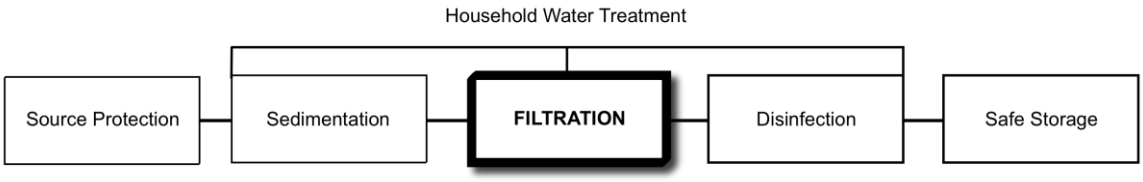
Centre for Affordable Water and Sanitation Technology

Household Water Treatment and Safe Storage Factsheet: Membrane Filters

The Treatment Process



Potential Treatment Capacity

Very Effective For:	Somewhat Effective For:	Not Effective For:
• Bacteria (UF[1], NF[2], RO[3]) • Viruses (UF, RO, NF) • Protozoa (MF[4], UF, NF, RO) • Helminths (MF, UF, NF, RO) • Salt (RO, NF)	• Colour (UF, RO, NF) • Turbidity (UF, RO, NF) • Iron (UF, RO, NF) • Manganese (UF, RO, NF)	• Chemicals, pesticides (UF) • Heavy metals (UF)

[1] Ultrafiltration (see below)
[2] Nanofiltration (see below)
[3] Reverse Osmosis (see below)
[4] Microfiltration (see below)

What Is a Membrane Filter?

A membrane is a thin barrier with holes, or pores. Some particles, such as water, are small enough to pass through the membrane pores, while larger particles cannot pass through and are retained on the membrane. Membrane filtration is used as a step in the multi-barrier approach for water treatment, but it is also used in other areas such as desalination and water quality testing.

Membrane filtration can be classified according to the diameter of the pores in the membrane, or by the molecular weight of contaminants the membrane retains.

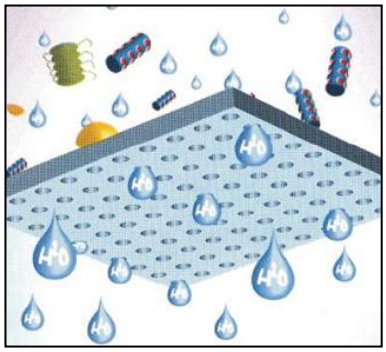
Filtration Type	Pore Size (µm / nm)	Molecular Weight (Daltons)
Microfiltration (MF)	0.1-10 µm (1-1000 nm)	
Ultrafiltration (UF)	0.01-0.1 µm (1-100 nm)	10,000-500,000
Nanofiltration (NF)	<0.001 µm (<1 nm)	200-1,000
Reverse osmosis (RO)	<0.001 µm (<1 nm)	<100

(Wagner, 2001 and US EPA, 2005)

Ultrafiltration is the most common membrane filtration in household drinking water treatment.

How Does It Remove Contamination?

As water passes through the membrane, pathogens and other contaminants are removed because they are too big to fit through the membrane pores. Pressure is required to force the water through the membrane. For microfiltration and ultrafiltration, gravity alone may provide enough pressure to make the water flow through the filter.



Filter Membrane Illustration
(Credit: www.firstprinciples.com)

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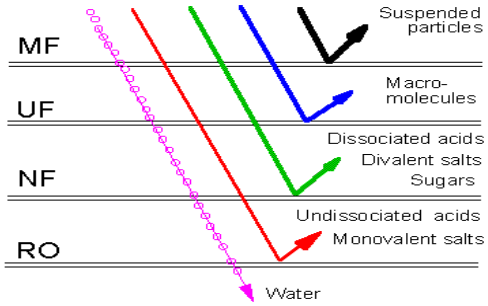
Ultrafiltration membranes will remove large and heavy particles such as sand, bacteria, protozoa, helminths, and some viruses. They will not effectively remove most dissolved or small substances such as salt or smaller viruses.



Types of Membrane Filtration and Their Contaminant Removal Capabilities
(Credit: https://netfiles.uiuc.edu/mcheryan/www/mem-tech.htm)

Microfiltration alone is not as effective as ultrafiltration for treating drinking water because the membrane pores are bigger than most viruses and some bacteria. Microfiltration is sometimes used as a pre-treatment step in a multi-barrier treatment system.

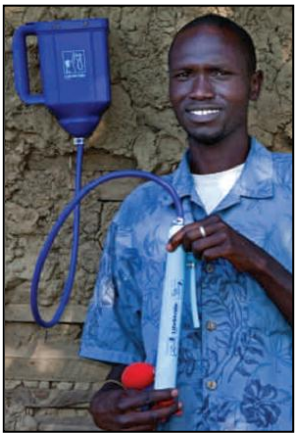
Nanofiltration and reverse osmosis are very effective at removing microbiological contamination, but these membranes are more commonly used in water desalination and industrial processes where the removal of dissolved contaminants is required.

Operation

There are several HWT products that use membrane technologies. Operation and maintenance procedures vary between products. A driving force is required to force the water through the membrane – this may be gravity (microfiltration and ultrafiltration), pressure or vacuum (nanofiltration and reverse osmosis). No electricity is required if manual pumping or gravity are used to force the water through the membrane. No chemicals are required, although some household membrane filter products also include a chemical disinfection step afterwards.

Some examples of such products are Sawyer® filters and Lifestraw®, which use ultrafiltration, and Nerox® filters, which use microfiltration. Please refer to the individual CAWST Membrane Filtration Product Sheets for further information on these technologies.

Sawyer Filter
(Credit: www.sawyerpointonefilters.com)



Lifestraw Family Filter
(Credit: www.vestergaard-frandsen.com/lifestraw)

Nerox-02 Filter
(Credit: www.scan-water.org)

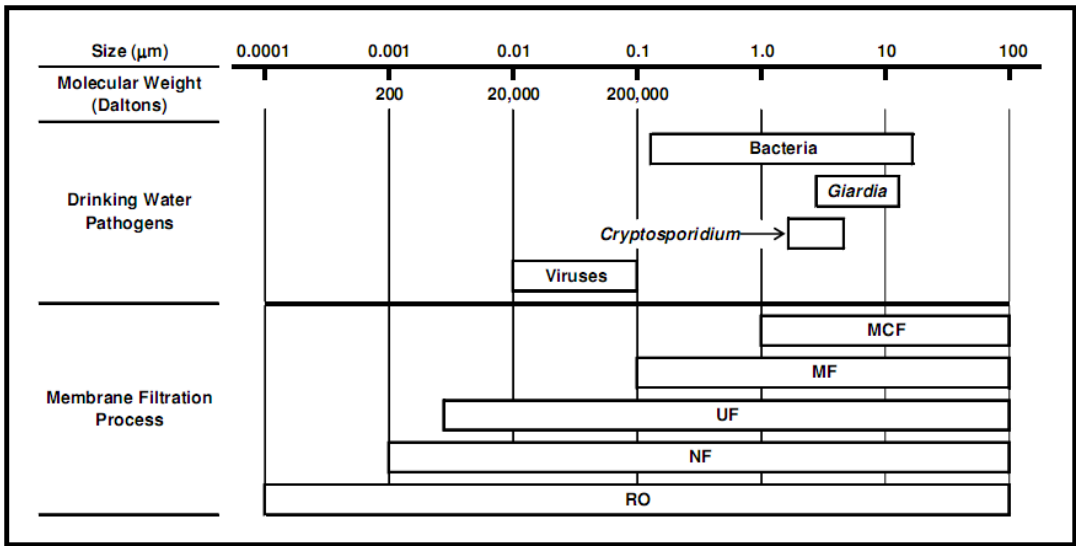
Household Water Treatment and Safe Storage
Fact Sheet: Membrane Filters Key Data

Inlet Water Criteria

- Some products recommend or incorporate a pre-filtration step such as straining through a cloth, settling, or sand filtration to reduce inlet water turbidity
- Very turbid water will clog membranes, reducing flow rate and requiring more frequent cleaning

Treatment Efficiency

- Depends on membrane pore size and filter product; see Membrane Filtration Product Sheets
- The following illustration shows the different pore sizes of each filtration type in comparison to the size of various pathogens. It is important to research the pore size and treatment capability of any filter product before purchase.



Pore Size for Various Filtration Types and Relative Pathogen Sizes ("MCF" = Membrane Cartridge Filtration)
(US EPA, 2005)

Operating Criteria

- Operation depends on product

Membrane Filter Product	Flow Rate	Daily Water Supply	Lifespan Volume
Sawyer® 0.02 filter[1]	13.6-15 litres/hour	327 litres	3.78 million litres
Sawyer® 0.1 filter[2]	46.5-54 litres/hour	1117 litres	N/A
Lifestraw® Individual[3]	N/A	2 litres	700 litres
Lifestraw® Family[3]	6-8 litres/hour	144-192 litres	18,000 litres
Nerox® filter[4]	N/A	15-25 litres	2,500 litres

N/A – not available
[1] www.sawyerpointonefilters.com; based on a 3-foot hose attached to a 5-gallon bucket at sea level. Increasing the hose length, using a larger container or continuously keeping the bucket full will increase flow rate.
[2] www.sawyerpointonefilters.com; based on a 1-foot hose attached to a 5-gallon bucket at sea level. Increasing the hose length, using a larger container or continuously keeping the bucket full will increase flow rate.
[3] www.vestergaard-frandsen.com/lifestraw
[4] www.scan-water.com

Household Water Treatment and Safe Storage
Fact Sheet: Membrane Filters — Key Data

Robustness

- Many membrane filter products cannot be used or stored in temperatures below zero
- Some products are available for use in emergency contexts

Estimated Lifespan

- Depends on product

Manufacturing Requirements

Worldwide Producers:
- There is a wide variety of companies that manufacture membrane filter products worldwide
- Compact designs usually allow for easy handling and transport

Local Production:
- It could be difficult to find local producers of membranes or membrane filter products
- Some components for manufacturing or assembling membrane filter products can be found locally (e.g. tubing, containers)

Materials:
- Membranes are made from a variety of materials such as acrylonitrile, polysulfone, polypropylene, polyester or polytetrafluoroethylene

Labour:
- Anyone can be trained to construct and install the system

Hazards:
- No specific manufacturing or operational hazards

Maintenance

- Membranes and other parts of the product may need regular cleaning and/or backwashing

Direct Cost

Capital Cost	Operating Cost	Replacement Cost
Depends on product	Not available[1]	Depends on product

[1] Operational cost will depend on product chosen, location, local infrastructure, pumping system (manual or electric)

References

Wagner, J. (2001). Membrane Filtration Handbook. Second Edition, Revision 2. Osmonics, Inc. USA. Available online at: www.ionics.com/content/pdf/1229223-%20Lit-%20Membrane%20Filtration%20Handbook.pdf

United States Environmental Protection Agency (US EPA). (2005). Membrane Filtration Guidance Manual. USA, Nov 2005. Available online at: www.epa.gov/ogwdw/disinfection/lt2/pdfs/guide_lt2_membranefiltration_final.pdf

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