Landustrie
Water Treatment Solutions

Landustrie

Surface aerators

Total Cost of Ownership (TCO)

Efficient surface aeration systems can significantly reduce total cost of ownership by lowering energy consumption and extending equipment lifespan. Expert support throughout the project ensures cost-effective implementation and long-term sustainability.

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Total Cost of Ownership (TCO)

Aeration systems

When selecting aeration technology for a wastewater treatment plant (WWTP), Total Cost of Ownership (TCO) offers a comprehensive lens to assess long-term value beyond initial investment.

This analysis compares surface aeration and fine bubble (diffused) aeration, drawing from operational data, published research, and practical experience.

Table 1

Aspect	Surface aeration	Bubble aeration (fine bubbles)
WWTP Conditions and Layout		
Sensitivity	**Low** Surface aerators demand no extensive pretreatment and are not sensitive toward chemicals	**High** Pretreatment by removing grease and sand is important to prevent clogging of the aerators and blocking of the propel-lers. Sensitive to chemical attack.
Basin	Optimal for water heigths until 5.5 m.	Optimal for water heights above 4 m.
Aerosols	High in proximity to the aerator / low at a distance	Low in proximity to the aerators, but travels further from the aerators.
Operation / Maintenance		
Maintenance	**Simple.** Gearbox oil check	**Complex and more frequent.** Every 2 years manual cleaning. Regular chemical cleaning. Compressor check.
Mixing	Aeration and mixing with surface aerator.	Additional mixing equipment is needed.
Man power	Simple operation. Controllable via speed or immersion depth.	More complex operation. Controllable via blower setting. Frequent intervention nee-ded by an operator.
Load flexibility	Less flexible; without a VFD load flexi-biliy is limited.	High flexibility with settings of the airflow and mixers.
Clogging sensitivity	**Low**	**High**

Capex and Opex		
Investment costs (Capex)	**Low.** Simple system.	**High**. More complex due to additional equipment, unlike simpler surface aerators.
Energy consumption (in clean water)	2.0 - 2.3 kg O_2/kWh (STOWA, 1999)	3.0-4.0 kg O_2/kWh (STOWA, 1999)
Alpha factor (wastewater)	0.8-1.0 (Roso et al., 2006)	0.25-0.8 (lower with fats, chemicals, sludge, surfactants) (EPA, 1981; Roso et al., 2006)
Effective oxygen transfer (OTE)	1.6-2.3 kg O_2/kWh (stable in wastewater)	0.75-3.2 kgO_2/kWh (highly dependent on water quality)
Maintenance costs	**Low.** Simple system.	**High.** Complex with multiple parts.
Equipment service life	30 years (Noardling, 2025; STOWA, 1999)	5-10 years for diffusers (AquaSust, 2024) 10-15 year for blowers (SGS, 2025)

Operational comparison

Surface aerators are particularly capable of accommodating variations in influent composition without compromising their efficiency in oxygen transfer. Surface aerators function reliable even in the presence of sand, grease, or surfactants. The aerators do not require elaborate pre-treatment and are not susceptible to chemical degradation, making them particularly robust in real-world conditions. Fine bubble systems, on the other hand, demand careful pre-treatment and routine monitoring to maintain efficiency, as their performance is directly affected by alpha factor variability and clogging risks.

The alpha factor, which represents the ratio between oxygen transfer efficiency in wastewater versus clean water, is a key driver of aeration efficiency. In typical conditions with mixed liquor suspended solids (MLSS) of 3 - 4 g/L, fine bubble systems may reach an alpha value of around 0.65 (Krampe & Krauth, 2003). However, as MLSS increases beyond this range, especially in the presence of surfactants, the alpha factor often drops significantly, sometimes below 0.3, due to increased viscosity and surface tension, which hinder bubble-mediated oxygen transfer. This decline in alpha directly increases the energy required to meet the same oxygen demand.

In terms of installation flexibility, surface aerators are optimised for basins up to 5.5 m deep, offering a versatile solution across a wide range of plant configurations . Although fine bubble systems perform well in deeper tanks, this benefit often comes with a trade-off: increased maintenance complexity. As seen in Table 1, surface aeration systems such as the Landy 7 can be maintained without draining the basin, while fine bubble systems typically require downtime and labour-intensive diffuser servicing every two years.

Mixing and operation also favour surface aeration. Surface aerators combine oxygen transfer and water mixing in a single device, whereas fine bubble systems often require additional mixers, increasing capital cost and energy usage. Operationally, surface aeration systems are simple to control through speed or immersion depth, while fine bubble aeration requires continuous adjustment via blowers and more operator supervision.

The complexity of wastewater treatment does not allow this TCO analysis to cover all scenarios with the amount of factors that influence aeration system performance. This analysis considers a wastewater treatment plant (WWTP) in the Netherlands, with a treatment capacity of 50,000 ie, featuring an oval aeration tank of 13,500 m³, a water height of 5 meters, and an average oxygen demand of 5,400 kg O_2/day (STOWA, 1999).

Table 2

Aspect	Surface aeration		Bubble aeration (fine bubbles)	
Operation				
	Scenario 1 (worst case)	**Scenario 2 (optimal case)**	**Scenario 1 (worst case)**	**Scenario 2 (optimal case)**
Efficiency clean water (kgO_2/kWh)	2	2.3	3	4
Alpha	0.8 with surfactants and high MLSS	1 no surfactants and average MLSS	0.25 with surfactants and high MLSS	0.8 no surfactants and average MLSS
Efficiency wastewater (kgO_2/kWh)	1.84	2.3	1	3.2
SOTR (kgO_2/d)	5,400	5,400	5,400	5,400
Annual energy use (kW/year)	1,231,875	856,957	2,628,000	615,938
Annual energy costs (€/year) assuming 0.15 €/kW)	184,781	128,543	394,200	92,391
Maintenance				
Annual maintenance costs 26 € / h (salary). *All costs for travelling and lodging are excluded.* Material costs for ceramic and membrane elements are 0.5 and 1 % of the investment for respectively the best and worst scenario.	6 h (working hours) € 179 Materials € 335	4 h (working hours) € 45 Materials € 149	Compressor 24h (working hours) € 4,474 Materials Ceramic elements 32h (working hours) € 5,335 Materials Membrane elements 8h (working hours) € 5,335 Materials 1 Total 64 (working hours) x 26 = € 1,664 + € 15,144 = € 16,808	Compressor 16h (working hours) € 1,790 Materials Ceramic elements 16h (working hours) € 2,668 Materials Membrane elements 4h (working hours) € 2,668 Materials Total 36 (working hours) x 26 = € 936 + € 7,126 = € 8,062

Total Cost of Ownership				
Investment equip-ment	€ 308,82		€ 533,522	
Operation /year	€ 184,781	€ 128,543	€ 394,200	€ 92,391
Maintenance €/year	€ 335	€ 149	€ 16,808 /year + € 53,352 /each 7 years (10% investement)	€ 16,808 /year + € 53,352 /each 7 years (10% investement)
Total operating cost (20 years)	€ 4,010,572	€ 2,884,695	€ 8,843,578	€ 2,641,216

Table 2

All costs presented were converted to EURO and compensated for inflation, based on the website https://www.cbs.nl/nl-nl/visualisaties/prijzen-toen-en-nu.

Table 2 shows surface aeration maintains a strong TCO, especially under average or suboptimal conditions. Even in fine bubble aeration's best-case scenario, high upfront and maintenance costs offset energy savings.

For a balanced view, Figure 1 presents an average scenario analysis, combining realistic energy, investment, and maintenance expectations. Even in this case, surface aeration equals or exceeds bubble aeration in total cost due to lower capital expenses, steady energy use, and minimal maintenance.

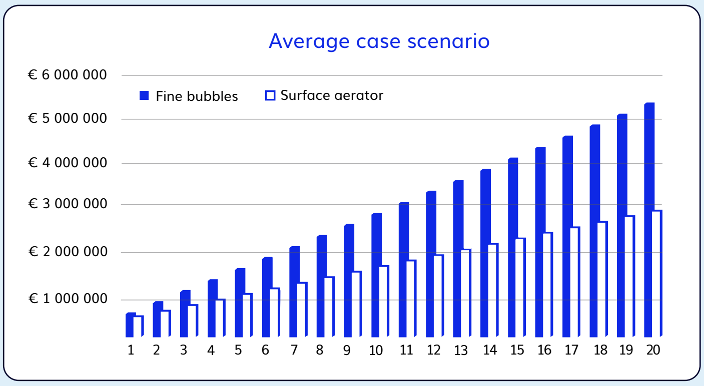

Figure 1

Conclusion

Although fine bubble aeration can be useful in specific settings, its complexity and cost often outweigh theoretical benefits. As shown in Tables 1 and 2 and Figure 1, surface aeration proves more reliable and cost-effective.

For municipalities and industries, the Landy 7 offers up to 30 years of service, combines aeration and mixing, and performs efficiently under varied conditions. This TCO analysis highlights its value and low risk for new and retrofit WWTPs.

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