

Advantages of Automatic Sampling on Wastewater Plant

It is important to know and effectively control the solids ratios of sludges going in a plant. Conducting a manual sampling round-the-clock and especially in a big plant could be a tedious and ineffective process. This article explains how automatic sampling done in a plant consistently produces a much more reliable composite than manual sampling done inconsistently.

In the early 1990s, the Jackson Pike Wastewater Treatment Plant in Columbus, OH, launched a plan to upgrade its single-stage digestion. That change, aided by the industry's first large-scale installation of multi-port sliding valve mixers, plus improved heating and continuous sludge feeding, would enable only six digesters to do the work that required 16 digesters under the earlier two-stage process. But boosting the new system to peak efficiency ultimately depended on finding the right recipe to feed it. After six years of experimenting, with the help of automatic sampling, Jackson Pike not only found the key to fine-tuning its new system, but along with that, a new way to cut costs and nearly eliminate the plant's most time-consuming task.

Jackson Pike WWTP was built in 1937. It treats an average of approximately 80 million gallons of wastewater daily. The eastern, northeastern and southern sections of Columbus and the city's Busch Brewery are treated by Southerly WWTP, built in 1967 ten miles farther south along the Scioto, which averages about 85 mgd.

The wastewater treatment process at Jackson Pike is basically biological, allowing aerobic bacteria to perform the purification naturally. Sludges harvested from primary and secondary clarifiers (settling tanks) following aeration are processed by anaerobic digestion. About 15% of the resulting digested biosolids is dewatered by centrifuges to 10% solids and hauled away in tank trucks — as much as 40 loads per week — for use as fertiliser injected into farmland soil. The remaining 85% is centrifuged to 20% solids and incinerated, producing ash that can be recycled into various commercial uses such as cover material for horse rinks or baseball diamonds, or fill for local land-

fills.

While the more visible mission of wastewater treatment is to reclaim water, Assistant Plant Manager Doug Wise notes that approximately 70% of the total plant cost is spent on dealing with the solids removed, so maximising efficiency on that side of the plant is especially important for over-all cost containment. "Digesting sludge reduces its solids

volume by more than half, so there's much less to incinerate," he explains. "It also increases the concentration of nutrients, nitrogen, phosphorus and potassium, making it ideal for land application as a soil amendment."

Bringing the new digesters up to peak performance was a complicated issue, he continues, because two different kinds of sludges are digested together. Sludge from the primary clarifiers comprises a mixture of the denser organic and inert matter, while sludge from the secondary treatment process is a lighter, fluffier, biologically active material.

Most of this activated sludge is returned to the secondary aeration tanks to treat the wastewater. The excess that isn't returned — called Waste Activated Sludge (WAS) — is

removed from the treatment process for disposal. But direct disposal of WAS is a problem. It can't go directly to incineration because its volume and high water content would require high temperatures and/or longer burn times, resulting in unacceptably high fuel costs. It cannot readily be dewatered by centrifuges above 15% solids because its water content is largely bound up inside live bacteria and microorganisms. This low solids content makes it undesirable for and costly to haul to the landfill. Primary sludge, by contrast, easily dewateres above 20%.

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Assistant Plant Manager Doug Wise checks sampler cycle times, individually adjustable for each sample point. Panels actuate the Isolok samplers with compressed air for greater safety and direct air passes through the sampler bodies to help eject sluggish materials.

“In order to incinerate WAS as economically as possible,” he points out, “we need to put it through digestion first, not only to reduce its volume, but also to kill the live organisms and allow fuller dewatering. Having already made the major commitment to single-stage digestion, our big challenge then was to maximise WAS digestion using the plant as-is, without any substantial equipment changes.”

Wise recalls that primary sludge and WAS initially were piped to a common mixing vessel and whatever blend occurred there was fed to the digesters. “Sometimes it worked well and sometimes it didn’t”, he says, “but we didn’t know when it would or wouldn’t, or why.”

Simplifying an explanation, Wise points out that primary sludge is digested readily but WAS takes more time to break down due to its complexity. “We get highest efficiency when the solids ratios in both sludges are correctly balanced so digestion of both components will be completed at the same time. If there’s too much WAS, it gets only partially digested and foams up into the digester’s fabric canopy. We refer to that as the digester getting sick.”

“Our first step toward learning how this works,” he continues, “was to re-route the two sludges into separate holding tanks so we could vary the mixture and study how different solids ratios affect digestion. Then we experimented with many different blends of WAS and primary sludge, also trying them on different types of anaerobic digestion to see what technology would work best with our plant equipment. For that we needed to draw and test a lot of samples.”

“Digesters are rated by pounds of volatile solids per cubic foot,” he notes, “so the key to pushing the system to its limit without overloading it is knowing the solids ratios of both sludges going in, and controlling the solids ratio of the blend by varying the proportions of both sludges.”

Stinky And Sloppy

For the first few years, Wise continues, samples were gathered the same way they had always been gathered for other purposes throughout the plant. Someone went out every two hours to turn a spigot, fill a cup and dump it into a jar to build up a 24-hour composite sample for analysis.

“With about twenty-eight sampling points in our sludge

Figure 1:

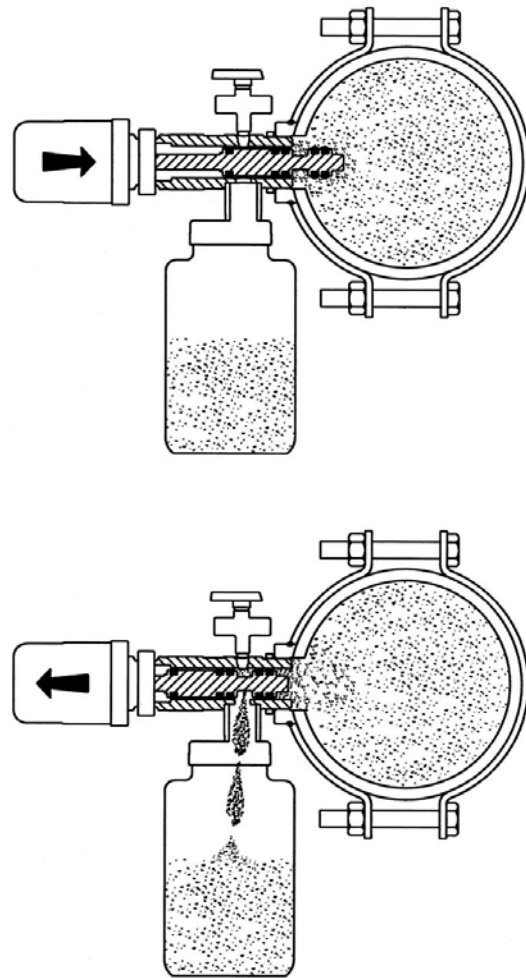


Fig 1: Cross-section drawing shows how Isolok’s positive-displacement design draws measured samples while keeping the process pipeline closed to the atmosphere. (Upper) Cylindrical plunger extends the spool into the sludge line, pushing any earlier accumulation out of the port, while seals behind the spool keep the port closed. (Lower) When the plunger retracts, a measured amount of material is trapped in the spool between the seals and dropped into a closed external container, while the seals in front of the spool maintains port closure. An air pulse directed downward from above the sample ejection port helps remove thicker, slower-flowing material.



◀
Wastewater Plant Operator Craig Kidwell harvests 24-hour composite samples simply by removing and replacing the collection bottle once a day.

▶
Chemist Tim Anderson calculates solids ratios of sludge samples based on weight before and after oven drying.



handling stream, this became the most time-consuming aspect of our work,” he observes. “It’s also stinky and sloppy, because when you open a line under pressure, the sludge just shoots out, especially at those spigots installed in pump volutes where the pressure is greatest. You can’t just crack the spigot open a little, or the sample just gets the thin liquid part; not a true representative grab of the solids. In other words, if you try to minimise the mess, you end up minimising the integrity of the sample.”

Making matters worse, he points out, each 24-hour composite was the work of different people across three shifts, and each person did it differently, so at the end of the day, no one was really sure about what was in the bottle.

“After several years of experiments based on manual sampling,” he continues “we began to realise that reaching an accurate conclusion would require more latitude in blending the digester input, with more reliable sampling of the material going into and coming out of the digesters.” For that purpose, a blending manifold was built to allow three pumps on both the primary sludge and WAS lines to feed a pipeline to the digesters or and/or a pipeline bypassing the digesters. Used simultaneously or in selective combinations, three pumps would allow very fine control over the proportions of both sludges going into the blend.

The bypass is needed, Wise adds, because sometimes there’s too much WAS for the amount of primary sludge available to mix it with. The undigested leftover WAS can go directly to incineration, but only if mixed with digested sludge in proportion small enough to prevent the blend’s dewatered cake solids from being less than 20% solids.

Automatic Sampling Proposed

To provide accurate assessment of what is moving through the system, the plant staff proposed using automatic Isolok, samplers built by Bristol Equipment Company in Yorkville, IL, near Chicago - two on lines coming out of the primary sludge and WAS holding tanks leading to the manifold, two on the digester infeed and bypass lines leaving the

manifold, and one on the line from the digesters to the centrifuges, downstream from where any bypass material would join the digester outflow.

“With that setup,” Wise says, “no matter what mix we put together or where we send it, we can accurately monitor solids content.”

Isolok samplers mount onto an access port installed in the side of a pipeline, tank or pressure vessel. The sampler body encloses a plunger positioned to extend through the port and into the process stream when activated by a pneumatic cylinder. (Fig. 1)

Near the plunger’s tip is an annular ring termed the sample spool, which is sized to capture a measured volume of process material by positive displacement...in this application, 8cc per cycle. When the spool darts into the product stream, then withdraws, it brings out a sample of process material flowing past it at that time, and drops the sample into a closed container attached beneath the sampler body.

Heavy elastomer seals around the plunger at both ends of the spool keep the port closed regardless of plunger position, and the sample remains contained within the sampler body until discharged, so there’s never any outpouring of process material contaminating workers or requiring cleanup.

The samplers are actuated pneumatically from a control panel provided by Bristol. Cycle time, user-programmed within the panel, was set at six minutes to gather enough 8cc samples to nearly fill a two-litre bottle within a 24-hour time span. The panel also directs a pulse of compressed air through a port above each sampler’s discharge opening to eject any sluggish material within the sample. The eject air enters through a special three-way valve that doubles as a flushing device. When the valve handle is turned 180°, the air line is blocked and water is allowed to wash through the sampler body to clean out any residual build-up inside.

“Automatic sampling done consistently every six minutes obviously produces a much more reliable composite than manual sampling done inconsistently every two hours,” Wise points out. “It also reduces labour cost considerably.”

Saving \$81,000/Year

After Jackson Pike management adopted the new “Kaizen” strategy for team-based problem solving a few years ago, he recalls, one of the teams studied the sampling process to assess the cost-effectiveness of adding more automatic samplers. They reported that manually drawing and handling a sample, then cleaning up the area afterward, takes an average of about 10 minutes. Doing this every two hours around the clock adds up to a labour cost of \$11,680 per year for each sampling site. The team’s findings thus credit the five automatic samplers installed in the blending/digesting system - plus two others monitoring the initial sludge outflow from the primary clarifiers - with saving more than \$81,000 per year in labour.

Now, each automatic sampler requires an operator visit only once a day to harvest the composite sample, typically done around midnight. The collected material is refrigerated until the plant’s laboratory staff arrives the following morning. Lab testing primarily checks total solids and volatile solids. Small cups of sludge are weighed, then dried in an oven for six hours at 103°C and weighed again to determine what percentage of the original sample weight remains as solid matter.

The sample is returned to the oven at 550°C for one hour to burn off volatile organic material, and weighed a third time to measure that loss.

With closely controlled variations made possible by the blending manifold and sampling system, the plant was able to explore alternative technologies of thermophilic digestion and acid fermentation while testing a wide range of blend ratios. In the end, they determined that although there are better ways to do it, the standard mesophilic digestion used previously - and widely used throughout the industry - will work best with the digesters now in place if controlled properly.

“For our system,” Wise sums up, “we now know we must keep the sludge solids content balanced by weight at 30 percent WAS to 70 percent primary sludge. Any more than 30% WAS makes the digesters start to get sick. Any less WAS lets the system fall off peak efficiency. Continual sampling and testing gives us the tools to keep the system tightly controlled.”

Sampler Confirms Truck Loadouts

Automatic sampling also gave the plant an easy way to verify the amount of digested sludge trucked out. “We not only give it away free, but pay to have it hauled,” Wise explains. “Charges are based not on liquid volume but on the pounds of liquid hauled. The most economical concentration was a liquid with 10% solids, which is the target concentration used by the contractor for delivering the desired organic application rates. By installing an Isolok on the load-out line, using a flow-proportional control to pull a sample from every 3,000 gallons pumped out, we generate our own solids weight data to compare with the samples received from the contractor.

With the Isolok’s potential to increase the reliability and reduce the cost of drawing samples, he adds, plans are already underway to add them to most of the sludge sampling points still using spigots. “The Isoloks have worked so well for us that we really didn’t care to consider anything else. Maintenance has been very easy, too. Occasionally we might replace a set of seals, which takes about twenty minutes...but that’s needed so seldom that we’ve never set up any schedule. We’ve found that these samplers generally run for years with no problems.”

Jackson Pike further eased its maintenance workload by installing more than 100 in-line

grinders - more than any WWT plant in the world, Wise asserts - to keep stringy, clumpy entrained material pureed for smoother pump operation and longer service life.

In addition to operational improvements, he continues, neighbouring area safety has been enhanced by switching Jackson Pike’s final water disinfectant process from the traditional but dangerous chlorine gas to sodium hypochlorite - which won a Mayor’s Excellence Award from Columbus Mayor Michael B Coleman for improvements that save money while protecting public health and welfare - and replacing equally dangerous sulfur dioxide with sodium bisulfite as the agent for removing the disinfectant before discharge into the river.

WWA

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Enquiry No: 000

This article is contributed by Mr Craig Johnson, Bristol Equipment Company.