HYDRAULIC MIXING OPTIMIZATION FOR ANAEROBIC DIGESTERS

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Hydraulic mixing has become the most preferred mixing technology for anaerobic digesters due to the high degree of mixing energy and effective mixing patterns generated from chopper pumps and specially designed jet nozzles. Consulting engineers have continued to increase expectations on digester mixing performance, from gentle mixing requirements for volatile solids (VS) destruction to more intense mixing for ensuring a homogenous mix of up to six percent solids throughout the entire tank. Minimizing solids accumulation on the tank floor and cone area is also increasingly important in improving performance and reducing maintenance. Sufficient mixing energy to minimize the foam and scum in the top layer is also now required for optimal performance. These increased performance expectations have led to design energy inputs that necessitate larger pumps and motors, thus resulting in higher operating costs for mixing.

At Milwaukee, Wisconsin's Milwaukee Metropolitan Sewerage District (MMSD) South Shore Wastewater Treatment Plant (WWTP), operated by Veolia, optimization strategies were investigated in order to reduce the total level of mixing energy used by the JetMix™ Vortex Mixing System while continuing to maintain optimum volatile solids destruction and methane gas production. The first phase of this study was performed over two weeks in December of 2014 with the second phase over a two week period in May of 2015. There are six other anaerobic digesters at MMSD with the potential for four more to be mixed with hydraulic mixing. One of the goals for MMSD was to reduce the electrical energy used in comparison to a linear motion mixing (LMM) system in another digester. Therefore, there is a possibility of significant energy savings if more of the digester mixing systems are converted to hydraulic mixing using Evoqua's JetMix hydraulic mixing system.

The first phase of the study focused on determining which method of energy optimization would best maintain consistent gas production per energy input, while providing a reliable free flow of digester gas for the downstream combined heat and power (CHP) cogeneration units. Tests were performed on two (2) 125 ft. diameter digesters with two (2) pumps coupled with 100 HP motors to deliver approximately 9,000 GPM through nine specially designed jet nozzles. Starting with simple approaches, including the use of one pump and simple on/off cycles, the on/off cycles for the pumps were staggered to cover a wide range of energy input and to dampen possible shock from starting the high degree of energy input. Further testing used the pumps variable frequency drives (VFDs) to increase to full motor speeds with on/off cycles in order to reach the most efficient energy optimization program. This was measured by the plants SCADA, which monitors real time power consumption.

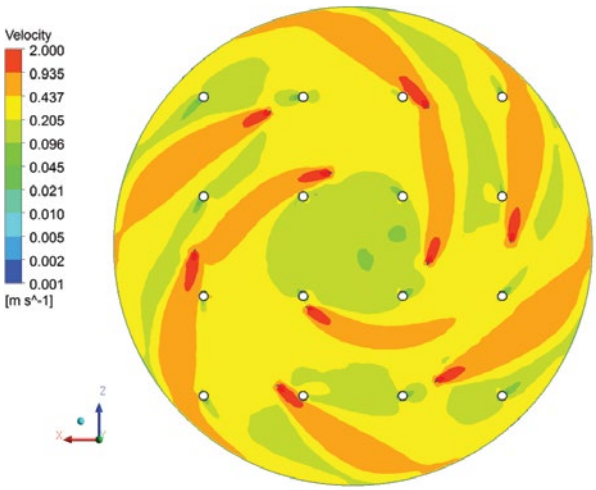

Figure 1. This velocity profile from the (CFD) Computational Fluid Dynamics Model shows the high velocity jet plumes created from the JetMix system that effectively sweep the bottom of the tank to maintain a homogenously mixed digester.

JetMix™ System Advantages:

- Highly efficient hydraulic mixing
- Significantly reduces operating costs
- Maintains efficiency regardless of tank level
- Custom designed to meet system requirements
- Easy installation for new or retrofit applications

JetMix system installed at MMSD South Shore WWTP

Evoqua worked closely with MMSD to assess how each strategy impacted the volatile solids destruction, spikes in gas flow, which may release gas to the waste gas burner, and consistency of the gas flow to the CHPs. Upon completion of the study we found that the total energy use could be reduced by over 80 percent without negative impacts on VS destruction, gas production or operation of the anaerobic digesters. As a result of the study, it was shown that optimization of the JetMix™ system run time reduced the total energy usage by 28 percent compared to the Linear Motion Mixing system used on another anaerobic digester with the same size and loading conditions.

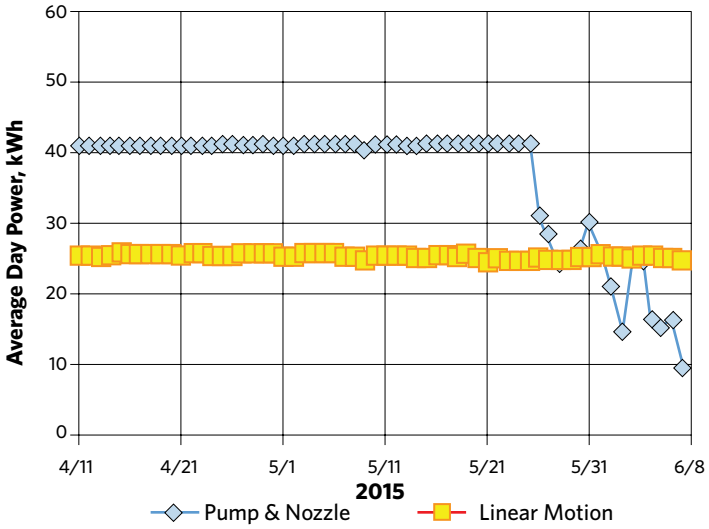

Figure 2. The JetMix system reduced total energy usage by 28 percent compared to the linear motion system during the test period.

When reduced energy input and digester maintenance costs are factored into the equation, hydraulic mixing provides the most cost effective ten year life cycle for anaerobic digesters. One of the largest benefits of JetMix system is the significant reduction in tank cleaning costs. With the system's unique ability to flush the non-volatile solids from the bottom of the tank, the tank can be cleaned using the pumps while draining, therefore eliminating almost $350,000 in cleaning costs. The JetMix system also provided the benefit of lower capital and installation costs at the MMSD WWTP when compared to the linear motion mixing system. In conclusion, hydraulic mixing optimization with the JetMix vortex mixing system significantly reduced energy inputs and operating costs, while optimizing VS reduction and gas production.

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