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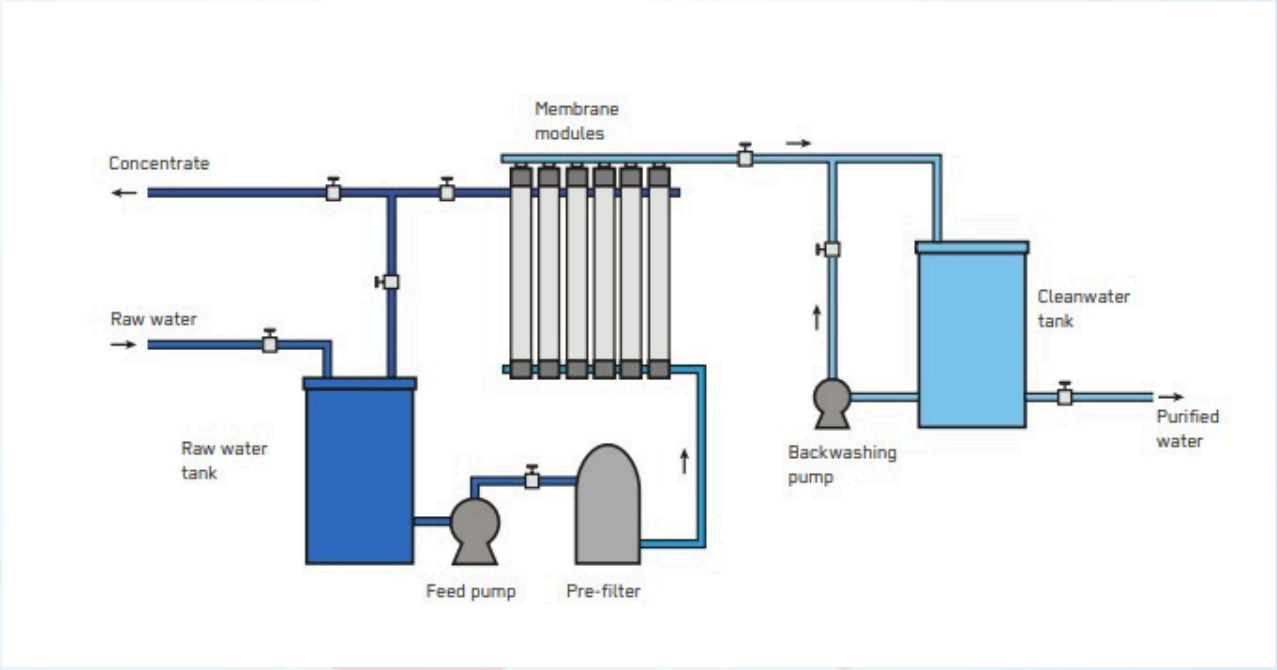
Ultrafiltration UF System



Ultrafiltration (UF) is part of the family of pressurised membrane filtration systems that can purify water from undissolved and most dissolved substances. UF is used as a final treatment step and can be applied in the acute response as well as in the stabilisation and recovery phases of emergencies.

UF uses membranes to filter water under pressure and functions the same as Microfiltration. UF units can be prefabricated and skid-mounted or available as single membrane modules. Most UF membrane modules in skid mounted systems are made of small, string-like hollow fibres (polymer materials) that are mounted in cylindrical (pipe-like) vessels or tanks due to the high packing density (2,000–15,000 m^2/m^3 depending on system type). The main difference between MF and UF is the exclusion size, which for UF is 0.1–0.01 µm and for MF is 0.5–0.1 µm. This leads to similar filtration results for particles, protozoa, bacteria (3-log to 6-log) and a significantly better removal of viruses (1-log to 5-log) with UF membranes. Additional proteins and polysaccharides are removed by around 80% and hemic substances by 40–60%. Post-treatment usually includes disinfection, such as Chlorination, to provide residual protection.

Design Considerations:

Membrane-based filters can be operated as dead-end-filters (feed is pushed completely through the membrane), or cross-flow filters (feed flows over the membrane, not all of the feed is filtered).

Typical UF membranes are run as dead-end filters. Depending on the intake water quality, particularly the turbidity (above 500 NTU), a pre-filtration or pre-treatment should be considered to avoid membrane plugging. Pre-treatment always includes a protective pre-screen (typically an auto-backwashing type rated at about 300 microns). Additional pre-treatment, such as Assisted Sedimentation, can improve the removal of dissolved materials and reduce the fouling potential of the water. Automatic in-line coagulation followed by direct microfiltration is also used for water with a high fouling potential.

Ultrafiltration (UF) systems use regular backwashing (every 20–30 minutes) with filtered water to remove particles from membrane surfaces. During the 2–3 minute backwash, no filtrate is produced. These systems recover 85–95% of feed water as usable filtrate, with the rest discharged as waste. Operated under 0.5–1 bar pressure, UF systems may use constant flow or gravity-fed designs. Monthly chemical cleaning and integrity tests ensure performance and prevent fouling. Membranes should not run dry but can be preserved for storage. No filter-to-waste step is needed after backwash.

Ultra Filtration System

Materials:

Typically in emergency situations, the UF system is bought as one unit, not just the membrane elements. Ancillary equipment, including support racks, pumps, valves, pre-screen(s) and a computer control system (for backwash and water quality monitoring) are just as important as the membranes themselves. Consumables include membrane elements (8–10-year service life if operated correctly), membrane repair kits, electricity and chemicals (e.g. citric acid, sodium hypochlorite for cleaning and disinfection; caustic sodium hydroxide and sodium bisulfide for neutralisation).

Applicability:

UF technology can be used in a wide variety of contexts due to its modular functionality, giving it a flexible filter performance. It can be a one-step treatment, as it has excellent filtration, though can also be used as a pre- treatment step to reduce turbidity for Reverse Osmosis. Automated small-scale, skid-mounted systems are available and can be set up in a few hours. UF is sometimes applied in remote locations, though is typically reserved for a village or city. UF membrane filtration can be used in the acute response (as smaller units) and in the stabilisation and recovery phases of emergencies. UF membrane elements are modular, though adapting the number of modules in skid-mounted systems is not easy due to limitations of the auxiliary equipment (pumps, control systems).

Operation and Maintenance:

Well-trained operators are required for a long, reliable service life. Although the systems are usually automated or semi-automated, operating mistakes can cause major damage to membrane elements (broken fibres, fouling). Regular O&M tasks include the daily verification of instrument accuracy and an integrity test, a daily check on chemical levels, a weekly calibration of chemical feed pumps, instrument cleaning, weekly review of data and consideration of revisions to operating parameters like flux, monthly (or sometimes more often) chemical cleaning and a volt-amp check on electric motors. Gravity-driven systems usually require regular manual backwashing (daily or weekly) and flow monitoring.

Health and Safety:

Retentate disposal must be carefully considered, as it contains the contaminants found in the feed water. Depending on the makeup and local regulations, retentate can be directed back to the source, disposed of in the municipal sewer, diluted and used for irrigation or treated on-site before disposal. Treatment before disposal and reuse is recommended when disposal in municipal sewers is not possible. Cleaning chemicals can be corrosive and require trained operators and personal protective equipment.

Costs:

Initial investment costs are comparatively high due to the cost of membrane modules and the need for advanced auxiliary equipment. While the UF membrane alone is relatively cheap (10–20 USD/m² of the membrane), the cost of the entire module varies between 70–120 USD/m² of the membrane, depending on the producer and membrane type. Regular maintenance will ensure a service life of up to 10 years (depending on the manufacturer), resulting in relatively low costs per user over time. A constant investment in cleaning agents, repairs and trained personnel is necessary and varies according to country and region.

Social and Environmental Considerations:

The acceptance of the water is high because it is considered safe and visually clear. The treatment process effectively removes a significant portion of the color, and importantly, it does not alter the natural taste of the water, making it more appealing and trustworthy for consumers.

Strength:

- High microbial removal performance
- Can be used as a one-step treatment
- Is very compact and easy to transport systems

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