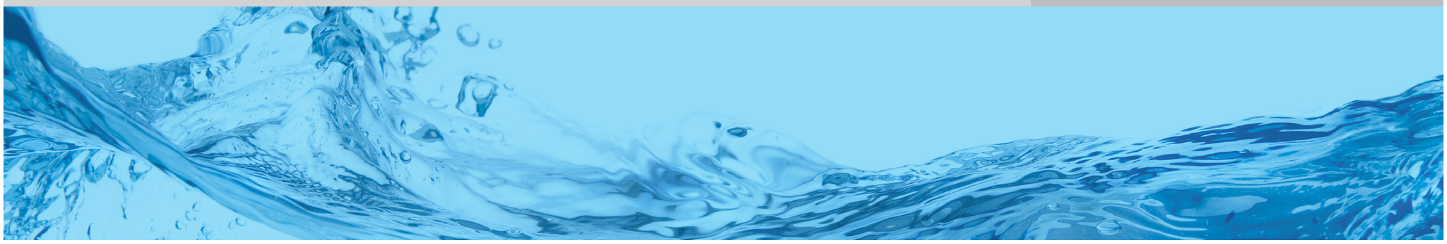

Raise Gravity-Fed Wet Well Levels to Reduce Head in Pumping System

Principle

Pumping at a wastewater treatment facility is a major energy consumer – typically second only to aeration[1]. This means that any energy savings in this process is critical to facility-wide energy savings. Thus, this energy tip looks to reduce facility pumping energy use by reducing the head in the pumping network. The electrical work required by a pump to move a fluid through a pipe is shown below:

$$W_{elec} = \frac{\dot{V} \times \Delta P_{tot}}{\eta_{pump} \times \eta_{motor}}$$

Thus, the variables affecting the amount of energy consumed by a pump are the volume flow rate of the fluid being moved ($\dot{V}$), the pressure rise created by the pump (ΔP_{tot}), and the efficiencies of the pump and motor (η_{pump} and η_{motor}, respectively). The pressure rise required (shown in the equation below) is dictated by the static head pressure difference between the inlet and outlet, the velocity head pressure differential between the inlet and outlet, the elevation head difference between inlet and outlet, and the frictional head pressure drop created by friction in the piping.

$$\Delta P_{tot} = \Delta P_{static} + \Delta P_{velocity} + \Delta P_{elevation} + \Delta P_{friction}$$

A decrease in any of these variables would reduce the pump's energy consumption which results in energy cost and emissions savings. It is also worth noting that these energy savings are applicable to other water treatment facilities outside of the wastewater treatment sector.

Suggested Actions

- Determine current wet well water levels and alarm setpoints.
- Determine whether the wet well levels can be adjusted without affecting the process.
- If so, raise wet well levels to pre-determined height by altering alarm setpoints and monitor process to ensure regular activity.

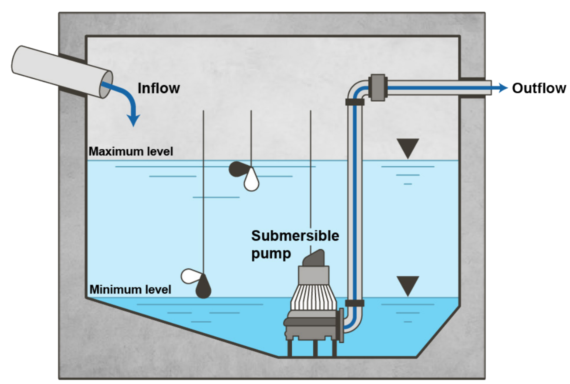

Diagram of Wet Well Pumping Station

Adapted from Fecarotta, Oreste, et al. 2018. "Optimal Pump Scheduling for Urban Drainage Under Variable Flow Conditions." Resources (7) 73: 3.

[1] US DOE. 2017. "Energy Data Management Manual for the Wastewater Treatment Sector." United States Department of Energy: 8.

Of the above-mentioned variables, one of the simplest to alter for a wastewater treatment plant (WWTP) is the head pressure (measured in feet of H_2O) related to elevation change from wet wells to their next destination. Wet wells are pits in pumping (lift) stations that collect water, sewage, and other gravity-fed fluids from piping networks such that they can then be pumped to a higher elevation. The elevation change head pressure can be altered by raising or lowering the top level of the wet wells which can usually be accomplished simply by altering the level at which controls alarms are set off. Increasing the wet well level height reduces the overall amount of elevation that the fluid needs to be pumped, thereby reducing the pressure rise in the pump work equation shown above. The pumping energy that can be saved by raising wet well levels can be calculated using the same equation with simple unit conversions, as shown below (right side of equation).

Resources

See the Sustainable Wastewater Infrastructure of the Future (SWIFt) website for more information on wastewater energy solutions at betterbuildingssolutioncenter.energy.gov/accelerators/wastewater-infrastructure

To view more Energy Tip Sheets visit energy.gov/eere/amo/tip-sheets-system

To access these and many other industrial efficiency resources and information on training, visit the Advanced Manufacturing Office Website at manufacturing.energy.gov

$$W_{elec}\,[kW] = \frac{\dot{V}\,[MGD] \times \Delta P_{tot}\,[ft - H_2O]}{\eta_{pump} \times \eta_{motor}} \times \frac{0.746\left[\frac{kW}{hp}\right] \times 1{,}000{,}000\left[\frac{gal}{MG}\right]}{3960\left[\frac{gpm \cdot ft - H_2O}{MG}\right] \times 24\left[\frac{hr}{dy}\right] \times 60\left[\frac{min}{hr}\right]}$$

Utilizing the above equation, simply input the average volume flow rate in MGD (millions of gallons per day), the amount of feet that the wet well level can be raised, and the estimated (or actual) pump and motor efficiencies.

Example

Let's say a WWTP is pumping 10 MGD on average. Currently, their wet wells have a high-level alarm set at 15 feet but overflow would not actually occur until 20 feet. Therefore, the facility believes they can increase their wet well levels about 3 feet comfortably. They estimate their pump efficiency to be about 70% and their motor efficiency to be about 90%. Therefore, the reduction in pumping power would be:

$$\mathbf{W_{elec}} = \frac{10\ MGD \times 3\ ft - H_2O}{0.7 \times 0.9} \times \frac{0.746 \times 1{,}000{,}000}{3960 \times 24 \times 60} = \mathbf{6.23\ kW}$$

This may not seem like much, but considering pumps typically run 24 hours per day, 7 days per week for the entire year, the savings do add up – this would be equivalent to saving about 55,000 kWh/yr, which (at $0.10/kWh) would equate to about $5,500 annual savings by simply changing a high-level alarm setpoint for the wet wells with no associated capital costs.