

Ammonia Cracker

A practical guide to ammonia cracker, covering the reader intent, the relationship to ammonia cracker, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In industrial metallurgy, semiconductor manufacturing, and the emerging hydrogen economy, the ammonia cracker serves as a vital component for generating high-purity hydrogen and nitrogen gas mixtures. By thermally decomposing anhydrous ammonia (NH₃), these systems provide a cost-effective and manageable source of "cracked ammonia" (typically 75% hydrogen and 25% nitrogen). For process engineers and plant managers, maintaining the efficiency of an ammonia cracker requires not only an understanding of the chemical decomposition process but also precise control over the feedstock—liquid ammonia.

Accurate level measurement of liquid ammonia is critical for ensuring a continuous supply to the cracker, preventing pump cavitation, and maintaining safety in pressurized storage environments. As a professional manufacturer of industrial level measurement instruments, Welk provides the technical framework necessary to select the right instrumentation for these demanding applications.

| Understanding the Ammonia Cracking Process

An ammonia cracker, also known as an ammonia dissociator, operates on the principle of catalytic thermal decomposition. The fundamental chemical equation is:



This endothermic reaction requires a significant heat input and the presence of a catalyst, usually nickel-based. The process typically involves several stages:

1. **Feedstock Supply:** Liquid anhydrous ammonia is stored in pressurized tanks. It is then vaporized before entering the cracking furnace.
2. **Dissociation:** The ammonia gas passes through a retort filled with catalyst material, heated to temperatures between 800°C and 900°C (1472°F to 1652°F).
3. **Cooling and Purification:** The resulting gas mixture is cooled via a heat exchanger. If high-purity hydrogen is required, the gas may pass through a molecular sieve or PSA (Pressure Swing Adsorption) unit to remove residual moisture and un-cracked ammonia.

The resulting gas is used in applications such as bright annealing of stainless steel, powder metallurgy, and as a protective atmosphere in furnace brazing. Because liquid ammonia is the primary feedstock, monitoring its volume in storage tanks is the first step in process automation.

| Measurement Principles for Ammonia Storage

Before selecting a level sensor for an ammonia cracker system, it is essential to understand the physical properties of the medium. Liquid ammonia is a hazardous, liquefied gas stored under pressure (typically 8–12 bar at ambient temperatures). It has a low dielectric constant ($\epsilon_r \approx 1.6$ to 2.0) and a relatively low density (approx. 600–680 kg/m³ depending on temperature).

| 1. Radar Level Measurement (Non-Contact and Guided Wave)

Radar technology is the preferred choice for ammonia level monitoring due to its high accuracy and lack of moving parts.

Non-Contact Radar (FMCW): High-frequency (80GHz) radar transmitters emit a continuous microwave signal. The frequency difference between the emitted and received signal is proportional to the distance. Given ammonia's low dielectric constant, 80GHz radar is advantageous because its narrow beam angle minimizes interference from tank internals and provides a stronger return signal from the liquid surface.

Guided Wave Radar (GWR): This technology uses a probe to guide the microwave signal. It is highly effective for low-dielectric liquids because the probe concentrates the energy, ensuring a reliable reflection even when the surface is turbulent.

| 2. Magnetic Level Gauges (MLG)

For pressurized vessels, magnetic level gauges offer a robust mechanical solution. A float containing a permanent magnet moves with the liquid level inside a bypass chamber. Outside the chamber, magnetized flaps or a follower indicate the level. When paired with a reed chain transmitter or a magnetostrictive sensor, the MLG provides both local visual indication and a 4-20mA signal for the control system.

| 3. Hydrostatic Level Measurement

This principle measures the pressure exerted by the liquid column. Because ammonia tanks are pressurized, a differential pressure (DP) transmitter is required. One side measures the total pressure (liquid + gas headspace) and the other measures only the gas headspace. The difference represents the liquid level. However, this method is sensitive to density changes caused by temperature fluctuations.

| Technology Selection Table

Choosing the right instrument depends on the specific requirements of the ammonia cracker installation. The following table compares common technologies used in ammonia service.

Feature	80GHz Non-Contact Radar	Guided Wave Radar (GWR)	Magnetic Level Gauge	Differential Pressure (DP)
Accuracy	±2 mm	±3 mm	±5 mm	±0.5% of span
Pressure Range	Up to 40 bar+	Up to 100 bar+	Up to 160 bar+	High
Dielectric Sensitivity	Low (needs 80GHz)	Medium	None	None
Installation	Top-mounted	Top-mounted	Side-mounted (Bypass)	Side/Bottom
Maintenance	Very Low	Low	Moderate (Float cleaning)	Moderate (Calibration)
Vapor Influence	Minimal	Minimal	None	Significant

Installation Considerations for Ammonia Systems

When integrating level sensors into an ammonia cracker's supply chain, several engineering factors must be addressed to ensure long-term reliability.

Material Compatibility

Ammonia is highly corrosive to copper, brass, and bronze alloys. All wetted parts of the level meter—including flanges, probes, and seals—must be constructed from compatible materials, typically 316L Stainless Steel. For sealing, PTFE or specialized elastomers are required to prevent degradation and leaks.

Pressure and Temperature Compensation

In pressurized ammonia tanks, the gas phase can become quite dense. This can affect the speed of sound, making ultrasonic sensors unsuitable. Radar and magnetic technologies are generally unaffected by these vapor space changes. If using hydrostatic methods, ensure the DP transmitter is rated for the maximum working pressure of the ammonia storage vessel.

| Stilling Wells and Bypass Chambers

For non-contact radar, a stilling well (a vertical pipe inside the tank) can be used to eliminate surface foam and turbulence, providing a steady surface for the microwave signal. Alternatively, a bypass chamber (external to the tank) allows for the installation of both a magnetic gauge and a radar transmitter, providing redundancy and ease of maintenance without depressurizing the main vessel.

| Hazardous Area Certification

Ammonia is flammable under certain conditions and toxic. Level instruments must carry appropriate explosion-proof or intrinsically safe certifications (such as ATEX, IECEx, or UL) to comply with safety regulations in chemical processing environments.

| Limitations and Common Risks

While modern instrumentation is highly reliable, engineers should be aware of potential pitfalls in ammonia level measurement:

Boiling Surfaces: If the pressure in the ammonia tank drops rapidly, the liquid may boil or flash. This creates bubbles and foam that can scatter radar signals or cause "float bounce" in magnetic gauges.

Dielectric Constant Shifts: Although radar can handle low-dielectric fluids, if the ammonia is contaminated with water, the dielectric constant will rise, potentially requiring recalibration if using older, less sophisticated radar units.

Ambient Temperature Effects: Extreme cold can cause ammonia to contract, while heat increases vapor pressure. Level systems must be robust enough to handle the full environmental range of the installation site.

For a comprehensive overview of available technologies and specific model specifications, engineers can Review product options and application support to find the most suitable match for their ammonia cracker configuration.

| Maintenance and Troubleshooting

To maintain the integrity of an ammonia cracker's feedstock supply, a proactive maintenance schedule is recommended:

1. **Visual Inspections:** Regularly check for signs of "white frosting" or corrosion on external fittings, which may indicate a small ammonia leak.
2. **Signal Strength Monitoring:** For radar units, monitor the "echo curve" or signal-to-noise ratio. A weakening signal may indicate buildup on the antenna or probe.
3. **Float Verification:** For magnetic gauges, ensure the float moves freely. Over time, oil contaminants from compressors can accumulate in the ammonia, potentially causing the float to stick.
4. **Zero-Point Calibration:** Periodically verify the zero-point of DP transmitters, as sensor drift can lead to cumulative errors in volume calculation.

| Frequently Asked Questions (FAQ)

Q: Why is ultrasonic level measurement not recommended for ammonia crackers?

A: Ultrasonic sensors rely on the speed of sound through the vapor space. In an ammonia tank, the concentration and pressure of ammonia vapor change with temperature, significantly altering the speed of sound and leading to large measurement errors. Furthermore, ammonia vapor can be corrosive to standard ultrasonic transducers.

Q: Can I use a standard stainless steel sensor for liquid ammonia?

A: While 316L stainless steel is generally excellent for ammonia, you must ensure that no copper-bearing alloys are used in any part of the instrument (such as internal wiring or connectors exposed to the gas). Welk level meters are designed with specific material configurations for chemical compatibility.

Q: What is the benefit of 80GHz radar over 26GHz radar for this application?

A: 80GHz radar has a much smaller wavelength, allowing for a smaller antenna and a tighter beam angle. This makes it easier to install in small nozzles and significantly improves the signal reflection from the low-dielectric surface of liquid ammonia.

Q: How do I handle level measurement if the ammonia tank is horizontal (bullet tank)?

A: Horizontal tanks require a strapping table or a volume conversion formula within the level transmitter. Most modern Welk radar transmitters include built-in linearization functions to convert measured distance into volume (liters or cubic meters) for cylindrical horizontal tanks.

By implementing high-precision level measurement, operators of ammonia cracker systems can ensure a steady hydrogen supply, optimize catalyst life, and maintain a safe working environment. For further technical guidance on selecting instruments for ammonia or other industrial gases, visit the [Main Page](#) for detailed engineering specifications.