Energy Efficiency in Municipal Water and Wastewater Treatment

SAVING ENERGY EQUALS SAVING MONEY

Iowa Association of Municipal Utilities

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Methane Gas Generated From Country's Largest Anaerobic Treatment Reactor Used as Fuel for Sludge Incinerator

Cedar Rapids Water Pollution Control System
Pat Ball, Water Pollution Control Director
Population Served: 155,000

Cedar Rapids is home to the largest anaerobic treatment system in the United States. Updates to their treatment system positioned them to be able to accommodate two major industrial dischargers. The publicly operated treatment works (POTW) treats residential and industrial wastewater. Biogas generated from the treatment of industrial wastewater is used as fuel for their sludge incinerator.

Treatment System History

Cedar Rapids, in response to the growth of major industries in their community, built a new trickling filter-activated sludge process treatment system in 1980 at an estimated cost of $75 million dollars. According to Pat Ball, Cedar Rapids Water Pollution Control System (CRWPCS) Director, "The community leaders decided early on to accommodate their industrial clients and would not require traditional pretreatment of the industrial wastewater." This system provided the capacity to handle their industrial, commercial, and residential customers while also providing the treatment capabilities required in their NPDES permit.

The treatment system consists of primary clarifiers that discharge to plastic, media-trickling filters that are used for biochemical oxygen demand (BOD) removal followed by discharge to activated sludge tanks that are used for additional BOD removal. This is followed by a nitrification activated sludge system for ammonia removal. Disinfection chambers are used only during required periods between April and August.

There are two sludge streams that use different processes. Sludge from the primary clarifiers is thickened by diffused air floatation (DAF) thickeners and then sent to a belt press that provides a 28% solids cake. The secondary sludge from the

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activated sludge process is thickened by gravity belt thickeners. Half of the thickened sludge is then put through a heat process and the rest combined with the heat-treated sludge for dewatering by centrifuge to produce a cake that is 26% solids. Nearly 67% of the flow for the entire treatment system is from residential customers with 90% of the BOD and 60% of the suspended solids in the influent coming from industrial customers

However, additional updates were needed to this system with industrial growth, including a new paper mill and a biotech company moving to the area. The treatment updates needed to treat industrial wastewater that would contain a high BOD with low suspended solids. The most cost effective option for treatment of these two wastewater streams as indicated by Ball, "Was to treat the wastewater streams separately from the other wastewater flows using a liquid anaerobic treatment system." The separation of these two streams from the main wastewater flow provided additional capacity for the rest of the plant to accommodate future growth in the community. Anaerobic reactor treatment system construction began in 1999 and was completed in 2003 at a cost of $19 million dollars. The system consists of three anaerobic reactors that are operated at mesophilic temperatures. Additionally there is a gas scrubbing system and sulfide oxidation basins.

Cedar Rapids water pollution control system.

Biogas Used as Fuel for Sludge Incinerators

Ball points out that, "One of the major benefits of using upflow anaerobic blanket reactors is that biogas is produced instead of sludge and this gas is used to replace the natural gas used to provide fuel to the incinerators used for combustion of the sludge generated from other portions of the treatment system. The biogas has reduced our need for natural gas which has resulted in decreased energy costs."

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Anaerobic reactors are used only to treat wastewater streams that contain high concentrations of BOD and are, therefore, typically used in industrial wastewater applications. The system was started up in mid-2003. The biogas generated by the reactors contains 65% methane, 1-2% hydrogen sulfide, with the remainder being carbon dioxide and water vapor. The gas is compressed before it is sent as fuel to the incinerator. High concentrations of hydrogen sulfide in the biogas require the use of a biological sulfur scrubber prior to burning the gas in the incinerator or in waste flares. The gas scrubber removes 99% of the hydrogen sulfide with very low operating costs. Both safety and corrosion problems would be caused by the hydrogen sulfide if not for the scrubbing system. At current natural gas prices, the savings from use of the biogas is about $500,000 per year. The savings will go higher if other industrial flows can be utilized in the anaerobic system to generate additional biogas. At full loading of 120,000 pounds per day of BOD, the anaerobic system will produce enough biogas to replace all natural gas usage in the incinerator with surplus that could be used for other energy uses such as electrical generation.

Another Unique Feature of Anaerobic Reactor System

Granular sludge that is generated in the reactors is being sold on a truckload basis to industries that need it as seed for the startup or replenishment of biological activity in their treatment systems.

Additional Energy Management Features

CRWPCS is developing an energy management program that includes energy efficiency features such as variable frequency drives on some of the treatment process pumps. Their SCADA system is used to improve the energy efficiency of plant operations through monitoring of processes and tracking electrical and gas usage. Another feature of their program is the load shed agreements they have with their local electricity provider. On-site generators are used during peak demand periods and have already paid for themselves.

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Suggestions for Similar or Smaller Wastewater Treatment Systems

Ball suggests, "As energy costs continue to rise, POTWs need to find additional ways to save on those costs. While reduction of energy use is frequently the first steps taken, there is also a need to look for lower cost types or sources of energies. Replacement of natural gas with biogas is one method that has been historically used by POTW through sludge digestion, but new liquid technologies that provide both treatment capacity and gas generation offer dual advantages. Capturing waste energy is another method often used, such as utilizing heat from compressor cooling to heat adjacent rooms. Lastly, make sure to take advantage of utility rate structures such as load shedding, gas transportation, or moving energy usage to off-peak timeframes. "

Acknowledgements

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