TRIPLET
by WFI Group

HOW TO MAKE WASTEWATER REUSE WORTH IT

The TAYA technology for wastewater treatment has been developed to meet the requirements for a decentralized WWTP, emphasizing simplicity of operation, process stability and reliability, low investment, and low operational costs, enabling easy and affordable autonomous wastewater treatment.

Decentralized WWTP enables wastewater reuse within the rural communities, increasing freshwater savings, due to the following:

- The local wastewater treatment delivers high-quality effluent level with no need to purchase tap water suitable for agriculture irrigation.
- There is no need to establish a large WWTP or to convey the wastewater through long pipelines, saving all related costs.
- Lower investment and operational costs are incurred on the end users compared to a centralized WWTP.

GUIDELINES FOR DESIGNING DECENTRALIZED WWTP

There are three major guidelines for designing a decentralized WWTP that can continuously operate in a remote location, supply a high-quality stable, and set a reliable effluent.

1. LOW INVESTMENT COST

It is important that the WWTP is constructed from local materials, mainly in developing countries to keep costs down.

Rural communities often use pond-based wastewater treatment technologies which do not meet the new effluent standards. Upgrading them via retrofitting to newer technologies can provide an economic advantage.

2. LOW OPERATIONAL COST

Reducing OPEX in local plants depends on multiple factors ranging from labor and skill level, to sludge handling and waste disposal, due to the low capacity of the treated wastewater:

- Labor
- Skill level of operator
- Laboratory analysis
- Process support
- Equipment maintenance
- Chemical costs
- Secondary sludge produced
- Electricity consumption

3. RELIABILITY AND SIMPLICITY OF O&M

A decentralized WWTP must be easy to operate, without the need for daily adjustments and maintenance by skilled labor in order to produce the effluent qualities required.

In practice these guidelines are translated into minimum electromechanical equipment, no chemical dosing, no secondary sludge handling, and small electricity connection as well as low electricity demand.

TAYA TECHNOLOGY

TAYA technology was developed under these guidelines to produce an aerobic anoxic, fixed film reactor, designed to reduce organic matter and nitrogenous compounds.

Using dual passive aeration units, wastewater is constantly circulated between two basins by first filling one basin, then the other. As the basin is filled, the biofilm receives nutrients and organic matter. After draining the basin, passive aeration allows oxygen to be supplied and for COD oxidation and nitrification to occur.

TAYA technology allows for simultaneous nitrification/denitrification (SND) as it occurs during the drain phase, while denitrification occurs during the fill phase.

As in constructed wetlands, the TAYA design parameters are calculated to prevent excessive biomass growth. It allows minimum secondary sludge and maintains the system's hydraulic conductivity.

Figure 1a, b, c. TAYA cycling simulation

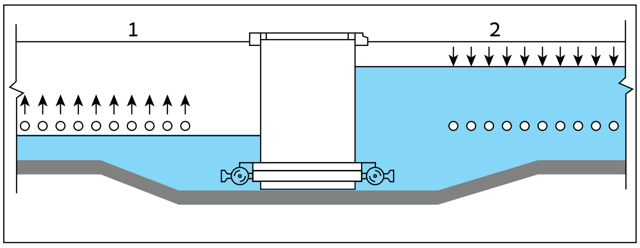

Figure 1a. Basin 2 is filled by pump, basin 1 is drained

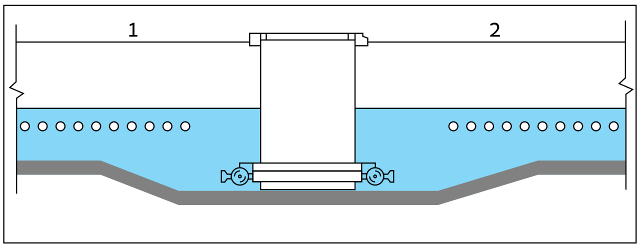

Figure 1b. Basins are leveled by gravitation

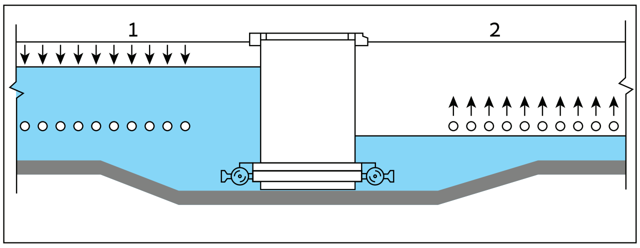

Figure 1c. Basin 1 is filled by pump, basin 2 is drained

Table 1 - The guidelines implementations by the TAYA technology vs. activated sludge

The guideline	Implementation by TAYA technology	Activated sludge
Minimum electromechanical equipment	Only 2 pumps for each TAYA.	Aeration systems, mixing, circulation pumps, oxygen control, sludge thickening and dewatering.
Stable and reliable process	Attached growth biomass process, Long hydraulic retention time, minimizes effect of variable conditions.	Suspended growth biomass, affected by high flows and loads fluctuations.
Secondary sludge and chemicals consumption	No sludge recirculation, secondary sludge treatment or daily settlings tests. The process does not involve the use of chemicals.	Daily testing and process monitoring for MLSS concentration, RAS and WAS balancing, sludge settling analysis (SVI test). Chemicals are required for sludge thickening and dewatering.
Low electricity demand	0.013 $/m^3 for treating daily flow of 2,280 and 1,320 m^3/day the energy required for the TAYA is less than 15% compared with the required energy for the activated sludge plant.	0.17 $/m^3 for treating 2,280 m^3/day (Palgey Mayim. 2016) 0.09 $/m^3 for treating 1,320 m^3/day (Giladi,A .2016).
Simple and easy to operate	Semi-skilled operator is needed.	Skilled operator is needed.
Low labor requirement	Operator is needed only twice per month.	Full time operator is needed.

INVESTMENT AND OPERATIONAL COSTS

OPEX

TAYA operational costs include labor, laboratory analysis, equipment maintenance, electricity consumption, waste disposal, and gravel washing every 10 years (replaces the treatment of excess sludge).

The below table compares the cost of Membrane bioreactor (MBR) technology vs TAYA. The costs include electricity consumption, equipment repair, chemical cleaning, membrane replacement, and labor. The cost does not include waste disposal, secondary sludge treatment, and disposal and laboratory analysis costs.

Table 2. Operation cost comparison – MBR vs. TAYA

Daily flow (m^3/day)	TAYA cost ($/m^3)	MBR cost ($/m^3)
300	0.06	0.25
500	0.04	0.23
1000	0.03	0.21
2000	0.02	0.19

TAYA costs were also compared to activated sludge WWTPs located in rural communities in Israel.

Table 3. Operation cost comparison – Activated sludge vs. TAYA

Daily flow (m^3/day)	TAYA ($/m^3)	Activated sludge ($/m^3)	Cost component	Source
4,800	0.07	0.3	Maintenance, materials, chemicals and energy	(Jafarinejad 2017)
2,280	0.03	0.24	Energy and sludge disposal	(Palgey Mayim. 2016)
1,320	0.04	0.15	Energy and sludge disposal	(Giladi,A .2016)

CAPEX

Comparing investment costs for different technologies is complicated as the construction regulations and demands as well as materials and construction costs change in different countries.

the investment cost for TAYA is 25%-40% less in comparison with activated sludge WWTPs. As rural communities often use pond-based simple wastewater treatment plants, it's possible to retrofit them and use TAYA treatment schemes for anaerobic ponds.

CONCLUSION

Increasing wastewater reuse is vital for managing the water cycle, and the TAYA system has demonstrated its ability to provide high treatment efficiency while slashing costs:

80% OPEX SAVINGS

25%-40% CAPEX SAVINGS

80% ENERGY SAVINGS

TAYA technology meets the guidelines for designing decentralized biological wastewater treatment systems and plants, while delivering high-quality effluent with a proven stability of a decade. Its pumps are based on a single fixed-film biological reactor, based on passive aeration. No chemicals and no secondary sludge handling are required.

The above-mentioned data and analysis prove the feasibility and sustainability of the TAYA as a simplified decentralized WWTP enabling affordable wastewater autonomy.