The Plot Thickens

By Michael Sargent & Michele Whitfield

Centrifuge technology emerges as a viable alternative to traditional thickening systems

It is easy to see why gravity belt thickeners, rotary drum thickeners and dissolved air flotation (DAF) systems have remained the dominant approaches to sludge thickening for decades. Early centrifuge technology for thickening—introduced more than 30 years ago—was plagued with issues, including high installation and processing costs, process stability, and frequent maintenance needs.

Since those days, however, centrifuge technology has advanced significantly. It has reached the point where it is a viable alternative—providing more technical, environmental and economic benefits than other technologies in applications, including secondary waste-activated sludge (WAS), primary sludge, oxidation ditch sludge, digested sludge and membrane bioreactor sludge. In this article, we will take a closer look at these new centrifuge thickening systems and the potential advantages for a treatment plant.

Taking Aim at Polymer Costs

The most important improvement of new centrifuge systems is that they now can operate with zero polymer—typically at a 150 sludge volume index—or with dramatically reduced polymer use. This advancement is made possible with a specialized drive system that achieves higher capacities and a more efficient and controlled discharge of thickened sludge. Variable-frequency hydraulic scroll drives now can weigh as little as 375 lb and produce 25,400 N·m of torque, compared with older models that weighed more than 1,000 lb and only produced about 20,340 N·m of torque. In addition, a hydropneumatic discharge maximizes G volume and allows for immediate response to control cake solids.

Advancing Operational Efficiencies

The new thickening centrifuge systems offer improved operational efficiencies, mainly due to two key design components: the conveyor/scroll and the bowl. The bowl is a critical centrifuge design feature. Its rotation creates G forces in excess of 3,000; separation of solids from liquids occurs under this high centrifugal force. During operation, thin sludge is fed continuously into the unit. The solids are discharged at the conical end of the bowl, while the liquid travels toward the cylindrical end, where it is discharged through adjustable weirs.

The conveyor shaft has a set of specially designed helical scrolls that continuously transport solids that have settled upon the inside of the bowl wall. Solids are conveyed to the conical section of the bowl and then discharged through cake discharge ports. As a result of these design enhancements, thickening centrifuges have evolved to offer the highest processing capacity for the lowest cost. Thickening centrifuges can produce up to 8% cake solids while running at flow rates of up to 1,000 gal per minute (gpm), per machine.

Facility & Operator Advantages

Another design advantage of a thickening centrifuge is a footprint that is up to 90% smaller than traditional technologies. Often, a centrifuge's length will only be a few feet, yielding an efficient flow rate per square foot of installed floor space. Thickening centrifuges also offer processing odor and safety benefits to treatment plant neighbors and operators alike. The THK systems are designed to be airtight. This contained system minimizes potential for spillage and contact with hazardous waste. It also reduces the potential exposure to harmful vapors and aerosols, while eliminating the need for costly air handling systems.

Delivering Return on Investment

Due to its design advantages, a thickening centrifuge can provide a relatively quick return on investment as well as lower costs for plant operators. Because of the centrifuge's capability to operate polymer free during the thickening process for WAS, wastewater treatment facilities can expect to save about $140,000 per dry ton of solids annually. Combined with a hydraulic scroll drive and other custom design innovations, the machine's power consumption is reduced; a thickening centrifuge operating continuously at 100 gpm uses only 11 kW of power per hour.

Case Study: Kenosha, Wis.

Prior to installing the new technology, the city of Kenosha's publicly owned treatment works utilized a DAF system that took up two floors of a 10,000-sq-ft building. The equipment was installed in the 1980s and contained an array of pumps and aeration equipment that would either have to be replaced or retired. In August 2011, the city chose to install a 6,300-lb, 50-hp thickening centrifuge with a feed capacity of 125 gpm to handle WAS.

The value of the thickening centrifuge still is being realized in many aspects of the plant's operations; however, the facility has already seen numerous savings and efficiency gains. The municipality saved about $80,000 to $100,000 in the pump and equipment upgrades that would have been required for the aging DAF system. More importantly for its operations, the facility is producing thicker sludge. The centrifuge thickens the sludge to 5% to 6% solids, whereas the DAF system only produced about 3% to 4% solids. The thickening centrifuge is capable of producing up to 7% solids, and will realize that potential once necessary upgrades are performed to the plant's pump infrastructure.

Additionally, the thickening centrifuge has a dramatically smaller footprint. The machine sits in a walkway between two DAF tanks and requires about 1,000 sq ft of space, as opposed to the two floors and 10,000 sq ft that the DAF system required. The thickening centrifuge also produces less odor and has reduced ventilation needs, making the building safer and more pleasant while eliminating the need for two large exhaust fans that had provided air circulation. The machine also requires little oversight and considerably less maintenance compared with the daily maintenance needs of the DAF system, which has freed up staff to perform other tasks.

The machine also has had a ripple effect of improvements on the efficiency of the treatment plant. The thickening centrifuge has improved the facility's digester operation. There is a higher concentration of feed to the digester, reducing the demand for heat. By not using polymer, the foaming in the digester is eliminated, allowing for 100% usage of digester volume. With those improved digester operations, more methane gas is produced organically for onsite use. The facility also has saved on electricity costs; the power consumption of the thickening centrifuge is about 50%, compared with the DAF system. Finally, the thickening centrifuge integrated with the plant's operating system, saving about $30,000 otherwise needed to upgrade the DAF's computer system. The treatment plant's experience with the thickening centrifuge has gone so well that it has plans to install a second machine to thicken primary sludge.

As Kenosha's experience suggests, thickening centrifuge technology has come into its own. The newer generation of systems has overcome earlier barriers and now is providing lower operational and maintenance costs, reduced power consumption, and improved control of cake solids and other advantages to forward-thinking treatment plants across the country. WWD

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