

O&M Energy Efficiency Checklist for Wastewater Treatment Plants

*The purpose of this list is to help identify no cost or low cost electricity savings through operation and maintenance practices at wastewater treatment plants. The list is organized by **System** (blower aeration, mechanical aeration, mixing, pumping, etc) in approximate order from highest to lowest energy use. Therefore, start at the top of the list and work down. Because some measures are common to multiple systems, they are repeated, so that each system has a complete list. Please review “**Other Measures**” on last page, which lists important ideas applicable to the entire plant.*

Please distribute this open source document to anyone who might be interested, and please provide comments, suggestions, and new ideas to Walt Mintkeski, P.E., at mintkeski@juno.com, 503-771-0232, in Portland, Oregon.

Blower Aeration System

- Fix air piping leaks. For exposed pipes, apply soapy water to create bubbles. For underground pipes, look for air bubbles surfacing through soil during or just after rain events.
- Reduce air demand – take excess aeration basins off line; eliminate air flow to empty aeration basins; reduce air flow in aerated channels to that necessary to keep solids in suspension; reduce air flow in aerated grit chamber to that necessary to separate organics from grit.
- Eliminate air flow restrictions – clean intake air filters, fix sticking check valves, open or eliminate throttling valves, enlarge undersized valves or piping.
- Minimize inlet air temperature for centrifugal blowers, especially those which draw air from inside buildings (such as turbo blowers). Consider piping blower intake to outside of building.
- Dissolved Oxygen (DO) Control Sensors – clean and check DO Probe calibration twice a month; airflow meters and pressure sensors annually.
- Check placement of DO probe in basin for representative DO reading.
- Lower DO set point to lowest possible setting which results in proper treatment. (That should be less than 2 PPM. However, if either ammonia or nitrogen removal is required, higher set point may be required, especially during cold weather).
- Lower blower output pressure by fully opening air valve to highest demand aeration zone, and then balancing other air valves to obtain uniform DO set point concentration across remainder of aeration basin; check and tune the settings annually. Use Most Open Valve control strategy for plants with centrifugal blowers and more than 3 aeration basins.
- Monitor Blower Performance – check air flow and pressure against blower curve to determine if units are operating at most efficient point.
- Identify most efficient blower (highest SCFM/kW) and program controls to run that unit as primary blower.
- If different capacity blowers are available, program blower operation to match diurnal air demand. If blowers are positive displacement units, adjust belts and sheaves to match output to diurnal air demand.

- Monitor SCADA System to identify if 2 or more blowers operate at reduced speed. Determine if one unit at higher speed will satisfy demand while drawing less kW. If so, take excess equipment off line.
- Diffuser air flow – check CFM/diffuser rate. If it exceeds manufacturer’s recommendation, add diffusers or reduce air flow per diffuser to restore oxygen transfer efficiency.
- Diffuser maintenance – every week, look for air “boils” which could indicate broken pipes or diffusers; measure air pressure of each drop leg (at a set SCFM blower air flow rate) to detect distribution piping resistance and diffuser fouling. Flex diffuser membranes with air pulses or clean diffusers as needed to reduce pressure and increase oxygen transfer efficiency.
- If nitrification is not required, lower Mean Cell Residence Time to 4 - 5 days and turn off aeration system from 1 to 2 hours during the early morning low flow period in order to inhibit nitrifying bacteria.
- Convert first zone of aeration basin to anoxic selector (if nitrifying) or to anaerobic selector (if not nitrifying). The selector helps remove surfactants, which increases oxygen transfer efficiency.

Mechanical Aeration Systems

- Check that the submerged depth of the mechanical aerator is set to produce the maximum mixing and aeration at a lowest amperage draw.
- Stage unit operation to match DO demand. If different capacity units are available, program operation to match diurnal air demand. Use timers to turn units ON/OFF or VFD’s to change speed. Take excess units off line.
- Monitor SCADA System to identify if 2 or more aerators operate at reduced speed. Determine if one unit at higher speed will satisfy demand while drawing less kW. If so, take excess equipment off line.
- Dissolved Oxygen (DO) Controls - Lower DO set point to lowest possible setting which results in proper treatment (less than 2.0 PPM for aeration basins and as low as 0.2 PPM for aerobic digesters).
- DO probe – clean and check calibration twice per month, replace parts as needed.
- Identify most efficient unit (lbs of O₂ transferred/kWh) and program controls to run that unit as primary unit.
- If nitrification is not required, lower Mean Cell Residence Time to 4 -5 days and turn off aeration system from 1 to 2 hours during the early morning low flow period in order to inhibit nitrifying bacteria.
- Monitor units for excessive vibration and amp draw to detect fowling. Clean and recheck.

Secondary Treatment Mixing System (in anoxic or anaerobic cells of aeration system) and Anaerobic Digester Mixing System

- Reduce number of aeration basin mixers and/or speed of units to point where solids settling is just beginning to be observed (visually on the surface or by tube sampler through tank depth). Take excess equipment off line.
- Reduce number of anaerobic digester mixers (or pumps) and/or speed of units to optimize methane production. Monitor digester solids concentration at various levels and maintain sufficient mixing to ensure that solids separation is not occurring. Take excess units off

line.

- Identify most efficient unit (GPM/kW) and program controls to run that unit as primary unit.
- Monitor units for excessive vibration and amp draw to detect fouling. Clean and recheck.

Pumping Systems – Lift Stations, RAS; WAS; Trickling Filter and Aeration Basin Recirculation

- Reduce RAS, WAS, and Primary Sludge flow rates to minimum needed. This increases solids concentrations and reduces pumping of excess water.
- Reduce Trickling Filter and Aeration Basin recirculation rates to minimum needed. This reduces pumping of excess water.
- Fix piping leaks and pump leaks (packing & seals).
- Eliminate piping restrictions: throttling valves, unnecessary valves, sticking check valves
- Eliminate air from pipelines by checking and flushing air release valves.
- Flush scum and sludge piping periodically to reduce headloss.
- Reduce pumping head – raise liquid level at pump inlet to maximize suction pressure.
- Monitor pump performance – check flow and total head (discharge pressure minus suction pressure) against pump curve to determine if units are operating on the curve and at most efficient point on the curve.
- If pump produces excessive flow, consider installing slower RPM motor or trimming impeller instead of throttling. However, trimming more than 9% of diameter results in too much efficiency loss.
- Calculate wire to water (W2W) efficiency using flow, total head, and measured kW of pump & motor. $W2W \text{ efficiency} = \frac{\text{measured kW}}{(\text{GPM})(\text{Head in feet})/5310}$. Efficiencies should be at least 65% for raw sewage pumps, 70% for RAS & recycle pumps, and 75% for secondary effluent & reclaimed water pumps.
- Where there are multiple pumps, identify most efficient pump (GPM/kW) and program controls to run that unit as primary pump. Take excess units off line.
- Monitor SCADA System to identify if 2 or more pumps operate at reduced speed. Determine if one unit at higher speed will satisfy demand while drawing less kW. If so, take excess equipment off line.
- Monitor pumps and motors for excessive vibration and amp draw to detect plugging and excessive wear. Clean and check clearance between impeller and volute. Replace impeller and/or wear rings if necessary.
- Reduce seal water pressure to no more than 10 psi above pump volute pressure.
- Reduce seal water flow to 1-2 GPM

Plant Water System for non-potable use

- Reduce demand – adjust spray nozzles in clarifiers and aeration basins; use quick ON/OFF/adjustable flow nozzles on wash down hoses; adjust pump seal water flow to lowest recommended setting; reduce chlorine gas dilution water flow rate.
- Fix piping leaks.
- Eliminate piping restrictions, throttling valves, unnecessary valves, sticking check valves.
- Tune pump control system – adjust pressure set point to minimum needed.
- Install accumulator pressure tank to allow system to turn off when there is no demand.

- If pump produces excessive pressure, consider eliminating a pump stage.
- If pump produces excessive flow, consider installing slower RPM motor or trimming impeller. Trimming more than 9% of diameter results in too much efficiency loss.
- Identify most efficient unit (GPM/kW) and program controls to run that unit as primary unit.
- Monitor SCADA System to identify if 2 or more pumps operate at reduced speed. Determine if one unit at higher speed will satisfy demand while drawing less kW. If so, take excess equipment off line.
- Monitor pumps and motors for excessive vibration and amp draw to detect plugging and excessive wear. Clean and check clearance between impeller and volute. Replace impeller and/or wear rings if necessary.
- Program SCADA system to display total daily usage and to alarm for excessive use of plant water.

Ultra Violet Disinfection System

- Replace lamps with low pressure, high output lamps, if possible.
- Keep lamps clean and remove scaling.
- Program light bank control for ON/OFF operation and intensity variation in proportion to plant flow.
- Check quarterly that UV intensity meter, water turbidity meter, and flow meter are clean, calibrated, and operating correctly.

Odor Control System

- Reduce air flow to minimum needed to control odor and corrosion during warm weather and to ensure code required air changes per hour.
- Consider enclosing odor sources so as to minimize the need to treat air for the entire building.
- Consider turning system off during cool weather when odor production is minimal.
- Consider using odor monitoring equipment to automatically control the system.
- For biofilters, measure air pressure of each distribution pipe at a set SCFM blower flow rate, to detect piping resistance, and to determine if filter media is compacting and needs to be changed.

Motor Maintenance

- Measure motor amp or kW draw under normal operating condition and compare with motor nameplate data to determine % motor loading. Upsize or downsize motor to achieve 50% to 100% loading range.
- Consider buying premium efficiency motors or doing *Green Rewind* if motors need replacement.

Building HVAC System

- Electric Unit Heaters in process and storage areas and pipe galleries – install timers which will allow no more than 1-2 hours of operation when personnel work in these areas.

- Tune HVAC controls and service units - clean air filters and gas burners; annually, have air conditioning technician check for refrigerant leaks and proper operation of economizers.
- Use automatic thermostats programmed for occupancy schedule – maximum 68° F heating setting and minimum 76° F cooling setting for continuously occupied areas, and maximum 60° F heating setting and minimum 80° F cooling setting for minimally occupied areas; set back temperatures for evenings and weekends; maximum 55° F heating setting for electrical rooms.
- Avoid or minimize simultaneous heating and cooling.
- Consider using infrared heaters which heat surfaces but not the air.
- Lower output of lab fume hood to required minimum. Turn off and close doors or damper when not in use.
- Use timers or occupancy sensors to control ventilation systems.
- Seal leaks at doors, windows, and wall and roof penetrations.
- Increase ceiling insulation and add wall insulation.
- Use waste heat from blower motors, boilers, and engine generators to heat building, water, and anaerobic digester.

Lighting

- Check twice per year that optical sensors for indoor and outdoor lights are operating correctly.
- Check twice per year that occupancy sensors are operating correctly. Minimize time delay for shutting lights off.
- Change lighting to more efficient bulbs and fixtures: compact florescent lights, T5 fluorescent tubes, and LED outdoor lights.
- Consider installing daylight controls to turn off indoor fixtures when adequate natural light is available.
- Consider installing motion sensors to control lights in infrequently occupied areas.

Laboratory

- Turn off hood fans and lights, COD reactors, spectrophotometers, analyzers, & other equipment when not in use
- Turn off muffle furnace at night and on weekends if not needed
- Schedule sample cooling and heating so as to consolidate refrigeration and oven use
- Insulate water baths
- Operate dish washers only when fully loaded, use energy efficient settings, and air drying
- Insulate COD reactors with sand vials
- Use automatic controls: thermostats and timers

Compressed Air

- Fix leaks.
- Reduce pressure setting to minimum needed for air operated equipment.
- Turn off compressor if not routinely needed, such as shop compressor.
- Use low pressure blower air rather than high pressure compressed air.
- Use compressor VFD control rather than throttling output.

- Use refrigerated cycling dryer rather than continuously operating dryer.

Other Measures

- Maximize Primary Treatment efficiency, (especially if using anaerobic digestion of solids) via proper baffling and improved hydraulics. Primary treatment is the most cost effective method for removing BOD, so maximizing primary treatment efficiency effectively minimizes secondary treatment costs.
- Maximize solids concentration of WAS and Primary Sludge sent to anaerobic digester to minimize heating requirement and maximize hydraulic detention time.
- Use SCADA System to observe trends, including larger motor kW demand and monthly plant kWh/Million Gallons treated. Use information to tune the controls.
- Use SCADA System to operate only the equipment needed, so blower, pumps and mixer outputs match demands.
- Regularly check for manual overrides (HOA switch in HAND position) so control systems can do their jobs. Fix or tune control systems so manual overrides are not necessary.
- Fix equipment that is not operating correctly or efficiently, such as worn bearings, failed control equipment and sensors, or improperly placed sensors.
- Examine equipment which operates 24/7 or on a fixed schedule, like odor control and ventilation blowers. Adjust operation to meet needs and seasonal variation.
- Rethink Standard Operating Procedures to maximize energy efficiency.
- Establish an energy management program which includes an energy champion and energy management team responsible for benchmarking and monitoring plant energy use, auditing plant operation monthly for energy efficiency, implementing efficiency measures, and developing energy efficiency specifications for equipment purchases.

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