Hutchinson WWTP

Josh Kirk
Environmental Engineering
University of Minnesota, Twin Cities

City Background

The Hutchinson Wastewater Treatment Facility was placed in service in 1988 as a "Class A" extended aeration activated sludge wastewater treatment facility. It was initially constructed as an oxidation ditch facility, and those ditches were, until recently, the largest of their type in the Midwest. In response to projected community growth and industrial expansion, a major construction project to increase capacity was completed in 2008. This project consisted of the installation of a membrane bioreactor (MBR) system. Since the MBR and the oxidation ditch systems would be run in parallel, this addition increased the average daily design flow of the plant.

"This summer I had the chance to explore and understand the process of municipal wastewater treatment from head to toe. Being onsite in Hutchinson this summer allowed me to access and utilize industry-standard equipment, as well as consult with professionals in the field. This boots-on-the-ground experience allowed me to enhance my theoretical knowledge base with practical experience." ~ JK

Project Background

The Hutchinson Wastewater Nutrient Optimization Project was focused on promoting biological nutrient removal (BNR) at the Hutchinson plant. The project is important because the city is expecting to receive tighter limits on effluent phosphorus, and meeting these new limits through chemical additions would be financially burdensome for the city. Biological nutrient removal will allow the wastewater plant to meet discharge nutrient limits without chemical additions, helping to keep Minnesota waters clean.

Incentives to Change

Phosphorus discharge is currently limited at the Hutchinson Wastewater Treatment Facility to 1.0mg/L. The plant stays in compliance with this limit by chemically treating with ferric chloride down to about 0.64 mg/L of phosphorus in the effluent. However, there is a more stringent effluent phosphorus limit proposed for the summer months from May - September that may go into effect within the next few years. This means that Hutchinson would need to keep their effluent phosphorus concentrations below 0.2 mg/L in order to consistently remain below this limit. It is unclear if this limit can be met by increasing chemical feed rates, and regardless, there are several disadvantages to increasing the use of iron salts at the plant. For one, iron salts are a safety hazard (the material is highly corrosive), they also consume alkalinity, and can stain UV bulbs, which reduces disinfection efficiency. In addition, chemical removal of phosphorus is expensive in regard to both purchase of the chemical, and the creation of additional sludge volume which must be stored and handled.

"The City of Hutchinson WWTP requested the help of a MnTAP intern due to implied MPCA NPDES permit limit adjustments to our phosphorous discharge and the possibility that we might not be able to achieve the new limit solely with the use of chemical precipitants. We wanted to examine the possibility of making changes to both our oxidation ditch and membrane bioreactor treatment trains in order to facilitate biological nutrient removal. Our team was very excited to view the result of the study that Josh has developed for us."

~ Tim Gratke
City of Hutchinson WWTP

Solutions

Oxidation Ditch Operational Changes

The oxidation ditch, like the membrane bioreactor system, currently does not have any true anoxic zones along its flow path. Near the bottom of the ditch, the dissolved oxygen levels sit consistently around 0.25 mg/L, but at higher points in the vertical column, these levels increase. At dissolved oxygen concentrations of 0.25 mg/L denitrification is inhibited. This suggests that the oxidation ditch is performing nitrification (the conversion of ammonia to nitrate under oxygen-rich conditions) successfully, but that oxygen levels are never low enough to promote denitrification (the conversion of nitrate to nitrogen gas).

A number of changes to the operation of the oxidation ditch treatment train at the Hutchinson Wastewater Treatment Facility were evaluated using computer modeling software. Ultimately, it was found that the most effective and efficient biological nutrient removal occurred by cycling aeration to the ditch at a rate of 1 hour on and 1 hour off for a period of one week. During periods when aeration is off, the oxygen levels drop to zero, enabling denitrification and biological phosphorus removal. It is believed that this first, one week period would create conditions allowing the microorganisms responsible for BNR to grow. After this one week period, aeration rates are changed to cycling for 2 hours on, 1 hour off, resulting in effective biological nutrient removal.

Membrane Bioreactor Configuration and Operational Changes

Using the ASIM (Activated Sludge SIMulation Program), a number of changes to the operation of the membrane bioreactor (MBR) system at the Hutchinson Wastewater Treatment Facility were evaluated.

Ultimately, it was found that the most effective and efficient biological nutrient removal occurred after creating separate anaerobic and anoxic zones, reducing aeration dissolved oxygen levels to 2 ppm, reducing the Return Activated Sludge rate, lowering the sludge age to 10 days, and recirculating flow from the anoxic tank to the anaerobic tank.

These changes would create an anaerobic zone to facilitate phosphorus removal, an anoxic zone to facilitate denitrification, and are expected to create the conditions that would make biological nutrient removal successful.

The change requires constructing a wall to separate each aeration tank into two, which would create the space required for the anaerobic and anoxic zones. The change would also require recirculation pumps and re-piping to implement the new flow strategy.

Recommendation	Annual Reduction	Annual Savings	Status
Oxidation Ditch Aeration Cycling	135,000 lbs ferric chloride solution 69,000 lbs of nitrogen 65,000 kWh	$30,000	Planned
MBR Operational/ Configuration Changes	136,000 lbs ferric chloride solution 1,800 lbs of phosphorus 40,600 lbs of nitrogen 330,000 kWh	$48,000	Recommended

MnTAP Advisor: Jon Vanyo, Engineer