Organics AMMONIA

Product Briefing

On-site Thermal Ammonia Recovery (OTAR®)

Waste-to-Resource for a Sustainable Future

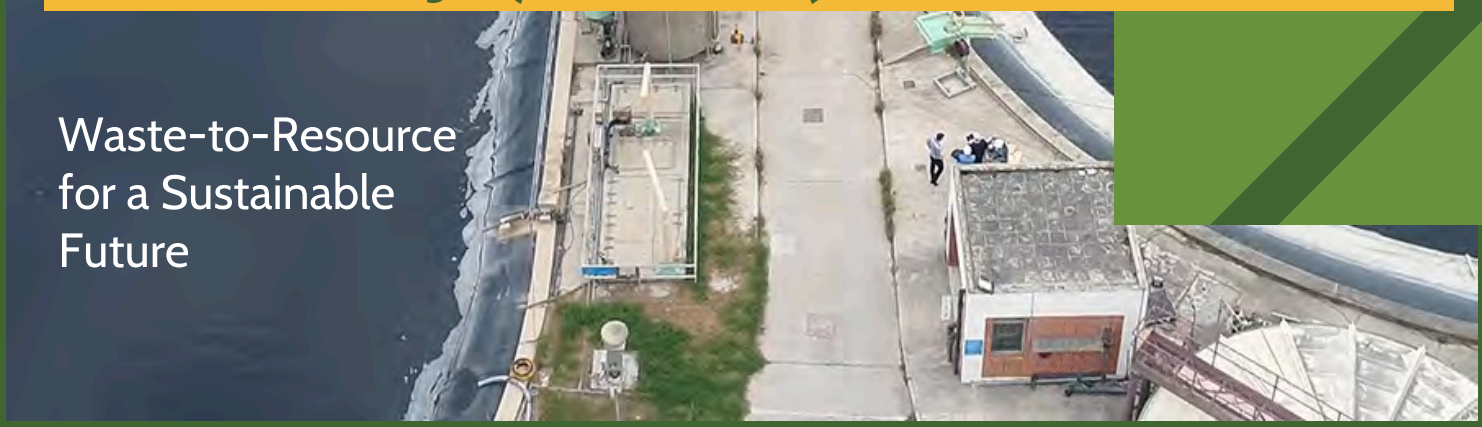

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TABLE OF CONTENTS

Executive Summary 4

On-site Thermal Ammonia Recovery (OTAR®) 4

The OTAR® Platform 5

Flexible deployment options 5

Global Context Drivers 7

Introducing OTAR® 8

Variant 1: Waste Heat with Thermal Destruction 9

Variant 2: Waste Heat to Recover Ammonium Hydroxide 11

Variant 3: Waste Heat to Recover Ammonium Sulphate 12

Variant 4: Heat recycling 13

Variant 5: pH Driven Conversion 15

Commercial Models and Roadmap 16

CONCLUSION 17

EXECUTIVE SUMMARY

On-site Thermal Ammonia Recovery (OTAR®)

Ammonia is one of the most significant contaminants in wastewater worldwide. It poses regulatory challenges, creates environmental risks, and adds operational costs to treatment plants. For operators, it can lead to rising compliance costs, regulatory risk, and missed opportunities to recover nitrogen. Yet ammonia is also a valuable resource, central to fertiliser production, industrial chemistry, and increasingly to the emerging hydrogen economy.

OTAR® transforms this dual challenge into an opportunity. By combining intelligent heat utilisation with advanced stripping technologies, OTAR® enables treatment plants and industrial sites to:

- **Achieve full compliance** with tightening nitrogen discharge limits.
- **Reduce operational costs** by using existing waste heat or high-efficiency heat recycling.
- **Generate new revenue** by recovering ammonia as® ammonium hydroxide, anhydrous ammonia, or ammonium sulphate — valuable feedstocks for fertiliser, chemical, and hydrogen markets

Unlike single-purpose systems, **OTAR® is a modular platform** that adapts to local conditions and market opportunities. This flexibility ensures a solution for every site — from municipal wastewater plants to industrial and agricultural facilities.

With over 20 years of operational experience and multiple installations already proven in Asia, OTAR® offers a **low-risk, high-impact** pathway for utilities and industries to meet environmental goals, improve ESG performance, and participate in the emerging circular nitrogen and hydrogen economies.

- Comply with tightening nitrogen discharge limits.
- Recover ammonia in usable forms: ammonium hydroxide, anhydrous ammonia, or ammonium sulphate.
- Destroy ammonia where markets for recovered products are absent.
- Deploy flexible systems using either waste heat or heat recycling.

OTAR® PLATFORM

FLEXIBLE DEPLOYMENT OPTIONS

OTAR's modular platform allows for flexible deployment based on site-specific needs, including energy availability and local markets for recovered ammonia products.

01 Waste Heat with Thermal Destruction

Uses available waste heat to strip ammonia from wastewater, which is then thermally destroyed. This is a straightforward compliance solution when product recovery is not practical.

02 Waste Heat to Recover Products

Captures value by using waste heat to recover ammonia as a chemical product like ammonium hydroxide. This can be reused on-site or sold, creating a revenue stream from a former waste product.

03 pH adjustment (with or without waste heat)

Where waste heat is in short supply or not available at all, recovery of ammonia may be facilitated by raising the pH of the wastewater using a suitable base, such as lime or sodium hydroxide.

04 Heat Recycling

For sites without waste heat, electricity is used to drive the heat recycling process. This highly efficient electrical option ensures operational independence and year-round compliance.

GLOBAL CONTEXT AND DRIVERS

Ammonia is a major environmental stressor. When discharged untreated, it contributes to eutrophication, aquatic toxicity, and greenhouse gas emissions through the formation of nitrous oxide. Around the world, regulators are tightening effluent discharge standards, often to levels that traditional biological treatments cannot meet.

At the same time, demand for nitrogen-based compounds continues to grow. The fertiliser industry alone consumes approximately 200 million tonnes of nitrogen each year, while ammonia is increasingly recognized as an effective carrier for clean hydrogen, offering a scalable way to transport renewable energy. This combination of stricter regulation and growing market demand is reshaping how industries and municipalities manage their nitrogen streams. Instead of being destroyed in energy-intensive processes, ammonia is increasingly being recovered as a valuable material. OTAR® positions itself at the heart of this transition by offering a set of technologies that convert what was once a compliance-driven cost into a commercially and environmentally beneficial opportunity.

Untreated, ammonia contributes to

- eutrophication,
- aquatic toxicity, and
- indirect greenhouse gas emissions through nitrous oxide formation.

The fertiliser industry alone consumes around 200 million tonnes of nitrogen each year.

INTRODUCING OTAR®

On-site Thermal Ammonia Recovery is not a single device but a modular platform designed to adapt to diverse operating environments. Its core principle is straightforward: ammonia is stripped from wastewater using thermal energy, after which the recovered gas is either destroyed or transformed into a usable product.

The energy that drives OTAR® can come from two sources. Where industrial facilities produce excess thermal energy, waste heat is captured and reused to power the stripping process. In locations without reliable waste heat, OTAR® can operate through heat recycling, which compresses and recycles steam with high efficiency.

Once separated, the ammonia can be handled in several ways. It may be oxidised and destroyed if there is no viable downstream market. It may be absorbed into water to create ammonium hydroxide, further processed into anhydrous ammonia, or reacted with sulphuric acid to produce ammonium sulphate fertiliser. This modularity makes OTAR® a flexible solution, equally at home in municipal wastewater plants, industrial chemical facilities, food processors, and agricultural or energy installations.

Energy Options:

- Waste Heat: Utilises surplus thermal energy from existing industrial processes.
- Heat recycling: Employs electricity to recycle latent heat, allowing OTAR® to operate independently of waste heat sources.

Product Pathways:

1. Thermal destruction of ammonia.
2. Recovery as ammonium hydroxide or anhydrous ammonia.
3. Recovery as ammonium sulphate .

Variant 1: Waste Heat with Thermal Destruction

There are cases where ammonia recovery is neither practical nor desirable. In such situations, OTAR® can be configured to strip ammonia using waste heat and then direct the gaseous stream to a thermal destruction unit. Inside the chamber, the ammonia is oxidised at high temperature, leaving only nitrogen gas and water vapor.

Multiple leachate treatment facilities in Hong Kong provides an example. Facing stringent nitrogen discharge rules but lacking any established local markets for ammonia products, the operators adopted this approach. By drawing on waste heat from nearby biogas engines and landfill gas, they were able to achieve regulatory compliance while avoiding the complexities of producing or handling downstream chemicals. The simplicity of this variant is appealing: it ensures full elimination of ammonia without the need for storage, transport, or marketing. The trade-off, of course, is that no additional revenue is generated, and the system relies on a consistent source of waste heat.

Process:

- Waste heat drives the stripping of ammonia from wastewater.
- Ammonia gas is fed into a thermal destruction unit, where it is oxidised to form nitrogen gas and water vapour

Advantages:

- Straightforward compliance with discharge regulations.
- No handling or marketing of chemicals.
- Uses otherwise wasted energy

Challenges:

- No financial return from recovered products.
- Waste heat may have other uses.

Variant 2: Waste Heat to Recover Ammonium Hydroxide

Where facilities wish to capture value from ammonia, OTAR® offers a recovery pathway that transforms stripped ammonia into ammonium hydroxide or, with further processing, anhydrous ammonia. In this variant, the gas is first absorbed into water, producing a liquid chemical that can be used directly in industry, agriculture, or municipal operations. If concentrated further, the product becomes anhydrous ammonia, a versatile compound with roles ranging from fertiliser to a carrier for hydrogen.

One industrial example is where a chemical manufacturing plant can integrate OTAR® to generate ammonium hydroxide for its own processes. By doing so, it reduces external purchases of this reagent by nearly a third, saving money while strengthening its sustainability profile. This pathway illustrates how ammonia recovery not only reduces pollution but also substitutes for purchased inputs. Facilities adopting this variant must invest in safe handling and storage systems, particularly if they produce anhydrous ammonia, which is subject to strict safety regulations. The return, however, is a product with immediate economic and operational value.

Process:

- Ammonia is stripped using waste heat.
- The gas is absorbed into water, creating ammonium hydroxide.
- With further concentration, the system can produce anhydrous ammonia

Advantages:

- Converts a pollutant into a saleable or usable asset.
- Flexible product form depending on market demand

Applications:

- Industrial reuse: Ammonium hydroxide for pH control and chemical processes.
- Agriculture: Direct use as fertiliser.
- Energy: Anhydrous ammonia as a hydrogen carrier.
- Maritime ammonia fuel applications

Variant 3: Waste Heat to Recover Ammonium Sulphate

Another option within OTAR® is to react stripped ammonia with sulphuric acid, creating ammonium sulphate, a stable and widely traded fertiliser. In this pathway, waste heat drives the stripping step, after which the ammonia-laden gas is absorbed into an acid solution, yielding either a liquid fertiliser or crystalline solids depending on the process configuration.

This approach has been particularly attractive in agricultural regions where there is strong local demand for fertilizer. In one case, a wastewater treatment facility partnered with farming cooperatives to distribute the liquid ammonium sulphate generated on site. The arrangement provided farmers with a dependable supply of nutrients, while the treatment plant secured a revenue stream that offset operating costs. The product is easy to handle, has established markets, and provides a bridge between urban wastewater management and rural agricultural supply. The main considerations are the reliable supply of sulphuric acid and the need to ensure that the recovered product meets agricultural quality standards.

Process:

- Ammonia stripped with waste heat.
- Absorbed into sulphuric acid, producing ammonium sulphate solution or crystals.

Advantages:

- Produces a stable, widely recognised product.
- Creates new revenue streams for municipalities and industry.

Applications:

- Direct fertiliser sales into local agricultural markets.
- Blending into complex fertilisers for export markets.

Challenges:

- Requires a steady supply of sulphuric acid.
- Must meet agricultural quality standards.

Variant 4: Heat Recycling

In locations where waste heat is scarce or unreliable, OTAR® employs heat recycling to provide the energy needed for stripping. In this configuration, steam is recycled, providing a highly efficient source of thermal energy with a coefficient of performance that can exceed fifteen.

Because the heat recycling system replicates the thermal environment of the waste-heat-driven approach, it can be combined with any of the product pathways described earlier. It can support thermal destruction, produce ammonium hydroxide, yield anhydrous ammonia, or generate ammonium sulphate fertilizer.

This flexibility has proven valuable in facilities such as a food processing plant where seasonal production created fluctuating waste heat. By relying on heat recycling, a site can maintain year-round ammonia recovery, ensuring continuous compliance with environmental regulations and uninterrupted product generation. Although the compressors add to capital expenditure and require a steady supply of electricity, the efficiency and independence they provide make this variant especially attractive for remote or standalone facilities

Process:

- Recycles steam, creating the stripping energy.
- Ammonia recovery can follow any of the product pathways described above.

Advantages:

- Independence from waste heat supply.
- High energy efficiency (COP often exceeding 15).
- Fully compatible with all recovery or destruction options.

Applications:

- Remote sites or standalone plants.
- Facilities with fluctuating waste heat availability


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Variant 5: pH Driven Conversion

An alternative approach that may be employed in locations where waste heat is in short supply is to use pH adjustment with a suitable alkali base, such as lime or soda ash (sodium bicarbonate). In this configuration, the conversion of ammonium ions to ammonia gas is driven by a change in pH. Where heat is available, the amount of alkali base required can be reduced proportionately.

This approach is particularly suited to streams with relatively high ammonium concentrations but limited waste heat availability, since the efficiency of the process depends less on temperature and more on chemical speciation. By integrating pH adjustment with stripping, facilities can ensure high levels of recovery even at ambient or moderately elevated temperatures.

The advantages of pH-driven stripping lie in its adaptability and effectiveness at moderate temperatures, as well as its compatibility with all OTAR product recovery routes. The trade-off is the need for consistent alkaline chemical supply, which adds operating cost and requires careful handling. In practice, the balance between chemical use and recovery value defines the commercial case, but for sites where pH control is already part of the treatment process, this variant offers a natural extension into resource recovery.

Process:	• pH adjustment to around 11 creates the conditions suitable for stripping. • Ammonia recovery can follow any of the product pathways described above
Advantages:	• Independence from waste heat supply. • Fully compatible with all recovery or destruction options.
Applications:	• Remote sites or standalone plants where bulk base chemicals can be obtained. • Facilities with fluctuating waste heat availability.
Challenges:	• Requirement for bulk handling of process chemicals. • The pH may require adjustment back from pH 11.

Commercial Models and Roadmap

From a commercial perspective, OTAR® can be justified on several grounds. At the most basic level, it avoids the costs and liabilities associated with non-compliance, which are rising as environmental standards tighten. Beyond compliance, it can generate revenue through the sale of ammonium sulphate fertilizer, ammonium hydroxide solution, or anhydrous ammonia. In some cases, these products are sold directly into agricultural or chemical markets; in others, they replace purchased inputs within the operator's own facility. A third model involves partnerships with fertilizer distributors or chemical off-takers, which secure predictable revenue streams and reduce marketing risk.

The roadmap to implementation is straightforward. It begins with an assessment of local wastewater streams, ammonia concentrations, waste heat availability, and product market conditions. Once these are understood, the most appropriate OTAR® variant can be selected. A pilot unit may then be deployed to validate assumptions and gather site-specific data, after which the full-scale plant can be commissioned with commercial partnerships in place to handle off-take or destruction.

Commercial Models:

- **Cost Avoidance**: Compliance with nitrogen discharge limits avoids penalties and environmental liabilities.
- **Revenue Generation**: Recovered products can be marketed directly or used internally to replace purchased chemicals.
- **Partnerships**: Off-take agreements with fertilizer distributors or chemical users provide revenue certainty.

Roadmap to Deployment:

- **Assessment**: Identify ammonia loads, waste heat availability, and local product markets.
- **Selection**: Match OTAR variant to site-specific needs.
- **Pilot**: Demonstrate performance on-site, if necessary.
- **Scale-Up**: Full deployment with commercial partnerships.

CONCLUSION

OTAR® represents a modular and future-ready platform for managing one of wastewater's most challenging pollutants. It allows operators to comply with tightening regulations, to generate useful products, and to demonstrate their commitment to circular economy principles. By turning ammonia from a liability into a resource, OTAR® creates value for both the operator and the wider community, offering a bridge between environmental responsibility and commercial opportunity.

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