# RUBBERNECK ENGINEERING

By Mark O. Liner

**New effluent guidelines focus on industry best practices, including some already in place at airports.**

"How much is this going to cost me?" That is the question airport managers are asking themselves with respect to the Environmental Protection Agency's (EPA) effluent guidelines that will be proposed next year. It's a hard question to answer because it will depend on the shape of the final regulations and how engineers will design in conformance with them. What we know is that EPA is evaluating best available technologies (BATs) and so far has conducted sampling at airports in Albany, Rockford, Pittsburgh and Denver. The technologies used at these airports will be candidates for BAT, so it is a good place to start in understanding how the final regulations will look. However, in the end,

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the costs necessary to comply with the new regulations will be the sum of all components in the system–not only the treatment unit–and airport managers will be wise to learn from those airports that already have systems in place.

## The cost of wastewater

A lot of energy goes into keeping ice off planes and airport pavement. And it's not only energy expended by the folks on the ground who are pushing snow and hosing planes down. Chemicals used by airports, like glycols and formates, have an energy value just like the calories in our food. When these chemicals find their way into a stream or sewage plant, they exert an oxygen demand. If the oxygen supply runs out, the water turns anaerobic–resulting in fish kills and plant upsets.

Because of the high oxygen demand of airport deicing fluid, it is the scale of the demand that is important with consideration to airports. A gallon of propylene glycol (PG) has roughly eight pounds of oxygen demand. To put that in some perspective, each of us flushes about 0.2 pounds of oxygen demand down the toilet each day. Another way of putting it is that one gallon of PG per day is equivalent to 40 people in wastewater terms. Since we have been building domestic sewage plants for more than 30 years, we have a good idea how much the new ones cost: between $3,000 to $9,000 in capital costs per pound of oxygen demand per day. Using the same metric, each gallon of glycol used per day would have a capital cost in the range of $24,000 to $72,000, if it were treated as a traditional sewage plant.

Luckily, this math doesn't reflect the reality on the ground. Domestic wastewater treatment is a well-developed field in which solutions have evolved to meet a need: quick treatment of dilute wastewater with relatively steady flows. In contrast, airport deicing takes place only a couple of months per year with much of the liquid being lost to the atmosphere, never making it to the treatment system. What is collected can be stored and paced to a treatment unit, which results in a smaller, more reasonable and less costly system. However, the math for treating domestic waste does reflect the scale of costs airport managers are seeing and the seriousness with which they must plan for EPA's guidelines.

## The cost of stormwater

Due to their footprint of paved surface area, airports are already in the business of stormwater management. Every airport has a strategy and an infrastructure dedicated to ushering rainfall off the airfield. After installation, most stormwater collection pipes and tanks have led a passive life with minimal attention. For some airports, re-engineering these passive systems to meet the new EPA guidelines will be a serious task.

While a wastewater engineer can go on and on about oxygen demand, a conversation with a stormwater engineer can be equally as technical and specific. Flood prevention requires storage, and most airports and their engineers have figured out how to capture, store and channel flow so as minimize standing water. Big pipes and big tanks make it happen. The challenge is to rework these big, established systems to aid in the collection and treatment of contaminated stormwater. In some instances, large plugs or valves isolate deicing areas and provide effective collection. In other instances, new, parallel collection systems are installed and dedicated to spent deicing fluid. While plugs and valves may seem simple, the cost of constructing a parallel collection system can be daunting for an airport.

While flood prevention involves managing volume, water quality protection aims to capture and control the first flush of airfield runoff generated in a storm. It is a different storage volume for a different purpose. And, yes, in an ideal world that would require two tanks: one for flood prevention and one for collecting the first flush.

For airports, this first flush volume also can be considered equalization for the treatment system, which will result in a smaller, less costly system. Storms can come and go with the first flush held and paced into the treatment system afterwards. The benefits of equalization cannot be understated; it smoothes out the peaks, normalizes the flow, and provides flexibility to airport operations. Most importantly, it will reduce the cost of the treatment system. Engineers know that a gallon of storage is cheaper than a gallon of treatment, particularly if the wastewater has a high concentration.

## The safety factor

Safety is a critical issue for airports. During severe weather, no limits are placed on keeping airplanes safe to fly. This is, of course, as it should be. But there is a cost associated with safety. And that cost is partly borne by the airports in cleaning up after deicing. When it comes to the environment, do we need to pose the same question? Is a permit violation acceptable during a 20-year storm? A 10-year storm? Or never?

Before starting work, a wastewater engineer must establish a basis of design that includes the flow, the concentration and limit to be met. Each item may have a simple answer and be simply derived. Each one impacts the overall cost of the system. The problem for airports is that flow and concentration are highly erratic and a statistical review will reveal a distinct point of diminishing return—a point beyond which additional investment will yield less and less risk. So, as part of the basis of design, the engineer must establish the acceptable confidence level for system performance.

Historical flow and concentration data can be analyzed to tease out 80 percent, 90 percent and 100 percent confidence levels, and, with some effort, an engineer can cost out the burden of each. Along with the level of confidence, two other factors will greatly impact the cost of the system: the cost of equalization and the cost of treatment. Such a statistical exercise is interesting, but may result in more questions than answers. A deterministic approach, in which a design storm event is selected, may provide a shorter route to design. In this case, historical flows and concentrations are reviewed and a "bad" storm event is selected. Flows and concentrations are modeled for the event, and a system is optimized for the given conditions of the scenario.

A variety of approaches are being used by airports for the treatment of deicing liquid. When available, most airports discharge to a sewage plant and pay a fee with respect to either the flow or loading. It is a convenient option but not always the most cost-effective. Handling the liquid onsite is becoming a reality for many other airports. A survey of EPA's Preliminary Data Summary on Airport Deicing Operations will reveal that there is a narrow range of approaches being used for these facilities.

## Recovery and recycle

Numerous approaches are being used to recover and recycle spent deicing fluids. Distillation, vapor recompression and reverse osmosis units are being used to clean up and concentrate some of the stronger concentrations of deicing fluids. In these systems, dilution by stormwater is the enemy, and great effort goes into collecting and storing the concentrate prior to processing. The systems perform best when concentrations are in the 8 to 12 percent range, though work with reverse osmosis and filtration units can be done on concentrations above 1 percent.

Pittsburgh, Denver, Salt Lake City, Detroit and Minneapolis are some of the airports that have worked on recovery systems. The list is long and experiences varied. The units can work well and do so when well operated and maintained. Advances and increased competition in filtration units has been considerable in the best decade, which has allowed many airports to consider recovery as a cost effective option to treatment.

## Anaerobic treatment

The anaerobic treatment unit at Albany airport in New York has received considerable study; the fluidized bed reactors there produce high quality effluent, while converting captured glycol to methane. The methane from the process is used as a fuel source for heating the incoming water and a number of buildings on site. Two 35-foot-high reactors are at the heart of the duplex system and are valved to allow operation in parallel or in series. The influent to the system is maintained at a 1 to 2 percent concentration level with a design loading rate of roughly 7,000 pounds per day. Built in 1998, the system processes about 150,000 gallons of glycol per season. The system also includes 11 million gallons of retention ponds and tanks along with polishing filters for the reactor effluent. Effluent from the system is directed to a nearby stream or to an airfield spray irrigation system.

## Aerated gravel beds

An innovative system centered on aerated gravel beds is currently in design for Buffalo Niagara International Airport. In this system, spent deicing fluid is collected and discharged over large beds of subsurface gravel. The beds are to be constructed on the airside below ground surface and topped with mulch and grass. Aeration of the gravel is critical. The system is designed to supply oxygen to bacteria attached to the gravel and can be controlled relative to the level of glycol being treated. Currently, the system is designed for 10,000 pounds of oxy-

gen demand per day and is roughly the size of four football fields. The relatively large size of the gravel used, one-half to three-fourths of an inch in diameter, allows for accumulation of bacterial biofilm (also known as slime), which grows during the deicing season and degrades in the summer. The system is designed to allow supplemental nutrient addition and online monitoring of oxygen demand.

## Hold and release

One common approach is simply to store the spent deicing liquid until the weather warms up. With warmer temperatures, biological treatment is accelerated and discharge can be paced over the off-season. The storage basins should be away from the airfield to prevent bird strikes and lined to prevent contamination of the groundwater. In some cases, like with Greater Rockford Airport in Illinois, aeration equipment is installed in the basins to facilitate treatment and reduce odors. Other airports, like Wisconsin's Green Bay and Michigan's Lansing, use insulated floating covers on their basins to control odors and algae. Simple usually translates to low-cost, and for these systems the cost is mainly associated with basin construction. The downside of this approach is that the quality of treatment may be erratic and require close monitoring to ensure discharge limits are met. Odors are another liability and the use of aeration or floating covers should be considered.

Now is the time for airport managers to be looking around and seeing what everybody else is doing. And frankly, that is what the EPA is doing in developing the regulation. Some airports are using sophisticated approaches with high-priced treatment and analytical equipment; others are using simple storage basins. The best advice in preparing for the upcoming changes is to understand your options and, more importantly, to understand the needs of your airport. As EPA is conducting sampling with airports, airport managers are speaking with their peers more than ever.

To know the cost of a system, you need to know the size of it. The size is directly related to the flow and strength of water being processed. Understanding your options is good. Understanding how much those options will cost is even better.

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