Onsite evaporation using waste energy solves disposal challenges

Water resource recovery facilities are increasingly refusing to accept landfill leachate due to rising treatment costs and environmental considerations. John Weigold of Heartland Water Technology explains how landfill managers can avoid these risks by treating leachate onsite using evaporation in a cogeneration configuration.

Landfill managers agree that dealing with landfill leachate is challenging, expensive, and a regulatory headache – yet the leachate just keeps coming. In fact, the annual costs for managing landfill leachate are counted in the billions and continue to rise.

Landfill leachate includes the wastewater that accumulates in landfills from rainfall as well as the decomposition of organic waste. While percolating through the garbage, the wastewater dissolves and entrains organic material, chemicals, metals, and minerals – whatever is in the garbage – resulting in a nasty mixture of contaminants that is unlike any other wastewater. Moreover, the mix of contaminants in the leachate changes constantly. Cover discipline by the landfill operator, volume of precipitation, and variations in garbage make-up dramatically alter the contaminants in landfill leachate.

According to the Environmental Research and Education Foundation, based in Raleigh, North Carolina, United States (US), approximately 62 percent of all leachate in the US today is managed by transporting the leachate to a water resource recovery facility (WRRF), where the relatively smaller volume of leachate is mixed with a larger volume of sewage and then processed in the treatment works. Leachate is transported often by truck and less commonly by pipeline.

Landfill leachate rejection

An increasing number of WRRF managers are refusing to accept landfill leachate. The reasons for this trend include high contaminant loading and the nature of the contaminants in the leachate. While landfill leachate volumes are generally tens-of-thousands of liters per day, and the treatment facilities are often millions-of-liters per day, the leachate is proving to be highly problematic. Treatment facilities are facing three major issues with respect to landfill leachate: nutrient loading, contaminants of emerging concern (CEC), and the negative impact on ultraviolet (UV) disinfection.

Nutrient loading: Nutrient pollution (i.e., eutrophication) in waterbodies is a growing environmental concern. Some of the consequences of nutrient pollution include algae blooms, anoxic water bodies, and a negative impact on biodiversity. While landfill leachates contain a variety of nutrients, the biggest concern is usually nitrogen. Nitrogen exists in leachate in a variety of forms (ammonia-nitrogen, organic-nitrogen, nitrate/nitrite) and often in concentrations of up to 2,000 milligrams per liter (mg/l), or more. Treatment facilities are generally good at treating low concentrations of ammonia-nitrogen but less effective at treating other forms of nitrogen or higher concentrations of nitrogen. Leachate nitrogen loading not only causes problems with the treatment process itself but also makes it increasingly challenging for treatment facilities to consistently meet their National Pollutant Discharge Elimination Systems (NPDES) permit limits for total nitrogen. When faced with being out of compliance with NPDES permits, upgrading the treatment facility itself, or refusing to accept leachate, the decision for facility operators becomes quite simple: stop taking landfill leachate.

Contaminants of emerging concern: CEC, very simply, are contaminants found in drinking water and wastewater that are under consideration for regulation and for which the conventional processes used by WRRFs currently do not treat. For years, discussions about CECs revolved mostly around endocrine disrupters – those pharmaceuticals, health and beauty products, and other chemicals that impact the human hormone system when consumed. To be clear, endocrine disrupters are still CECs, but the focus now has rapidly shifted to include per-and-polyfluoroalkyl substances (PFAS) – and people are concerned.

Heartland LM-HT® Concentrator

PFAS are chemicals found in a variety of products, such as aqueous film forming foam (AFFF) used in firefighting and in water and stain repellants for textiles and leather, paper coatings, non-stick coating products, and many other applications. PFAS compounds are characterized by chains of carbon-fluorine bonds, which are extremely strong, making PFAS very stable and able to exist in the environment for long periods of time. Health studies suggest PFAS may increase the risk of cancer and impact cognitive and behavioral growth in children, female fertility, and the hormone and immune systems. While yet to fully regulate PFAS discharges, the US Environmental Protection Agency (EPA) has issued a health advisory for PFAS, setting an advisory threshold for PFAS of 70 parts per trillion (ppt). PFAS can be found in landfill leachates often in concentrations that are many orders of magnitude above the EPA health advisory limit.

UV disinfection: Prior to discharge into the environment, WRRFs must disinfect the treated wastewater to inactivate bacteria and viruses. Increasingly, the facilities are switching from using chlorine to UV light systems to disinfect wastewater. According to the Water Environment Research Foundation (WERF) in Alexandria, Virginia, US, approximately 21 percent of WRRFs today use UV for disinfection. Logically, the UV light must be able to penetrate the water to dose all of the viruses and bacteria sufficiently in order to be effective. It turns out, landfill leachate can be a big problem for treatment facilities using UV because it contains high concentrations of humic and fluvic acids, which absorb the UV light before getting to the bacteria and viruses, ultimately decreasing the transmittance of UV light in the treated water. According to Stephanie Bolyard at EREF, landfill leachate volumetric contributions of as low as 0.1 percent can cause interference with UV disinfection performance.

Individually, any one of these issues is a cause for concern for WRRF managers. Collectively, nutrient loading, contaminants of emerging concern, and the impact on UV disinfection are causing more and more treatment facilities to simply stop accepting landfill leachate. While a comprehensive survey has not been done, anecdotal evidence suggests that when the cutoff notice comes, it comes quickly – either immediately or with a short warning period. When the notice comes that the treatment facility is no longer accepting landfill leachate, landfill managers question who they can then call.

Onsite treatment

Finding a new disposal outlet for leachate is often quite a challenge. What was once a simple trucking evolution to a local treatment facility can become a multi-state, multi-modal logistics operation to haul leachate to a more receptive facility. Leachate disposal costs can quickly become very expensive when managers are forced to find new disposal outlets.

More and more, landfill operators are choosing to treat leachate onsite and exercising firm control over their landfill leachate management. Sam Cooke, the national liquids management leader for SCS Engineers, says, "Increasingly, landfill operators are asking for ways to control their own destiny when it comes to leachate management. Onsite treatment can be a good way to reduce costs and reduce risk."

While multiple options are available for treating leachate onsite, two approaches are the most common: biological membrane and evaporation systems.

Biological membrane systems: Biological systems alone, such as a sequencing batch reactor, used to be a common approach for onsite leachate treatment. However, operators have learned that leachate is a challenging wastewater for biological systems, as it can easily become toxic and kill the biologics. Moreover, consistently achieving discharge limits with biological systems alone can be problematic given the dynamic nature of leachate chemistry.

More often today, biological systems are combined with membrane systems consisting of reverse osmosis (RO), nanofiltration (NF) or ultrafiltration (UF), or a combination of membrane technologies. The biological system reduces biological oxygen demand/chemical oxygen demand (BOD/COD) and nitrogen, and the membrane systems remove suspended solids, dissolved organics, and salts so that the water can consistently meet increasingly stringent discharge limits. While effective, the combination of biological and membrane systems must be carefully designed to ensure proper performance and requires a team of skilled operators to run and maintain. These systems can take a long time to design, permit, and construct. Moreover, when using RO, there is always a reject stream (concentrate) to dispose of, which can be 20 to 35 percent of the starting leachate feed rate. Because RO reject is a concentrated stream, it is often more expensive to dispose of than the raw leachate (on a per gallon basis).

According to Cooke, "Average daily volume of leachate generation, the concentration of regulated constituents, and where the treated leachate is ultimately discharged are all important considerations in determining the technology that customers select for onsite leachate treatment. For example, if a landfill cannot readily discharge treated leachate to a wastewater treatment plant or surface waterbody, leachate evaporation should be considered."

Evaporation systems: Evaporation is a proven solution for onsite management of leachate and is gaining broader acceptance by landfill managers for a number of important reasons. First, evaporation eliminates the leachate stream entirely, resulting in a small concentrate volume that can be safely returned to the landfill. Evaporation systems that are designed well with appropriate construction materials can last for many decades and are simple to operate. However, to be cost effective, evaporators require low-cost thermal energy. For submerged combustion evaporators, this typically means landfill gas, and for Heartland's LM-HT Evaporator, it can mean either landfill gas or exhaust from an engine or turbine that is using landfill gas to make electricity. Use of waste heat in this manner is generally considered the most cost-effective and environmentally friendly leachate evaporation option.

Conclusion

Landfills around the world face a growing challenge because leachate treatment costs are increasing, with rising costs increasingly being driven by WRRFs that refuse to accept landfill leachate. Multiple onsite treatment options exist that can help landfill operators limit this risk, regain control, and save real or potential costs. While biological treatment is an important and accepted treatment solution, the complexity of design and operation of these systems should be carefully considered. Evaporation is a proven solution that is gaining broader acceptance for onsite leachate treatment given its low total cost-to-treat and ease of design and operation.

Author's Note

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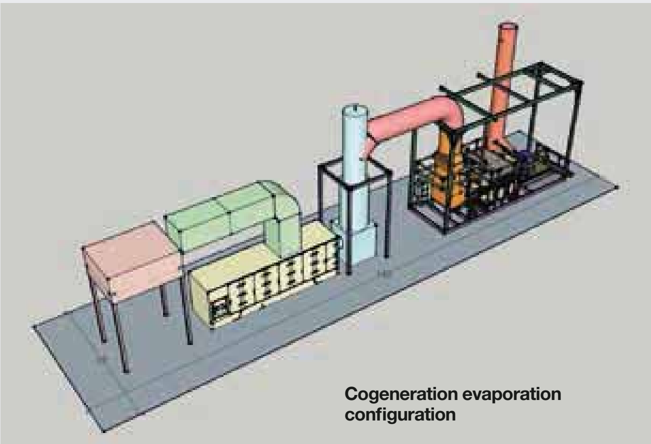
Evaporative system reduces leachate costs and risks

A large municipal solid waste (MSW) landfill in the eastern United States is demonstrating multi-faceted success of an evaporative solution using waste heat. The landfill generates more than 379,000 liters (100,000 gallons) per day of landfill leachate requiring appropriate treatment and/or disposal. The landfill also operates a significant landfill gas-to-energy facility, which collects and treats the biogas formed from the decomposition of organic material within the landfill, using Solar® Centaur gas turbines to generate electricity from the biogas gas turbines.

Prior to using the evaporative system to address its leachate volume, the landfill hauled leachate to a local water resource recovery facility (WRRF). Due to the challenging nature of the leachate, the treatment facility decided to stop accepting leachate, and the landfill was forced to transport the leachate several hundred miles, which resulted in a dramatic cost increase.

The landfill now treats its leachate onsite using Heartland Concentrators™ in a cogeneration configuration with its existing turbines. The simple, pre-tested, and skid-mounted system was easily installed and permitted. The ease of operation highlights another important benefit of evaporation over larger biological treatment solutions.

By beneficially reusing thermal energy, the Heartland Concentrators allow the landfill a cost-effective way to gain maximal control over its leachate management. Use of the Heartland Concentrator has yielded environmental benefits for the landfill by maximizing the value and productive use of its landfill gas, reducing greenhouse gas emissions by taking trucks off of the road and decreasing the risk of an environmentally damaging leachate spill. More importantly, use of the Heartland Concentrator in this cogeneration configuration has dramatically lowered the landfill's cost and other economic risks related to leachate management. It virtually eliminates high trucking disposal costs and significantly reduces the operator's dependency on municipal wastewater treatment plants. In short, use of the Heartland Concentrator at this landfill shows the many benefits attainable through using evaporation in a cogeneration configuration.



Cogeneration evaporation configuration

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