MARMARA UNIVERSITY-ENVIRONMENTAL ENGINEERING DEPARTMENT
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Characterization of Ultrafiltration Membranes and Determination of Membrane & Fouling Resistance Coefficients

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MEMBRANE FILTRATION

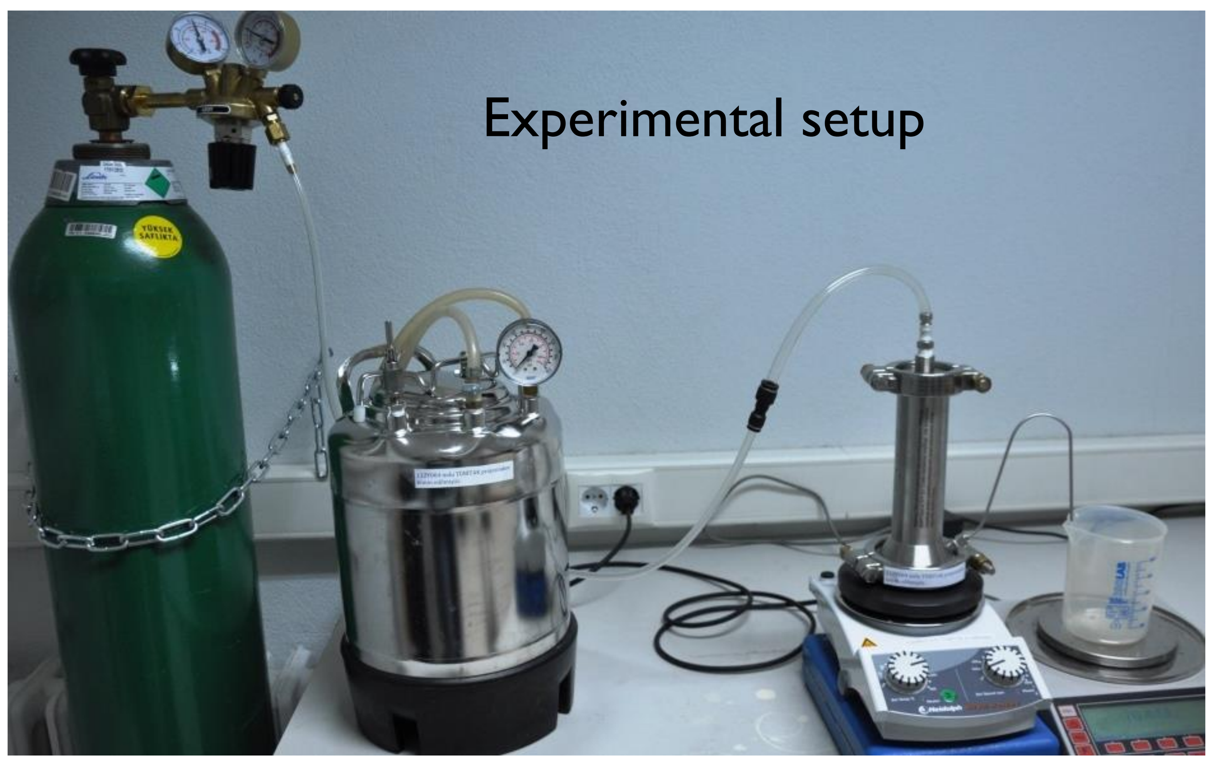
Membrane filtration can be a very efficient and economical way of separating components that are suspended or dissolved in a liquid. The membrane is a physical barrier that allows certain compounds to pass through, depending on their physical and/or chemical properties.

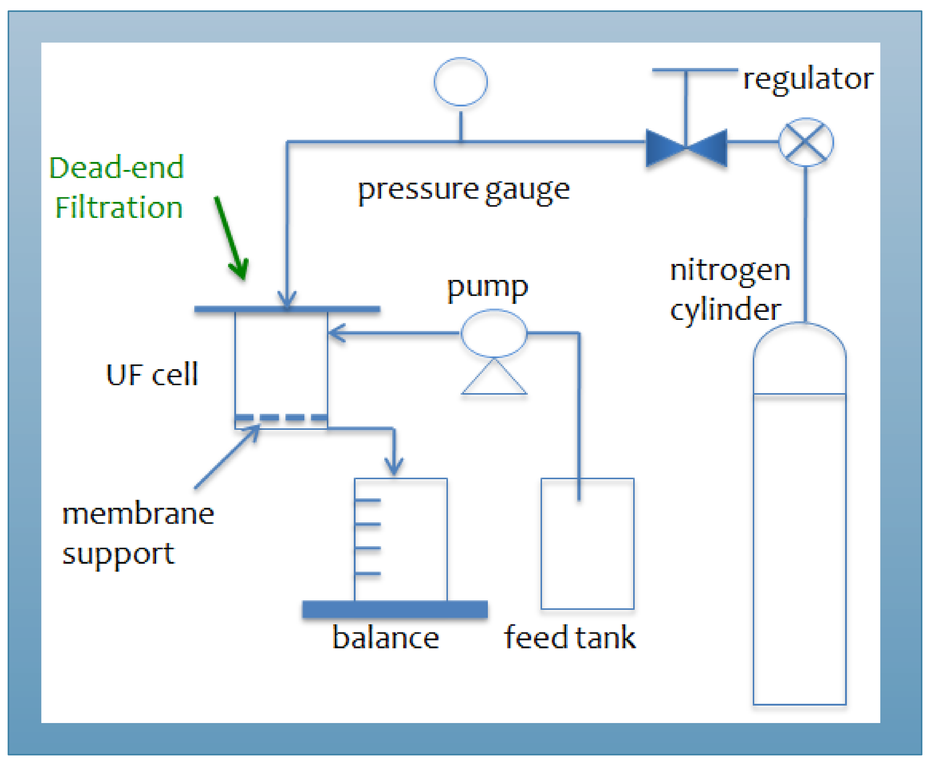
Membrane processes are increasingly used for removal of bacteria, microorganisms, particulates, and natural organic material, which can impart color, tastes, and odors to water and react with disinfectants to form disinfection by products.

Membrane resistance coefficients and membrane fouling are the most important issues affecting membrane operation and design.

AIM OF THE STUDY

- To determine specific flux of an ultrafiltration membrane
- To study the effects of pressure on membrane flux
- To determine membrane resistance coefficient of a membrane at a constant temperature
- To study the decline in flux while filtering a river water or a natural water
- To calculate cake resistance coefficients following fouling and observe the effects of membrane backwash (surface cleaning) on filtering performance & flux decline





- Sterlitech™ HP4750 Stirred Cell
- Membrane
- Compact laboratory balance KERN PFB
- Nitrogen gas cylinder
- Raw Water (Elmalı Dam Water)
- Distilled Water
- Magnetic Stirrer
- Pressure regulators and gauges
- Online data accusation system and PC

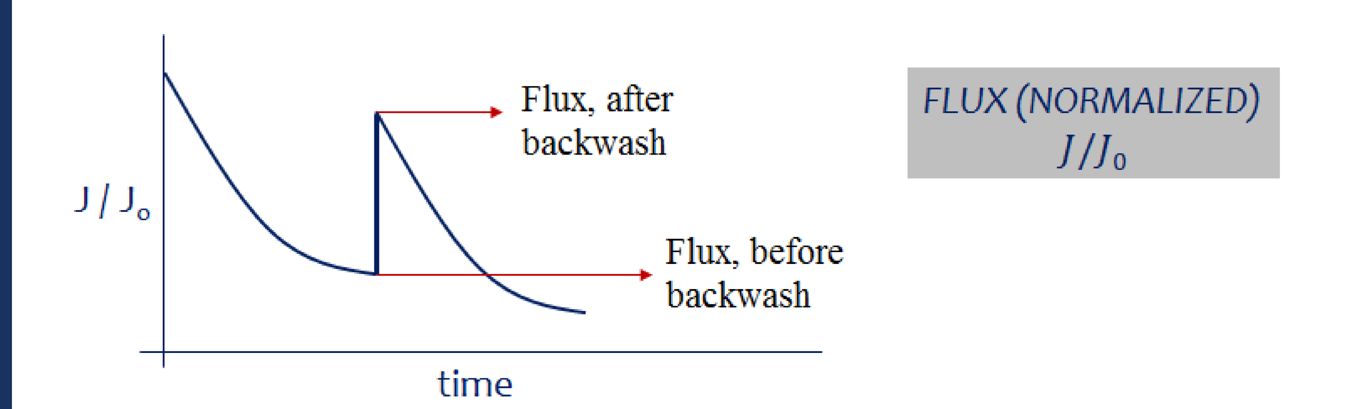
Procedure

1. Characterization of the membrane used: specific flux of membrane was determined by measuring pure water flux at four different transmembrane pressures (TMP)
2. Pure water flux determination: Deionized water was filtered through the membrane going to be studied for river water filtration
3. Membrane resistance coefficient was found (K_m, m^{-1})
4. River water (taken from Elmalı Dam) was first filtered through a microfiltration membrane as a pretreatment step to remove large particulates (0.5 bar)
5. Pre-filtered river water was filtered through a 20 kDa ultrafiltration membrane
6. Filtration cycle consists of 1 min of backwash (membrane surface cleaning) in every 15 minutes of filtration

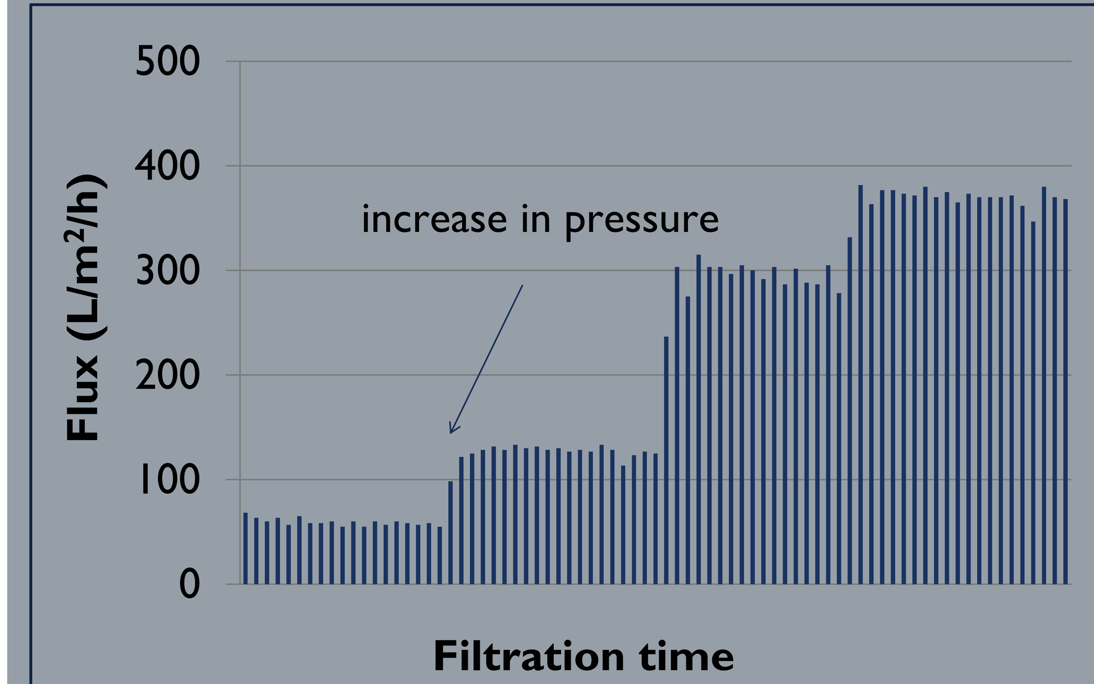
$$Reversible\ Flux\ Decline = Flux_{after\ backwash} - Flux_{before\ backwash}$$

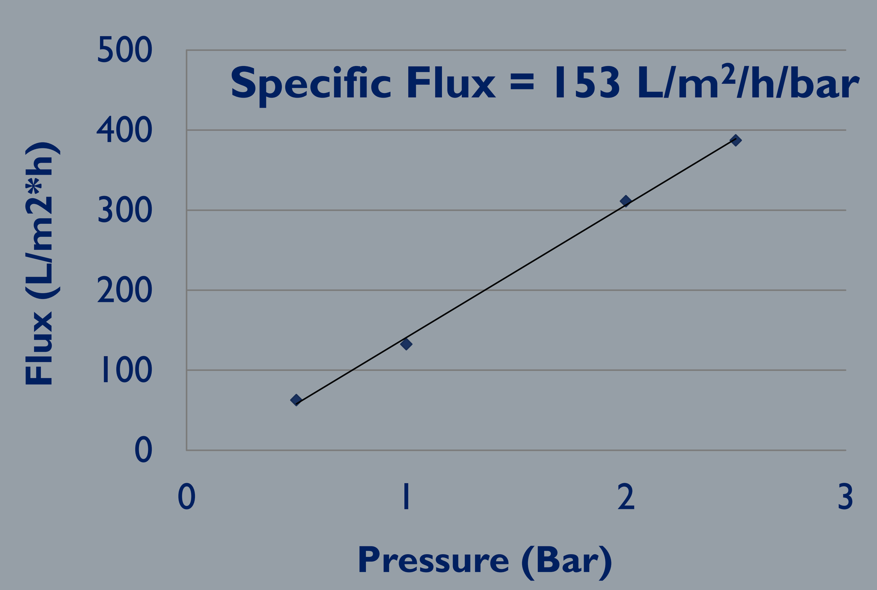
$$Irreversible\ Flux\ Decline = 1 - Flux_{after\ backwash}$$

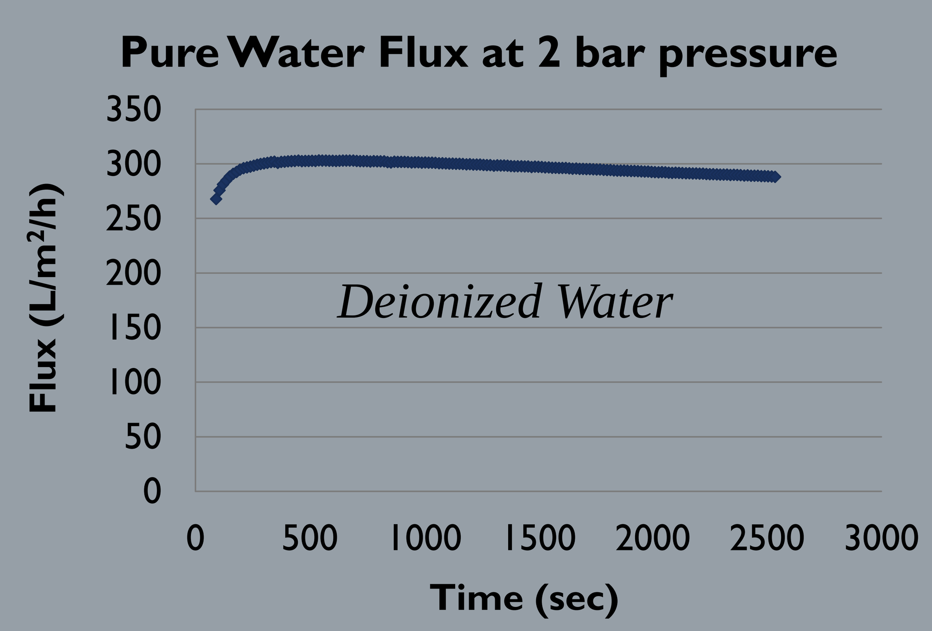
$$Total\ Flux\ Decline = Reversible\ Flux\ Decline + Irreversible\ Flux\ Decline$$



Results



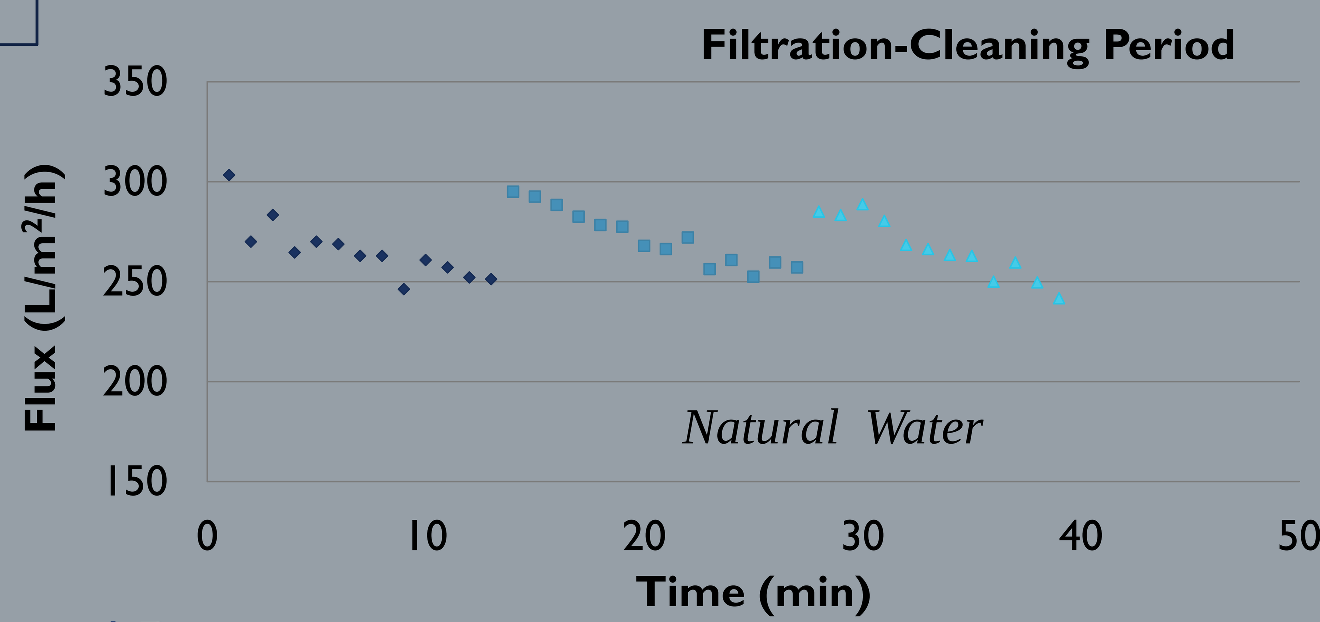




$$J = \frac{Q}{a} = \frac{\Delta P}{\mu \times Km} \qquad Km = \frac{\Delta P}{\mu \times J} \qquad K_m = 2.37 \times 10^{12}\ m^{-1}$$

Resistance-in-series model

- To calculate irreversible fouling resistance coefficient flux data were recorded immediately after backwash.
- Cleaning removed the reversible components of fouling so immediately after cleaning the chemically reversible fouling resistance coefficient is zero.
- Only membrane resistance coefficient and irreversible fouling resistance coefficient were observed.



$$Kir = \frac{\Delta P}{\mu \times J} - Km$$

$$Kir = \frac{\Delta P}{\mu \times J} - 2.37 \times 10^{12}\ m^{-1} \qquad K_{ir} = 7 \times 10^{10}\ m^{-1}$$