Hazardous Gas Monitoring Throughout the Semiconductor Manufacturing Facility

Semiconductor manufacturing facilities employ a number of hazardous gases in their production processes. Whenever these gases are stored, distributed or used in manufacturing processes, there exists the potential for a hazardous condition. The primary hazards associated with these gases include fire, explosion, and contamination, resulting in product loss or unscheduled preventative maintenance. These gases must be continuously monitored to ensure the health and safety of employees, to protect property, as well as to maintain regulatory compliance.

Reliable gas detection and monitoring systems are an essential element of the semiconductor plant's safety system. A variety of systems are available for different monitoring applications. Using the correct system will result in managing gas hazards in the most effective and efficient way.

Hazardous gas monitoring systems benefit the semiconductor industry in the following applications:

- PPM (parts per million) detection in ventilated gas cabinets, enclosures, process equipment chases and clean rooms
- Flammability monitoring of LFL (Lower Flammable Limit)/ LEL (Lower Explosive Limit) levels in and around process tools
- Flammability monitoring of LFL/ LEL levels to protect thermal oxidizers
- Area monitoring for toxics and combustibles in storage areas, distribution, delivery piping and equipment chases

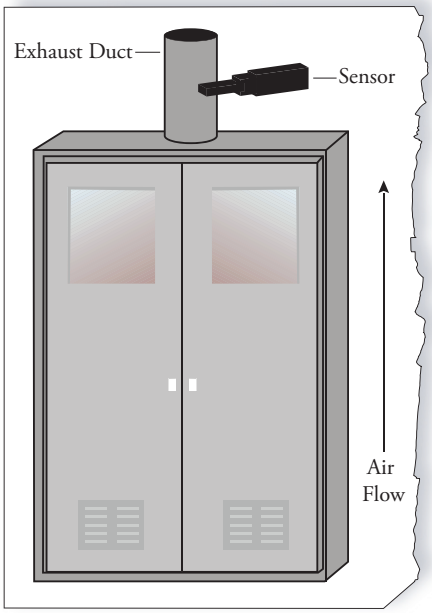
Parts Per Million Detection in Ventilated Gas Cabinets, Enclosures, Equipment Chases and Clean Rooms

Containers of hazardous gases, both flammable and toxic, are often isolated from the surrounding environment by safety enclosures (gas cabinets). Some process tools have a gas control enclosure section that serves the same purpose as a gas cabinet. Some of the common gases found include hydrogen, hydrogen chloride, ETO, chlorine, ammonia and oxygen. It is important to monitor these enclosures for leaking gas to save product as well as prevent a toxic condition. The cabinets and enclosures are ventilated to prevent the buildup of any leaking gas. The ventilation dilutes the vapors which quickly mix with air flowing through the cabinet, preventing buildup.

Detecting the diluted leak requires a gas sensor in the low ppm (parts per million) range. Placement of ppm sensors in the exhaust duct will allow continuous sampling of all air moving through the enclosure. When a leak is detected, the detection system can sound an alarm to notify personnel, and /or close a delivery valve to stop the flow of gas from the cylinder.

Some process tools have gas enclosures that contain the piping jungle carrying hydrogen and toxic gases such as arsine, phosphine, diborane or silane. These gases are introduced into processes in metered quantities to obtain product specifications. Any type of leak could jeopardize the integrity of the lot resulting in loss of product. In addition, many of these gases are highly toxic and require precautions to protect personnel. If a technician opens the enclosure section when a leak is present they would be exposed to the toxic gases. Continuous monitoring and early warning are the best means of preventing both of these accidents.

A clean room is an enclosed contamination-free environment where state-of-the-art manufacturing and assembly take place. Clean rooms range from very small chambers to large scale rooms. Piping carrying process gases are connected to deposition, etching and other process tools. The connections are sources of possible leaks and contamination. Therefore, the air must be continuously monitored for ppm levels of hazardous leaking gas.



Control Instruments ppm sensors employ electrochemical sensing technology. The sensors are rugged, highly stable and excellent for detecting low ppm concentrations of selected gases in gas cabinets, enclosures and clean rooms. They offer immunity to cross interference, low maintenance, excellent repeatability and long-term stability. These ppm sensors can be calibrated to read hydrogen and carbon monoxide . Hydrogen also is often employed as a carrier for other gases such as arsine, phosphine and silane. Control Instruments ppm sensor can be calibrated to hydrogen in a variety of ranges, making it useful for the detection of either pure hydrogen or toxic process gases being carried in hydrogen.

Flammability Monitoring of LFL/LEL Levels in and Around Process Tools

Process tools are enclosed areas in which specific wafer processing functions occur. Any process tools handling flammable gases require a hazardous gas detection system to ensure safety and be in compliance to codes.

The FM standard states that "ventilation shall be provided for all tools handling flammable and combustible liquids. Ventilation shall be provided to ensure the atmosphere does not exceed 25% of the LFL/LEL in the event of the largest possible leak."

The equipment contains exhaust ducts to remove the hazardous gases. Detectors are located in each process control cabinet and exhaust plenum to monitor the atmosphere for % LFL/LEL. When an alarm occurs the process is shut down and the gas supply to the tool is turned off. Some of the process tools that need to monitor for flammable gases include furnaces, reactors, alcohol vapor dryers and ion implanters.

Control Instruments catalytic sensors are typically used to monitor flammable gases and vapors in the 0-100 % LFL/LEL range. The sensor is a high performance design that offers fast response, high accuracy and long life. It is stable and has superior tolerance to catalytic poisoning agents.

Flammability Monitoring of LFL/LEL Levels to Protect Thermal Oxidizers

Semiconductor wafer fabrication generates significant amounts of volatile organic compounds (VOCs) that are sent to a thermal oxidizer for abatement. In order to stay safe and meet regulations, the oxidizer must be continuously monitored.

The National Fire Protection Association's standard for the safe operation of ovens and furnaces defines direct-fired thermal oxidizers as Class A furnaces, mandating the use of continuous flammability analyzers on the inlet streams exceeding 25% LFL.

Measuring flammability at the inlet of the oxidizer will prevent fires, explosions, or catalyst destruction by monitoring the flammability of the incoming VOC stream. These streams are of varying energy content that can change rapidly in a matter of minutes. Danger is present when the inlet stream suddenly gets rich enough to ignite or explode.

Control Instruments PrevEx Flammability Analyzers are used on the inlet duct to monitor the flammability of the incoming stream and protect it from dangerous concentrations caused by rich vapor streams.

They offer a direct measurement of flammability, with highly accurate readings, as well as a response time that is less than one second. Additionally, they demonstrate a principle known as "universal calibration," giving accurate readings over a very large cross-section of industrial solvent vapors without the need to re-calibrate the instrument for differing process recipes. This helps to maintain a high degree of safety while reducing operational costs. PrevEx Analyzers are robust, designed for tough, 24/7/365 industrial use, and heated to a temperature sufficient to keep water in a vapor state.

Area Monitoring of Storage Areas, Distribution and Delivery Piping

Hazardous gases are stored and distributed in the semiconductor plant. In these operations there exists the possibility that the hazardous gas could accidentally leak or spill into the surrounding area. Pumps, control valves, manifolds, piping junctions, fittings and connections are some of the potential sources for leaks or spills. With so many opportunities for leakage, continuous monitoring of such hazards is an essential part of keeping the plant safe.

Detector placement should consider the importance of early warning, which is accomplished by placing the sensors so as to favor the probable gas release point while maintaining the ability to protect the total area selected. Sensor selection (ppm or LFL/LEL) depends on the gas hazard present.