Savings—Not Sludge—Accumulate at Treatment Facility

Eight years ago, a Wisconsin wastewater treatment plant installed a JetMix Vortex Mixing System and an Aquastore tank. The upgrade not only improved sludge storage and disposal, it continues netting the plant annual energy and maintenance savings.

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Turn back the clock to 1992, when concerns about sludge storage and mixing compelled the wastewater treatment plant in Denmark, Wisconsin to upgrade its facilities. Faced with the prospects of increased sludge load and longer sludge storage periods, the plant opted for a design that included the installation of a storage tank and the JetMix Vortex Mixing system. Though these components appeared to be the best way to satisfy the plant's established upgrade criteria—cost-effectiveness, minimize maintenance, improve operational efficiency—doubts lingered about the new system's effectiveness. However, it took only one test to dispel any reservations. According to Jim Krueger, the plant supervisor at the Denmark facility, the system performed beyond anyone's best expectations.

After nearly a decade of operation, enthusiasm for the system has not diminished. Savings generated in the areas of operating costs and maintenance have been substantial. "In eight years, I haven't spent a red nickel on maintenance," said Krueger, who championed the system from the start.

Because the system requires less energy than conventional mixing systems, the plant has also saved more than $18,000 a year in energy costs. Conventional mixers designed for the same purpose need to operate continuously; the Denmark facility operates its system only on an as-needed basis. Above all, because it produces a homogenous mix, the system makes sludge handling and disposal so much easier.

As part of Wisconsin's land application program, the plant can not apply the biological sludge during the growing season, or when the ground is frozen. As a result, during the spring and fall the sludge is incorporated directly into the soil. "We either spread the sludge on the surface of hay fields, or we inject it in fields where farmers are going to plow it under for corn crops," explained Krueger. Essentially, the plant's role in preparing sludge for land application includes storing the sludge, mixing the sludge to make it easier to pump, and then pumping the sludge onto the trucks that apply it to the soil.

Two factors placed new demands on the plant's system and drove the need for the upgrade. First, new EPA regulations that went into effect at the time required storage of biological sludges over the winter. Second, a local dairy, one of Denmark's largest wastewater contributors, switched from producing powdered milk to cheese, a move that would significantly increase Denmark's biological load. Specific problems involved:

- Insufficient storage capacity—The Denmark plant used anaerobic disgesters to stabilize sludge before land

disposal, but their volume was insufficient to meet the needs of the plant as well as provide adequate winter storage capacity.

• Mixing capabilities—Sludge settles during long-term storage, creating mixing problems that include accumulation of solids, "dead areas" in the center of tanks, or chunks of sludge that rise to the surface. These problems make pumping the sludge for the purpose of land application more difficult.

During the investigative phase of Denmark's upgrade, Krueger stressed the need for a sludge mixing system that could handle the thick, sticky sludge generated by the plant. He explained a typical mixing problem that can occur when sludge settles. One time, the plant had contracted with a farmer to use his manure pit to mix the sludge. "The sludge had settled quickly and we tried to de-water it with one of those big propellers that farmers typically use in their manure pits," he said. "When we started it up, the sludge looked very smooth. But then, when we shut off the propeller and went to start pumping the sludge out, the pump quit when the land application truck was half full. The solids had accumulated at the bottom of the pit. We had to try and keep it stirred as we were pumping."

Robert E. Lee & Associates, a Green Bay firm, provided the planning, design and construction administration for the upgrade. To meet the criteria established for the plant, the firm had to upgrade the secondary treatment process to be compatible with the existing wastewater treatment facility. Designers determined that the most cost-effective way to upgrade the process was to add a biotower that would provide additional secondary water treatment capacity. (The upgrade also included septage receiving facilities, dechlorination facilities, digester mixing equipment and a supplemental air system for the existing rotating biological contactor system.) The most important element of the upgrade would be the new sludge storing and mixing system, which included a sludge storage tank combined with the JetMix Vortex Mixing System.

The JetMix system itself was chosen because it fit in well with the plant's operational philosophy, which is to purchase equipment that needs minimal maintenance and operator attention and that operates efficiently. Of all the options investigated, the JetMix system proved to be the only one that could operate on an as-needed basis, instead of continuously. It consists of three rotatable nozzles and two 12" inlet suctions in the bottom of the 70' diameter x 24' high storage tank. It was developed especially to tackle the kinds of problems associated with long-term sludge storage and sludge disposal. Employing relatively simple components, the system sweeps all areas of the storage tank. Essentially, what happens is that a unique flow pattern created by floor-mounted nozzles combines with

the action of chopper pumps to keep solids suspended or to resuspend solids that have settled. The result is a homogenous mix.

The tank and JetMix system were installed by the team of Great Lakes Aquastore Systems, Inc. and Miron Construction Company. Installation, particularly the nozzles, was easy. In all, it took a few weeks.

In early December 1992, Denmark placed sludge into the storage tank and allowed it to settle through the winter and early spring. About five months later, it was time to go online. All eyes were on the upgraded system when the plant started it up in April 1993. Would it work as well as promised? Surprisingly enough, it only took 36 hours for the solids in the tank to become completely suspended. Pumping was easy. The plant filled up its disposal trucks and the smooth, homogenous sludge was ready for land application. Furthermore, when the storage tank was drained, operators discovered no sludge had accumulated at the bottom, nor had any of the JetMix nozzles clogged. At the time, Krueger said the sludge storage system had passed its "toughest test" with "flying colors."

The auspicious startup was no fluke. Even after several cycles, when the tank was filled and emptied, the mixing pattern alone sufficiently resuspended the bottom solids. What makes the system so effective is the storage tank's circular shape combined with a unique flow pattern created by the JetMix nozzles. Circular tanks are best for sludge storing and mixing because the contents are easily rotated. However, rotation alone won't sufficiently mix the thick, sticky contents. Flow pattern is the crucial element. With its nozzles mounted in a circular pattern, the JetMix system takes advantage of the hydraulic characteristics of circular tanks by creating an effective, "reverse helical" flow pattern. At the same time, powerful floor-mounted nozzles efficiently mix very large volumes of liquid while chopper pumps reduce solids. Vortex is the key word in the JetMix system. "Everything is drawn down into the center of the tank, like into a vortex," explains Krueger. "Then the nozzles shoot out at the sidewalls at an angle. The sludge goes around the tank and is rolled right back into the center. So you have a vortex going down, plus you've got circular motion, and then you've got nozzles hitting the sidewalls coming up from the bottom, right straight up the sides of the tank."

The system can be fine-tuned to meet specific operating conditions such as sludge thickness and depth. Krueger can vary the number of pumps and nozzles used. When continuous mixing is not needed, the powerful jets can resuspend and homogenize thick blankets of accumulated sludge. And Denmark turns the system on only when it really needs to. "We run it when we are ready to haul out," says Krueger. "We pump it two days ahead of time to emulsify it more. So we're not wasting a lot of electricity."

The Denmark facility isn't wasting much money or manpower, either. Even after eight years online, the system requires only routine maintenance. The plant hasn't had to change the pumps, the bearings, or seals. The tanks don't even need to be cleaned out. "With other systems, you'd have to go down inside the tanks to clean them out," Krueger says. "We haven't had to do that yet. By just turning on the JetMix nozzles, we can get right down to the concrete. We flush the bottom right off." The low maintenance coupled with the mixing efficiency makes it an ideal system for a wastewater treatment plant like Denmark's. Contents are completely mixed. "Its uniform consistency makes it ideal for land application," says Krueger.

The adjustable, top mounted discharge nozzle is designed to break up surface crusts. However, Kruger reports, they use it primarily for circulating supernatant when starting up the system.