Ammonia and Ammonia Sensors

Ammonia (NH3) is a very useful but dangerous gas. When we come into contact with ammonia, it corrodes our skin, eyes and lungs. Inhaling ammonia is dangerous because it can irritate the throat, nose and lungs. Although ammonia is harmful, it has many industrial applications. Ammonia can be used as a refrigerant in the production of fertilizers, plastics, dyes and textiles.

Can ammonia be smelled?

Yes, humans can smell ammonia. However, the odor threshold varies from person to person. In general, it's not feasible to rely on your sense of smell to determine the dangers of ammonia. That's because when you get used to the smell, your nose becomes less sensitive. This phenomenon is called olfactory fatigue.

When should ammonia be detected?

Ammonia is used in large quantities in manufacturing and industrial processes. In the environment, ammonia is part of the nitrogen cycle and is produced in soil from bacterial processes. Ammonia is also produced naturally from the decomposition of organic matter, including plants, animals and animal wastes. A high concentration of ammonia in the environment is dangerous so there are various regulatory controls put in place by governments to the exposure limits of ammonia in many applications.

- Due to its low cost and high energy efficiency as well as having a negligible environmental impact, ammonia is common in large refrigeration units which require leak detection for facility and personnel protection.
- One of the largest applications for ammonia detection is poultry and pig markets to check indoor air quality to improve livestock health and production yield.
- Fertilizer for agricultural applications is commonly produced using a combination of gas-phase anhydrous ammonia and concentrated nitric acid to produce ammonium nitrate. Monitoring ammonia levels is a required safety feature.

What are safe ammonia gas levels?

Various government agencies and associations have recommended ammonia gas exposure limits, examples can be seen below in Table 1.

How does an ammonia detector work?

An ammonia detector is generally composed of an electronic circuit and an ammonia (NH3) sensor. The NH3 gas sensor converts the detected gas concentration into an electronic signal that is analyzed by an onboard microprocessor. Upon receiving the signal, the processor displays a reading. When the measured value exceeds the specified alarm value, an alarm is triggered.

Table 1 - Recommended Ammonia Gas exposure limits

Agency	Recommendation / Requirement
National Institute for Occupational Safety and Health (NIOSH)	NIOSH Recommended Exposure Limit (REL): 25 ppm, 10-hour TWA 35 ppm, 10-minute ceiling
Occupational Safety and Health (OSHA)	50 ppm average over 8 hours
American Conference of Governmental Industrial Hygienists (ACGIH)	25 ppm average over 8 hours 35 ppm (Short Term Exposure Limit - STEL)

Selection of ammonia (NH3) sensors

It is important to choose the right NH3 sensor for your application. The following questions narrow down the selection of the NH3 sensor for your applications:

- Is fast response time important to my test?

  For some applications and certain regulations, there are specific requirements for response time (T90) to meet safety standards. SemeaTech manufactures NH3 sensors with T90 meeting many regulations, such as

  T90 < 40 seconds   *4NH3-500S   4NH3-1000S*

  T90 < 45 seconds   *4NH3-100S   7NH3-100S   7NH3-200S   7NH3-1000S   7NH3-200S*

- Am I using it for personal protection or continual monitoring?

  If T90 Is not critical and continual monitoring is the case, the best choice is to use SemeaTech non-depleting NH3 sensors. These sensors are also called long-life or extended-life NH3 sensors. They are designed for a 5-year lifespan and can be functional continuously in an environment where ammonia persistently exists 24/7 like some refrigeration facilities or livestock farms. For example, *4NH3-100L* is ideal for refrigeration facilities, and *4NH3-500L* is recommended for chicken farm ammonia detection.

- Do I need to test for very low concentrations of ammonia, such as air quality monitoring?

  For this application, the SemeaTech 4-electrode NH3 sensor, *7E4-NH3-10*, is preferred. This is one of the SemeaTech air quality monitoring (AQM) sensors designed using SemeaTech proprietary technology by adding an additional auxiliary electrode to a standard 3-electrode electrochemical sensor. The auxiliary electrode provides a fine resolution in ppb and outstanding long-term stability to the sensor.

- Do I need digital outputs from the NH3 sensor?

  For user convenience, SemeaTech also offers smart modules that pair with these NH3 sensors. The smart module provides UART and I2C outputs and has a compensation mechanism for environmental parameter fluctuations.

About the life span of electrochemical NH3 sensors

Most of the electrochemical NH3 sensors available in the market are depleting. Performing like an alkaline battery, the depleting NH3 sensor consumes the chemicals sealed inside the sensor when exposed to the ammonia in the environment. It can only measure a certain amount of ammonia, typically in ppm-hours, in its lifespan. Most depleting NH3 sensors are rated at 3,000 ppm-hours, which means they can work for 1500 hours at 2 ppm ammonia atmosphere or 600 hours at 5 ppm ammonia atmosphere. Once 3,000 ppm-hours is reached, the ammonia-sensitive material in the sensor is exhausted and then the sensor stops sensing ammonia furthermore.

SemeaTech manufactures a family of depleting NH3 sensors with the best response time T90 less than 40 seconds. Based on its proprietary technologies, SemeaTech depleting NH3 sensors are rated at 10,000 ppm-hours or better.

To overcome the disadvantages of a short life span, SemeaTech has developed long-life NH3 sensors that do not affect their service life regardless of how long and how much they are exposed to ammonia atmosphere. These long-life NH3 sensors are ideal for use in places where ammonia may be present 24/7, such as refrigeration facilities or livestock farms.

Ammonia detection with Photo-Ionization Detection (PID)

The first ionization energy of Ammonia is 10.18eV, which can be easily measured with a standard 10.6eV PID. PID has considerable advantages as described below for measuring ammonia:

- PID lasts long regardless of how much it has been exposed to ammonia and will not be damaged by over range. With ranges up to 10,000 PPM, PID can therefore be used for all personal protection equipment (PPE) decisions and leak detection.
- Compared with the response time T90 of the electrochemical NH3 sensor, PID provides an almost instantaneous response to ammonia, PID can be used as an accurate leak detector to quickly detect and locate ammonia leaks.
- PID can be calibrated with isobutene, which is stable and relatively inexpensive compared to ammonia calibration gas. The correction factor of ammonia to isobutylene is 10.9.
- SemeaTech PID with 10.6eV lamp lasts a minimum of 1 year (4-series) and 2 years (7-series).

Highlights of SemeaTech Ammonia (NH3) Sensors

Table 2 below highlights the key performance characteristics for the popular SemeaTech NH3 sensors with recommended applications to be used.

Table 2 – Characteristics of Popular SemeaTech NH3 Sensors

Model	T90 (sec.)	Resolution (PPM)	Detection Range (PPM)	Life Span	Recommended Applications
4NH3-100S	< 45	0.20	0 – 100	Depleting 10,000 ppm-hrs	Handheld gas monitors
7NH3-100S	< 45	0.30	0 – 100	Depleting 10,000 ppm-hrs	Fixed gas monitors in compliance with regulations for T90<45 seconds
4NH3-500S	< 40	0.50	0 – 500	Depleting 10,000 ppm-hrs	Applications requiring fast response T90
4NH3-100L	< 90	0.20	0 – 100	Non-Depleting	Refrigeration facility detection
7NH3-100L	< 90	1.00	0 – 100	Non-Depleting	Refrigeration facility detection
4NH3-500L	< 85	2.00	0 – 500	Non-Depleting	Livestock farms indoor applications
7NH3-500L	< 90	2.00	0 – 500	Non-Depleting	Livestock farms outdoor applications; Fertilizer applications
7E4-NH3-10	<120	0.06	0 – 10	Non-Depleting	Air quality monitoring
4PID-200	< 3	0.05	0 – 20	1 year	Applications requiring fast response and no cost concerns