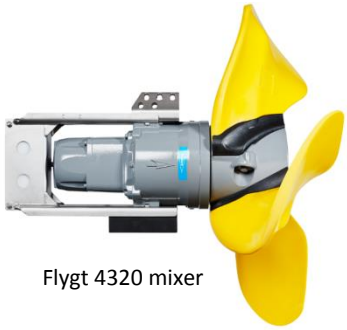
Submersible Mixer with Adjustable Thrust Adds Flexibility, Boosts Efficiency

For Wastewater Treatment Applications

INTRODUCTION

Xylem's Flygt 4320 mixer allows operators to adjust mixing effect to meet varying application demands, enhancing operational capabilities while reducing mixing energy costs by as much as 50 percent.

Mixing is performed in many stages of wastewater treatment to generate a hydrodynamic state that secures blending, solids suspension, or distribution. Here, conventional single-speed submersible mixers have traditionally been used for applications such as activated sludge treatment, sludge holding and digestion.



Flygt 4320 mixer

Although the use of Variable Frequency Drives (VFD) 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.

Many wastewater plants use single speed mixers in switch-on/switch-off mode. Some plants install tank-side VFDs to achieve some operational flexibility in a single speed mixer. Xylem, however, has recently engineered a significantly more effective approach -- a VFD integrated with the mixer's submerged motor. The Flygt 4320 low-speed submersible mixer is the first submersible mixer that provides variable speed mixing without using an external, tank-side VFD.

With the Flygt 4320 submersible mixer, operators have complete control over the mixer's thrust, thereby enabling continuous process results and reducing energy consumption. By typically eliminating electromagnetic compatibility (EMC) issues and other installation and commissioning issues often associated with using external, tank-side variable frequency drives, Flygt integrated drive technology allows continuous thrust variation to be operated as a simple switch-on/switch-off functionality.

ADJUSTABLE MIXING

Mixing processes in most wastewater treatment plants continuously change over time. Examples of this include long-term changes due to gradual increases or decreases in loadings, or resulting from seasonal, daily, or even hourly variations. In addition process modifications, such as changing the inlet screen type, changing average bulk flow velocity, adjusting mixed liquor suspended solids levels, or adjusting aerobic/anoxic zones can significantly change thrust requirements.

"Wastewater treatment processes are not static, but rather vary over time," Andreas Lindberg, Product Manager for Mixers at Xylem, says. "The variable speed functionality of the Flygt 4320 makes it easy to adjust mixing thrust to real-time process conditions, making it a flexible and powerful mixer."

Numerous parameters need to be considered when selecting a mixer. However, when a wastewater treatment plant is in its design stage, mixing conditions and other considerations are not always known. These may include:

- The tank's internal dimensions, including eventual obstacles such as pipe work, etc.
- Rate of flow through the tank
- Dry matter content
- Consistency of the fluid to mix
- Level of pretreatment (e.g. grit removal)
- Location of inlets and outlets
- Presence of aeration equipment and air-flow rate.

Submersible mixers, traditionally driven by single-speed motors, are typically chosen to accommodate the plant's peak design load. But because peak load rarely occurs, the mixer typically consumes more power than needed, resulting in unnecessarily high operating costs.

With the Flygt 4320 variable speed mixer's flexibility, much of the uncertainty at the design stage can be eliminated, giving 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 that facility's specific conditions can save energy cost significantly -- sometimes more than 50 percent, or thousands of dollars per mixer," Lindberg says. "The Flygt 4320 mixer allows a treatment plant to use only the energy the process requires today, while remaining well-prepared for future increases in demand."

MAXIMUM THRUST / MINIMUM POWER

The thrust produced by a mixer and its associated power draws are the key performance parameters of a submersible mixer. Among a set of comparable mixers, the mixer that produces the most thrust using the least power should be preferred in flow controlled mixing systems.

For example, as a mixer propeller exerts a thrust on liquid contained inside a tank or vessel, the liquid will start to move, accelerating until the loss associated with the flow in the tank balances the mixer's thrust. The velocity attained at the balance point is the "equilibrium velocity". Higher thrust equates to higher equilibrium velocity, resulting in more intense mixing.

Sufficient mixing can be achieved with almost any rotating device, provided that unlimited power is available. However, sufficient mixing using the lowest amount of power requires a sophisticated adjustable mixer. The Flygt 4320, with its hydraulically optimized propeller, integrated VFD and IE4 equivalent motor, provides for optimum overall mixer performance.

A SOPHISTICATED, ADJUSTABLE MIXER

The propeller design of the Flygt 4320 mixer provides high hydraulic efficiency to maximize the level of

thrust delivered while minimizing energy consumption. The large-diameter propeller (ranging from 1.4 to 2.5 meters and available in two or three-bladed models with maximum thrust up to 6,000 newtons) is engineered with high-strength materials and a backswept self-cleaning design for non-clogging performance.

The mixer's drive package consists of a synchronous permanent magnet motor close-coupled to a VFD, with both components enclosed in the mixer's sealed motor compartment. The Flygt 4320's motor efficiency is equivalent to Super Premium Efficiency IE4 levels. Unlike the majority of today's mixers, which are driven by asynchronous squirrel cage inductive motors, permanent magnet motors such as that used in the Flygt 4320 exhibit virtually no induction-associated losses, thereby making attainable efficiency substantially higher.

The Flygt 4320 mixer's gearbox is the same field-proven unit as in the Flygt 4400 low speed mixer series, with several thousand installations spanning more than 30 years of service. The VFD of the 4320 mixer is designed to not require service during the mixer's lifetime. The VFD protects the mixer from overload/over currents. The drive disallows for higher currents than what is dictated by the preprogrammed current limitation.

The Flygt 4320 mixer is also pre-programmed with soft start/stop algorithms, reducing wear and fatigue on mechanical and electrical components to extend equipment life and reduce maintenance. It also provides sustained high starting torque without excessive current as well as sustained drive-motor efficiency at part loads. Unlike asynchronous induction motor-driven mixers, the Flygt 4320 mixer motor provides high efficiency at all loads.

THE INTEGRATED VFD ADVANTAGE

The integration of the VFD into the mixer's motor housing results in a number of advantages over a mixer motor controlled by a tank-side VFD.

Tank-side VFDs often incur increased costs due to a need for weather protection plus cooling or heating, also adding to the complexity and vulnerability of a mixing system. In contrast, the 4320's VFD is enclosed inside the mixer, protected from harsh conditions including dust and varying humidity. Cooling is also automatically supplied by the mixer's submergence.

The integration of the drive into the motor housing also typically eliminates the EMC issues that can make external electric control equipment more costly.

Installing a submersible mixer with tank-side VFD operation is no simple task. The VFD must be carefully matched to the mixer's motor, which involves selecting the proper rating of the VFD - a task requiring sufficient knowledge of the expected process variations in the mix tank. Matching further involves programming the VFD's parameters so that the VFD/motor combination is optimized. The Flygt 4320 mixer's built-in VFD is predesigned and pre-optimized for its motor.

CONTROL FLEXIBILITY

The Flygt 4320 accepts control signals from process control systems or any other relevant source. This gives operators unprecedented possibilities to operate the mixer consciously and adaptively. A small control panel can be mounted in series with the mixer's power cable, enabling the operator to locally change mixing effect as easily as dimming a light in a conference room. Mixer speed can also be controlled via Modbus protocol, allowing for remote mixer control (as well as status information and alarms) from the plant's control room.

THE POWER OF ADAPTIVE MIXING

"Compared to a single speed mixer, a variable speed submersible mixer makes it possible to adapt mixing to each current situation - ideal for hourly, daily, seasonal or yearly peak conditions." Xylem's Lindberg says. "Adjusting for actual thrust requirements also reduces wear and stress on the mixer during lower power periods, for longer life and reduced maintenance. High efficiencies and easily adjustable thrust can minimize energy consumption while still meeting process objectives."

Integrating the variable frequency drive into the mixer makes the mixer/VFD combination very compact, plus simplifies operation, installation and commissioning. By adjusting mixing to actual process conditions, the integrated VDF also results in a more efficient mixer, resulting in the lowest life cycle mixing energy costs.

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ABOUT THE AUTHOR: Magnus Fahlgren is application engineer at Flygt, a Xylem brand. He specializes in mixing and mixer applications and supports Xylem's local organizations around the globe. Magnus holds a Master of Science in mechanical engineering from the Royal Institute of Technology in Stockholm, Sweden.