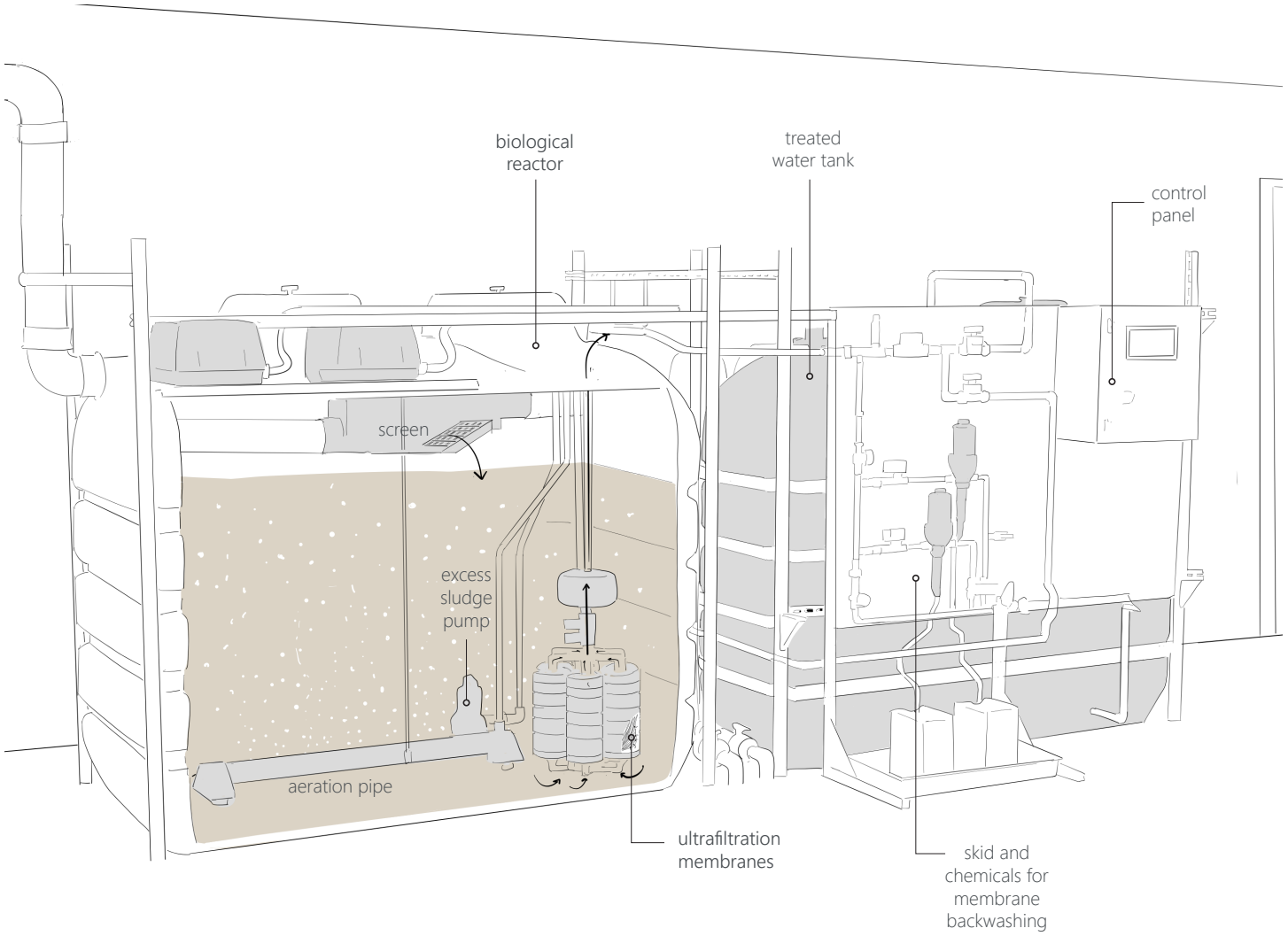
T.47 MEMBRANE BIOREACTORS

TECHNOLOGY



A membrane bioreactor (MBR) combines biological treatment with membrane filtration. In the aerated bioreactor, microorganisms degrade organics and remove nutrients (see T46 for more information on aerated bioreactors). The subsequent microfiltration or ultrafiltration membranes (pore sizes ~0.01–0.1 microns) physically separate suspended solids and microorganisms (see T48 for more information on membrane filtration), and eliminate the need for a clarification step. Membranes (flat sheet or hollow fiber) can be directly submerged in the biological tank, or placed in a dedicated membrane tank. MBRs are compact systems, compared to other bioreactor configurations, that ensure a high quality effluent that is often already suitable for some types of non-potable reuse. The treated water can be further disinfected or treated for micropollutant removal or desalination.

MBRs provide effective biological treatment and filtration in one system, producing high quality treated water in a relatively small footprint. They are therefore often the preferred solution for water reuse projects in urban settings where space is limited.

INPUT STREAMS

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

TARGET OUTPUT(S)

- Treated Water

GUESTHOUSE

Schleswig-Holstein, Germany | 2021

Greywater treatment and reuse

Source-separated greywater from a guesthouse serving 62 users is treated with a membrane bioreactor followed by UV disinfection. The treatment system is located in the basement of the building. The treated water is used to cover the water demand (~1.5 m³/d) for toilet flushing (35 toilets) and running two large washing machines.

SPECIFICATIONS

INFRASTRUCTURE

MBRs are typically installed in a technical room, often in the basement of the building. Often a concrete foundation or slab is needed to support the weight of the tankage and equipment. Biological tanks, and membrane tanks (if separate), can be prefabricated or reinforced concrete tanks. These tanks require space and access to a reliable power supply to operate the blowers and pumps. Additional space is needed to store chemicals required for cleaning the membranes, and for buffer and treated water storage tanks. If a connection to the sewer is available, waste streams from membrane cleaning and excess sludge can be discharged to the sewer. For off-grid configurations, waste streams have to be collected and disposed of at regular intervals.

OPERATION & MAINTENANCE

Smaller plug and play systems can be managed by users; custom systems serving larger buildings are usually operated and maintained by skilled personnel to ensure long-term performance and cost-effectiveness. Main tasks for operation include aeration adjustment to optimize biological treatment efficiency, membrane fouling management, and sludge management. Membranes require regular chemical cleaning, which can be highly automated with sensors and feedback loops. For submerged membranes, air scouring reduces sludge buildup on the membrane. For chemical cleaning, chemicals such as NaOCl or citric acid are required. Membrane modules have a high cost and typically need replacement every 5-10 years depending on type and usage.

A membrane bioreactor is an efficient water treatment technology with a relatively small footprint. The combination of biological treatment with a physical barrier eliminates the need for additional clarifiers for secondary treatment.

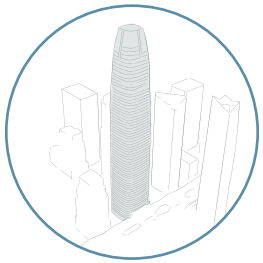
TARGET OUTPUTS

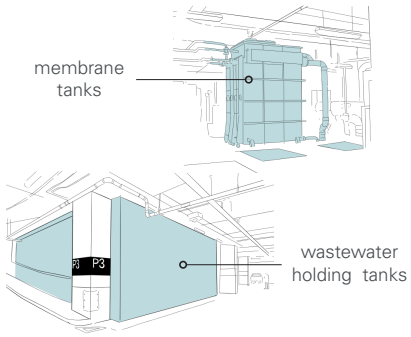
Membrane bioreactors yield high-quality treated water thanks to biological treatment combined with a physical barrier (the membrane). For single-family systems treating greywater, a MBR produces water that is suitable for toilet flushing. A further disinfection step increases reuse safety by removing smaller viruses and helps prevent microbial regrowth during storage and transport of the water before reuse. Suitability of the treated water for reuse depends on the type of water treated, intended use, local regulations, and public health requirements.

SELECTED CASE STUDIES

SALESFORCE TOWER

San Francisco, CA, USA | 2019





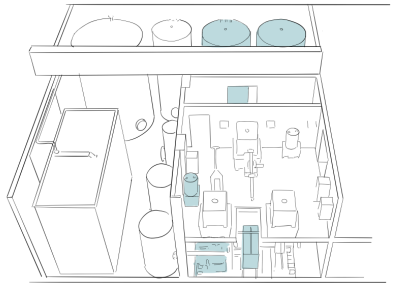
MBR in concrete tank for mixed wastewater treatment

Salesforce tower harbors the largest in-building water recycling system in the USA, treating 150 m^3 of mixed wastewater per day to non-potable water reuse standards. The biological concrete tanks of the MBR are integrated in the building structure (in the parking garage), while the mechanical room, including a separate membrane tank, a membrane operating skid and other treatment units, is situated one floor above. The treated water is redistributed through the building via a dedicated pipe network used for toilet flushing, drip irrigation and cooling towers. Water savings (76%) are equivalent to the annual average water consumption of 16,000 residents in San Francisco.

MW — T.42 SCREEN — T.41 BUFFER TANK — T.47 MBR — T.48 REVERSE OSMOSIS — T.50 UV DISINFECTION — CALCITE FILTER — T.50 CHLORINE DISINFECTION — T.41 STORAGE TANK

DE NIEUWE DOKKEN

Ghent, Belgium | 2020



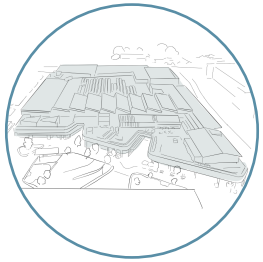
District scale treatment of source separated streams

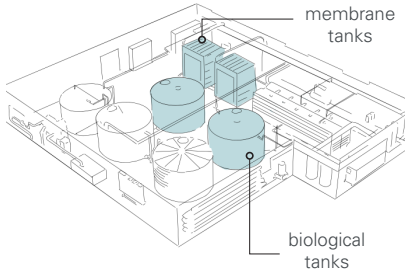
An MBR system treats greywater and effluent from the vacuum-collected blackwater treatment and sends the treated water to a neighboring soap factory to be used as process water. The biological reactors are large (PE) tanks spanning the height of two floors. They require the addition of a carbon source for denitrification and Ferric Chloride ($FeCl_3$) for phosphorus removal. The ultrafiltration membranes are located in a separate membrane tank. The offgases from the biological tanks are treated with biofilters; the excess sludge is sent to the blackwater treatment train.

GW — T.42 SCREEN — BW — T.41 BUFFER TANK — T.47 MBR — T.49 ACTIVATED CARBON FILTER — T.61 HEAT EXCHANGER — T.50 CHLORINE DISINFECTION — T.41 STORAGE TANK

BURWOOD BRICKWORKS

Melbourne, Australia | 2019





Large MBR treating mixed wastewater and stormwater

Burwood Brickworks is a large retail center certified by the Living Building Challenge for its contributions towards achieving "net zero water". An MBR is the core technology of the water reuse treatment train, designed to treat 60 m^3 of mixed wastewater and 30 m^3 of stormwater per day. The treated water is reused via the dedicated water pipe network for toilet flushing, for irrigation and in cooling towers.

MW — SW — T.42 SCREEN — T.41 BUFFER TANK — T.47 MBR — RW — T.51 OZONATION — T.50 UV DISINFECTION — T.49 ACTIVATED CARBON FILTER — T.41 STORAGE TANK