SWANSON RINK

THOUGHT LEADERSHIP SERIES | JULY 2022

Struggle with Deicing and Anti-icing Waste Fluids?

8 Alternatives that Evaluate Cost, Maintenance and Environmental Impacts

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EAGLE COUNTY CASE STUDY

8 Alternatives for Deicing and Anti-icing Waste Fluids Disposal that Evaluate Cost, Maintenance and Environmental Impacts

Airport operators are constantly on the hunt for cost-effective and environmentally sound solutions to dispose of waste deicing and anti-icing products.

While deicing and anti-icing glycol-based products are biodegradable, spent fluid that reaches habitable streams can adversely affect fish and other aquatic life. Disposal processes require large quantities of dissolved oxygen (DO) for microbial decomposition and additives that enhance deicing performance are non-biodegradable and toxic. As a result, airport operators are constantly on the hunt for cost-effective and environmentally sound solutions to dispose of waste deicing and anti-icing products.

Currently, many airports process deicing and anti-icing waste via managed drainage to underground storage and then transfer to local landfills, which still has environmental impacts. Others have successfully dealt with disposing of waste deicing fluid without harmful effects to the local ecosystem, but few have found a financially successful solution.

Our team recently worked with Jviation on a ramp improvement project for the Eagle County Regional Airport (EGE) that serves Vail and Beaver Creek ski resorts. Our task was to identify viable waste disposal alternatives and evaluate cost-of-ownership, considering first costs, operating costs, and major repair/replacement cost for a life expectancy of 20 years. The results were surprising.

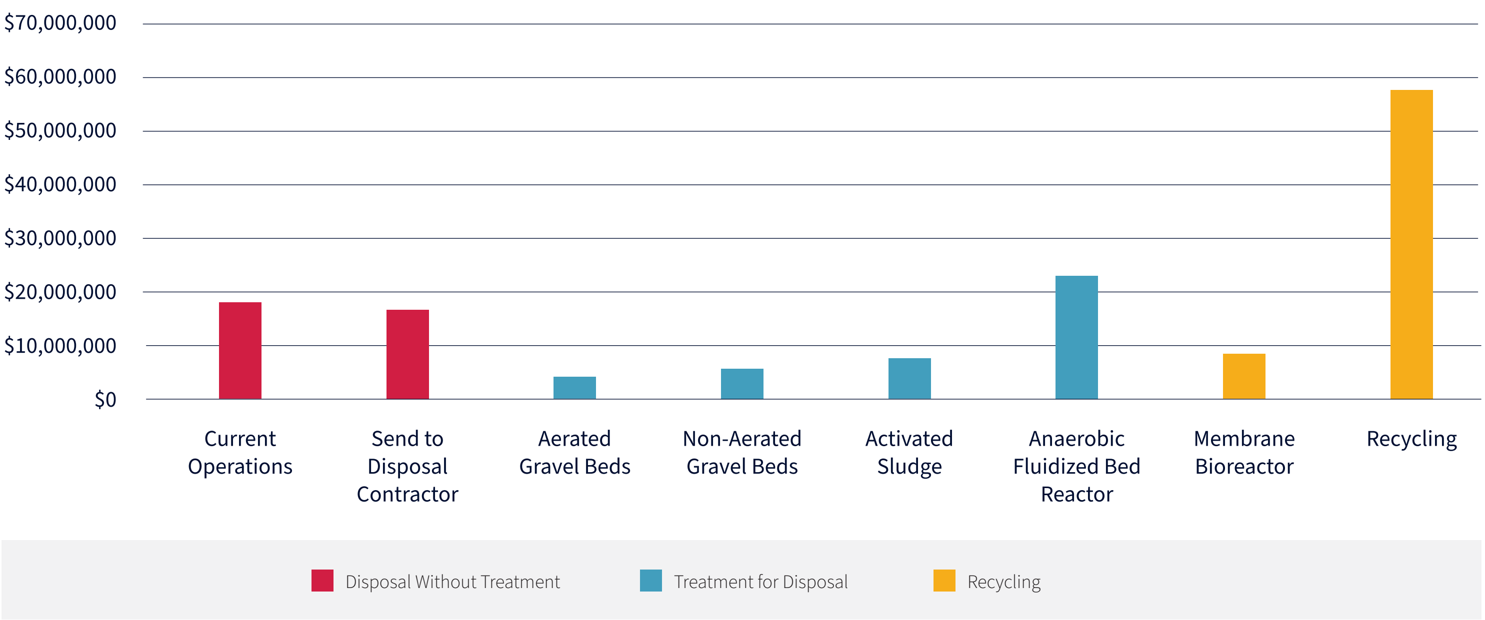
Summary of Findings

For the EGE analysis, the Life-Cycle Cost Analysis (LCCA) approach was used to estimate each alternative's total cost of ownership over a 20-year life expectancy. Considered were the utilities required to run the system, parts replacements over 20 years, staff needed to operate and maintain the system, and escalations in various cost centers. Future costs were discounted, so all figures are presented in current dollar values. The table below presents all relevant costs.

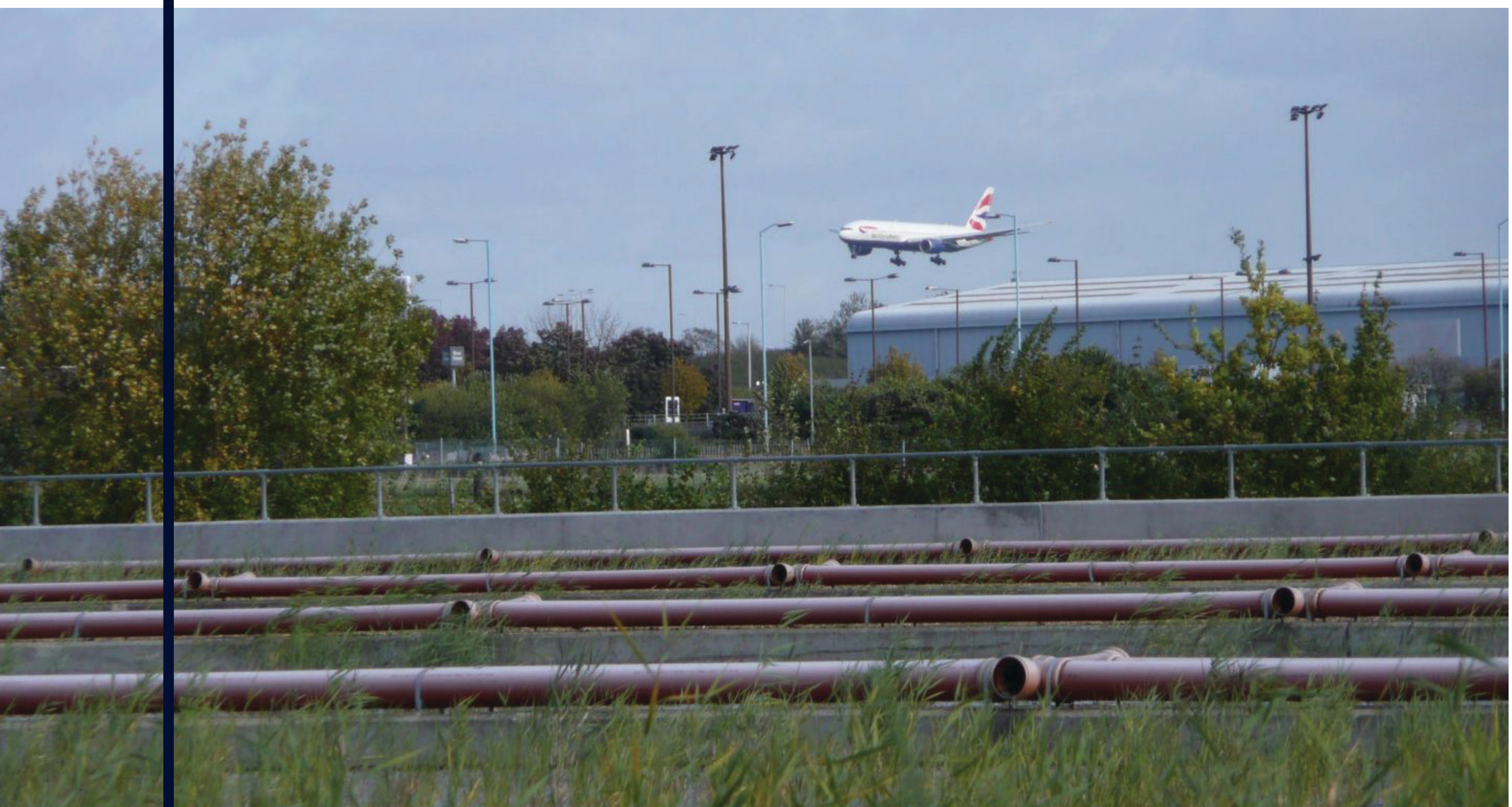
The Recommendation

The recommended solution for treating and disposing of EGE's deicing fluid runoff was Aerated Gravel Beds because they demonstrate the lowest construction cost and lowest total cost of ownership over the 20-year analysis period. Aerated beds also demonstrated the largest cost reduction compared to current practice and the least disruptive alternative to airport operations. Aerated gravel beds offer the airport an affordable, efficient, and simple solution for deicing runoff handling.

Airport Present Value (PV) Total Cost Of Ownership*



Swanson Rink Study Process Identifying Alternate Methods



Our evaluation considered life cycle costing with primary emphasis on environmental impact while achieving financial self-sufficiency.

Deicing and Anti-icing Disposal Methods

First, disposal can be categorized as managed bio-degradation or recycling. While some options are complex and require a significant amount of energy, others are simple but self-limiting because of space requirements. Our evaluation considered life cycle costing with primary emphasis on environmental impact while achieving financial self-sufficiency.

Though deicing/anti-icing is necessary at most northern airports, there is not one approach suitable for all. There are issues of flow, volume and concentration of the runoff effluent produced during a storm event, the scalability of each approach, and the availability of ready markets for disposal of the collected effluent.

The conditions at EGE can vary greatly during the winter season. Deicing fluid runoff concentrations depend on the amount of precipitation collected on the deice pad during a deicing event. Precipitation levels at the airport are generally low and can range between 1” and 2” in January. However, anti-icing is still needed because of extreme weather conditions in the surrounding mountains. As a result, EGE’s glycol concentrations are high compared to other airports where significant precipitation occurs during the event.

EGE’s two deicing pads were being consolidated and relocated to a new area with airside access so product delivery and waste disposal could be handled with minimal impact on ramp operations. The new deicing drainage system delivers waste fluid to underground holding tanks that are emptied periodically throughout the deicing season. EGE is currently working with a local vendor to empty the holding tanks and transport effluent to solidification basins at the local landfill. The waste fluid is combined with fly ash and then buried. Though not inert, the encapsulated glycol residue will degrade at a much slower rate thus minimizing impact on nearby ground water. The local wastewater treatment plant will not accept any waste deicing fluid if it is pre-treated.

OTHER PRECEDENTS

Previous page: Aerated gravel bed at Heathrow Airport

Above left: Activated Sludge Basin at Cincinnati International Airport

Above right: Aerated gravel bed at Edmonton International Airport

Project Focus: Identify and Evaluate 8 Treatment Alternatives

After considerable review and analysis our alternatives fell into three general categories:

- Disposal without treatment.
- Treatment for disposal of onsite runoff to achieve an acceptable BOD level for discharge to a sewer or landfill.
- Recycling, which consists of different processes to increase the fluid's glycol concentration.

Disposal Without Treatment

1. **Current Operations: Effective but costly**. The cost of $0.90 per gallon covers pumping/ transport and disposal at the landfill. One collection truck can transport 3,200 gallons per trip.

2. **Offsite Disposal by Contractor. Effective and less costly.** Fees include 60 cents per gallon plus $125 hour which equates to roughly $0.85 per gallon total for EGE. The only restriction is that fluid must have an oil level less than 100 ppm. Utilizing a local disposal contractor could reduce total cost compared to current operations.

Treatment for Disposal

Glycol fluids can also be broken down with naturally occurring or artificially introduced bacteria to reduce Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) to levels harmless to the local ecosystem. The treated fluid can be discharged to surface waters or leach fields, and most options produce sludge, a by-product that consists of bacteria and other contaminants, also less harmful to the local ecosystem. Effluent must be treated to levels as low as 20 mg/L to mitigate harm to aquatic life.

Discharging process effluent to surface waters requires a permit and a certified operator to monitor and report the effluent on a monthly basis, which adds significant cost. Four effluent treatment approaches include:

3. **Aerated Gravel Beds: Simple and the smallest footprint.** Aerated gravel beds are subsurface engineered wetlands that consist of a six-foot-deep gravel bed over an array of perforated aeration piping installed at the bottom of the beds. A layer of soil is placed on top of the gravel. Air introduced by blowers supports bacteria growth naturally present in the soil and the runoff wastewater, and liquid fertilizer is also added to promote bacterial growth. Perforated drain lines at the bottom of the beds collect the treated effluent and pipe it to a septic drain field. When the deicing season ends, deicing fluid, fertilizer, and oxygen are no longer fed to the system, causing the bacteria population to die off.

   Such a system requires regular monitoring to verify blowers, fertilizer feed, and pumps are operating correctly. If discharge is sent to surface water, a licensed operator is also required, whose duties include sampling effluent quality and writing compliance reports. Aerated gravel beds can treat deicing fluid runoff to BOD levels as low as 250 mg/L, not low enough for release to local waterways. As a result, the effluent must be trucked away at a cost.

4. **Non-Aerated Gravel Beds: Least amount of energy, lowest maintenance cost, and more time or area required for treatment.** Non-aerated gravel beds operate as batch treatment systems. During winter, the beds are filled with waste product and influent is digested through spring and summer. The beds are drained before the start of the next winter season.

5. **Activated Sludge System: Reliable performance, low construction cost, limited treatment capability**. The activated sludge process is similar to the Aerated Gravel bed approach but requires more equipment. It consists of an aerated basin containing suspended bacteria that feed on wastewater contaminants. Floating aeration chains attached to bubble membrane diffusers supply oxygen to the basin. After aeration, the wastewater passes through a clarifier where sludge settles to the bottom of the tank, leaving clear liquid at the top which is then discharged to a septic drain field system. The sludge must be disposed of in a landfill or lagoon.

   During summer months when no deicing activity occurs, the system can be put into maintenance mode where aerated basins are filled with an organic solution (molasses, methanol) to feed bacteria. An activated sludge system can treat deicing fluid runoff to BOD levels as low as 200 mg.

6. **Anaerobic Fluidized Bed Reactors: High treatment capability with high construction and annual costs**. Anaerobic Fluidized Bed Reactor (AFBR) treatment occurs in a vertical tank. Anaerobic (no oxygen) bacterial films form on inert medium, such as granular activated carbon. The bacteria require nutrients to promote growth and must also be kept at a temperature between 85 to 90 degrees Fahrenheit. Collected deicing runoff is cycled through the reactor from the bottom to top, resulting in a suspension (fluidizing) of the medium containing bacteria. Treatment produces methane, which is extracted and used to heat the water in the bed reactor. Temperature is maintained using boilers, particularly at the beginning of the season. A clarifier is the final step to separate sludge from clarified effluent. Solid waste from the clarifier must be dewatered prior to disposal to a landfill.

   AFBRs reduce wastewater BOD levels as low as 13 mg/L which meets the BOD limit of 20 mg/L needed for discharge of process effluent to surface waters. AFBRs are best suited for high load, low flowrate applications typically seen at airports that deice planes on pads. AFBR systems operate better when fed continuously rather than in batches.

   There are several variants similar to the activated sludge process except that treatment.

7. **Membrane Bioreactor Systems: High treatment capability and significantly less expensive.** Membrane Bioreactors are hybrids of the activated sludge process that employ membrane filtration. The process consists of a single stage reactor where oxygen is supplied to bacteria feeding on the contaminants in the wastewater. A jet aeration system supplies oxygen. Unlike a conventional activated sludge system, no clarifier is present after the aerated basin. Instead, a tubular semi-permeable membrane is used that retains solids and bacteria and squeezes out smaller liquid molecules through its walls. Membrane Bioreactor systems can reduce BOD levels to as low as 4 mg/L. Treated effluent is squeezed from the membrane tubes and can be discharged to surface waters. Accumulated sludge can be sent to compost or a landfill and must be dewatered prior to disposal.

   Membrane Bioreactors are sophisticated treatment systems that require licensed operators, and additional qualifications may be required depending on the effluent discharge method. Only one operator is needed for a couple of hours each day to monitor the system.

RECYCLING

Recycling consists of multiple steps and a great deal more energy. The waste fluid must be pre-treated to remove contaminants, followed by filtration and/or distillation to drive off the water and increase the concentration of the remaining glycol. Glycol concentrations approaching 99% are possible with some mature recycling technologies.

8. **Deicing Fluid Recycling: Potentially generate revenue but still expensive.** This method is more appropriate at larger airports that handle more fluid annually. The main goal of recycling is to drive up glycol concentration. Fortunately, the glycol can be sold to certain markets at different concentrations, which can range from 30 to 60 percent to 99.5%. Depending on the equipment used, some airports can respray 99.5 percent glycol, which means recycling deicing fluid can be attractive to certain airports that have the proper equipment; a better alternative than disposal.

   Recycled glycol can reach concentrations as high as 99.5 percent, and can be used for other non-aviation (deicing) applications.

   Recycling still produces by-products for disposal. Solid waste generated from the vacuum distillation column must be sent to a landfill, and clean water from distillation and mechanical vapor recompression is recirculated into the system.

** Notes: The costs to compare each alternative were estimated quantitatively. A rough order-of-magnitude (ROM) construction cost, followed by a life cycle cost analysis, were used to determine the Total Cost of Ownership for each alternative. The costs were obtained from vendors. Life cycle period was set at 20 years, and factored discount rates, construction cost escalation, fuel escalation, labor rates, etc. were based on producer price indices obtained from the Office of Management and Budget (OMB) Circular A-94, and RS Means historical data.*

CONTACT THE AUTHOR

Airport operators know when it's time to evaluate routine processes to identify alternatives to cut costs, improve maintenance, or address environmental impacts.

William J. Gibbs, PE, Vice President, Airport Systems, has more than 40 years of experience in airport systems, and regularly shares his expertise to improve the aviation industry. Contact him at 303-832-2666 or wgibbs@swansonrink.com.

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