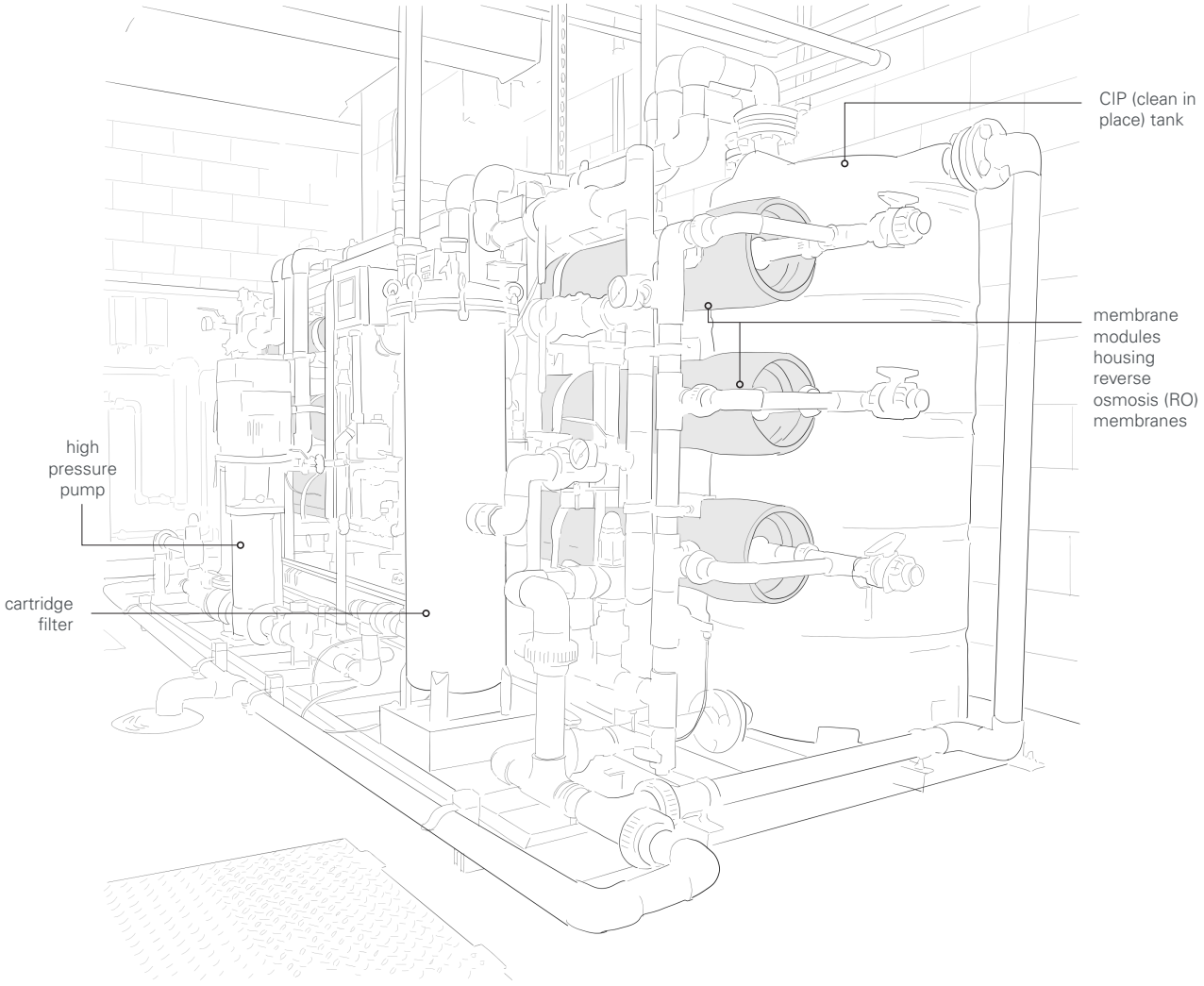
MEMBRANE FILTERS

TECHNOLOGY



Membrane filtration is a pressure-driven separation process where water is pumped through a semi-permeable membrane to filter out contaminants. Membrane pores allow water to filter through, but hold back contaminants that do not fit through the pores. Membranes can be hollow fiber or spiral wound, and have different pore sizes: microfiltration (~0.1), ultrafiltration (~0.01), nanofiltration (~0.001), and reverse osmosis (dense membranes). Depending on the type of membrane chosen, membrane filters can be used to remove suspended solids and colloids, pathogens (bacteria and viruses), organic micropollutants (e.g., PFAS, microplastics), compounds causing odor or color, and salts or ions from a water stream. Membrane bioreactors (MBR) have microfiltration or ultrafiltration membranes integrated directly into the biological treatment (see T.47).

Membrane units are often used as a filtration step after biological treatment of greywater or mixed wastewater, or for the treatment of rainwater. Micro- and ultrafiltration membranes are often placed before nanofiltration and reverse osmosis membranes to protect them from fouling.

INPUT STREAMS

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

TARGET OUTPUT(S)

- Treated Water

SALESFORCE TOWER

San Francisco, CA, USA | 2019

Reverse osmosis treats MBR effluent for on-site water reuse

The Salesforce Tower treats 150 m^3 of mixed wastewater per day to non-potable water reuse standards. A reverse osmosis system, set up as a skid in the mechanical room, treats the effluent from an MBR. The filtered water is disinfected and remineralized with a calcite filter before distribution in the building via a dedicated water network for toilet flushing, drip irrigation and cooling towers. Brine, produced as a byproduct of the reverse osmosis unit, is discharged to the sewer.

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

SPECIFICATIONS

INFRASTRUCTURE

Membranes filters (hollow fiber or spiral wound) are housed inside membrane modules (cylindrical pressure vessels). These are generally mounted on a metallic structure (skid) together with high-pressure pumps, interconnecting piping, inline valves, control systems, and backwash and cleaning systems. These skids facilitate transport and practical operation of the system, and ensure a compact footprint. They are usually placed in a (basement) mechanical room together with pre- and post- treatment steps. Infrastructure to handle brine (reject stream) from nanofiltration and reverse osmosis should be carefully considered. Significant volumes of brine are produced (e.g., 15-25% of the treated stream for reverse osmosis) and due to its high content in salts, it is sometimes not possible to send the brine to the sewer.

OPERATION & MAINTENANCE

Membrane filters can have relatively high energy requirements when they require high-pressure pumps. Reverse osmosis is the most energy-intensive of the membrane filters with operational pressures of more than 6 bar. Micro- and ultrafiltration require much less energy. Though much of the membrane filtration process can be automated, specialized personnel is usually responsible for its operation and maintenance. Conventional micro- and ultrafiltration systems must be regularly backwashed (i.e., the flow is temporarily reversed) to remove foulants accumulating on the membrane surface. Membranes also require periodic chemical cleaning to remove the long-term accumulation (scaling) of salts, organic materials or biolfilm on the membranes with citric acid, caustic, detergents or chlorine (e.g., every 30-60 days for micro- and ultrafiltration, or every 3-12 months for nanofiltration and reverse osmosis). Membranes must be replaced depending on fouling rates and operational conditions every 10-15 years.

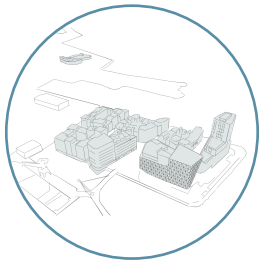
TARGET OUTPUTS

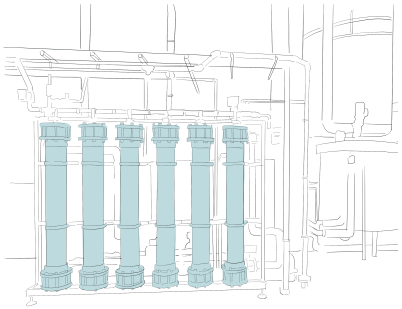
The quality of the filtered water (in terms of pathogen, dissolved organics and salt content) will depend on the type of membrane system used. Micro- and ultrafiltration membranes are generally sufficient for non-potable water reuse applications when followed by a disinfection step (to further remove pathogens) and/or advanced oxidation step (to remove micropollutants). Nanofiltration and reverse osmosis retain bacteria and viruses, and deionize and/or desalinize the stream to, e.g., avoid long term damage to plumbing fixtures, and heating and cooling systems. A multibarrier approach with redundancy in pathogen and micropullutant removal steps, helps ensure safe water reuse.

SELECTED CASE STUDIES

OCEANHAMNEN

Helsinborg, Sweden | 2021





Nanofiltration coupled to ozonation for micropollutant removal

Greywater from the neighborhood (scaled for 2100 p.e.) is treated in an activated sludge system followed by a drum filter (10 µm) and nanofiltration. The nanofiltration unit comprises a skid with 12 membrane modules, a permeate tank and a cleaning skid. The reject stream from the nanofiltration is treated by ozonation, to break down persistent micropollutants, before being recycled back into the activated sludge system. The backwash is also recycled back to the activated sludge, while the water from the chemical cleaning of the membranes is discharged to the sewer.

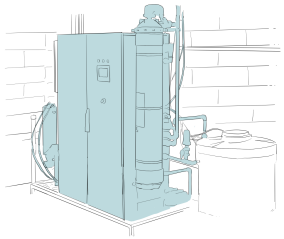
GW — COLLECTION TANK — T.46 ACTIVATED SLUDGE — T.42 DRUM FILTER — T.48 NANOFILTER — T.61 HEAT PUMP — T.41 STORAGE TANK

T.51 OZONATION

heat

HOLLAND PARK

London, UK | 2021



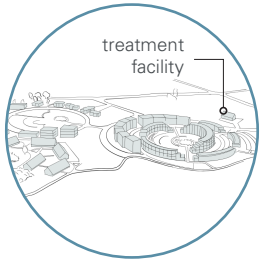
Greywater treatment “on demand” with ultrafiltration

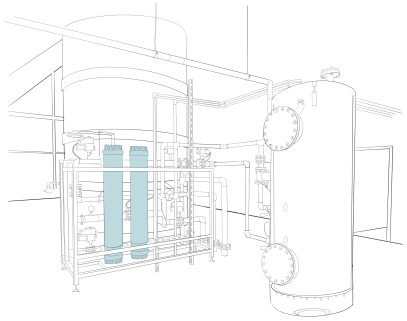
Ultrafiltration membranes are the core technology of this greywater treatment unit. At this 25-home residential complex, greywater is collected from sinks, baths, and showers and is sent via a dedicated piped network to a storage tank in the basement. The water is treated without a biological step due to very strict space limitations. Key to the correct operation of this system is that greywater can be quickly treated and reused on demand and does not need to be stored for long periods of time. A high pressure disc filter ensures that the membranes will not clog. The water is reused for toilet flushing.

GW — T.41 STORAGE TANK — T.42 DISC FILTER — T.48 ULTRAFILTRATION MEMBRANES — T.50 CHLORINE DISINFECTION — T.41 STORAGE TANK

NYE SUBURB

Aarhus, Denmark | 2018





Rainwater treatment with ultrafiltration for non-potable reuse

The Aarhus suburb of Nye (~13,500 p.e.) is a modular housing project, with a rainwater reuse system operated by the local utility. Rainwater is treated in a multimedia pressure filter followed by ultrafiltration membranes (0.2 µm) before storage in a clean water tank (55 m^3). Before distribution, the water undergoes UV disinfection. The treated water is reused for toilet flushing and in washing machines, providing 40% of the water demand in Nye.

RW — T.41 CISTERN — T.49 MULTIMEDIA FILTER — T.48 ULTRAFILTRATION MEMBRANES — T.41 STORAGE TANK — T.50 UV DISINFECTION