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Energy-Efficient Biological Treatment

Biological wastewater treatment consumes 50 – 80 % of an entire plant's power supply. Energy efficiency thus depends predominantly on its design.

- Simultaneous aerobic stabilization or extended aeration has a high power consumption of 25 – 30 kWh/(PE•a).
- Activated sludge systems designed for N removal after primary clarifiers consume 15 – 20 kWh/(PE•a) and permit power generation from digester gas.
- Activated sludge systems designed only for carbon (BOD) removal consume around 10 kWh/(PE•a). Nutrient removal is not always required, particularly where effluents are reused for irrigation (See also [Huber ReUse Solutions](#)).
- Nitrifying trickling filters consume 7 – 10 kWh/(PE•a) and nitrifying rotating contactors only 2 - 4 kWh/(PE•a).
- Multi-stage biological treatment is often more energy-efficient than single-stage treatment.

The following recommendations apply for activated sludge treatment:

- Most power is consumed for aeration and tank mixing.
- The aerobic sludge age must be sufficient for the selected process, but should not be too long either. Oxidic, anoxic and anaerobic tank volumes should be variable; e.g. less oxidic volume is needed during summer.
- Fine bubble diffusers are more energy-efficient than coarse bubble diffusers or mechanical aerators. Optimum bubble diameter is around 2 mm.
- Even arrangement of air diffusers on a tank's bottom improves oxygen transfer and reduces power consumption.
- Energy-efficiency of fine bubble aeration has an optimum at 4 - 6 m immersion depth
- Turbo-blowers consume about 10 % less energy than roots blower.
- Smart control of oxygen concentration, redox-potential or ammonium and nitrate concentration saves power.
- Efficient propellers for non-aerated tank mixing consume 1.5 – 3.0 W/m³ tank volume, or 1.5 – 3.0 kWh/(PE•a).
- Internal recirculation should be controlled. Variable flow propeller pumps consume around 0.5 kWh/(PE•a).
- Sludge return flow should be controlled. Variable flow centrifugal pumps consume about 0.5 kWh/(PE•a).
- Secondary clarifier scrapers and surplus sludge pumps consume around 0.15 kWh/(PE•a).

See also [Membrane Bio-Reactors](#).