aquafficiency®

Wastewater Treatment Efficiency **FACTS AND FIGURES**

1 TOP 10 CATEGORIES OF WASTEWATER O&M Energy Savings

1. Control & Optimize DO Levels
2. Control & Minimize Blower Discharge Pressures
3. Optimize Pumps & Pumping
4. Non-potable Water: Flow & Pressure
5. Nitrification (needed?) w/o Denitrification
6. Optimize Mixing
7. Control Your Odor Control
8. Control Your UV System
9. HVAC & Lights in Unoccupied Rooms
10. Record/Standardize/Document

2 IMPACT OF DO LEVELS ON ENERGY

Saturated DO

DO in basin = driving force for oxygen transfer
Driving force UP means Energy goes DOWN

DO rule of thumb

0.5 mg/l reduction creates ~ 6% energy savings

DO calibration & cleaning

A probe that reads 10% low (e.g. 2.0 when actual is 2.2) is costing you 2.4% at the blower.

DO level increases

As mixed liquor temp increases, the impact of elevated DO levels increases.

IMPACT OF AVERAGE DO LEVEL ON BLOWER ENERGY

Mixed liquor temp		DO sat	Energy savings potential if DO reduced from __ to 2.0 mg/l			
°C	°F	mg/l	2.5	3	4	5
0	32	14.6	4.0%	7.9%	15.9%	23.8%
2	36	13.8	4.2%	8.5%	16.9%	25.4%
5	41	12.8	4.6%	9.3%	18.5%	27.8%
10	50	11.3	5.4%	10.8%	21.5%	32.3%
15	59	10.1	6.2%	12.3%	24.7%	37.0%
20	68	9.1	7.0%	14.1%	28.2%	42.3%
25	77	8.2	8.1%	16.1%	32.3%	48.4%

NOTE Higher impact as elevation increases

3 IMPACT OF BLOWER PRESSURE ON ENERGY

Disch. pressure	Reduction in pressure of ___ psig				
	-0.2	-0.4	-0.6	-0.8	-1.0
12	1.3%	2.7%	4.0%	5.4%	6.7%
11	1.5%	2.9%	4.4%	5.9%	7.4%
10	1.6%	3.3%	4.9%	6.6%	8.3%
9	1.8%	3.7%	5.5%	7.4%	9.3%
8	2.1%	4.2%	6.3%	8.4%	10.6%
7	2.4%	4.8%	7.3%	9.7%	12.2%

*Assumes 70% blower eff & 92% motor/drive eff

Reduce pressure across blower by

- Clean inlet air filter
- Clean the aeration basin diffusers (which also improves OTE = reduces air demand)
- Use most open valve control strategies
- Reduce or eliminate throttling
- Hold return stream flows (e.g. centrate) until low load conditions at night (lower airflow lowers friction losses)

PSIG	IN H_2O
0.1	2.8
0.2	5.5
0.3	8.3
0.4	11.1
0.5	13.8
0.6	16.6
0.7	19.4
0.8	22.1
0.9	24.9

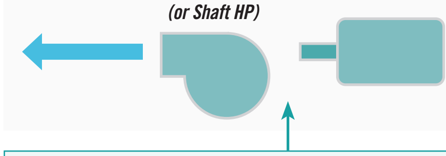
1 PSI = 2.31 feet of water
1 foot of water = 0.43 PSI

4 PUMPING ENERGY

Basic equation

$$\frac{GPM \times Feet}{3960} \times \frac{1}{Pump\ Eff} \times \frac{1}{Motor\ Eff} \times 0.746 = \text{kW from utility}$$

Water HP — *Brake HP (or Shaft HP)* — *Motor HP*



*Input HP x 0.746 = motor input kW**

Include transmission loss between motor and machine if not direct coupled:

Gear box - 92-98% depending on type
V-belt - 89-95% depending on proper tension
"cogged" or "synchronous" belt - 98%

VFD efficiency

$$\text{*Input motor kW} \times \frac{1}{VFD\ eff} = \text{VFD input kW}$$

VFD efficiency = 97%

Running at 100% speed consumes 3% more energy than running without a VFD.

5 CALCULATING kWh

It takes 3.14 kWh to lift 1 million gallons 1 foot at 100% efficiency

Estimating energy from nameplate data

BHP ≈ Motor Nameplate HP x 90% (for mixers) x "% of Full Load Power"

BHP ≈ Motor Nameplate HP x 80% (for pumps) x "% of Full Load Power"

BHP ≈ Motor Nameplate HP x Operating Amps / Full Load Amps (FLA)

$$\frac{\text{Brake Horsepower (BHP)} \times 0.746}{\text{Motor Efficiency}} \times \text{hours} = \text{kWh}$$

Amp to kWH calculation

For three phase power (be wary of using amps from a VFD panel readout)

$$\text{Amps} \times \text{Volts} \times 1.73 \times \text{Power Factor} \times \frac{1}{1{,}000} \times \text{hours} = \text{kWh}$$

Saving energy in pumping

- Reduce the head: static and/or friction
- Reduce the flow: pump only what is needed
- Improve equipment efficiency: new equipment or better operating point

6 REDUCING ENERGY AT PUMPS, MIXERS, AND FANS

Reduce flow

- Put non-potable spray systems on timers; use PRV's & non-clog nozzles to reduce flow
- Run RAS and internal recycle pumps at an "intentional" multiple of plant flow; if pumps are oversized, trim impellers or install VFDs
- Run sludge pumps intermittently to move more solids with less water
- Equalize return stream flows (e.g. centrate) to load aeration basin at night when influent loads are lowest
- Minimize water used for "sluicing" screenings and grit
- Go to intermittent or reduced speed operations on mixers
- Does odorous airflow depend on number of trains on-line?
- Does odor vary seasonally?

Reduce head

- Increase wet well level on influent, effluent, RAS, WAS, intermediate, and collection system pump stations when possible A 2-foot increase on a 20' TDH system is a 10% reduction in energy
- Lower non-potable water system pressure to a default low pressure; use timers or SCADA system to boost pressure when needed for washdown; use booster pumps for those single uses that require high pressure (e.g. belt press)
- Use dedicated low pressure blower for channels that are not as deep as aeration basin
- Dampered fans are common; resheave to lower flow and eliminate throttling

Improve efficiency

- Consider semi-open impellers in lieu of open impellers if influent screens are 1/4" or less
- Check pump operating conditions against factory curve; adjust to maximize gal/kWh
- Run "best" equipment in lead & leave it until it is no longer the best

7 USEFUL TIME AND ENERGY CALCS

Constant (24/7) running is 8,760 hrs annually

8 hr/day for 7 days/week = 2,920 hours

8 hr/day for 5 days/week = 2,085 hours

Runtime reductions
1/24th = 4.2% **1/7th** = 14.3% **1/12th** = 8.3% **1/52** = 1.9%

Quick conversions
1 HP = 0.75 kW **100 HP** = 75 kW **10 kW** = 13.4 HP

Rough kWh **10 HP 24/7** = 65,000 kWh

8 DEFINITIONS

NAME	DEFINITION
Efficiency	Energy "Out' divided by Energy "In"
HP	Motor Nameplate Horsepower, this is motor output
BHP	Brake Horsepower, the shaft power at pump
WHP	Water Horsepower, theoretical minimum power required to move water
BTU	British Thermal Unit, enough energy to raise 1 pound of water by 1°F
kW	Kilowatt, unit of power (1,000 watts)
kWh	Kilowatt Hour = Units of energy, kW x hours
kVA	Kilovolt-amps, "Apparent Power" = Volts x Amps x 1.73 / 1,000 (skip x 1.73 if single phase)
kVAR	Kilovolt-amps reactive - "Reactive Power," non-useful power that the utility still has to carry
PF	Power Factor = kW / kVA, or % of power that is "real"

9 MOTOR EFFICIENCY

MOTOR NAMPLATE HP	STANDARD EFF.	PREMIUM EFF.
1	74%	82%
5	84%	90%
10	87%	91%
25	90%	93%
50	91%	94%
100	92.2%	94.7%
250	93.3%	95.2%
500	94.0%	95.5%
1000	94.5%	95.7%

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