Addressing the Challenges of Ammonia Detection: Core Technology and Performance Advantages of SemeaTech's Long-Life Ammonia Sensors

In applications such as ammonia refrigeration, livestock farming, fertilizer production, and cold chain warehousing, ammonia is present at low concentrations over long periods. Traditional electrochemical ammonia sensors, due to their **consumptive operating principle**, commonly face issues including short lifespan, poor stability, and high maintenance costs. SemeaTech's L-series long-life ammonia sensors leverage dual-core innovations—**non-consumable catalytic reaction technology and ionic liquid-based electrolyte**—to completely overcome traditional limitations, achieving **up to 5 years of extended service life, strong environmental tolerance, and highly stable signals**, making them the preferred solution for ammonia detection in harsh industrial conditions.

I. Core Principle Innovation: Addressing the Root Causes of Short Lifespan from "Consumable Materials" to "Cyclic Catalysis"

Traditional ammonia sensors use neutral aqueous composite electrolytes, relying on active components in electrodes or electrolytes to undergo irreversible reactions with ammonia for detection. This approach leads to two critical flaws: first, aqueous electrolytes are prone to evaporation and drying out, causing concentration drift and performance degradation; second, active components are continuously consumed during the reaction, and once depleted, the sensor fails. The cumulative ammonia tolerance of **standard consumable ammonia sensors on the market** is limited to approximately **3,000 ppm·hours.** SemeaTech has extended the lifespan of its **consumable sensors to 12,000 ppm·hour** by optimizing the loading method of active components to reduce waste. However, even with this improvement, sensors based on the consumable reaction mechanism still have limited lifespans when exposed continuously to ammonia. The calculation formula for the lifespan of consumable ammonia sensors is as follows: 3,000 ppm·hour ÷ (24 hours × 5 ppm) = 25 days. In typical refrigeration environments with a 3 ppm ammonia concentration, the lifespan of a consumable sensor is just 1,000 hours (42 days); in common poultry farms where ammonia levels reach 10 ppm, the lifespan drops to only 300 hours (13 days).

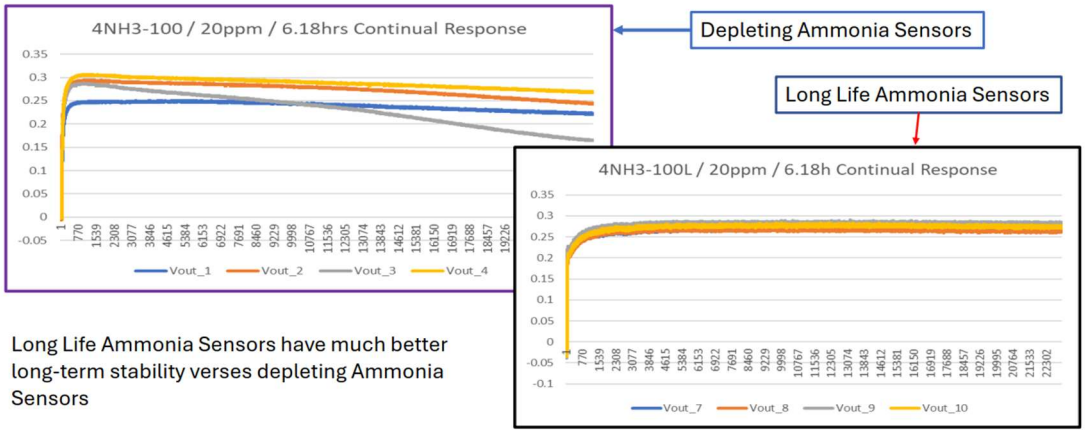


Figure 1: Continuous Response Test Comparison (20 ppm Ammonia, Sustained for 6.18 Hours)

As shown in Figure 1's continuous response test comparison (20 ppm ammonia, sustained for 6.18 hours), the consumable ammonia sensor (4NH3-100) on the left exhibits a clear signal decline over time, while the long-life sensor (4NH3-100L) on the right maintains a stable signal throughout, **fully demonstrating its significantly superior long-term stability compared to conventional consumable sensors.**

The SemeaTech L-series sensors achieve dual advancements in reaction mechanism and electrolyte material selection, establishing a **non-consumable operational system**:

1. **Zero-loss precious metal catalytic reaction:** Using high-performance precious metal catalytic electrodes, ammonia undergoes a direct electrochemical oxidation reaction on the electrode surface. The electrode serves solely as a catalytic support; the catalyst does not participate in the reaction and no active materials are consumed. Theoretically, the sensor lifespan is independent of the internal active material content.

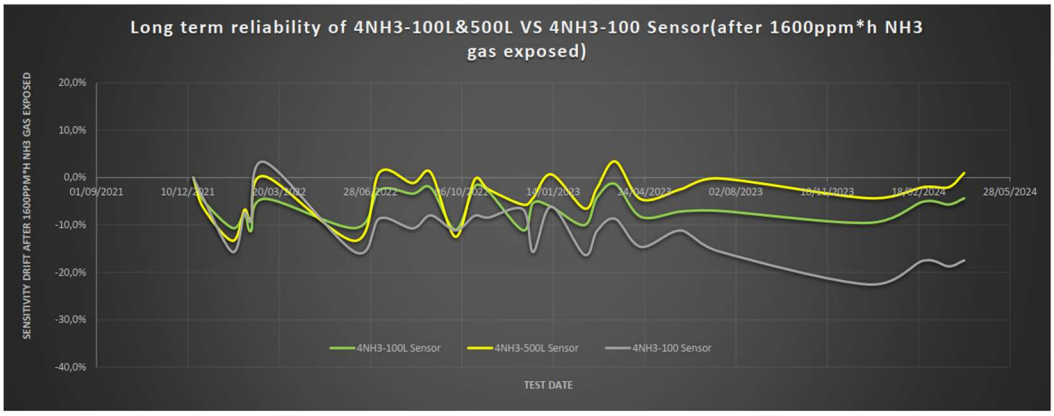
2. **Replacement of aqueous electrolytes with ionic liquid-based electrolytes:** By selecting a highly chemically stable ionic liquid as the conductive medium, it exhibits three distinct advantages: zero volatility, robust chemical stability, and excellent electrode compatibility: it does not evaporate or dry out, maintaining long-term liquid stability; it does not undergo irreversible reactions with ammonia, preventing consumption or degradation; and it does not corrode precious metal electrodes, continuously preserving catalytic activity—eliminating lifespan limitations from the electrolyte side entirely.

II. Four outstanding features, perfectly suited for demanding detection requirements across all scenarios

1. Exceptionally long service life, stable and reliable throughout the entire lifecycle

As a **non-consumable sensor**, L-series ammonia sensors are unaffected by ambient ammonia concentration levels, with a designed lifespan of up to **5 years** in air, backed by a 2-year warranty. They can withstand total ammonia exposure exceeding 50,000 ppm·hours—over 16 times that of traditional sensors. Long-term stability is less than 2% signal drift per month, with no significant signal attenuation during continuous ammonia exposure.

Even after exposure to high-load ammonia levels of 1,600 ppm·hours, sensitivity drift remains significantly lower than that of conventional sensors, and they possess the ability to **self-recover after excessive exposure**—enabling long-term use without frequent recalibration or replacement (as shown in Figure 2: green: 4NH3-100L, yellow: 4NH3-500L, gray: SemeaTech consumable sensor 4NH3-10).

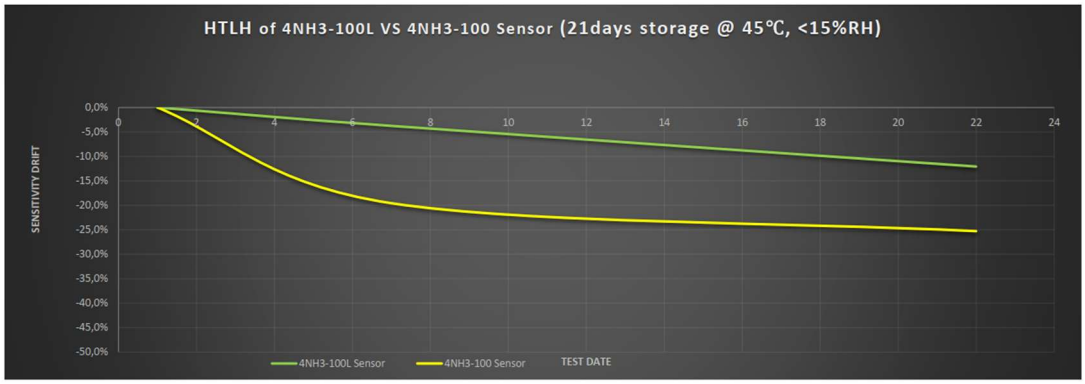


Sensitivity of depleting NH3 sensors declines faster than long-life NH3 sensors over time.

Figure 2: Response signal under exposure to 1,600 ppm·hour ammonia (Test date: Sep 1, 2021 – May 28, 2024)

2. Exceptional environmental tolerance, stable output under extreme conditions

Overcoming the traditional limitations of temperature and humidity sensitivity, the L-series (as shown in Figure 3: green line: 4NH3-100L sensor) leverages the wide-temperature-range stability of ionic liquids, offering an operating temperature range from -40°C to 40°C. It maintains stable signal output even in extreme cold at -40°C. After being stored for 21 days under high-temperature, low-humidity conditions (45°C, <15% RH), its sensitivity drift remains significantly lower than that of conventional sensors (Figure 3: yellow line: 4NH3-100 sensor). With humidity tolerance spanning 15% to 95% RH (without condensation), it performs reliably in both humid and dry environments, making it ideal for harsh settings such as cold storage facilities, outdoor livestock farms, and industrial workshops.



Long Life Ammonia sensors are much more insensitive to humidity than depleting Ammonia sensors in the same storage condition.

Figure 3: High-temperature, low-humidity environment adaptability test (45°C, <15% RH, storage for 21 days), green line: 4NH3-100L;

yellow line: 4NH3-100.

Results show: Under identical storage conditions, long-life ammonia sensors exhibit significantly lower sensitivity to humidity compared to consumable ammonia sensors.

3. High precision with minimal interference, ensuring truly reliable measurement data

- **High-resolution detection**: The mini-series achieves a resolution as fine as 0.08 ppm, while standard models offer resolutions between 0.2 and 5 ppm, enabling precise detection of trace ammonia leaks to meet high-precision demands in industrial safety and environmental monitoring.
- **Strong anti-interference capability**: Ionic liquids are poorly compatible with ethanol and other alcohol-based substances, effectively blocking vapor penetration from alcohol and preventing cross-interference. Meanwhile, the stable electrode interface suppresses side reactions, resulting in temperature and humidity drift below 3 ppm, ensuring measurement stability and reliability regardless of environmental changes.
- **Zero-bias design**: No additional bias voltage is required, simplifying circuit design, reducing development and operational costs, and enabling seamless integration into various detection devices.

4. High compatibility and easy integration, reducing total lifecycle maintenance costs

The L-series is fully compatible with traditional 4-series sensor housing, serving as a direct drop-in replacement for standard electrochemical ammonia sensors on the market. It allows for seamless and effortless replacement without requiring any modifications to the existing device structure. With measurement ranges spanning from 0–100 ppm to 0–5,000 ppm, it suits diverse applications including low-concentration environmental monitoring and high-concentration leak alarms. The 5-year ultra-long lifespan drastically reduces replacement frequency, lowering labor and spare parts costs—particularly ideal for scenarios requiring 24/7 continuous monitoring such as refrigeration plants, large-scale livestock farms, and fertilizer production workshops, greatly reducing total lifecycle maintenance costs.

III. Scenario validation and market recognition

Semeatech's L-series long-lifespan ammonia sensors have successfully helped customers pass the UL-62990 performance standard certification for compressor rooms. During a rigorous one-year testing period, it was the only sensor product to achieve certification, earning high recognition from industry-leading clients. The technology is now widely applied in ammonia refrigeration compressor rooms, livestock farms, fertilizer production facilities, cold chain warehouses, and environmental monitoring systems, delivering reliable, long-term ammonia detection solutions for industrial safety, environmental protection, and public welfare. As shown in Figure 4, the NH3-L series exhibits more stable sensitivity without any downward trend, fully demonstrating its superior performance.

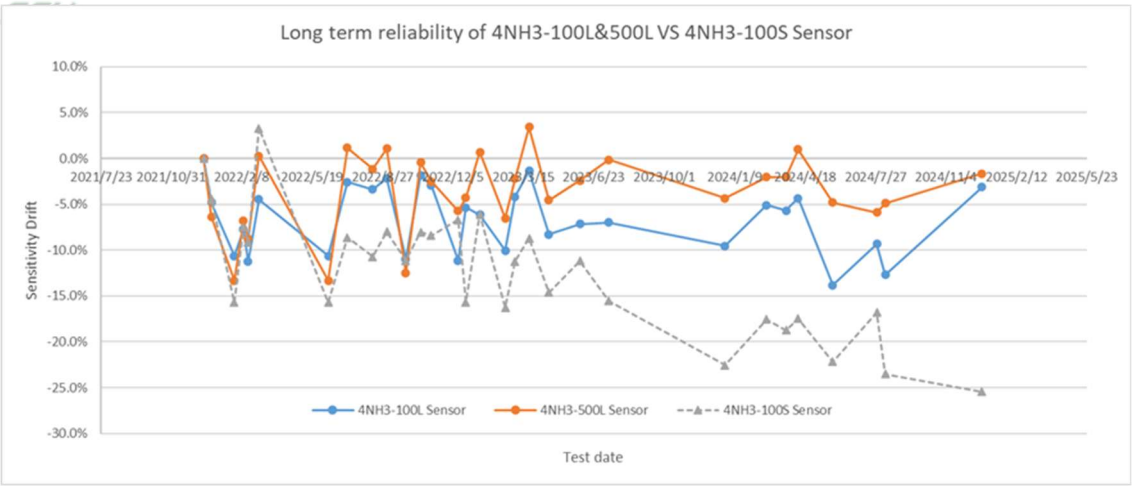


Figure 4: Sensitivity variation curves over three years for long-life 4NH3-100L, 4NH3-500L, and conventional 4NH3-100 sensors

Summary

Semeatech's L-series long-life ammonia sensors, powered by **non-consumable precious metal catalytic technology and ionic liquid-based electrolytes**, thoroughly eliminate traditional sensor pain points such as short lifespans, environmental sensitivities, and high interference. Featuring four core advantages—**an ultra-long 5-year lifespan, ultra-wide environmental tolerance, high precision with low interference, and easy integration at low cost**—it serves as the ideal choice for ammonia detection under harsh operating conditions, helping the industry achieve its upgrade goals of long-term monitoring, precise protection, and enhanced cost-efficiency.