



THERMALLY-DRIVEN AMMONIA STRIPPERS

Ammonia stripping with waste heat

Thermally-driven ammonia stripping was developed by Organics to offer an alternative route to that of pH adjustment for continuous-process ammonia stripping. With a thermally-driven stripper no chemical additions are required, apart from the minor addition of anti-foam agent. The single important input is waste-heat with which to drive the chemical reactions. Such waste-heat can be derived from combustible waste gases, engine exhaust gas, excess process steam or any other source where energy is available for disposal.

Thermal stripping also provides a very low cost alternative to the use of carbon-source addition in a biological process. In many instances savings can be measured in six digits when taken over the lifetime of a project.

The thermal-stripper breaks the ammonium-ion bond with heat alone. This action converts ammonia into a gas, NH_3 , which can be driven from the liquid-phase with suitable quantities of air. In a single pass it is possible to achieve greater than 98.5% removal of ammonia by this mechanism.



KEY FEATURES

AMMONIA REMOVAL WITH
HEAT ALONE

NO REQUIREMENT FOR
CARBON SOURCE ADDITIONS

HIGH-RATE AMMONIA
REMOVAL WITH NO ADDED
pH ADJUSTMENT CHEMICALS

SINGLE-PASS SYSTEMS CAN
ACHIEVE > 98.5% AMMONIA
REMOVAL

MINIMAL AIR MOVEMENT
COSTS

MINIMAL PLANT FOOTPRINT:
REMOVAL RATES OF UP TO
840 kg $\text{NH}_4\text{-N}/\text{m}^2/\text{day}$

LOW NO_x EMISSIONS
WHEN COMBINED WITH
SMART FLARE THERMAL
OXIDISER TECHNOLOGY (SEE
DATASHEET ODSF05)

OPTIONAL CHEMICAL
OXIDATION AND AMMONIA
RECOVERY SYSTEMS
AVAILABLE

A WIDE RANGE OF
AUTOMATION OPTIONS
AVAILABLE



PROJECT ROUTE

ESTABLISH EFFLUENT FLOW RATE

ESTABLISH AMMONIA REMOVAL REQUIREMENT

DEFINE PERFORMANCE OBJECTIVES AND HEAT LOAD

DETERMINE THE SUITABILITY OF THERMAL STRIPPING

DETAILED DESIGN AND PRICING

PROCURE COMPONENT PARTS OF THE PROJECT

CONSTRUCTION AND COMMISSIONING

OPERATION AND MAINTENANCE

PROCESS SELECTION

Conventional ammonia removal comes in two forms. The first, and most commonly employed method, is the use of bacteria in aerated or anoxic reactors. For waste-water streams with relatively low ammonia and comparatively high carbon loading, it has proven to be a robust, viable and long-term solution. Difficulties only arise when the carbon available in the waste-water is not adequate to drive the necessary conversions to nitrogen gas. When a waste-water stream has very high ammonia levels (circa <3000 mg/l) and carbon is inadequate, the cost of operation for an extended duty-of-care period can become excessive.

The second process often employed is that of pH-driven ammonia stripping. The waste-water stream is dosed with lime or caustic soda to raise the pH to above 11. This process converts ammonium ions to ammonia gas. Air is then passed through the waste-water, typically in a packed column or plate tower at a ratio of approximately 3,000:1. The effluent may be finally dosed with acid to reduce the pH to acceptable discharge levels. The big issue here is the cost of chemical additions to drive the pH adjustment. Unless a large and in-house source of lime is available the cost can be prohibitive.

Thermally-driven ammonia stripping requires a heat source. If waste-heat is not available, the fuel-cost can be as prohibitive as that of chemical additions or carbon source requirements. Where waste-heat is available, from an engine-exhaust or unwanted biogas, the long-term operating cost can be confined to plant Operation and Maintenance, as well as electricity costs.

AMMONIA DISPOSAL

There are a number of options available for disposal of ammonia. It is tempting to consider the possibility of commercial recovery, and in some circumstances this may be a realistic option. Recovery may be accomplished by reacting stripped ammonia gas in a reactor designed to combine the gas with a sulphate or phosphorous ion. Both ammonium sulphate and ammonium phosphate are commercially used as soil additives. However, great care must be made to establish the market, and the specifications required for acceptance within the market, in order to produce a commercially viable product.

Another option is to destroy ammonia gas using a catalytic bed. Such approaches have been employed with success. They have the great advantages of requiring low fuel consumption (the catalytic bed normally operates at relatively low temperature) as well as releasing the ammonia as nitrogen into the atmosphere.

The preferred option within the Organics process is to use the ammonia-laden air as combustion air in the heat-raising process. By this means ammonia gas is destroyed as a part of the process of thermally powering the system.

Organics has developed a low-NOx combustion process for flaring waste gas which involves Exhaust Gas Recycle. When combined with the destruction of ammonia gases the result is extremely low NOx emission levels. Heat from the thermal-oxidiser used to destroy ammonia is recovered in conventional heat-recovery economisers and used to power the thermal ammonia stripper.



O&M ISSUES

Packing fouling

The thermal ammonia stripper requires inputs of water, electricity, energy and anti-foam agent. The Organics approach to this technology has developed over the years with the construction of many such systems, targeted primarily at reducing thermal load and increasing performance efficiency. A key item that must be addressed in operation is that of carbonate build-up on packing. There are a number of factors in the plant operation which lead to the conditions precedent for precipitation of carbonates. The plant is designed to tolerate certain levels of fouling prior to cleaning being required. Packing-cleaning is carried out with systems which enable the activity to happen quickly and efficiently. An analysis of specific waste-water composition will give an indication of the levels of build-up that may be expected and the sophistication of the cleaning systems required.

Process drift

It has been Organics experience over the years that plant performance may drift from the conditions established at the outset. This is often the result of changes in the waste stream composition, the plant operation or the plant performance.

In order to combat process drift, Organics can offer a regular, periodic plant performance review in order to assess equipment status, plant operating regimes and overall performance set against operating parameters.

CASE HISTORY - SITE #1

Flow rate: 1,800 m³/day
Influent ammonia concentration: 7,000 mg/l
Effluent requirement: <100 mg/l

Method adopted:
Twin columns of half the rated capacity each. Having available capacity at all times was deemed to be essential. Twin landfill gas fired thermal oxidisers were used to destroy ammonia off-gases and to generate heat to drive the process.

Operational experience:
The system was installed in 1997 and is still in operation.

CASE HISTORY - SITE #2

Flow rate: 250 m³/day
Influent ammonia concentration: 4,000 mg/l
Effluent requirement: <100 mg/l

Method adopted:
Single column rated at full capacity.

Operational experience:
The system was installed in 1998 and remains in operation.

CASE HISTORY - SITE #3

Flow rate: 3,000 m³/day
Influent ammonia concentration: 1,250 mg/l
Effluent requirement: <50 mg/l

Method adopted:
Single column rated at full capacity.

Operational experience:
The system was installed in 2006 and is in operation.

ORGANICS

PROVEN EXPERIENCE IN AMMONIA STRIPPER DESIGN USING WASTE HEAT FOR MORE THAN 15 YEARS

SMALL FOOT-PRINT, HIGH REMOVAL RATES IN A SINGLE PASS SYSTEM

SUBSTANTIAL SAVINGS AVAILABLE WHEN COMPARED TO ANOXIC REACTORS OR pH DRIVEN STRIPPERS

ENVIRONMENTAL COMBUSTION SYSTEMS FORM A PART OF THE PROPRIETARY SCOPE OF SUPPLY

TURNKEY DESIGN, BUILD, INSTALL AND COMMISSION

OPERATION AND MAINTENANCE SERVICES AVAILABLE

A ONE-STOP SOLUTION FOR A COMPLETE SERVICE RELATING TO THE TREATMENT OF WASTE-WATERS USING THERMAL AMMONIA STRIPPING



SPECIFICATION DATA

Flow rates available:
50 to 3,000 cubic metres per day

Ammonia concentrations:
Up to a maximum of 6,700 mg/l has been reduced to less than 100 mg/l. However, the process is not limited to these figures.

Materials:
All materials employed are carefully selected to meet the requirements of the application

Heat sources:
Engine exhaust gases, flare exhaust gases, high-temperature hot-water streams, steam

Energy requirements
Approximately 450 MJ of energy is required per cubic metre of leachate treated. This is equivalent to 25 cubic metres of landfill gas with 50% methane. A 1MW electrical engine will provide adequate waste heat in its exhaust (at ~50% of electrical power) to treat 80 - 100 cubic metres per day of leachate

Chemicals required
Subject to the exact process selected it may be necessary to dose the leachate with anti-foaming agents

Pre-treatment requirements
Coarse filtration for solids over 2 mm diameter

Land requirements
This is as much a function of the process capacity as the actual process selected. As an indication of land requirements, a 200 cubic metre per day ammonia stripper will occupy approximately 120 square metres

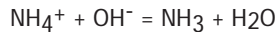
PROBLEMS WITH AMMONIA

Ammonia is found in raw domestic sewage in concentrations of about 30 mg/litre. In leachate from landfill sites and other organic wastewater streams it may rise to several thousands of milligrams per litre.

It is necessary to remove ammonia from discharged water for three reasons:

- Ammonia is toxic to fish. Lethal concentrations range from 2.5 to 25 mg/l.
- As ammonia is biologically oxidised to nitrate it exerts an oxygen demand on the receiving water. This can reduce the oxygen in the water to a point where aquatic life forms cannot survive.
- Ammonia acts as a fertiliser, causing the profuse growth of stringy bacteria and/or fungi and generally disrupting the natural environment.

The equation governing the relationship between ammonia gas and the ammonium ion is as follows:



The ratio of ammonia in the gas phase to the total ammoniacal nitrogen, referred to as " f ", may be expressed as follows:

$$f = [\text{NH}_3] / [\text{NH}_3] + [\text{NH}_4^+]$$

THEORY IN BRIEF

Ammonia nitrogen is present in water in two forms. The first is as dissociated ammonia, NH_4^+ , also referred to as the ammonium ion. The second is as undissociated ammonia, NH_3 , known as ammonia gas.

Dissociated ammonia may be converted to undissociated ammonia by the addition of a base, such as sodium hydroxide.

It is a key component of the thermally-driven stripping process that this dissociation is achieved by means of thermal addition without the need to adjust pH.

Each application requires to be tailored to the specific demands of individual applications but the principles remain.

Detailed analysis of exhaust gases has shown that the formation of NOx does not take place within a SMART technology thermal oxidiser, the ammonia being converted to nitrogen gas and water.

The thermally-driven stripping process has been run for over a combined 500,000 hours of compliant operation. The process has been demonstrated as consistently reliable and effective.

For further information about this process and its application please contact our Technical Sales Department.



Organics Limited

Sovereign Court II
University of Warwick Science Park
Coventry CV4 7EZ,
United Kingdom
T: +44 (0)2476 692141
F: +44 (0)2476 692238
E: comms@organics.com
W: www.organics.com

