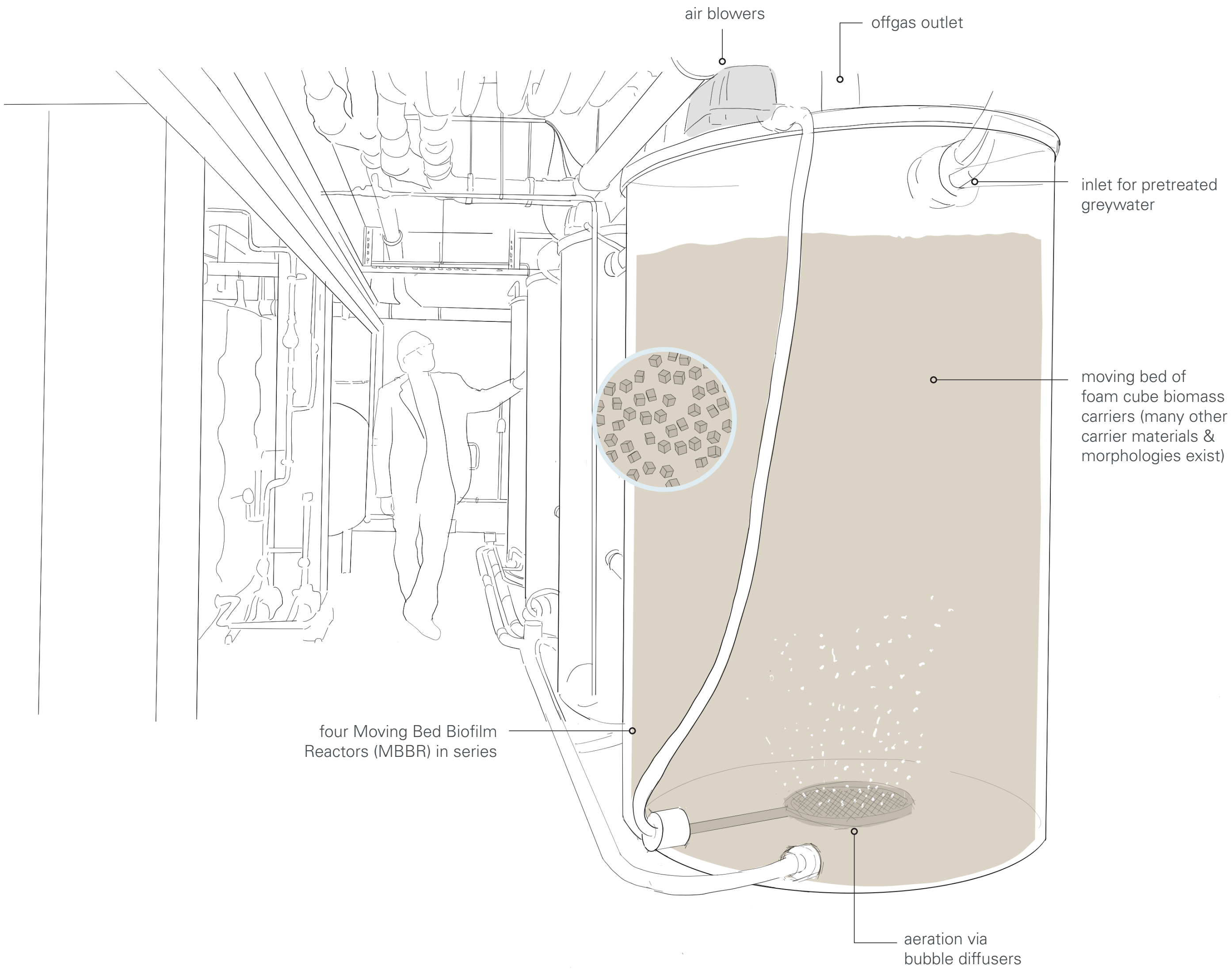
T.46 AERATED BIOREACTORS

TECHNOLOGY



GW — T.42 SCREEN — T.61 HEAT EXCHANGER — T.46 MBBR — T.49 SAND FILTER — T.50 UV DISINFECTION — T.61 HEAT EXCHANGER (heat) — T.41 STORAGE TANKS

Aerated bioreactors make use of microorganisms growing in flocs (i.e., activated sludge), and/or biofilms on fixed beds or moving carriers, to degrade organics and remove nutrients from wastewater. Active bubble aeration maintains aerobic conditions and keeps the activated sludge and/or carriers suspended. The biological treatment can occur in one tank or be distributed over several tanks (multistage). To enhance nitrogen removal when treating mixed wastewater, the set up can include a non-aerated chamber (i.e., pre-anoxic tank) or non-aerated intervals. Aerated bioreactors are sometimes combined with plants growing hydroponically, the roots serving as an extra support for biofilm growth while taking up nutrients. Depending on the bioreactor configuration, these systems are called sequence batch reactors (SBR), moving bed biofilm reactors (MBBR), submerged fixed bed biofilm reactors (SFBBR), or integrated fixed film activated sludge (IFAS). The specific configuration of aerated bioreactors combined with integrated micro- or ultrafiltration membranes, referred to as membrane bioreactors (MBR), and is described separately in T.47.

INPUT STREAMS

- GW Pre-treated Greywater
- MW Pre-treated Mixed Wastewater

TARGET OUTPUT(S)

- Treated Water

BERLIN-PANKOW STUDENT HOUSE

Berlin, Germany | 2022

MBBR system for greywater treatment and reuse

Roughly 16 m³/d of greywater from showers and bathroom sinks are treated in the basement of this 450 bed student housing apartment complex with a multistage MBBR system coupled to filtration and disinfection. The treated water is reused for toilet flushing. The heat from the greywater (up to 10kWh per m³) is recovered via heat exchangers for the hot water supply to the building.

SPECIFICATIONS

INFRASTRUCTURE

Bioreactor tanks can be prefabricated or built in concrete, and are typically placed in a mechanical room in the basement of a building, underground, or in a separate building dedicated to treatment. The design must be based on wastewater composition and volume as to not compromise treatment efficiency with an over- or under-dimensioned reactor. Different pre-fabricated reactor models are available.

Bioreactor variations with plants, integrated in a greenhouse or in the urban landscape, can provide aesthetically pleasing spaces.

OPERATION & MAINTENANCE

Energy use for aerated reactors can vary greatly depending on the configuration, though bubble aeration is generally energy intensive. Mechanical equipment such as mixers, aerators and pumps requires electricity and maintenance. Chemical consumption can also vary depending on the system configuration and wastewater characteristics. Ferric chloride ($FeCl_3$) can be used for phosphorus removal and other chemicals may be necessary to enhance settling of the sludge. Excess sludge must be regularly removed from the system and disposed of (e.g., pumped to the sewer network, if available), or valorized if there is an exisiting treatment for solid streams.

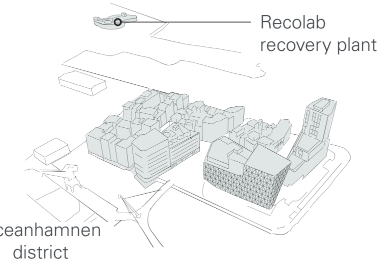
TARGET OUTPUTS

Aerated reactors are useful for the removal of organic matter (measured in COD and BOD_5 removal) and nitrogen. Effluent quality depends on the type of treatment configuration and operation. As with other biological treatment technologies, removal of pathogens and micropollutants is variable, therefore the effluent should be treated with additional biological treatment, filtration and/or disinfection steps to achieve the water quality necessary for the desired water reuse application, that also complies with local regulations, and public health requirements.

SELECTED CASE STUDIES

OCEANHAMNEN, RECOLAB

Helsinborg, Sweden | 2021



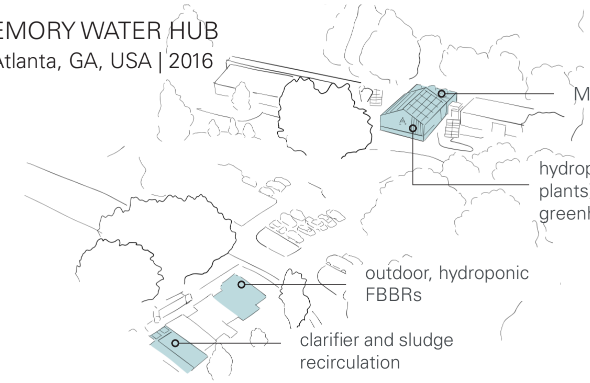
District scale treatment of greywater with activated sludge

Oceanhamnen district (2100 p.e.) uses an activated sludge system to treat greywater. The buffer tank (80m³), biological tank (65 m³) and a clarifier are concrete structures built below ground in the Recolab recovery plant, and can be accessed via hatches on the floor. A drum filter enhances solids separation before nanofiltration. In the future, it is expected that the liquid effluent from the blackwater and organic waste treatment will also be treated in this system. The recovered water will be used as bathing water in a neighboring swimming pool (under construction).

GW — COLLECTION TANK — T.46 ACTIVATED SLUDGE — T.42 DRUM FILTER — T.48 NANOFILTER — T.61 HEAT PUMP — T.41 STORAGE TANK (heat) —
T.51 OZONATION

EMORY WATER HUB

Atlanta, GA, USA | 2016



"Sewer mining" and "hydroponics" for water reuse on campus

The treatment plant at Emory University is designed to treat 1500 m³/d of wastewater in a space of 195 m². The screened wastewater is treated in a series of moving bed biofilm reactors (MBBR) (above-ground, concrete tanks) and fixed bed biofilm reactors (FBBR) with plants, or "hydroponic reactors", (integrated in a greenhouse and outdoors). The effluent from the biological reactors is treated further with a disc filter and UV disinfection located in the technical room before storage in a ... tank. It is then redistributed around campus for non-potable reuse in steam and chiller plants, and for toilet flushing, accounting for ~40% of total water use.

MW — T.42 SCREEN — T.46 MBBR — T.46 FBBR — T.42 DISC FILTER — T.50 UV DISINFECTION — T.41 STORAGE TANK

BLITSAERD

Leeuwarden, the Netherlands | 2024

Household greywater treatment units for direct water reuse

14 homes in the new district development were built with separate greywater piping and each home is equipped with a commercially-available water treatment unit. Each treatment unit occupies 0.8 m². Greywater from the showers is treated and reused for toilet flushing and for laundry resulting in significant water savings. The treatment units run automatically and are monitored online by the provider. Another 27 homes in the district were also built with separate piping. Future residents can choose to install greywater or rainwater systems.

GW — PRETREATMENT — T.46 MBBR — T.50 UV DISINFECTION