Solutions to Address Osmosis:
Blistering of Liquid Applied Waterproofing Membranes

CCBST CONFERENCE, VANCOUVER BC

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PRESENTED BY ELYSE HENDERSON

RDH CELEBRATING 20 YEARS EST. 1997

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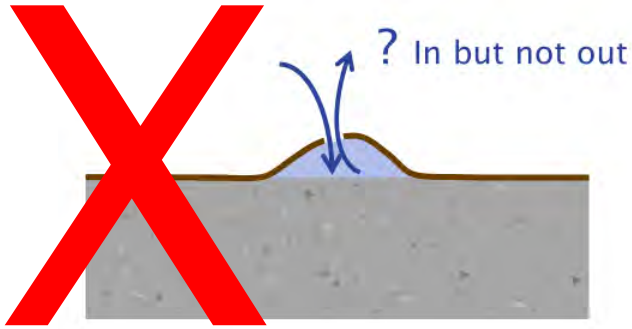
Agenda

- → Background
- → Review of theories
- → Current research
- → Recommendations

Background & History

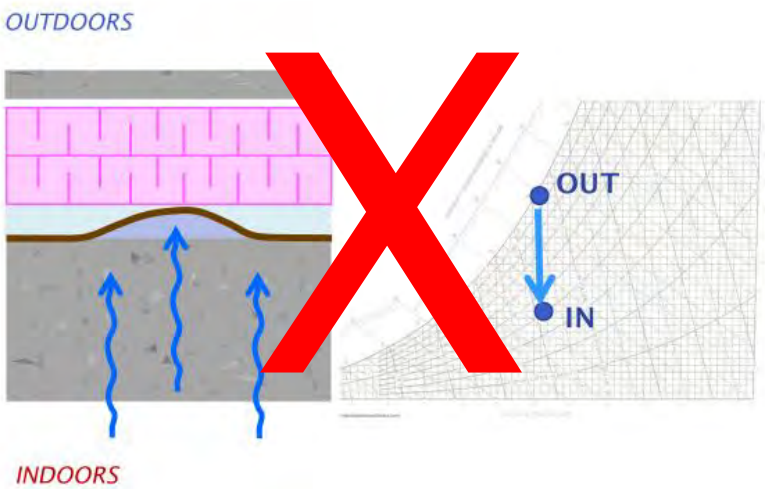
Review of Theories

Pinholes in thin membrane

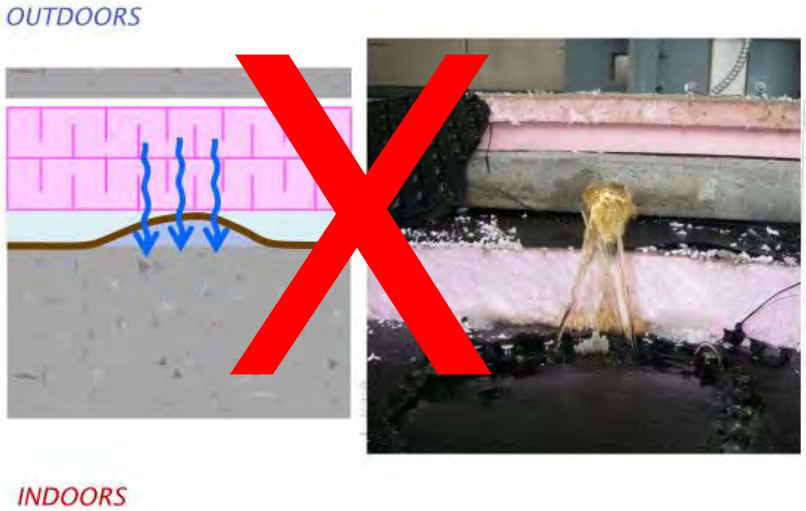


Hydrostatic head from details

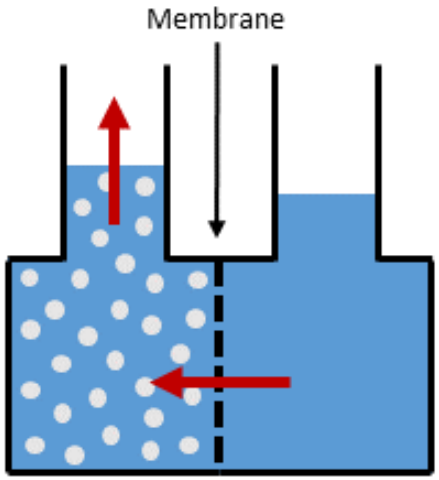
Vapour diffusion from inside



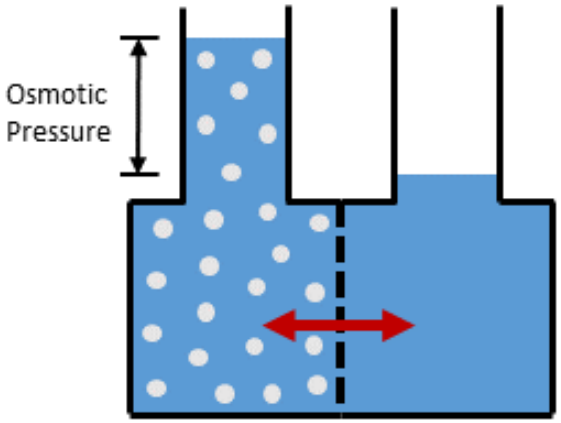
Diffusion & capillary from outside



The Osmosis Mechanism



Osmosis: Water flows from low to high concentration of solutes



Equilibrium: Osmotic pressure is the pressure required to stop water flow and reach equilibrium

→ Requirements for osmosis to occur:

1. Semi-permeable membrane (impermeable to Total Dissolved Solids)
2. TDS concentration differential (higher osmotic flow rate with higher differential)

Colligative Property

TDS and Equivalent Osmotic Pressure

	Sample A	Sample B	Sample C	Rain water pooled on membrane
Total Dissolved Salts (TDS), mg/L	17,500	13,056	3,650	7
Osmotic Pressure, kPa	1,488	1,089	326	~3

→ Extracted from water blisters under blistered membranes

→ TDS and equivalent osmotic pressure are elevated!

Research Objectives

1) Determine the susceptibility of various waterproofing membrane types to osmotic blistering

   → Find true "zero" osmotic flow

2) Set test parameters and recommendations for low-risk membranes

   → e.g. osmotic flow rate, vapour permeance, absorption

3) Understand the aging effects of membranes in contact with liquid water for long periods of time

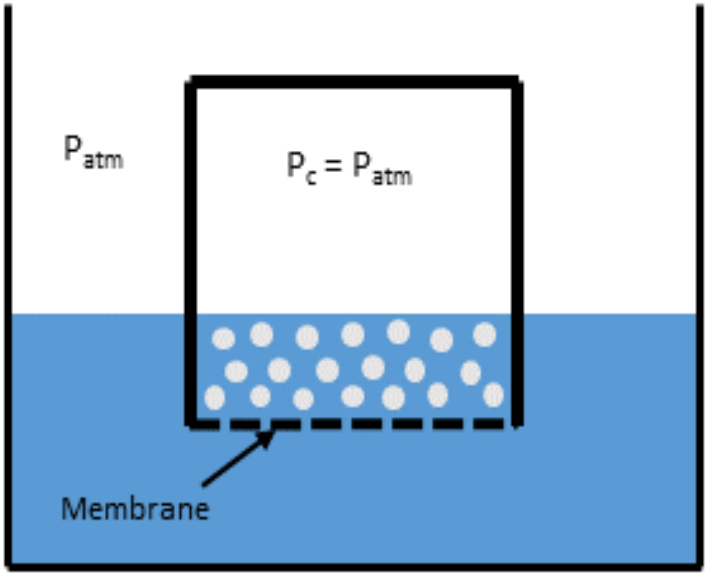
   → Changes in material properties (e.g. vapour permeance)

   → Degradation of the membrane

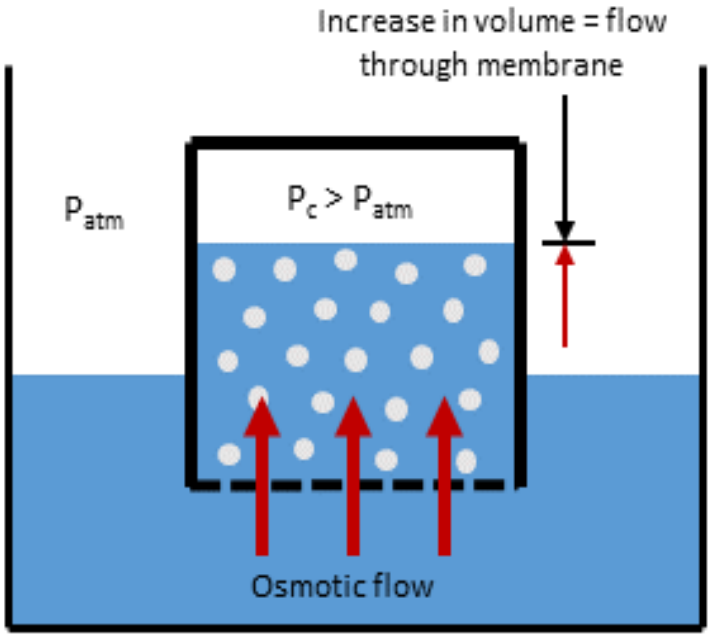
Project Methodology

→ Osmotic flow rate testing

→ Method developed by RDH



Initial Setup: Pressure within container is equal to atmosphere



Effect: Osmosis occurs until the pressure within container reaches the osmotic pressure

Project Methodology

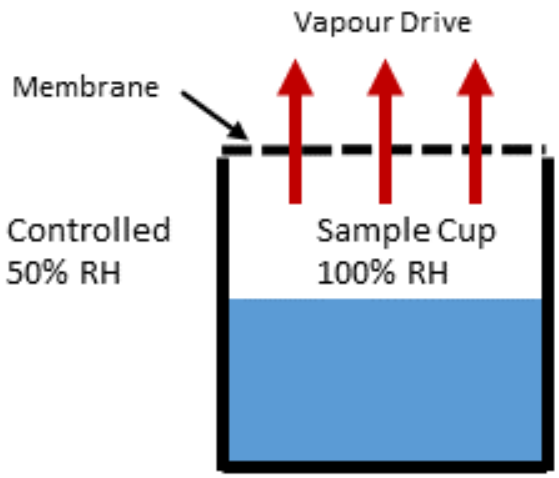
→ Osmotic flow rate testing

→ Method developed by RDH

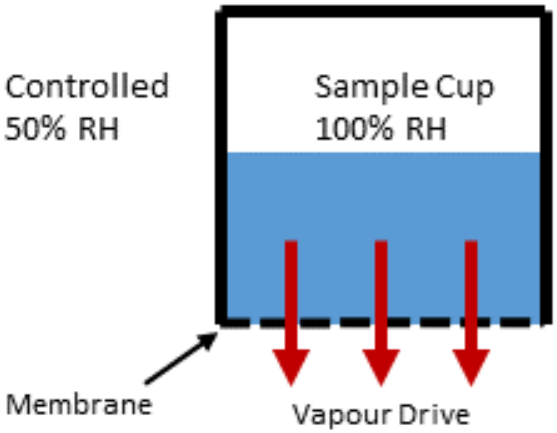
→ Vapour permeance testing per ASTM E-96

→ Wet cup

→ Inverted wet cup



Wet Cup

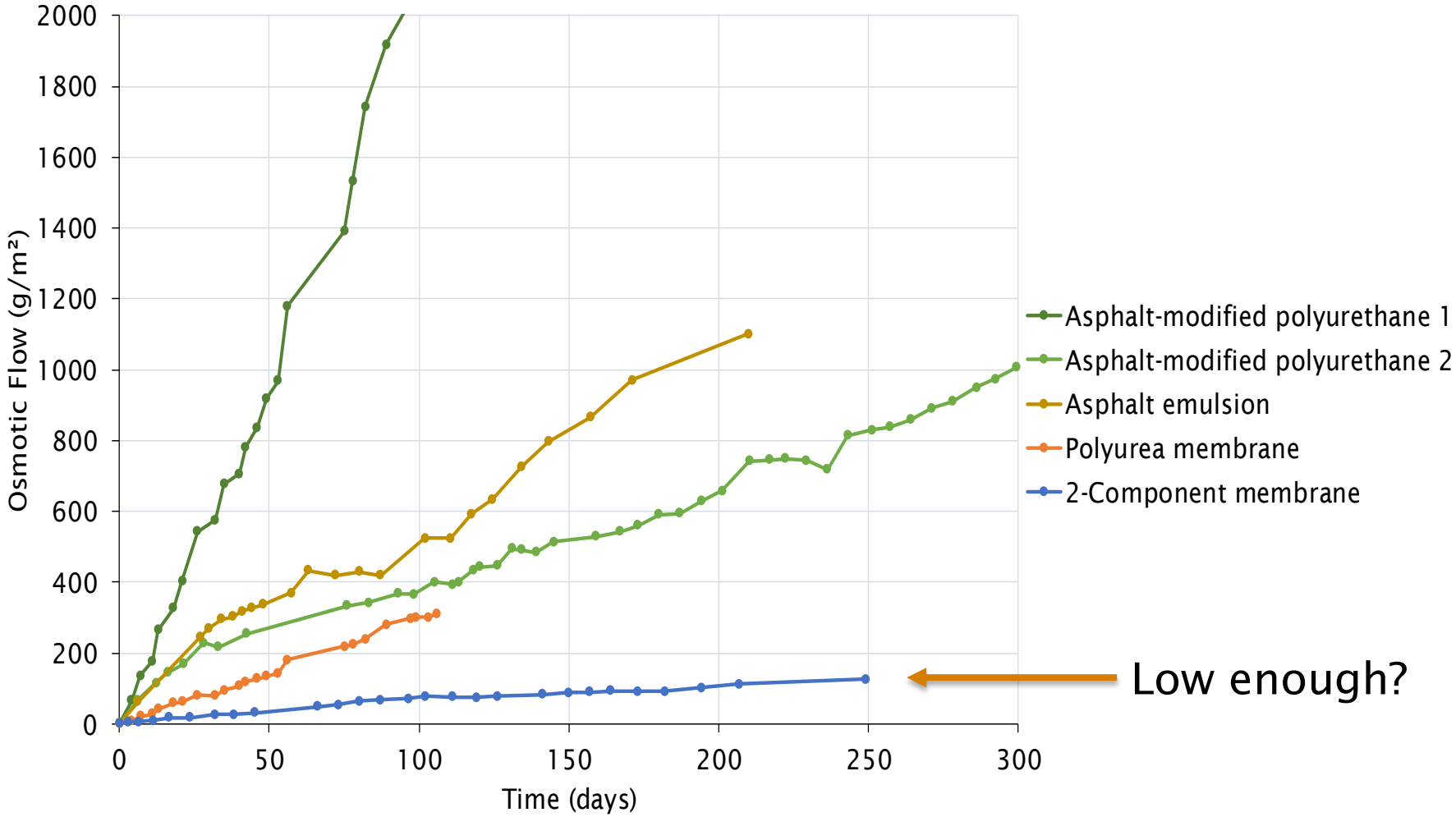


Inverted Wet Cup

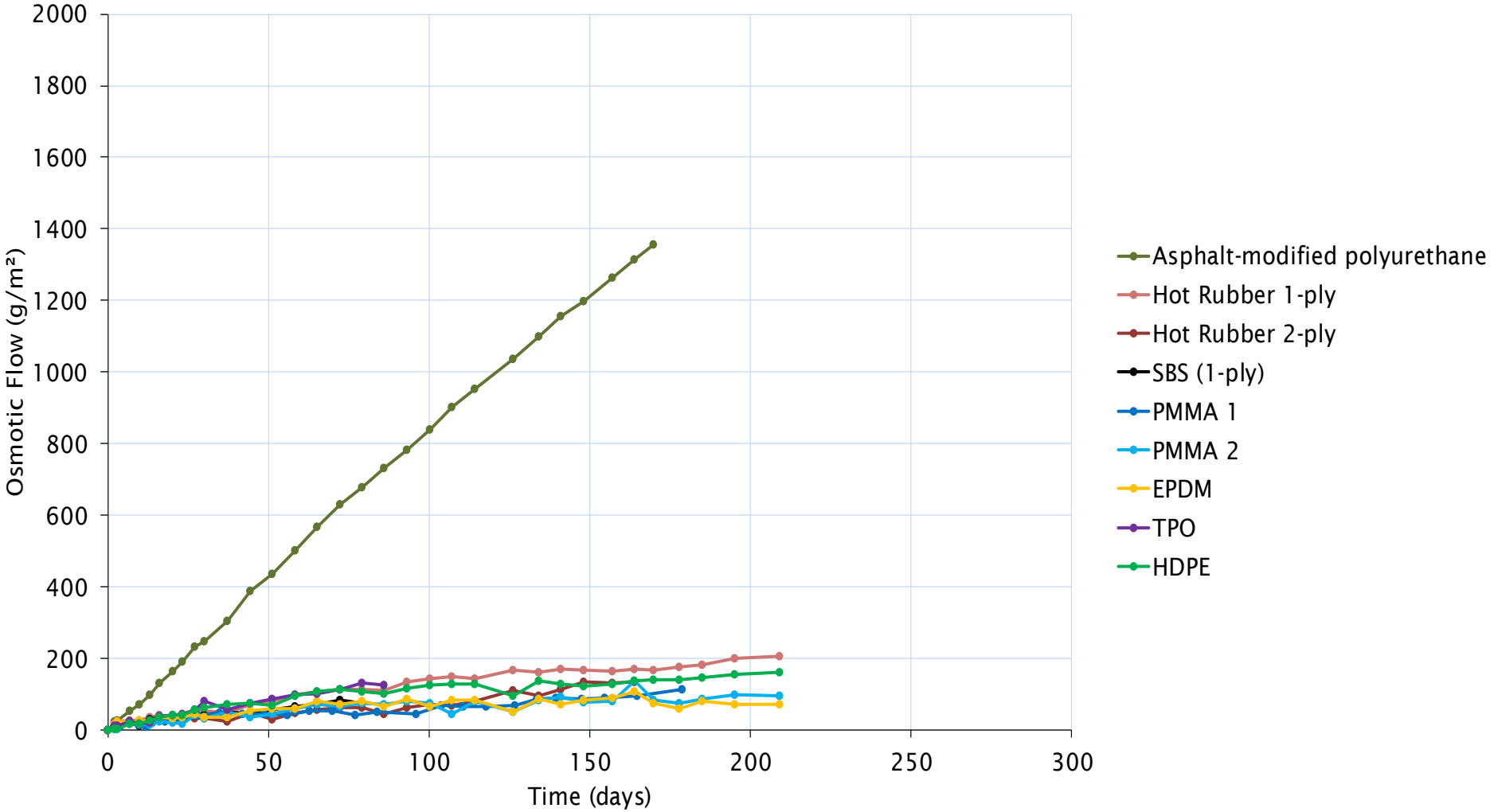
Project Methodology

- → Osmotic flow rate testing
  - → Method developed by RDH
- → Vapour permeance testing per ASTM E-96
  - → Wet cup
  - → Inverted wet cup
- → Water absorption testing
  - → Method adapted from ASTM D-570 for prolonged time
- → Water analysis
  - → 3rd-party analytical lab
  - → Measure TDS concentrations and specific solutes

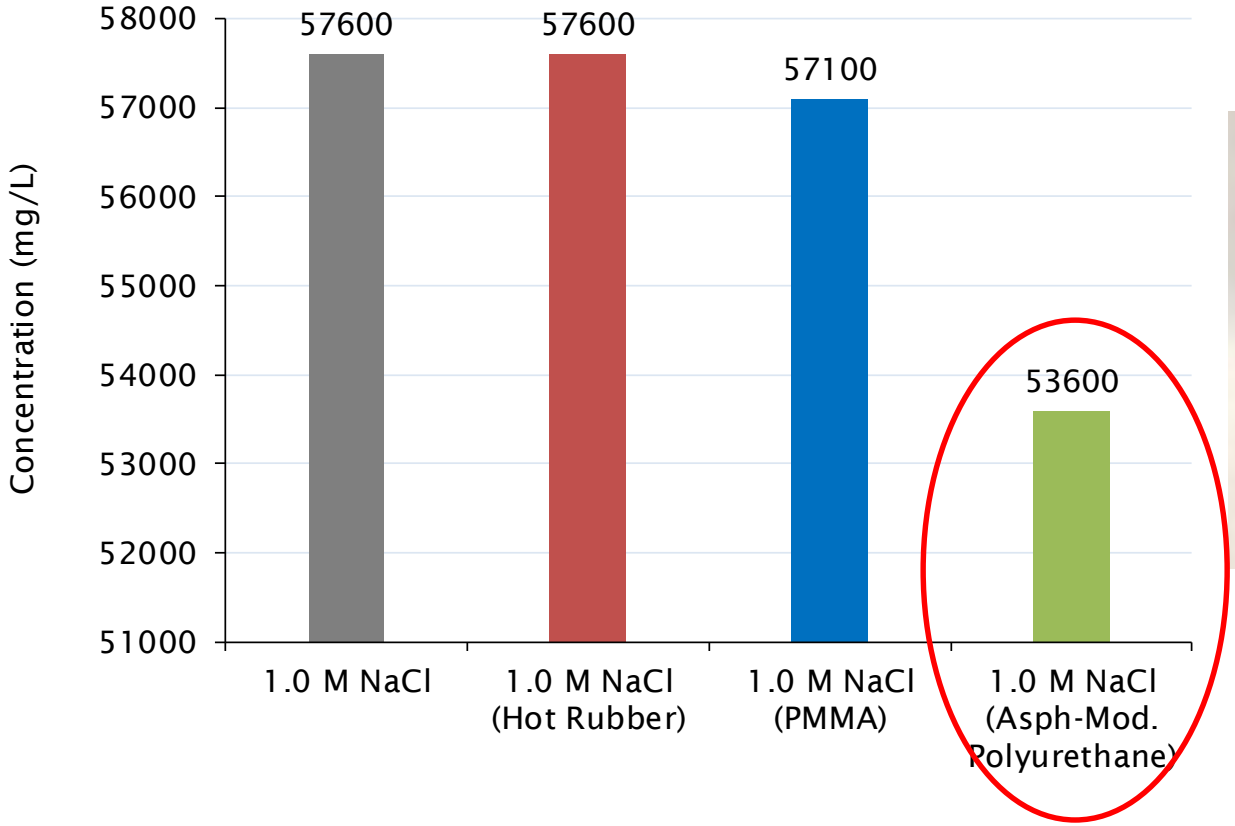
Previous Osmosis Results



Current Osmosis Results



TDS Dilution from Osmotic Flow



→ Total Dissolved Solids (TDS) concentration after 8 months

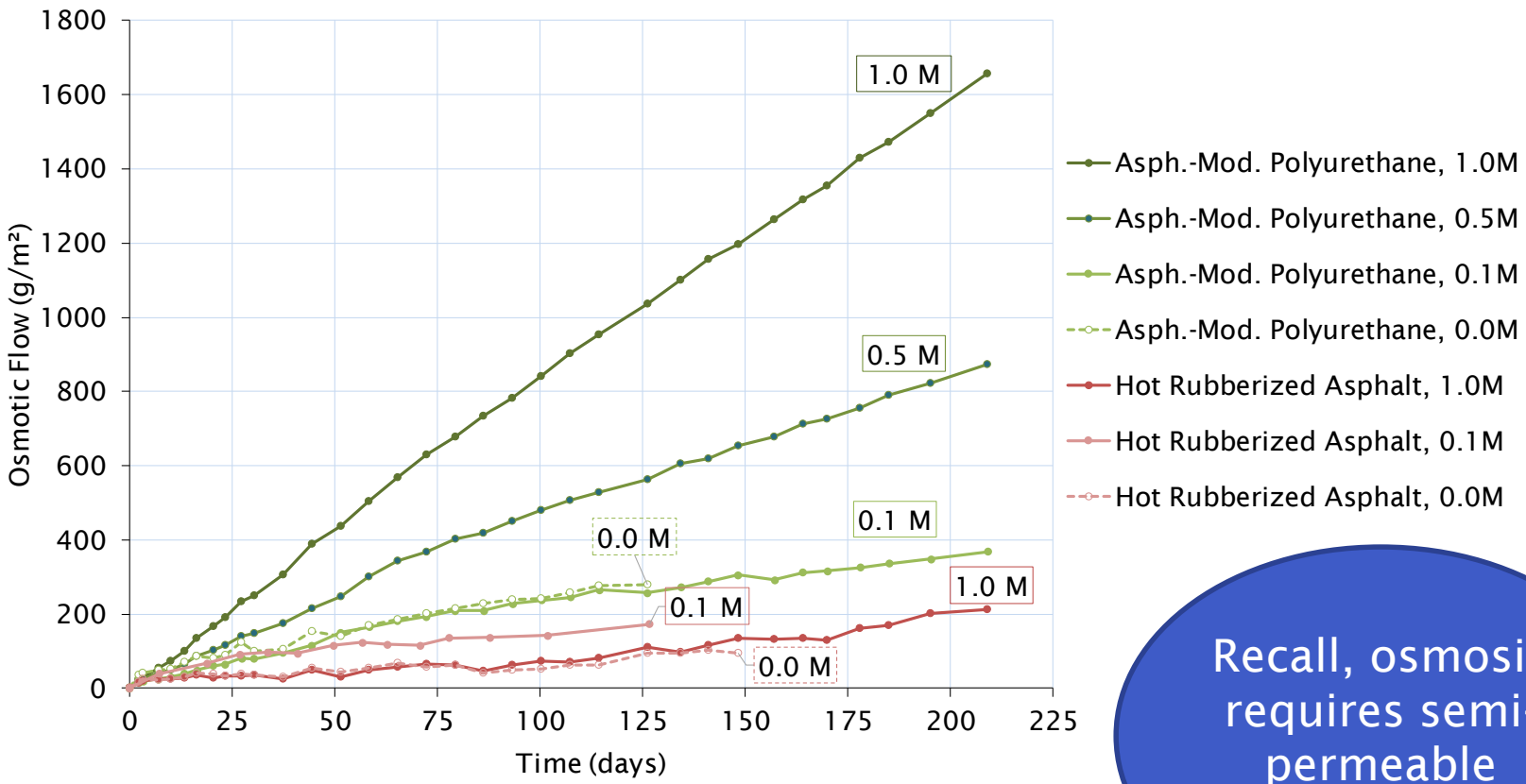
→ TDS is diluted in the jar that took up most water, i.e. had the highest osmotic flow across membrane

Osmosis Results

Membrane Type (name or material)	Membrane Thickness (mil)	Osmotic Flow Rate ($g/m^2/day$)
Asphalt-modified polyurethane*	30 – 90	1.4 – 26.2
Asphalt emulsion	110	4.6 ±1.6
Polyurea	30 – 100	2.1 ±1.6
SBS (1-ply)	100	0.3 ±0.8
TPO	58	0.8 ±0.9
Hot rubberized asphalt (2-ply)	244	0.0 ±0.7
HDPE	52	0.0 ±0.7
PMMA	70 – 80	-0.2 ±0.8
2-Component cold-applied	40 – 90	-0.3 ±0.8
EPDM	47	-0.3 ±0.7

*Large range of membrane thicknesses and osmotic flow rates for asphalt-modified polyurethane samples (macroscopic variations in the samples)

Colligative Property of Osmosis, Demonstrated



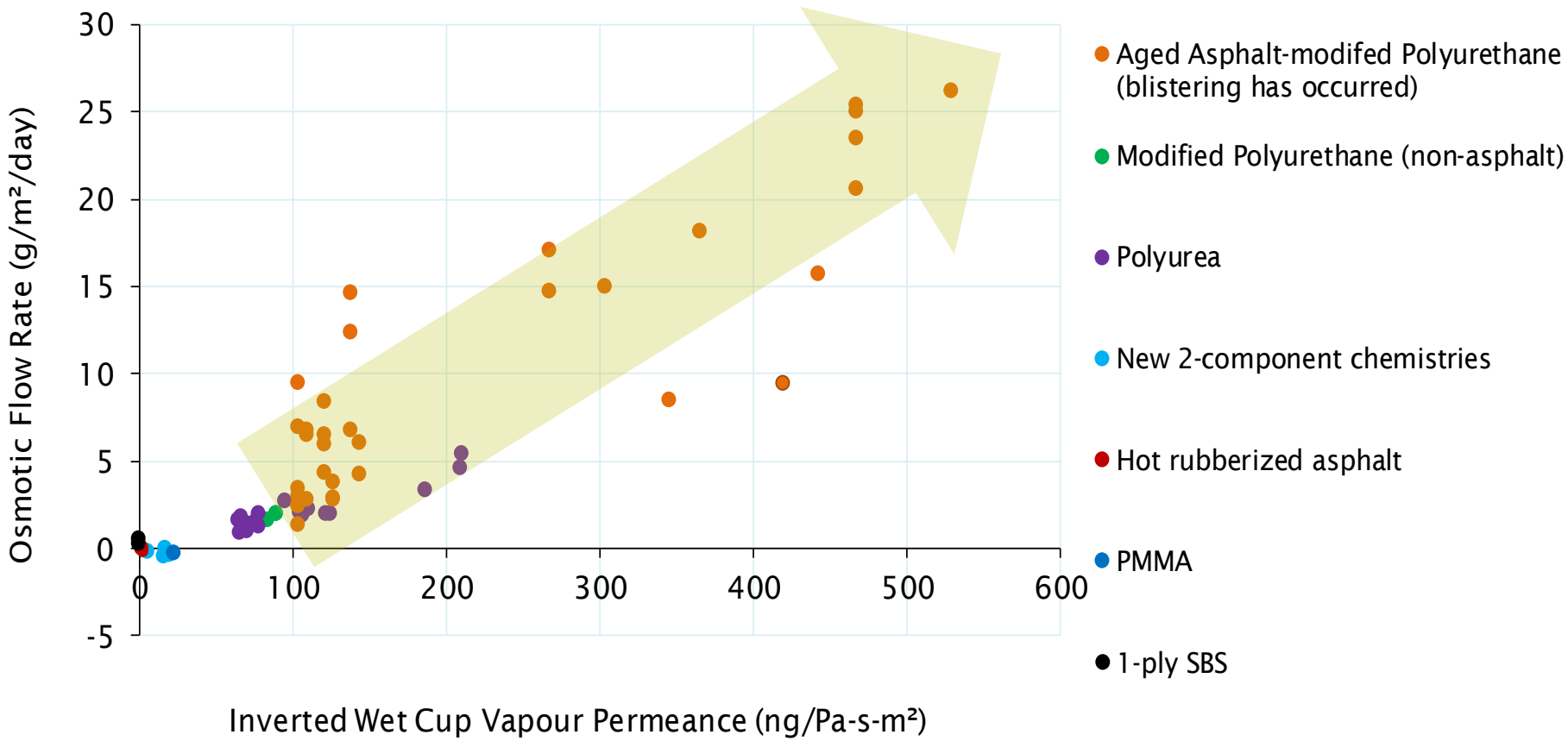
→ Flow rate depends on TDS concentration

→ Higher TDS = higher osmotic flow rate

→ But only for semi-permeable membranes

Recall, osmosis requires semi-permeable membrane

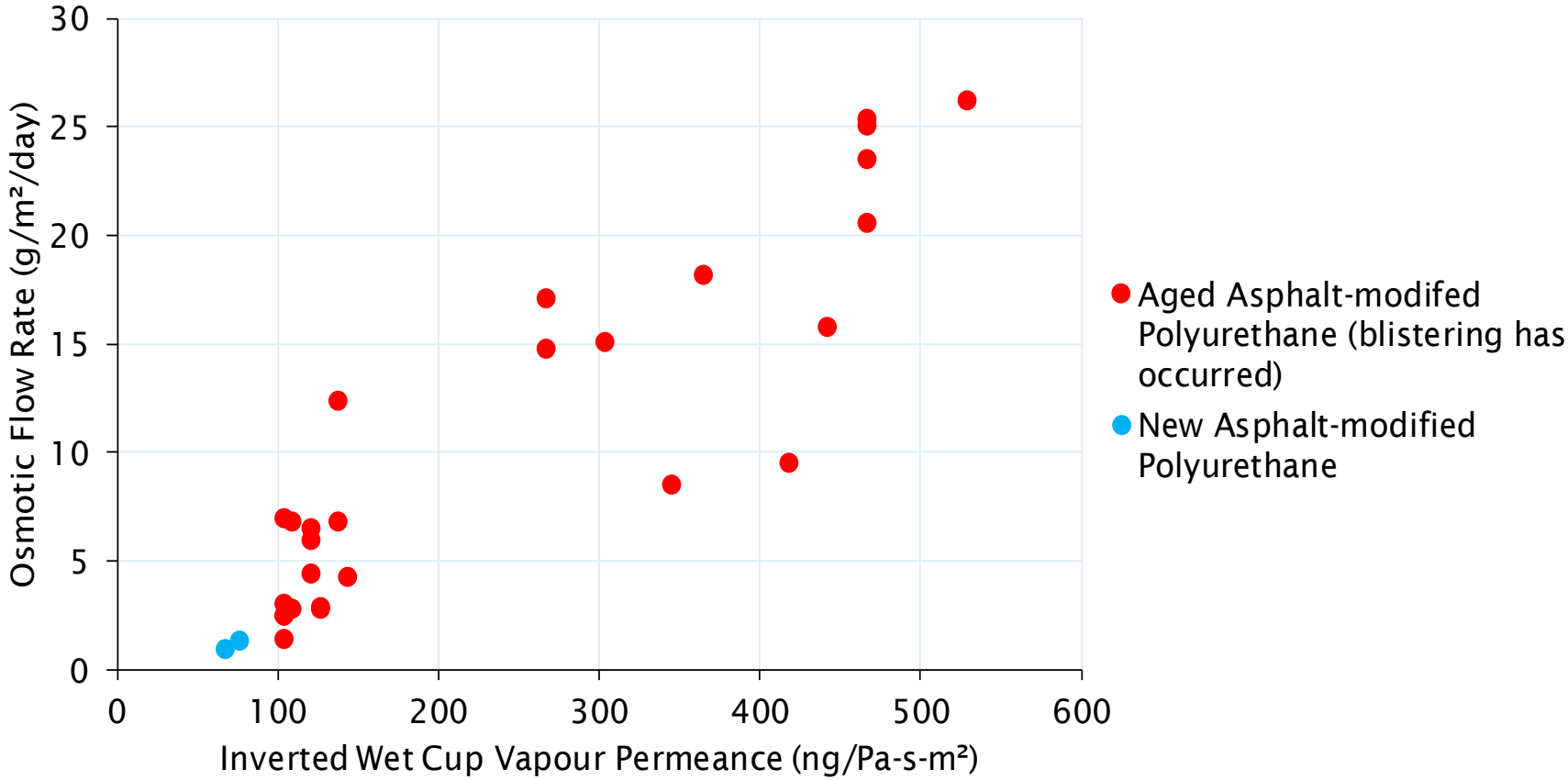
How Does Vapour Permeance Affect Osmosis?



→ Osmotic flow rate is higher for high vapour permeance

→ How does aging affect membrane permeance?

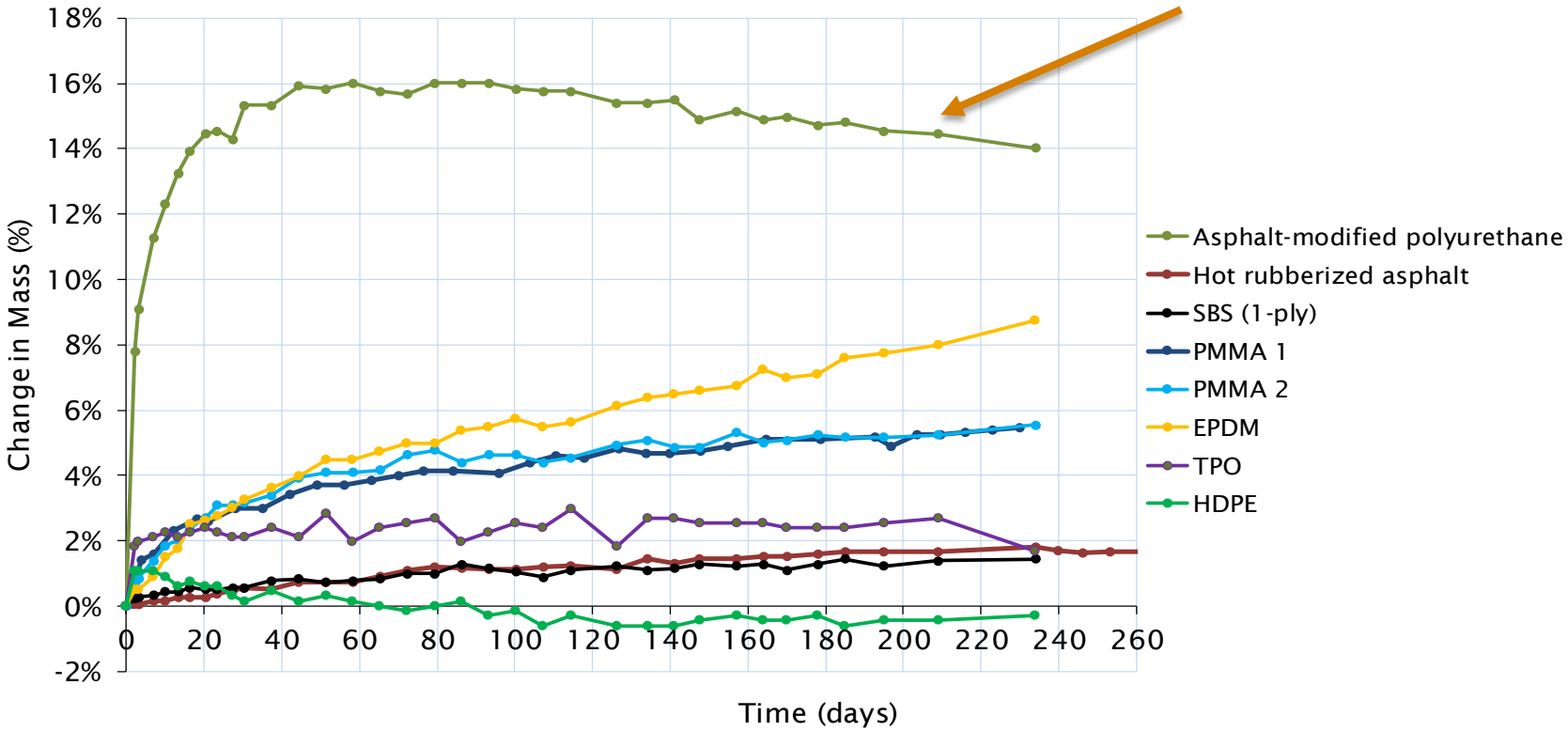
Effects of Aging Membranes



→ Aged asphalt-modified polyurethane = higher permeance

→ Can prolonged water absorption help us understand aging?

Water Absorption Results



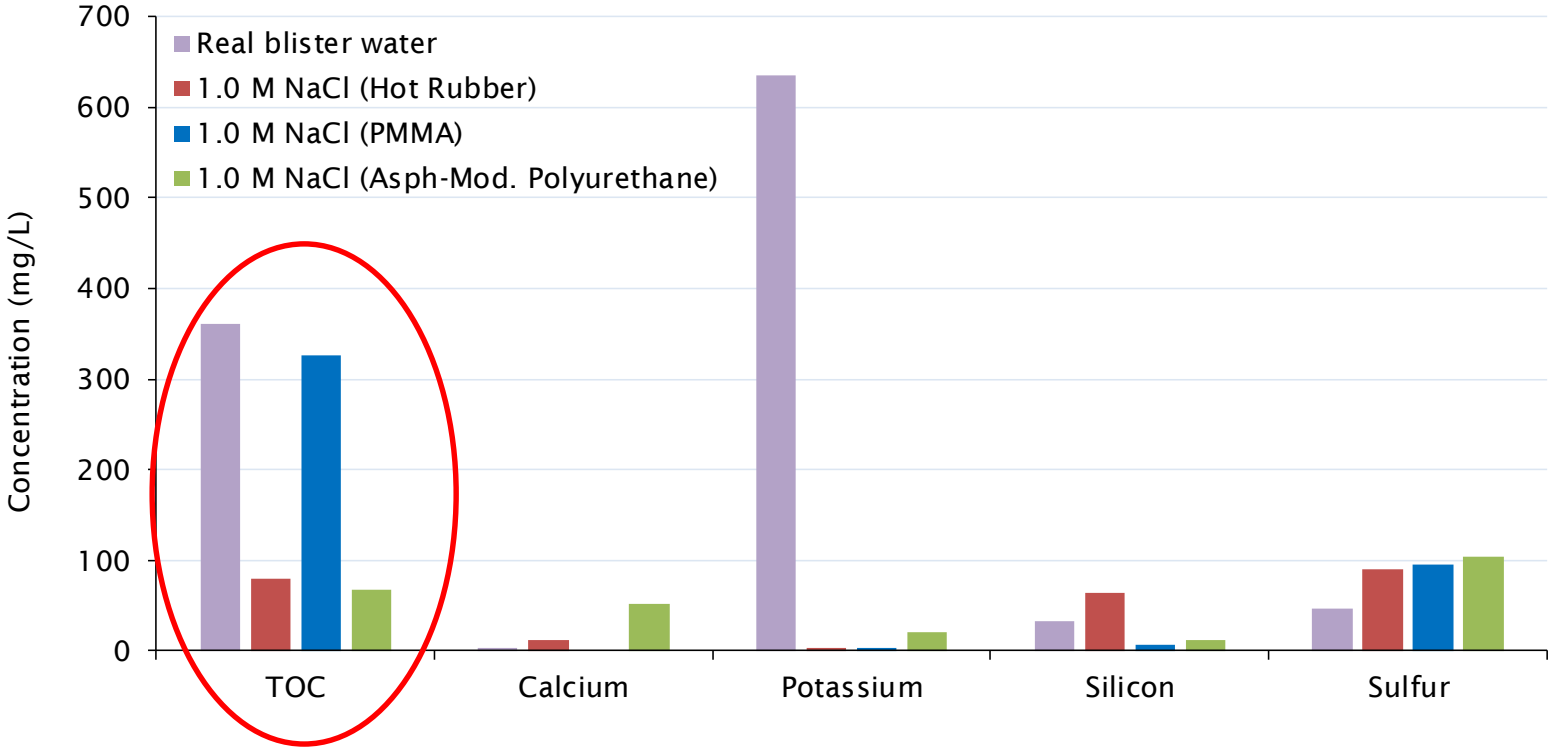
→ Some membranes do not reach equilibrium

→ Unknown effects over longer time: 1 year? 5 years? 10 years?

→ Asphalt-modified polyurethane absorbs the most

→ Decease in mass points to membrane degradation

What is Coming Off the Membranes?



→ Total Organic Carbon (TOC) points to membrane degradation

→ Degrading membranes:

- → Change membrane properties (vapour permeance, rigidity, etc.)
- → Increase the TDS in the water blister
  - › Self-propagation of osmosis in susceptible membranes

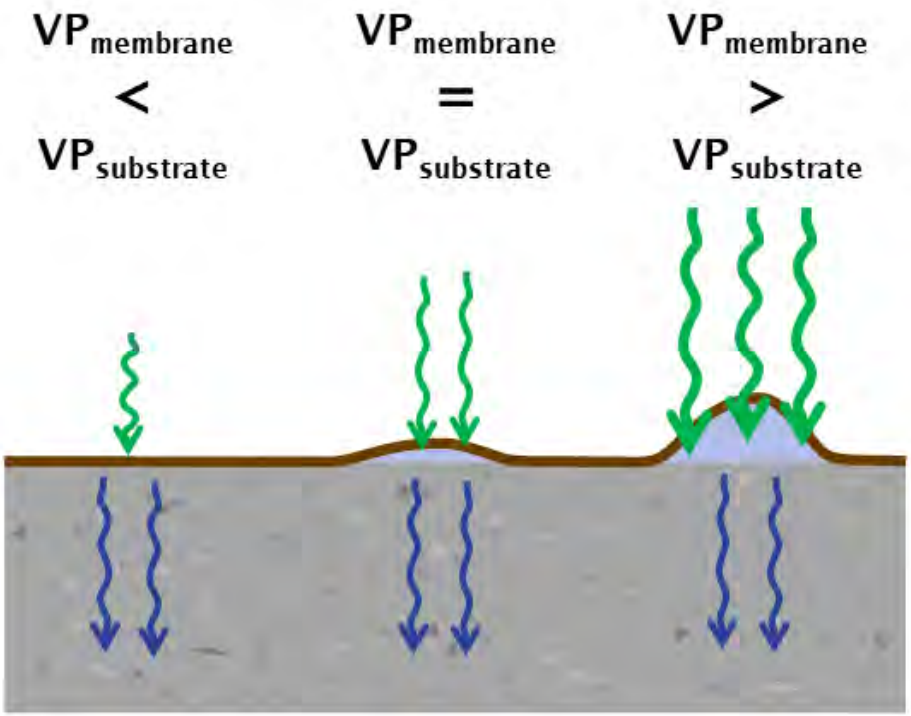
What are the Solutions?

→ Rules of thumb for selecting waterproofing membranes:

1. Measured osmotic flow rate near 0 g/m²/day (+/- 1)

2. Inverted wet cup vapour permeance lower than substrate

3. Minimal long-term water absorption or membrane degradation



Questions

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