WRF 4973 Fact Sheet: ID 1710

Strategy: Energy Savings

Optimize Available Equipment

Blowers Are Key Energy-Consuming Equipment.
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Pumping is a Key Energy-Consuming Process.
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Power use constitutes one of the major operational cost centers at a water resource recovery facility (WRRF). While the process demands (flow to be pumped, amount of blower aeration required, etc.) cannot easily be changed, energy requirements can be reduced by using energy-efficient equipment and managing aeration demand to maintain operation at the most energy-efficient point.

The efficiency of many high-energy-consuming equipment (blower, pumps, etc.) changes as the output and operating pressure differential change. Energy use can be optimized by operating at the point of optimal performance efficiency of the equipment. Installed equipment is typically sized to meet peak demand but mostly operates at average or below average conditions. Energy use can be reduced by installing equipment that will maintain efficient operation under all operating conditions.

Energy savings from equipment can also be maximized by creating the optimum conditions for best performance. These types of strategies include process changes to reduce operating dissolved oxygen (DO); improving oxygen transfer efficiency by using different, more-efficient diffusers to reduce blower demand; improving ultraviolet (UV) transmittance by operating at a longer sludge age; and adding better solids separation for UV.

This fact sheet focuses on strategies that reduce energy usage at WRRFs. These strategies include improving the efficiency of the equipment, changing the process operational conditions to reduce energy usage, and other strategies. See the Additional Information section for more details.

Fact Sheet Application Checklist

R = fact sheet relevant to item
PR = fact sheet is potentially relevant to item depending on application, existing conditions, etc.

Category		Intensification
		Chemical addition
		Carbon management
	R	I&C strategies
		Sidestream mgmt.
	R	Energy savings
		Chemical savings
	R	Operational savings
		Other means of NutRem
Nutrient	R	Ammonia
	R	NOx
	R	TN
	R	Ortho-P
	R	TP
Scale (design flow)	R	Small (<1 mgd)
	R	Medium (1–10 mgd)
	R	Large (>10 mgd)

Goal		Improve reliability
		Reduce nutrient
	R	Reduce O&M cost
Group	R	Optimize existing CNR
	R	Optimize existing TNR
		NutRem in secondary plant
Process		Small
		Pond
	R	Fixed film (secondary)
	R	Conventional act. sludge (CAS)
	R	Nitrifying act. sludge (NAS)
	R	Conventional NutRem (CNR)
	R	Tertiary NutRem (TNR)
		Other

CAS = conventional activated sludge (BOD only)
NAS = nitrifying activated sludge (without denitrification)
CNR = conventional nutrient removal no chemical/no filter, etc.
TNR = tertiary nutrient removal with chemical, filter, etc.

Technology Summary Evaluation

Footprint	3	Compared to conventional (1 = much smaller; 3 = conventional; 5 = much larger)
Development status*	4–5	Technology ranking based (LIFT) see below*
Energy use	1–2	Scale 1–5: 1 = use much less; 3 = use similar to conventional; 5 = use much more
O&M cost	2	Scale 1–5: 1 = cost much less; 3 = cost similar to conventional; 5 = cost much more
Material/consumables	1	Scale 1–3: minimal = 1; some = 2; significant = 3 (e.g., UV lamps/membranes)
Chemical use	1	Scale 1–3: minimal/none = 1; some = 2; significant = 3 (e.g., chemical process)

* Technology ranking based on Leaders Innovation Forum for Technology (LIFT) Water Research Foundation (WRF) Technology Development Level (TDL) definitions:
1 = bench research and development
2 = small-scale pilot
3 = full-scale pilot (demonstration)
4 = pioneer stage (production and implementation)
5 = conventional

Descriptions/Evaluation

Strategy	Optimize available equipment
Description	This strategy focuses on optimizing the operation of existing equipment and ways to reduce their energy consumption—for instance, adjusting the control loops for a pump station so that the pumps operate within their most efficient ranges when more than one pump is available.
Application	The major power-consuming processes at a WRRF are the following: • Aeration blowers • Pumps • UV disinfection • Mixing • Dewatering
Constituents removed	None: these energy-savings strategies should maintain treatment performance
Development status*	The energy optimization strategies fall generally in LIFT TDLs 4–5.
O&M considerations	Implementing a new strategy will require some additional training for staff.
Benefits	Reduce cost and power consumption. Reducing energy or generating power from digester gas provides a more sustainable, green treatment process.
Limitations	None
Design considerations	Depends on strategy, but generally some minor design is required.
Potential fatal flaws	None
Footprint requirements	None
Residuals	No change in residuals
Cost considerations	Some investment may be required for programming, equipment refurbishing, and equipment replacement. A life-cycle cost analysis is recommended to determine if the return on investment is acceptable.
Past experience	Clean Water Services, Oregon: blower Hampton Roads Sanitation District (HRSD), Virginia: energy, chemical Central Contra Costa Sanitary District, Martinez, California: diffuser testing/cleaning
Publications	Menniti, A. and K. Eberhardt. 2017. "Optimizing aeration system performance and efficiency at the Durham Advanced Wastewater Treatment Facility." Annual Conference: PNCWA. Reardon, D. 1998. "Energy Usage Wastewater Treatment Plants." Waterworld, August 31. U.S. Department of Energy. 2019. "Energy Data Management Manual Wastewater Treatment." DOE/EE-1700 Better Buildings, U.S. Department of Energy, December 2017. WEF. 2009. "Energy Conservation in Water and Wastewater Facilities. MOP 32." Water Environment Federation (WEF).
Related fact sheets	1701: Reduce Energy Consumption Overview 1740: Reduce Process Power Demand 1901: Optimize Operation and Maintenance
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Note

* Technology ranking based on LIFT WRF TDL definitions:

1 = bench research and development
2 = small-scale pilot
3 = full-scale pilot (demonstration)
4 = pioneer stage (production and implementation)
5 = conventional (https://www.waterrf.org/sites/default/files/file/2019-07/LIFT%20Scan%20Application-LIFT%20Link%2BHub_0.pdf : accessed September 2020)

Additional Information

The strategies in this fact sheet aim to reduce energy demand at WRRFs by operating at the optimal operating points for equipment, modifying process demands, and managing the process to reduce the overall power demand and price of power (WEF 2009).

Optimize available equipment: Blowers and pumps at WRRFs must cover a wide operating range in terms of flow and aeration demands. This is because the equipment must not only cover large daily and seasonal variations in demand, but also do so over the 20-year (or more) planning period. The result is that the equipment must operate outside optimal efficiency. This strategy relies on "jockey" blowers and pumps to provide more efficient operation (Menniti and Eberhardt 2017).

Optimize equipment set points: Modify operation and control set points for blowers, pumps, and mixers to provide more efficient operation. These set points may be a header pressure control set point, variable versus constant rate pumping, wet well operation, etc. (Menniti and Eberhardt 2017).

Maintain equipment efficiency: Some equipment becomes less efficient with age (for example, diffusers become fouled, mechanical equipment wears out, etc.) and can be restored with maintenance, cleaning, or rebuilding. Newer equipment may provide a sufficient increase in energy efficiency so that it has a short return on investment. New blowers, higher-efficiency diffusers, or simply adding more diffusers could also increase energy efficiency.

Equipment use time: Avoid using equipment during peak power rate hours when possible (WEF 2009). Major power users (e.g., dewatering centrifuge) do not have to run at any specific time, and the times of peak power rate can be avoided. Another example of this practice would be storing the recycled ammonia load of a WRRF into an equalization tank instead of returning it during the peak power rate times of the day.

Abbreviations

BOD	Biochemical oxygen demand
CAS	Conventional activated sludge: BOD removal only
CNR	Conventional nutrient removal
DO	Dissolved oxygen
HRSD	Hampton Roads Sanitation District
I&C	Instrumentation and controls
LIFT	Leaders Innovation Forum for Technology (now RIC and RISE)
mgd	Million gallons per day
NAS	Nitrifying activated sludge
NO_x	Oxidized nitrogen (nitrate + nitrite)
NutRem	Nutrient removal
O&M	Operations and maintenance
RIC	Research & Innovation Committee
RISE	Research and Innovation for Strengthening Engagement
TDL	Technology Development Level
TN	Total nitrogen
TNR	Tertiary nutrient removal
TP	Total phosphorus
UV	Ultraviolet
WRF	The Water Research Foundation
WRRF	Water resource recovery facility