GAS DETECTION INSTALLATION GUIDE AND BEST PRACTICES

When dealing with toxic gases in industrial settings, proper gas sensor placement is critical for ensuring the safety of personnel and the environment.

This guide focuses on recommendations for installation heights of sampling points based on gas densities, outlines best practices for industrial applications, and highlights potential issues of which businesses should be aware when working around or with toxic gases.

DETERMINING SENSOR HEIGHTS BASED ON GAS DENSITIES

It is crucial to classify toxic gases based on their density when compared to air to ensure that sensors are optimally placed for early detection.

The following charts categorize toxic gases commonly used in semiconductor manufacturing based on their densities relative to air. At room temperature (20° C), air has a density of approximately 1.204 kg/m³.

The comprehensive charts below serve as a critical resource for semiconductor manufacturing facilities. Specifically, these charts allow for precise gas density identification, which in turn can assist in facilitating informed decisions regarding both sensor placement and safety protocols in environments where toxic gases are present.

GAS NAME	SYMBOL	DENSITY (KG/M³)
Lighter Than Air		
Hydrogen	H_2	0.08
Methane	CH_4	0.67
Ammonia	NH_3	0.72
Hydrogen Fluoride	HF	0.83
Density Similar to Air		
Hydrogen Cyanide	HCN	1.13
Diborane	B_2H_6	1.15
Silane	SiH_4	1.16
Carbon Monoxide	CO	1.16
Nitric Oxide	NO	1.25
Oxygen	O_2	1.33
Phosphine	PH_3	1.35
Hydrogen Chloride	HCL	1.39
Methyl Fluoride	CH_3F	1.42
Hydrogen Sulfide	H_2S	1.43
Fluorine	F_2	1.57
Propylene	C_3H_6	1.75
Propane	C_3H_8	1.84
Carbon Dioxide	CO_2	1.84
Nitrogen Dioxide	NO_2	1.91

The gas density information can be found in the public domain.

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GAS NAME	SYMBOL	DENSITY (KG/M³)
Heavier Than Air		
Ozone	O_3	1.99
Difluoromethane	CH_2F_2	2.16
Butane	C_4H_{10}	2.41
Methylpropane	C_4H_{10}	2.41
Iso-Propyl-Alcohol	C_3H_8O	2.5
Disilane	Si_2H_6	2.58
Sulfur Dioxide	SO_2	2.66
Nitrogen Trifluoride	NF_3	2.8
Chlorine Dioxide	ClO_2	2.8
Boron Trifluoride	BF_3	2.81
Dichlorosilane	$SiCl_2H_2$	2.96
Chlorine	Cl_2	2.99
Germane	GeH_4	3.19
Arsine	AsH_3	3.24
Hydrogen Bromide	HBr	3.36
Triethylamine	$C_6H_{15}N$	3.63
Phosgene	$COCl_2$	3.96
Cyclopentyl Methyl Ether	$C_6H_{12}OCH_3$	4.17
Tetrafluoroethane	$C_2H_2F_4$	4.24
Ethylcyclohexane	C_8H_{16}	4.66
Octane	C_8H_{18}	4.74
Boron Trichloride	BCl_3	4.86
Bromine	Br_2	6.65
Hexafluoroisobutylene	C_4F_6	6.9
Hexafluoro-2-butane	C_4HF_6	8.31
Octofluorocyclopentene	C_5F_8	8.31
Tungsten Hexafluoride	WF_6	12.37

RECOMMENDED SENSOR PLACEMENT

Gases Lighter than Air
Install sensors at or just below the ceiling level, typically around 1 to 2 feet (30–60 cm) below the highest point.

Gases Heavier than Air
Place sensors 1 to 2 feet (30–60 cm) above the floor to effectively monitor concentrations as these gases settle at lower levels.

Gases with Density Similar to Air
Install sensors at a height of approximately 4 to 6 feet (1.2–1.8 meters) or at breathing zone level for worker safety when performing tasks near these gases.

Note: 4 to 6 feet is considered an ideal default height when installing sampling points as many gases readily disperse in air.

BEST PRACTICES FOR EXTRACTIVE SENSOR PLACEMENT

Minimize Long Tubing Runs
- The longer and more convoluted the tubing, the more opportunity for gas to disperse before it reaches the sensor. Minimize tubing length while ensuring it reaches all necessary sampling points.

Note: Vertex unit max tubing length – 400 feet (130 meters), Midas product max tubing length – 100 feet (30 meters, gas dependent)

Use Recommended Tubing
- Utilize recommended tubing diameter and material to provide adequate flow rates, prevent excessive pressure drops along the line, and to maintain an inert surface for sticky gases measurement and chemical compatibility for highly corrosive gases.

Inlet Positioning
- Direct the sample inlet towards areas of potential gas leaks or high risk (i.e. connection points, flanges, gas-machine entry points); while ensuring it is unobstructed by machinery, structures, or personnel.

Consider Tubing Orientation
- Situate sampling tubing so it naturally drains any condensed moisture away from the sensor. Horizontal runs should be gently sloped; vertical runs should be straight.

Regular Maintenance Checkpoints:
- Establish points for routine inspections of sampling tubing and confirm that any seals are intact, as leaks could affect readings significantly.

Note: Honeywell Vertex, Midas M, Midas S2, and ACM150G2 products feature an automated line integrity test to detect leaks or blockages in the sampling line.

POTENTIAL ISSUES AND CONSIDERATIONS WITH EXTRACTIVE SENSORS

Sampling Delay
- **Issue:** Due to the time it takes for gas to travel through the tubing, there may be a delay in response time for real-time concentration levels.
- **Solution:** Utilize direct tubing and minimize distance when possible.

Moisture Build-Up
- **Issue:** Extractive systems can collect moisture, which may condense in the tubing and affect sensor performance or accuracy.
- **Solution:** Install moisture traps, filters, or heat tracing sample line at designated intervals to prevent condensation from reaching the sensor.

Note: Installation of some moisture traps or filters can block/hinder the flow of target gases (sticky gases). Consult a service expert to before selecting filters.

Blockages and Contaminants
- **Issue:** Dust, particulates, or chemical build-up can clog the tubing or sampling inlet, leading to inaccurate readings, unnecessary faults/warnings or sensor failure.
- **Solution:** Use in-line filters and schedule routine cleaning of the tubing and sampling devices to mitigate build-up.

Note: Filters should be replaced every 3-6 months (frequency is dependent on customer facility).

Tubing Compatibility
- **Issue:** Certain gases may corrode or degrade particular tubing materials over time, impacting sampling.
- **Solution:** Use recommended tubing. Tubing material is chosen based on resistance to specific gases being monitored (e.g., polyethylene or Teflon for a range of substances).

Calibration and Response Time
- **Issue:** Certain gas sensing technologies, including Electrochemical and Catalytic Bead, may require regular calibration to maintain accuracy, and ambient conditions can affect response times.
- **Solution:** Implement a strict calibration schedule, including bump tests, and regularly review the response rates to verify they meet gas detection specs.

ADDITIONAL BEST PRACTICES

Safety Considerations:
- Ensure that sampling points are accessible and that operators can conduct maintenance safely without exposure to toxic gases.

Documentation:
- Keep thorough records of tubing lengths, sensor calibrations, maintenance checks, and any operational anomalies for compliance and operational efficiency.

Training for Personnel:
- Train all personnel involved with the extractive gas sensors on proper usage, maintenance procedures, and emergency response protocols relevant to toxic gas exposure.

Note: Honeywell offers operational and maintenance training on all its gas detection products, and offers service contracts to support your operations and personnel.

For a more comprehensive understanding of Honeywell Gas Sensing solutions and the gases they detect, please view the Honeywell Gas Book.

For more information
automation.honeywell.com

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