South Carolina
Economy - Energy - Environment

WASTEWATER TREATMENT ENERGY CONSERVATION REPORT – SAMPLE RECOMMENDATION

AUTOMATE AERATORS BASED ON DISSOLVED OXYGEN LEVELS

Recommended Action

Automate the use of mechanical mixer motors based on the dissolved oxygen (DO) level of wastewater.

Background

Based on Monod equation which characterizes kinetics for microbial growth, a low specific growth rate coefficient (μ) for bacteria is desired for the most efficient consumption of substrate in the wastewater. This coefficient can be controlled in a number of ways including limiting the electron donor needed for the growth to occur. In processes where nitrification is occurring, the electron donor is oxygen, and higher DO levels encourage the growth of nitrifying bacteria leading to less efficient treatment of wastewater.

$$\mu = \hat{\mu} \cdot \frac{S_s}{K_s + S_s}$$

Where $\hat{\mu}$ is the maximum specific growth rate, K_S is the half-saturation coefficient, and S_S is the soluble substrate available in the wastewater.

By setting a target DO level and automating sensors to control the speed of the mechanical mixers or turn them off when the DO level is sufficient, a wastewater treatment plant can save energy using the existing treatment setup. It is recommended that one of the mechanical mixers is turned off when the target DO level is reached and turned back on when the DO level is deficient. This is currently being done in the plant manually, but it is recommended the process is automated and controlled using a DO sensor and a VFD to control the motor speed of the mixers in the aeration basin.

Anticipated Savings

As a conservative estimate, automation of mechanical mixers in the aeration basin may allow the mixers to be turned off an additional 30 minutes per day. The plant is currently using four 125 hp aerators. Assuming 85% efficiency for the motors, the estimated annual *electric consumption savings (ECS)* is:

$$ECS = 125\ hp \times 4\ motors \times 0.85 \times 0.7457\ \frac{kW}{hp} \times 0.5\ \frac{hours}{day} \times 365\frac{days}{year}$$

$$\boldsymbol{ECS = 57,840\ \frac{kWh}{year}}$$

At an electricity consumption rate (*CR*) of 0.075 \$/kWh, the estimated annual *electrical consumption cost savings* (*ECCS*) would be:

$$ECCS = ECS\ \times CR$$

$$ECCS = \ 57{,}840\ \frac{kWh}{year} \times 0.075\ \frac{\$}{kWh}$$

$$\boldsymbol{ECCS = \$4,338/year}$$

Note: Because this recommendation would only affect the power usage of the plant for 30 minutes a day, it is predicted the implementation would not have an effect on the plant's demand. For this reason, only *ECS* and *ECCS* are shown in this recommendation. Additionally, the *total cost savings (TCS)*, is equivalent to the *ECCS*, and is not calculated separately.

TCS = $4,338/year

Implementation Cost

It is estimated an implementation and material cost (*IC*) for this automation would be between $6,000 and $12,000. In order to update the system, a skilled technician with the correct knowledge of sensors and automation technology would need to be hired. Assuming this work would take about a week at around $100 an hour, this would be around $3,000 to $5000. It is estimated the material costs and upgrades for this project could be anywhere from $3,000 to $7,000. An example of materials required for this implementation would be a microcontroller with associated relay module and wiring to go along. As a conservative estimate, $12,000 will be used as the implementation cost.

$$\boldsymbol{IC = \$12{,}000}$$

Simple Payback Period

Assuming $12,000, the *simple payback period* (SPP) associated with installation and automation of the necessary equipment and labor is the *implementation cost* (IC) divided by the *total cost savings* (TCS).

$$SPP = IC / TCS * 12$$

$$SPP = (\$12{,}000/\$4{,}338)*12 \text{ months/yr.}$$

$$\boldsymbol{SPP = 33.2 \text{ months}}$$