Monitoring ammonia levels is critical due to its hazardous nature. Ammonia (NH3), an alkaline gas, is commonly known as anhydrous ammonia when devoid of water or in its gaseous state. With a strong odor and corrosive properties, it poses significant risks, particularly to respiratory systems, causing fatality at concentrations as low as 5000 ppm. According to NIOSH (1994), exposure limits are set relatively low:

- TWA (Time-Weighted Average): 25 ppm
- STEL (Short-Term Exposure Limit): 35 ppm
- IDLH (Immediately Dangerous to Life or Health): 300 ppm
- LEL (Lower Explosive Limit): 15 Vol %

Ammonia's adoption as a refrigerant (R717) has surged as an eco-friendly alternative to ozone-depleting chlorofluorocarbons. Its presence is prominent in various industries, including fertilizer plants, urea resin production, explosives manufacturing, nylon production, semiconductor fabrication, wastewater treatment facilities, and even clandestine drug labs. Effective monitoring and measurement of ammonia levels are essential across these sectors to ensure safety and compliance with regulatory standards.

Why Measure Ammonia?

The need to measure ammonia arises from several crucial factors. Despite its distinct odor, human olfaction isn't equipped to accurately gauge its concentration. Hence, real-time monitoring becomes imperative for continuous assessment and determining the necessary Personal Protective Equipment (PPE) to ensure adequate protection against ammonia exposure. NIOSH guidelines (NIOSH, 1994) stipulate that protection from lower levels of ammonia (up to 250 to 300 ppm) may require nothing more than a respirator fitted with appropriate ammonia cartridges. However, when dealing with concentrations exceeding 300 ppm or in cases of unknown concentrations, full encapsulation suits (Level A) are mandated due to ammonia gas's highly reactive alkaline properties. Moreover, concentrations surpassing 15% (150,000 ppm) render the ammonia atmosphere potentially explosive, further underscoring the criticality of accurate and reliable portable ammonia monitors for making informed decisions in real-time.

LEL and EC Sensors for Measuring Ammonia

LEL (Lower Explosive Limit) sensors based on catalytic bead technology are effective in measuring ammonia in the low volume % range, providing initial warnings of very high ammonia levels. However, they lack the sensitivity required to detect low-ppm concentrations necessary for making decisions at TWA (Time-Weighted Average) or STEL (Short-Term Exposure Limit) levels. Additionally, ammonia can deactivate these sensors, limiting their lifespan in high-concentration environments to mere minutes or hours, contingent upon the concentration of ammonia present.

On the other hand, electrochemical sensors offer a cost-effective means of selectively measuring ammonia in the low ppm range. Despite their affordability, these sensors suffer from drawbacks such as extended response times (typically 2 minutes) and rapid burnout when exposed to high concentrations of ammonia. This burnout is primarily due to the use of sacrificial iodine reagents within the sensor cells, which are consumed in the detection process. Consequently, while electrochemical sensors provide selective measurements, their efficacy is compromised in high-ammonia exposure scenarios due to these limitations.

Measuring Ammonia with a PID

Measuring ammonia with a PID offers several advantages over other detection methods. Ammonia's ionization energy of 10.16 eV makes it compatible with a standard 10.6 eV lamp commonly used in PIDs. With a correction factor (CF) around 10 for ammonia with a 10.6eV lamp, the PID can achieve a detection limit of approximately 1 ppm, comparable to or better than that of an electrochemical sensor.

Portable PIDs offer notable advantages, particularly in measuring ammonia concentrations above the TWA and STEL levels (25-35 ppm range):

- PIDs have a broader detection range than electrochemical sensors, facilitating all PPE decisions and leak detection.
- They are not susceptible to damage from over-ranging.
- PIDs boast significantly faster response times, typically less than 5 seconds compared to the 100 seconds required for electrochemical ammonia sensors. This rapid response enables swift assessment of changing conditions and prompt leak detection.
- Calibration gas, such as isobutylene, used for PIDs is more cost-effective and stable than ammonia gas required for electrochemical sensors.
- Lower operating costs are realized with PIDs due to less frequent lamp changes, which are also less expensive compared to replacing an electrochemical ammonia sensor.

In summary, PIDs offer a reliable and cost-effective solution for measuring ammonia concentrations, particularly in applications requiring rapid response, broad detection range, and minimal maintenance.

PID Specificity to Ammonia

While a PID is not inherently specific to ammonia and can respond to a range of other compounds, the distinct smell of a major ammonia leak often aids in its identification. However, for verification purposes, particularly in scenarios where the smell may not be readily detectable or to confirm ammonia presence quantitatively, complementary techniques like gas detection tubes offer a cost-effective solution.