Submersible Mixer with Variable Thrust Reduces Energy Costs By As Much As 50% or More

Introduction

Mixing is performed in many stages of wastewater treatment to generate a hydrodynamic state that secures blending, solids suspension, or distribution. Conventional single-speed submersible mixers have traditionally been used for these applications, including activated sludge treatment, sludge holding and digestion. Mixer selection is typically based on accommodating a plant's peak design load.

But peak load rarely occurs at most plants, and a single speed mixer will still run as if peak load is constant, consuming far more energy than needed. Although aeration control based on oxygen need has been widely practiced for quite some time, mixer capacity turndown is hardly ever practiced in unaerated (anoxic or anaerobic) zones or in oxidation ditches, for example. If correctly implemented, however, adjustable thrust mixer operation can lead to significantly lower energy consumption and other efficiency improvements.

Maximum Thrust / Minimum Energy = Substantial Cost Savings

The key performance parameter of a submersible mixer is the thrust produced and its associated energy draws. The mixer producing the most thrust using the least energy should be preferred in flow controlled mixing systems. Sufficient mixing can be achieved with almost any rotating device, provided that unlimited power is available. Sufficient mixing using the lowest amount of power, however, requires a sophisticated, adjustable mixer.

Adding variable frequency drive (VFD) technology to a submersible mixer allows operators to efficiently adjust mixing thrust to meet varying application demands, thereby enhancing operational capabilities while reducing mixing energy costs substantially. Variable frequency drive capability allows for continuous thrust variation to be acquired while operating more reliably than manual "switch-on/switch-off" practices. Additional energy savings are gained through more efficient automated operation with all mixers running, but at the lowest produced thrust per unit required as conditions vary, such as when flow rate into an anoxic or anaerobic tank is reduced, or when the risk of a bypass decreases, or where 100% activated sludge suspension is not required 100% of the time. And, when diffused aeration is reduced or turned off, mixer thrust (and associated power draws) can be simply reduced to meet the current lower thrust requirement.

Milwaukee, Wisconsin: Only 0.28 W/m3 Energy Consumption

A comprehensive mixer energy pilot study was recently conducted at the Milwaukee Municipal Sewerage District South Shore Wastewater Treatment Plan, with the goal to minimize mixing consumption. Results show that energy consumption of only 0.28 W/m3 is sufficient to fully homogenize activated sludge. This was achieved using a high-efficiency adjustable thrust submersible mixer optimally positioned in the plant's 48ft long x 30ft wide x 15ft deep BNR (biological nutrient removal) selector zone.

TSS profiles, phosphorous removal and energy measurements were studied as mixing energy in the selector basin was gradually reduced over time. The study concluded that one key to this success was the use of a submersible mixer with adjustable thrust combined with a low speed, large diameter propeller fine-tuned to the basin shape (a hydraulically optimized propeller). The other key was positioning the mixer to produce an efficient bulk flow loop that takes full advantage of basin shape.

Mixer Selection Considerations

Selecting adjustable thrust mixing offers many advantages during the design process. Although numerous parameters should be considered when selecting a mixer, specific mixing conditions and other considerations are not always known when a plant is in its design stage, such as:

- The tank's internal dimensions, including eventual obstacles such as pipe work, etc.
- Actual rate of flow
- Dry matter content
- Consistency of the fluid to mix
- Actual level/results of pretreatment (e.g. grit removal)
- Inlet and outlet locations
- Presence of all aeration equipment and resulting airflow rate.

These design stage uncertainties do not have to be a big factor when certain adjustable thrust mixing is selected because it provides the engineer more flexibility right up to the time all facts are known (typically when the mixer is commissioned). Having the ability after installation to change mixer thrust to meet the facility's specific conditions can save energy cost significantly -- **sometimes more than 50 percent, or thousands of dollars per mixer**. This flexibility also allows a treatment plant to use only the energy the process requires today, while remaining well prepared for future increases in demand.

Tank-Side VFD Often Problematic

Although the use of VFDs in certain wastewater treatment plant applications has steadily increased, particularly for controlling pump driven flow, the development of equally effective systems for controlling mixer driven flow has lagged. One reason for this is that adding a tank-side variable frequency drive (VFD) to a submersible mixer often incurs increased costs due to a need for cooling, heating and weather protection. In addition, installing a tank-side VFD operation is no simple task and adds to the complexity and vulnerability of a mixing system. For example, the VFD must be carefully matched to the mixer's motor - a task requiring sufficient knowledge of the expected process variations in the mix tank. Matching further involves programming the VFD's parameters to optimize the VFD/motor combination.

Integrated VFD: The Power of Adaptive Mixing

Xylem has introduced integrated drive technology in a new submersible mixer (Flygt 4320) that provides for continuous thrust variation to allow for energy-efficient demand-based mixing.

With integrated drive technology, electromagnetic compatibility (EMC) issues and other installation, commissioning and operational issues often associated with installing external, tank-side VFDs are eliminated. Integrated drive technology coupled with the mixer's hydraulically optimized propeller work effectively to meet process objectives.

Most importantly, having complete control over the mixer's thrust assures the lowest energy consumption while at the same time achieving sufficient mixing. *Having complete control over the mixer's thrust allows for continuous process results while reducing energy consumption by as much as 50 percent, or more.*