	106-89-8	8.50
Ethanol	C2H6O	64-17-5	10.00
Ethene	C2H4	74-85-1	9.00
Ethyl acetate	C4H8O2	141-78-6	4.50
Ethylbenzene	C8H10	100-41-4	0.60
Ethylene glycol	C2H6O2	107-21-1	16.00
Ethylene oxide	C2H4O	75-21-8	13.00
Ethyl ether	C4H10O	60-29-7	1.10
Ethyl mercaptan	C2H6S	75-08-1	0.56
Gasoline #1	m.w. 72	8006-61-9	0.90
Glutaraldehyde	C5H8O2	111-30-8	0.80
Heptane, n-	C7H16	142-82-5	2.60
Hexane, n-	C6H14	110-54-3	4.30
Hexanol, 1-	C6H14O	111-27-3	2.50
Hydrazine	H4N2	302-01-2	2.60
Hydrogen iodide	HI	10034-85-2	0.60
Hydrogen sulfide	H2S	7783-06-4	3.30
Iodine	I2	7553-56-2	0.10
Iodomethane	CH3I	74-88-4	0.22
Isobutane	C4H10	75-28-5	100.00
Isobutanol	C4H10O	78-83-1	3.80
Isobutane	C4H8	115-11-7	1.00
Isobutyl acrylate	C7H12O2	106-63-8	1.50
Isoprene	C5H8	78-79-5	0.65
Isopropanol	C3H8O	67-63-0	5.00
Isopropyl acetate	C5H10O2	108-21-4	2.50

Isopropyl ether	C6H14O	108-20-3	0.80
Jet fuel JP-4	m.w. 115	8008-20-6 + 64741-42-0	1.00
Jet fuel JP-5	m.w. 167	8008-20-6 + 64747-77-1	0.60
Jet fuel JP-8	m.w. 165	8008-20-6 + 64741-77-1	0.70
Limonene, D-	C10H16	5989-27-5	0.33
Mesitylene	C9H12	108-67-8	0.35
Methoxyethanol, 2-	C3H8O2	109-86-4	2.40
Methoxyethoxyethanol, 2-	C5H12O3	111-77-3	1.20
Methyl acetate	C3H6O2	79-20-9	6.60
Methyl acrylate	C4H6O2	96-33-3	3.70
Methylamine	CH5N	74-89-5	1.20
Methyl bromide	CH3Br	74-83-9	1.70
Methyl t-butyl ether	C5H12O	1634-04-4	0.90
Methylcyclohexane	C7H14	107-87-2	0.98
Methyl ether	C2H6O	115-10-6	3.10
Methyl ethyl ketone	C4H8O	78-93-3	0.95
Methylhydrazine	C2H6N2	60-34-4	1.20
Methyl isobutyl ketone	C6H12O	108-10-1	0.90
Methyl isocyanate	C2H3NO	624-83-9	4.60
Methyl isothiocyanate	C2H3NS	551-61-6	0.45
Methyl mercaptan	CH4 S	74-93-1	0.60
Methyl methacrylate	C5H8O2	80-62-6	1.40
Methyl sulfide	C2H6S	75-18-3	0.44
Mineral spirits	m.w. 144	8020-83-5, 8052-41-3 68551-17-7	0.70
Naphthalene	C10H8	91-20-3	0.42
Nitric oxide	NO	10102-43-9	5.20
Nitrogen dioxide	NO2	10102-44-0	15.00
Octane, n-	C8H18	111-65-9	1.80
Pentane	C5H12	109-66-0	8.40
Perchloroethene	C2Cl4	127-18-4	0.55
PGME	C6H12O3	107-98-2	1.50
PGMEA	C6H12O3	108-65-6	1.00
Phenol	C6H6O	108-95-2	1.00
Phosphine	PH3	7803-51-2	3.90
Picoline	C6H7N	108-99-6	0.85
Pinene, α-	C10H16	2437-95-8	0.32
Pinene, β-	C10H16	18172-67-3	0.40
Piperylene, isomer mix	C5H8	504-60-9	0.70
Propanol, n-	C3H8O	71-23-8	5.50
Propene	C3H6	115-07-1	1.40
Propylene oxide	C3H6O	75-56-9	6.50
Pyridine	C5H5N	110-86-1	0.70
Styrene	C8H8	100-42-5	0.42
Tetrahydrofuran	C4H8O	109-99-9	1.70
Tetramethyl orthosixicate	C4H12O4Si	681-84-5	2.00
Toluene	C7H8	108-88-3	0.50
Tolylene-2,4-diisocyanate	C9H6N2O2	584-84-9	1.40

Trichloroethene	C2HCl3	79-01-6	0.55
Triethylamine	C6H15N	121-44-8	1.00
Turpentine	C10H16	8006-64-2	0.40