Nothing To Ammonia About

Dr Robert Eden of Organics discusses the world's largest ammonia stripper, which is able to remove ammonia from leachate using heat alone.

As is well known, leachate is created by the passage of water through landfills, which contain a pretty comprehensive, random mixture of nearly all of the materials employed in a modern day society. It is the liquid product of rainwater, groundwater and biological activity. Almost every landfill site has a leachate with its own unique combination of flow rate, chemical composition and discharge requirements.

One of the principal contaminants often requiring removal from landfill leachate is ammonia. Ammonia is toxic to fish, with lethal concentrations ranging from 2.5 to 25 mg/l. Further, as it 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. Finally, it acts as a fertiliser, causing the profuse growth of stringy bacteria and/or fungi and generally disrupting the natural environment.

To achieve ammonia removal from leachate there are two basic options available. The first, and most widely used option in leachate treatment, involves the use of biological reactors, either sequencing batch reactors with an anoxic phase, for low-level concentrations of ammonia, or standalone anoxic reactors for higher concentrations. The second, and less commonly employed method employed for removing ammonia, is that of air stripping. This involves the passage of air counter-current to the leachate in a packed column, thus maximising surface area and driving ammonia from the liquid-phase to the gaseous-phase.

In 1996 Organics supplied its first ammonia air stripper, in this case operated by changing the pH of the leachate to over 10. During site trials it was found that as the temperature of the leachate was raised the quantities of alkali required to adjust the pH actually reduced. This discovery, and subsequent events, led to the development of the patented thermally driven ammonia stripping cycle.

Key Technology Features

THE KEY feature of a thermally-driven ammonia stripper is that it provides ammonia removal with heat alone. There is no requirement for pH adjustment, as with a pH-driven air stripper, or carbon-source additions, as with an anoxic reactor. A single-pass stripper can achieve greater than 98.5 percent ammonia removal from leachate. The largest unit, of eight such systems supplied by Organics into Hong Kong, can remove 12 tonnes of ammonia per day in a footprint of 15m x 15m.

As chemical additions are not required, and where waste heat is available, the thermally driven ammonia stripping method incurs a substantially lower operational cost. Where waste heat is not available it will probably be less costly to employ pH driven stripping, although this will depend upon energy and chemical costs at a specific locality. Raising pH may be achieved with relatively low-cost lime but if it is necessary to reduce the pH significantly, acids may be extremely expensive.

Prior to the development of the large-scale thermal ammonia stripping technology, Organics had many years of experience supplying high-temperature thermal oxidisers, and associated systems, into the landfill gas industry, both in the UK and worldwide. It was from this core expertise in thermal engineering that the thermal ammonia stripper arose.

The first commercial supplied thermal ammonia stripper was supplied into Hong Kong in 1997 at the West New Territories landfill site (WENT), now operated by SITA. This unit remains in operation. It was, in fact, one of the largest units ever supplied, rated at almost 2 000m^3 per day and designed to remove 12 tonnes of ammonia in one day. SITA's staff played a key role in implementation, with commissioning running to three months and involving the collection of a great deal of data. SITA has a very high-quality laboratory at the WENT landfill site, so it was possible to have accurate, reliable and consistent data provided without the normal waiting period common for a remote laboratory.

In Hong Kong, SITA operates two strategic landfills, one at WENT and the other in the North East New Territories (NENT). Hong Kong landfills are big by anyone's standard. WENT is the biggest, containing over 65m tonnes of municipal solid waste. Much of this waste received is putrescible and capable of generating large quantities of methane-rich landfill gas, as well as heavily contaminated leachate.

In Hong Kong, the thermal ammonia stripper technology meets many country-specific criteria. It is compact, which is helpful where land is at a premium. Being a physical process, it is reliable and predictable. When performance issues arise they can be traced to specific items of equipment. Until comparatively recently, landfill gas was of little commercial value or interest in Hong Kong, so the thermal process was able to operate a dual role; disposing of landfill gas in an environmentally sound manner and using the resultant waste heat to treat leachate. The combustion process both provided heat for the process and served to dispose of the ammonia by using the stripper air as combustion air in a thermal oxidiser.

Future Use

THE USE of the thermal ammonia stripper has evolved considerably over the last 16 years. The first plant was required to use as much landfill gas as possible, to assist with potentially more than 20 000m^3 per hour of landfill gas requiring disposal from the site.

Subsequent work with SITA, related to landfill restoration projects, had a different objective, which was to match the anticipated decline in landfill gas production with the treatment of leachate. In many such instances, ammonia removal was the only treatment required to meet discharge consent requirements. In such a situation, optimising the use of landfill gas became essential. This was achieved using as much heat recovery as practical, combined with control of heat losses and optimising the use of the gas.

It is now the case in Hong Kong that landfill gas is recognised as a valuable renewable energy resource, changing the dynamics of the design process once again. Optimisation has turned to minimisation. With this comes additional cost and improved thermal engineering. Where landfill gas has a value, use must be reduced to a commercially achievable minimum.

There are, in fact, many sources of waste heat. It is not necessary for the thermal energy required to drive the process to come from fuel gas. It is a process requirement to raise steam and heat water. This can be achieved perfectly well using the exhaust gas from an engine, for example. The thermal oxidiser both drives the thermal systems and destroys the ammonia. If this is replaced, ammonia may be destroyed in a catalytic oxidiser or recovered in an acid scrubber.

Organics continues to work on the evolution of the technology for ammonia removal with heat alone and no requirement for pH adjustment to meet site-specific requirements in varying industries and scenarios. There are many options available for adaptation. The key requirement is to have available a source of waste heat which matches the thermal load of the system. ■

The Author

Dr Eden has worked in the landfill gas and leachate market since 1983, when he was employed as a researcher by Warwick University to study the possible use of cryogenically-liquefied methane from landfill gas as a fuel for fleet vehicles. With the current international movement away from landfill, he is now actively working on the application of new technologies, such as anaerobic digestion and pyrolysis, to help reduce the ingress of all forms of waste to landfill sites, as well as to produce renewable energy and reduce greenhouse gas emissions.