Large-Scale Potable Water Production

Inorganic Membrane Purification

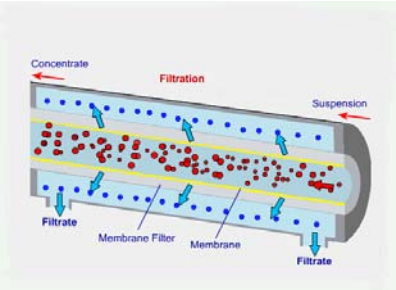
Technical Concept

Filtration occurs by preventing passage of particles as small as one-tenth the size of the pores through the filter. Membranes can be fabricated to remove even the smallest of viruses.

ORNL's inorganic membranes are surface filters as opposed to depth filters. Capturing particles near the surface makes the tubes easier to clean. Specific contaminants, such as cyanide, can be removed using functionalized membranes. For the ultimate in water purification, ORNL's inorganic reverse osmosis (RO) membrane operates on a vapor-gap principle, preventing the passage of any particles or nonvolatile chemicals.

The membrane filters can be fabricated from porous stainless steel or another suitable rugged metal (see figures). These filters can be used to remove silt, bacteria, and viruses for improved feed to conventional RO systems. By improving the quality of feedwater, the RO membranes will last longer with vastly improved performance. Because these metal filters are rugged and can be cleaned and sterilized repeatedly without performance degradation replacement costs, both materials and labor, are reduced. In addition to municipal application, this technology is also useful for military applications. Because ORNL filters are cleanable, the weight and volume required on trucks and ships for replacement filters can be used for more food, ammunition, and fuel. This technology is extremely scalable from small enough to be incorporated into a canteen to large enough to serve municipal water systems.

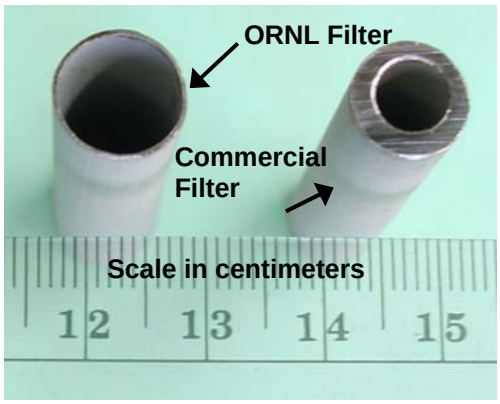
Filtration tubes are closely bundled to increase the membrane area allowing greater through puts.



Filtration is performed by the membrane that lines the inside surfaces of all tubes.

ORNL's Inorganic Membrane Fabrication Process is Quite Versatile

- Pore diameters of 0.5 nm to 20,000 nm
- Support structure and layer made of variety of metals and ceramics
- Thin filter wall reduces manufacturing materials costs while maintaining strength and improving permeance
- Mechanical, thermal, and chemical stability
- Separative membrane layer thickness of 2µm or less yielding a high permeance at low pressure drop
- Proven scalability



Photograph of ORNL filter and commercial filter which shows difference in wall thickness.

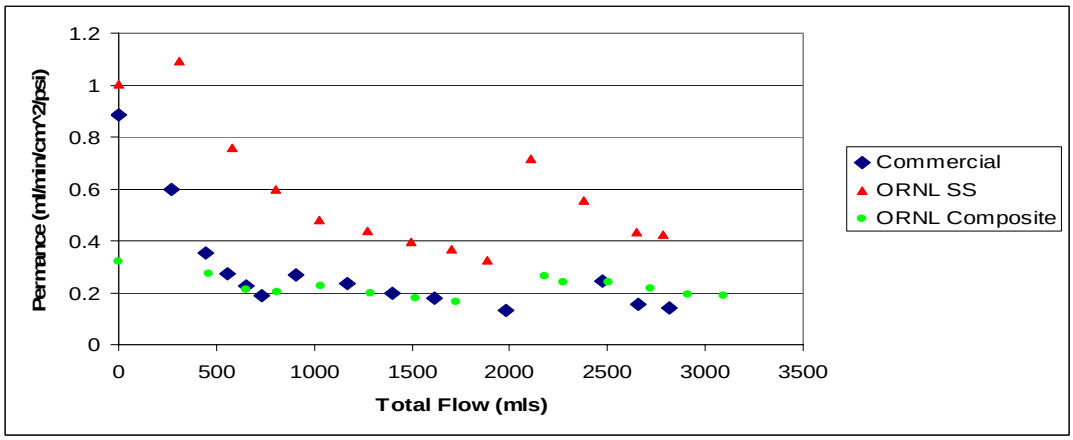
Advantages of using this technology to purify water include:

- rugged and significantly longer service life than polymeric filters;
- capability to filter as small as 0.01 microns;
- low manufacturing cost, lightweight and easily transportable;
- availability in small, canteen size as well as 5000-gal/h size;
- reduced reliance on chemicals;

Recent Results

Rejection of polystyrene microsperes, inititally, after backflush of filter, and at the end of test.

		Particle Size (µm)					
Filter Type	**Initial, Back Flush and Final Fractions**	**10**	**6**	**3**	**1**	**0.5**	**0.5**
ORNL 4.2 µm	Initial fractions	[1]>99.90	99.9	99.98	99.96	98	96.85
Commercial	Initial fractions	>99.90	99.91	99.97	99.6	99.8	99.89
ORNL 0.6 µm	Initial fractions	>99.90	>99.99	99.93	99.98	99.8	99.9
ORNL 4.2 µm	After Back flush	>99.90	99.98	99.99	99.98	98.75	98.9
Commercial	After Back flush	>99.90	99.97	99.8	99.3	98.72	99.2
ORNL 0.6 µm	After Back flush	>99.9	>99.998	>99.9992	99.99	99.996	99.994
ORNL 4.2 µm	Final fractions	>99.90	99.98	99.99	99.997	99.93	99.97
Commercial	Final fractions	>99.90	99.97	99.9	99.97	99.98	99.97
ORNL 0.6 µm	Final fractions	>99.9	>99.998	>99.9992	>99.998	>99.998	99.999



Flow comparison of ORNL filter with commercial stainless steel filter. Flow decreases rapidly for commercial filter while flow for ORNL filter remains high throughout experiment.

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