# כנס בנושא אסדות הגז: קהילה, בריאות וסביבה
## יוני 2018

# התפלה מבוססת-ממברנות:
# עקרונות וסיכונים כתוצאה מזיהום קונדנסט ומי תוצר

**גיא רמון**

*הפקולטה להנדסה אזרחית וסביבתית*

הטכניון - מכון טכנולוגי לישראל

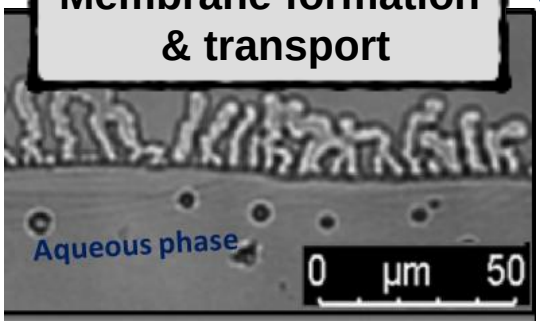
Water & Energy Technologies Laboratory

# Our research activities

***Membrane-based water production***

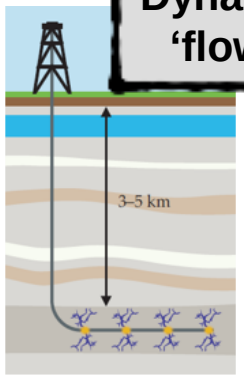
***Water management in shale-oil & gas production***

**Membrane formation & transport**

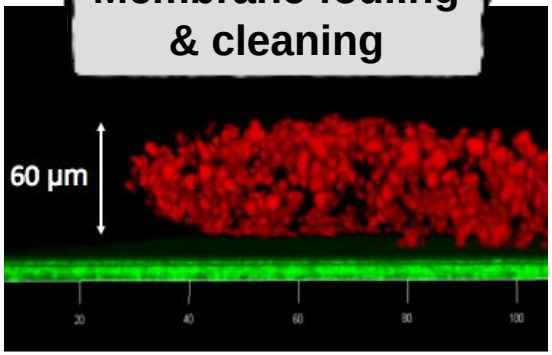


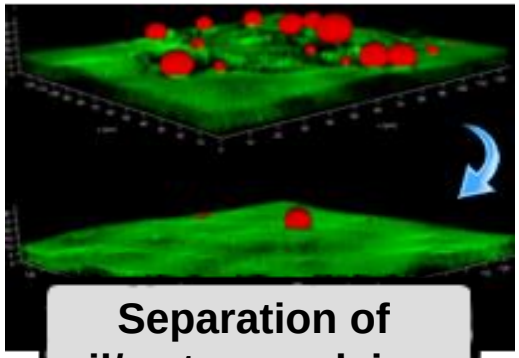

Water & Energy Technologies Laboratory

**Dynamics of 'flowback'**




**Membrane fouling & cleaning**

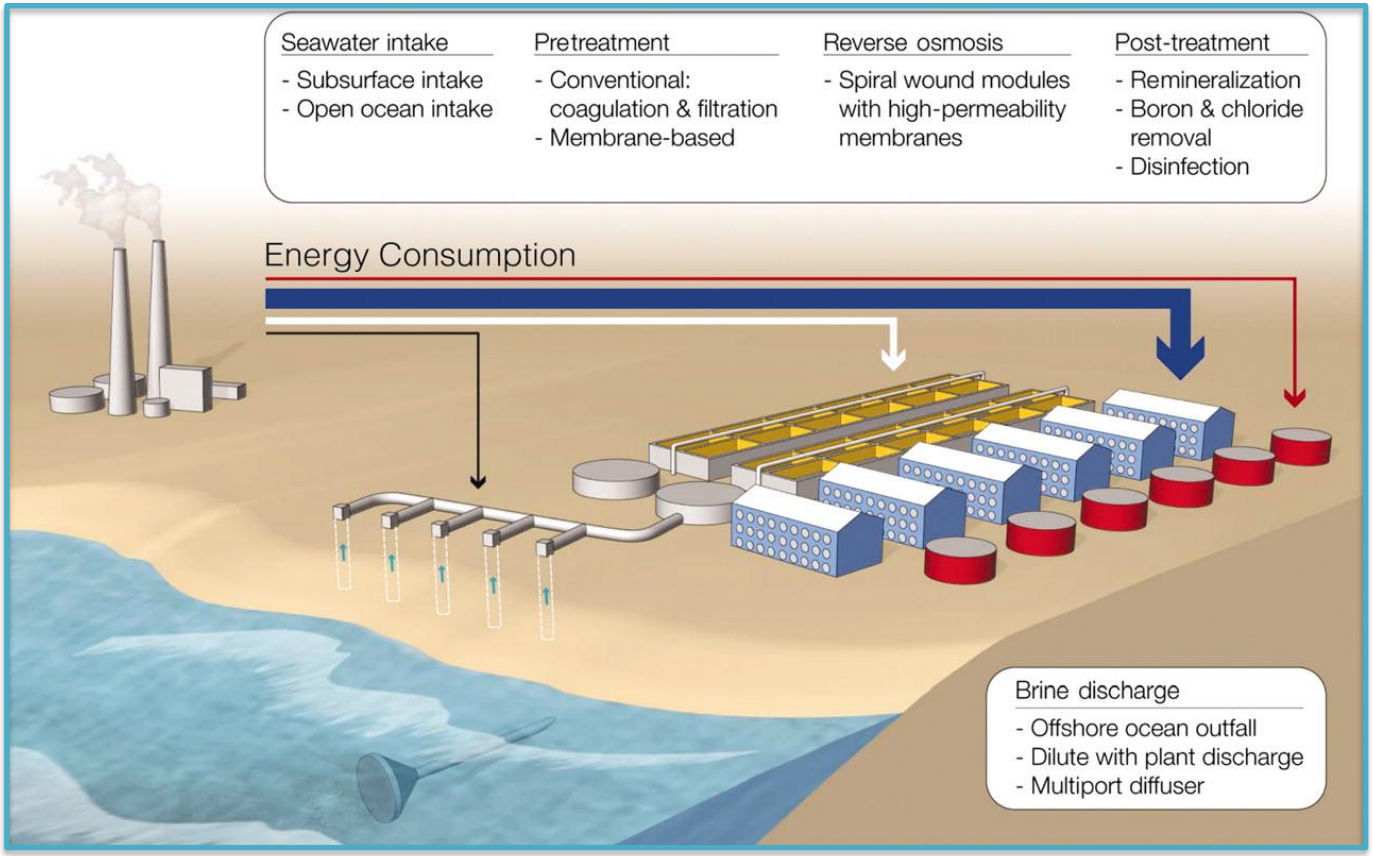


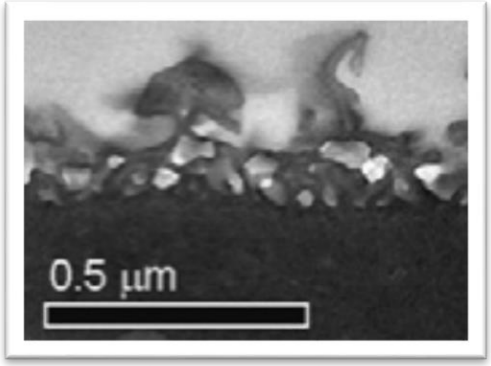
**Separation of oil/water emulsions**

***Acoustic energy conversion***

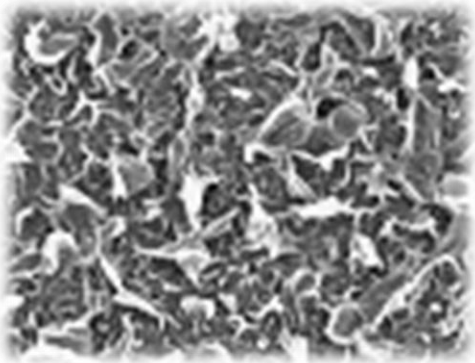
# Membrane-based seawater desalination: Reverse Osmosis




Phillip & Elimelech, Science, 2012




Pacheco et al, JMS, 2011

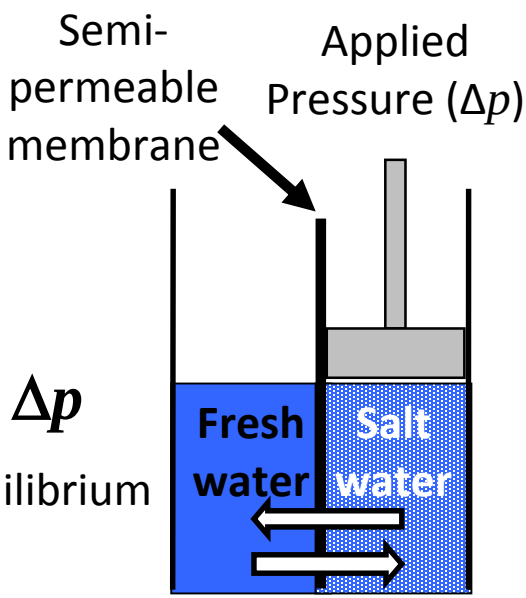


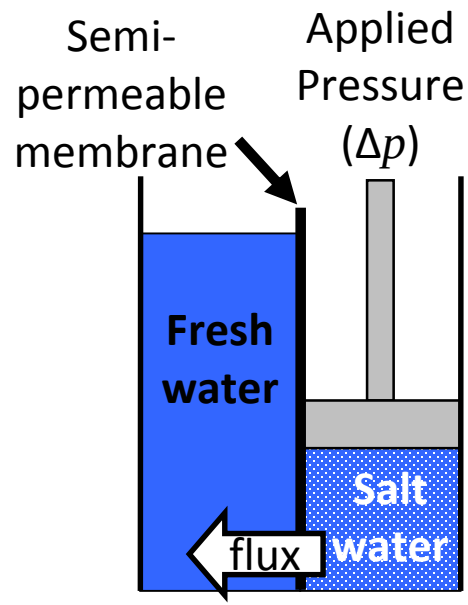
Ghosh & Hoek, JMS, 2008

# Reverse Osmosis: principles

$\Delta\pi = \Delta p$

Osmotic equilibrium

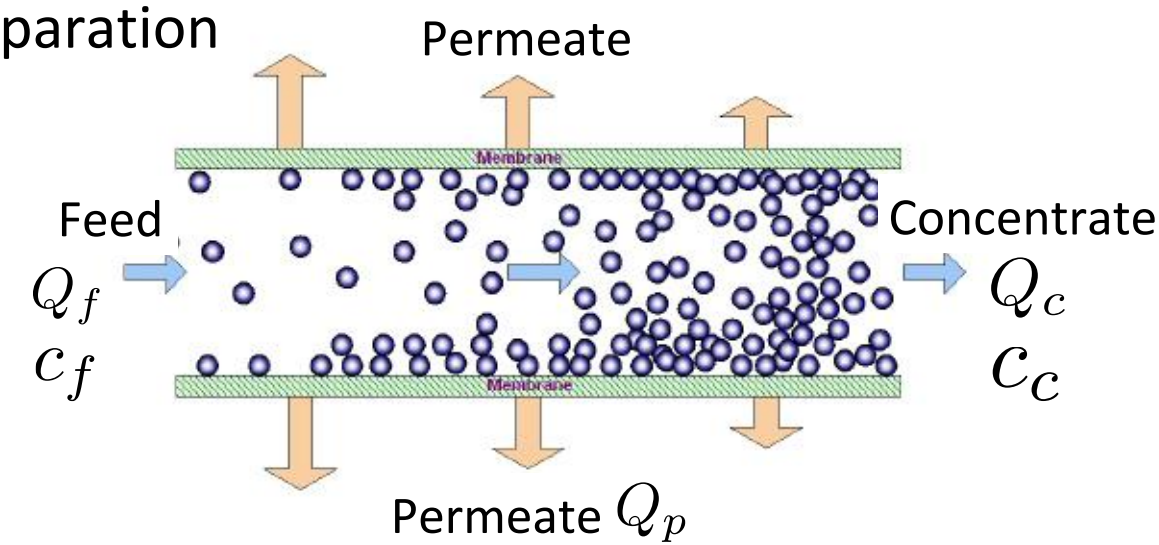



$\Delta p >> \Delta\pi$

Reverse osmosis

Crossflow membrane separation

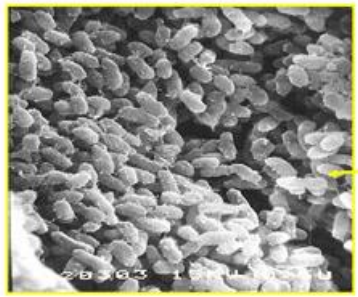


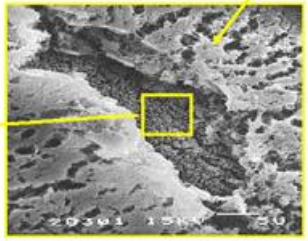

Recovery: $Y = \dfrac{Q_p}{Q_f}$

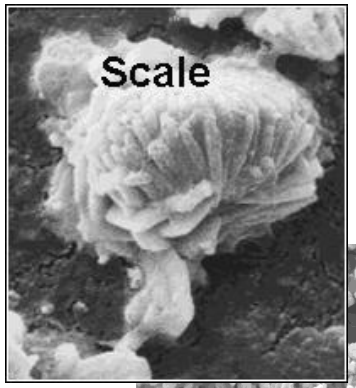
# The ‘Achilles heel’ – fouling…

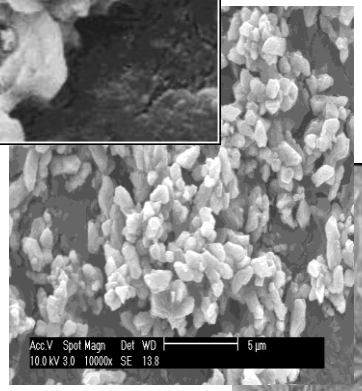
Since the membrane acts as a separation barrier, things tend to accumulate and stick to it…

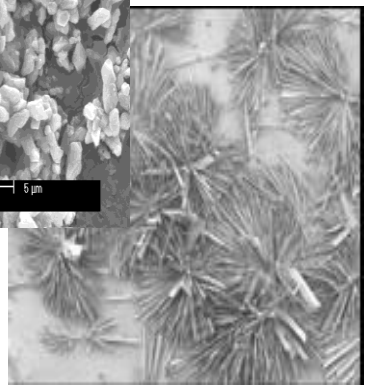
Allred et al., JMS, 2005

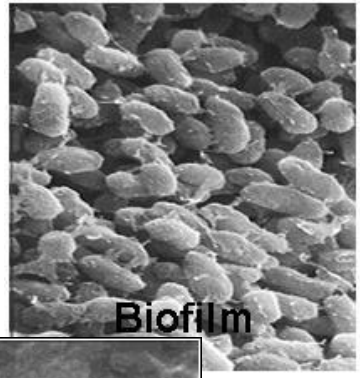


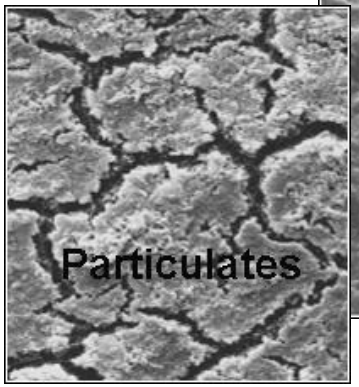


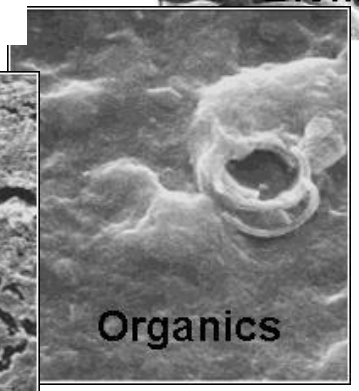




# Produced water and condensate: potential risks

## Permeate quality

Incomplete rejection of heavy metals and dissolved organics

| מתכות | אסדת תמר ריכוז ממוצע לשנים 2013-2015 מ"ג/ליטר | אסדות ים צפוני ריכוז ממוצע של מתכות במי תוצר מ"ג/ליטר |
|---|---|---|
| Pb | 0.77 | 0.0083 |
| Cd | 0.77 | 0.046 |
| Cu | 0.02 | 0.082 |
| Hg | 0.03 | 0.02 |
| Ni | 0.19 | 1.651 |

דו"ח משרד הבריאות, 2018 Utvik et al, Chemosphere, 1999

Seawater RO membranes have >95% rejection for most of these, with the exception of Hg (can be as low as 60%).

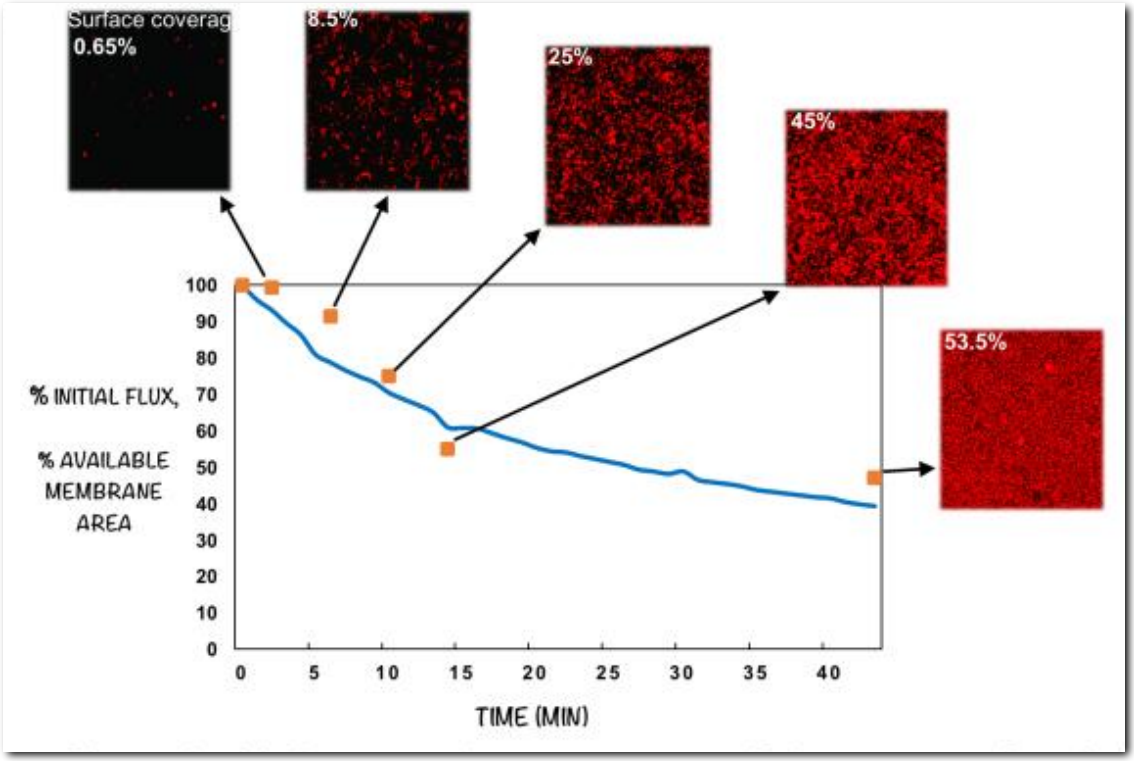
Rejection of uncharged hydrocarbons can be ~90%, or less…

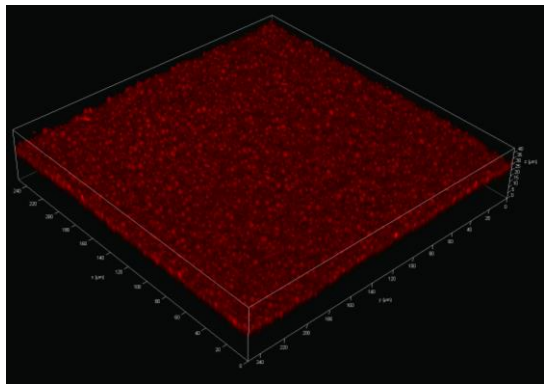
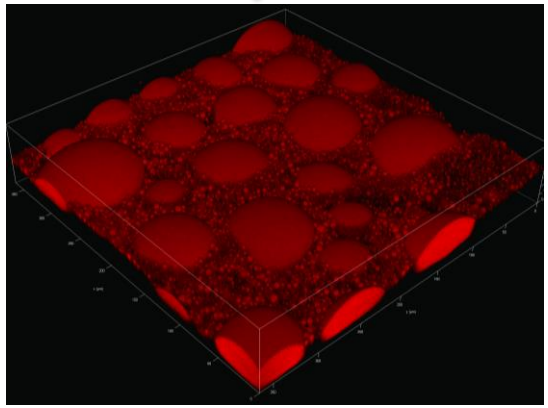
# Produced water and condensate: potential risks

## Membrane operation - fouling

Scaling by sparingly soluble salts – Fe, Cu, Pb, Cr, Ni, Hg, Cd…

**A low viscosity oil such as condensate can emulsify – creating stable droplets dispersed in the water**






Increased flux