April 2007

ce NEWS

for the business of civil engineering

COLD-WEATHER CONTAMINANTS

Wastewater regulations loom for airport deicing operations

www.cenews.com

ZweigWhite

Joshua Paurus/Metropolitan Airports Commission

Cold-weather contaminants

Airports begin planning for federal guidelines regulating management of glycol deicing fluids.

By Mark O. Liner, P.E.

Flight delays are the bane of every airline traveler. We all know the feeling of sitting on the runway waiting for the plane to take off with no idea of when it will depart. Some airport managers might have that same feeling about glycol management. By the end of this year, the U.S. Environmental Protection Agency (EPA) plans to propose guidelines for airport deicing operations. With new airport deicing regulations looming, many airports do not have a clear idea on when or what will happen and are waiting for clearance to take off.

The EPA's new rules are designed to limit the discharge of pollutants to streams and other surface water bodies. Airport managers are waiting to see how the regulations will affect their operations, but are aware that changes will be needed. For some airports, such as Buffalo Niagara International Airport in New York, the changes are already underway. Design work is currently in process on an aerobic subsurface wetland system sized to treat spent glycol, and construction is scheduled for this year (see "Engineered wetlands design" on page 30).

How each airport takes on glycol management will vary from site to site; the peculiarities of each airport will drive the process for treatment and the solution. How much deicing activity is there? What are the options for disposal? What is the existing infrastructure at the airport? Each facility will need to answer these questions to channel its solution in an appropriate direction. So before starting down a treatment path, airport managers and their engineers should consider all the factors affecting their deicing operations, as well as the available options.

Environmental impact

The impact of deicing fluids on the environment is most notably related to the high oxygen demand they exert

Left: Airplane deicing provides for safe air travel in winter months, but spent glycol fluids create wastewater and stormwater treatment challenges for airports.

Right: Worldwide, three airports currently use subsurface-engineered wetlands to treat glycol-contaminated stormwater.

North American Wetland Engineering

when released to rivers and streams. A large slug of glycol can quickly deplete the dissolved oxygen in receiving waters, thereby killing fish and other organisms that need aerobic environments. Removal of these "loads" prior to discharge is the primary basis for the use of wastewater treatment plants throughout the world. As a reference, typical household wastewater has a biological oxygen demand (BOD) of around 200 milligrams per liter (mg/l), while some discharges from airports have measured more than 100 times stronger than that at 22,000 mg/l, according to the EPA's 2000 Preliminary Data Summary on Airport Deicing Operations. In most cases, surface water permits limit discharge of BOD to less than 30 mg/l.

Depletion of oxygen in water bodies is only part of the story; recent work by the U.S. Geological Survey (USGS) examined the toxicity of airport deicing fluids. The research, presented by the USGS's Steve Corsi at the American Association of Airport Executives' 15th Annual Deicing and Stormwater Management Conference, examined the toxic effects associated with the melt of glycol-laden snow banks. Further, the presentation probed the toxicity associated with the additives used in deicing liquids. It concluded that toxicity can be related to the additives used in deicing and anti-icing formulations. Although treatment for glycol may eliminate oxygen depletion in streams, glycol additives may be of more concern in terms of toxicity to the environment.

Regulatory background

Under the Clean Water Act, the EPA establishes technology-based national regulations, called effluent guidelines, to reduce pollutant discharges from categories of industrial facilities that discharge to waters of the United States. The rules are designed to provide uniform guidance for National Pollutant Discharge Elimination System (NPDES) permit writers across the country. The new deicing fluid guidelines will establish a baseline with which all U.S. airports must comply. Currently, the EPA is working with airports to collect survey data and conduct detailed sampling programs. This work will be used to identify the best available technology (BAT) that is economically achievable for treating deicing and anti-icing fluids. Typically, the BAT is the basis on which numerical discharge limitations are developed. The EPA plans to publish the proposed rule in December 2007 and take final action by September 2009.

Complicating matters is a separate wing of the EPA charged with regulating stormwater under the NPDES. The NPDES program has a well-established permitting system for end-of-pipe discharges typically associated with sewage plants and other pipe outfalls. This area of stormwater permitting is still evolving and undergoing implementation of a second phase. Currently, most airports have an NPDES permit that regulates the discharge of stormwater collected in and around the airfield. For these discharges, permit writers have little uniform guidance on how to establish limits for pollution from deicing. Effluent guidelines should fill the gap; however, such guidelines are rarely used to support stormwater permits. Permit writers will need to balance local stormwater conventions with national guidance.

Along with current stormwater permitting and the new Airport Deicing Effluent Guidelines, airports will also be subject to constraints related to water quality-based discharge limits and total maximum daily loads (TMDLs). These constraints vary from state to state and place to place and will add complexity to the permitting process.

Technical challenge

Future regulatory challenges faced by airports will prove to be perplexing. More problematic will be the technical challenges raised in the treating and disposing of spent deicing liquid. Not only is the waste stream cold, which makes it difficult for biological treat-

North American Wetland Engineering

The U.S. Environmental Protection Agency expects to propose effluent guidelines for airport deicing operations by the end of 2007.

ment, but its unpredictable strength and volume make it tricky to manage.

At present, most deicing areas are constructed to provide quick drainage, as reflected by the pipes and drains around an airport. Though good for keeping the gates and pads free of ponding water, this flush-and-forget approach results in the potential for downstream flooding. To combat this, airports incorporate stormwater storage tanks, vaults, and ponds to shave peak flows. With large airfields producing significant runoff, stormwater storage volumes can be massive, typically sized in the millions of gallons.

Though good at buffering peak flows, these large storage volumes are not usually piped to capture the initial "first flush" of a storm. This is the period of time that generally contains the largest concentrations of pollutants. Civil engineers are increasingly aware of this and are incorporating front-end "quality control" volumes into stormwater management systems. The dirty, first flush that is captured is pulled aside during a storm event and treated. A common challenge in this is that most airports do not have quality-control volumes integrated into the airfield storm piping and this would require a significant engineering effort to implement.

Then there is the nature of the deicing wastewater itself. Wastewater engineers need three pieces of data to design a treatment system: the strength of wastewater, the required quality for discharge, and the volume. In most cases, these pieces are easy to define, resulting in the stepwise development of a treatment system. The greatly fluctuating nature of deicing activity, however, can make the development of a good design just as erratic.

As a summary, a design must address the following criteria to be an effective solution:

- provide treatment of cold and variable-strength wastewater;
- integrate into the existing stormwater management system;
- handle large seasonal variations;
- be on or close to the airport property;
- not present a bird strike or airside hazard;
- have negligible odor production; and
- demonstrate cost effectiveness.

From a technical standpoint, the most important aspect is coupling wastewater treatment with stormwater management. However, the two disciplines have competing interests: a wastewater engineer is interested in first flush, high-concentration treatment, and the stormwater engineer is interested in storing the peak, diluted flows. The competition leaves each fighting for storage volume that is difficult to accommodate onsite.

Options

There are four areas to consider in developing a strategy for managing the wastewater from airport deicing operations: 1) source reduction, 2) containment, 3) stormwater treatment, and 4) disposal. The importance of each area differs from airport to airport. In some cases, an airport may choose to do away with glycol-based deicing activities completely in favor of non-chemical means such as infrared heating. In other cases, an airport may have the luxury to dispose of all wastewater to a sewage plant. For the rest, some form of treatment is necessary.

From a wastewater standpoint, source reduction — to reduce the quantity of glycol being flushed downstream — is probably the most sensible course. For airports, source reduction is most commonly associated with the use of vacuum "sweeper" trucks that circulate during deicing activities to suck up spent deicing liquids. The reclaimed glycol is purified and sold. For every gallon of glycol that is vacuumed, one less gallon of glycol requires treatment. This gathers importance when one considers that once the glycol becomes diluted, the volume of water requiring treatment increases proportionately. Source reduction not only limits the wastewater requiring treatment, but

From a technical standpoint, the most important aspect is coupling wastewater treatment with stormwater management. However, the two disciplines have competing interests ... The competition leaves each fighting for storage volume that is difficult to accommodate onsite.

also provides some level of income. The downside of using vacuum trucks is managing traffic in and around the airfield.

Most airports practice some form of containment for collecting the most contaminated deicing fluid. This highly concentrated wastewater can be collected in a sump and trucked directly to sewage plants for treatment in anaerobic digesters; however, this strong waste stream often requires some treatment to reduce its organic load prior to discharge. The Albany, N.Y., airport has had noted success in using an onsite anaerobic treatment process to lower the BOD loadings greatly. Treatment of high-strength wastewater typically favors anaerobic processes that convert glycol and other hydrocarbons to methane gas, though these processes have a reputation for being sensitive and potentially malodorous. Conventional aerobic treatment is also an option, but the high strength of the wastewater typically results in high operational costs associated with running blowers and managing bacterial sludge.

As much as 40 percent of glycol can be recovered and recycled or treated. What happens to the remaining portion is less clear. A significant percentage of it ends up in stormwater and can have concentrations as high as raw sewage. Subsurface-engineered wetlands are proving to be effective in treatment of this contaminated stormwater. There are three wetlands now operating to treat glycol-contaminated stormwater: Edmonton International Airport, Edmonton, Alberta, Canada; Heathrow International Airport, London, United Kingdom; and Air Express Airport, Wilmington, Ohio.

How the glycol-contaminated water

Engineered wetlands design

Pilot-scale testing determined that engineered wetlands currently under design for Buffalo Niagara International Airport could remove 96 percent to 97 percent of target pollutants from deicing operations.

An innovative method for stormwater treatment is the use of subsurface, aerated gravel beds. These engineered wetlands are currently under design for Buffalo Niagara International Airport (BNIA) in Buffalo, N.Y. The below-grade beds are designed to sustain a resident, attached community of bacteria acclimated for the specific task of glycol removal. The stormwater is distributed uniformly over the beds and flows vertically through the gravel to a system of underdrains. Air is pumped to the beds through a network of aerating tubing. The bed is insulated on top with a layer of peat mulch, which has been proven to be an important means to conserve heat.

Key to executing the design was the successful off-site treatability testing of propylene glycol-spiked stormwater from the airport. Pilot work at wetland test facilities was conducted to evaluate the performance of the system and to determine process kinetics. Results of the pilot-scale testing determined that there was very good treatment (96 percent to 97 percent removal of target pollutants) at both the high and low-design basis temperatures.

At full build out, BNIA's wetland will comprise eight wetland cells excavated from an existing open area near the airport's main runway and will encompass roughly 10 acres. At ground level, only a field of wetland grasses will be observable, growing from a "dry" mulch surface. An important design factor is the size of the gravel used and the porosity of the bed. Detailed analysis of biomass growth, storage, and decay was undertaken to ensure that the bed could seasonally accommodate the transient nature of the bacterial community.

is ultimately disposed of has a significant impact on the final design of a system. Discharge to a sewage plant is often the easiest solution. The challenge is that sewage plants are bumping up against their rated design capacity and operators are frequently less inclined to receive large, cold, high-strength flows from airports. In most cases, the level of treatment required will dictate the options chosen and is directly related to the environmental health of the receiving water body. As the EPA continues to develop and revise the effluent guidelines and the stormwater permitting criteria, the level of treatment necessary may be a moving target. This may mean that environmental managers should expect stringent limits.

Airplane deicing provides a foundation for safe air travel in winter months. However, environmental impacts from the practice are now coming under regulatory scrutiny, and airport managers will soon have to take action. What action will be necessary will differ from airport to airport and depend on the scope of the new EPA effluent guideline. One thing is certain: Each airport that conducts deicing activity will require a solution. And for now, as we wait for the proposed rule, time is best spent planning on what to do once we get clearance for take off. ■

Mark Liner, P.E., is a senior engineer at North American Wetland Engineering, LLC, White Bear Lake, Minn., specializing in the design of onsite treatment and disposal systems for industrial wastewater. He can be reached at mliner@nawe-pa.com. For more information about engineered wetlands, visit www.nawe-pa.com, or call 651-255-5046.