solecta

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Dairy Membrane Filtration Training

September 11, 2025

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Agenda

- Background
- Membrane & Element Manufacturing
- Installation
- Troubleshooting
- Best Practices

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DAIRY MEMBRANE SEPARATION

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Milk Components

87.7% Water

3.5% Fat

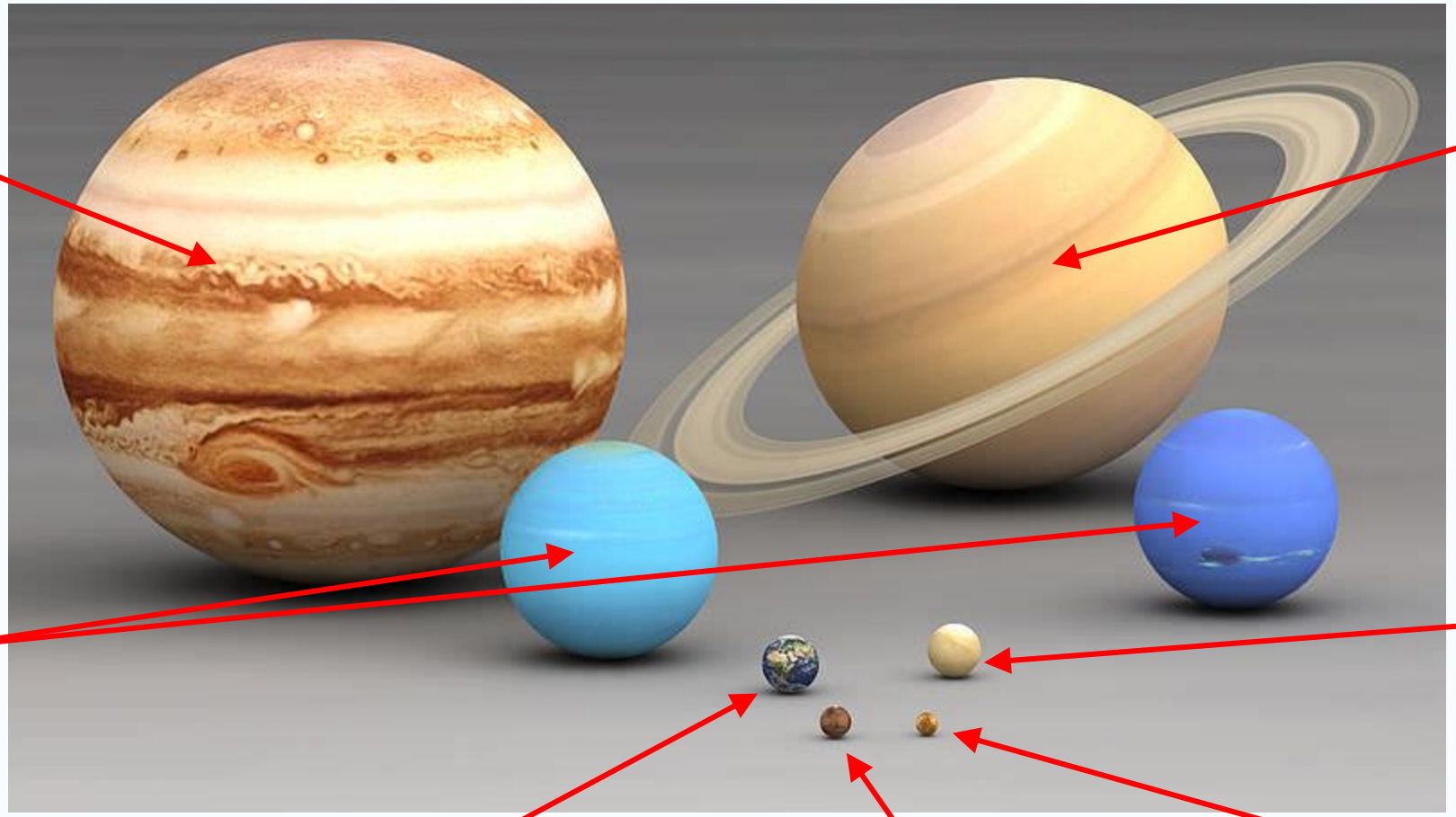
3.2% Protein

- 2.4% Casein
- 0.6% Whey
- 0.2% NPN

4.8% Lactose

0.8% Minerals

Relative Size of Milk Components



Applications

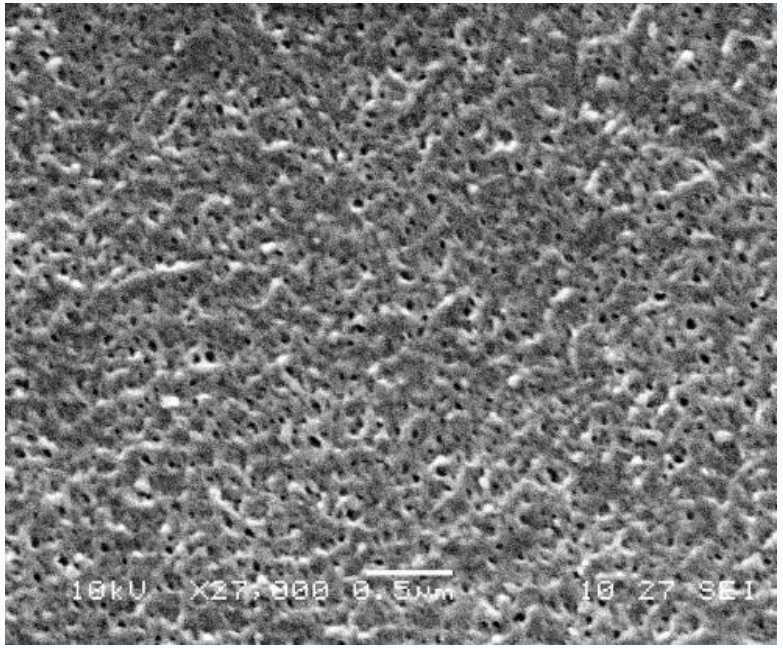
Membrane Type	Application
Microfiltration (MF)	Fat removal in Whey Protein Isolate (WPI) Cheese brine clarification
Ultrafiltration (UF)	Whey protein concentration (WPC) Milk protein concentration (MPC) Milk standardization
Nanofiltration (NF)	Solids concentration Lactose concentration Ash reduction
Reverse Osmosis (RO)	Solids concentration Polished water production Wastewater treatment

MEMBRANE & SPIRAL MANUFACTURING

Membrane & Element Manufacturing

Polymer

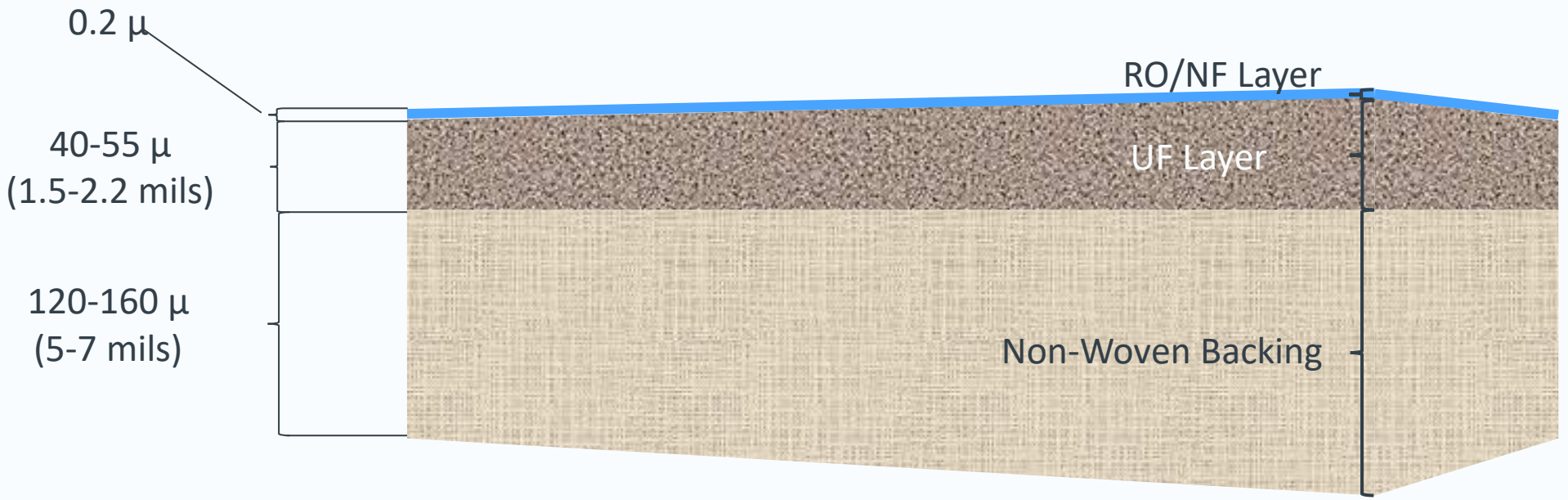
Porous Membrane



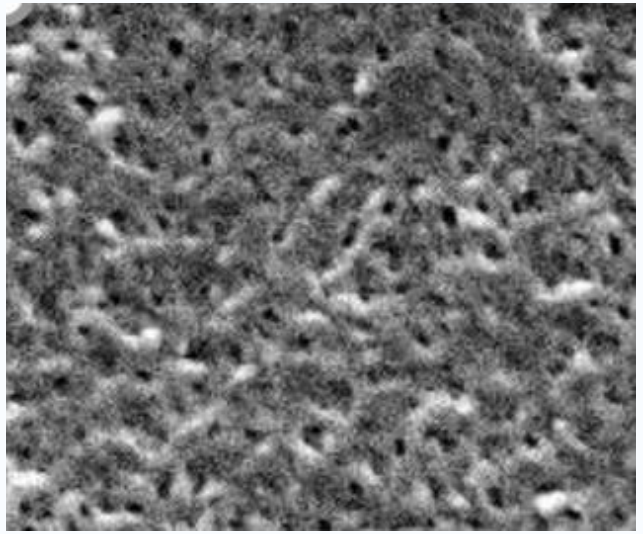
Spiral-Wound Element

Membrane Cross-Section

- Non-woven backing provides the support to cast the UF/MF membrane
  - Backing is typically a wet-laid polyester or polypropylene (for high pH requirements)
- Very thin RO or NF layer is coated on top of a UF membrane via a polymerization reaction

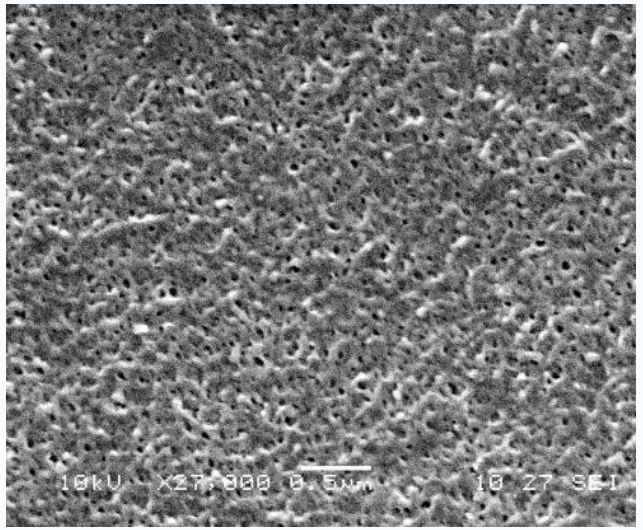


Membrane Separation



Microfiltration
Fat Removal

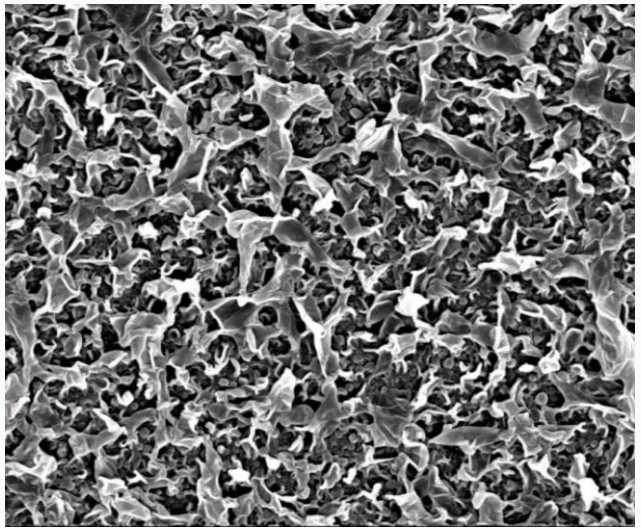
Size
Based Rejection



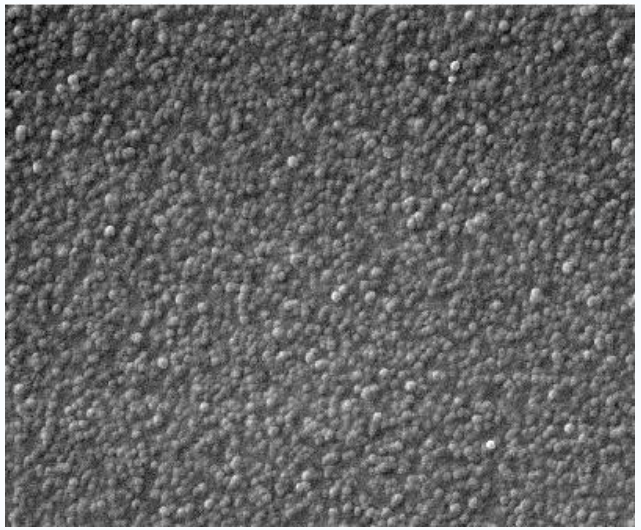
Ultrafiltration
Protein Purification

Reverse Osmosis
Water Removal

Size + Charge
Based Rejection



Nanofiltration
Solids Concentration



Element Manufacturing

- Membrane flat sheet has been made, now it needs be put into a usable configuration → Spiral-wound element

Sanitary Net-Wrap Elements

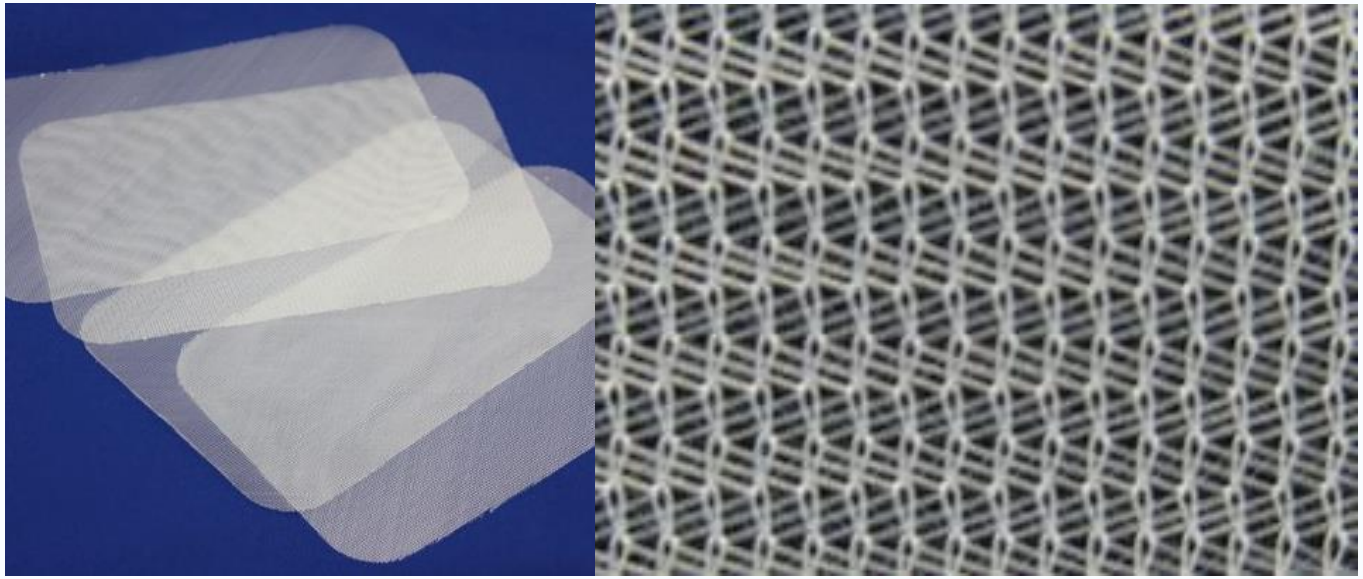
Industrial FRP Elements & Potted Fiberglass Modules

Raw Materials – Element Manufacturing

Permeate Tube

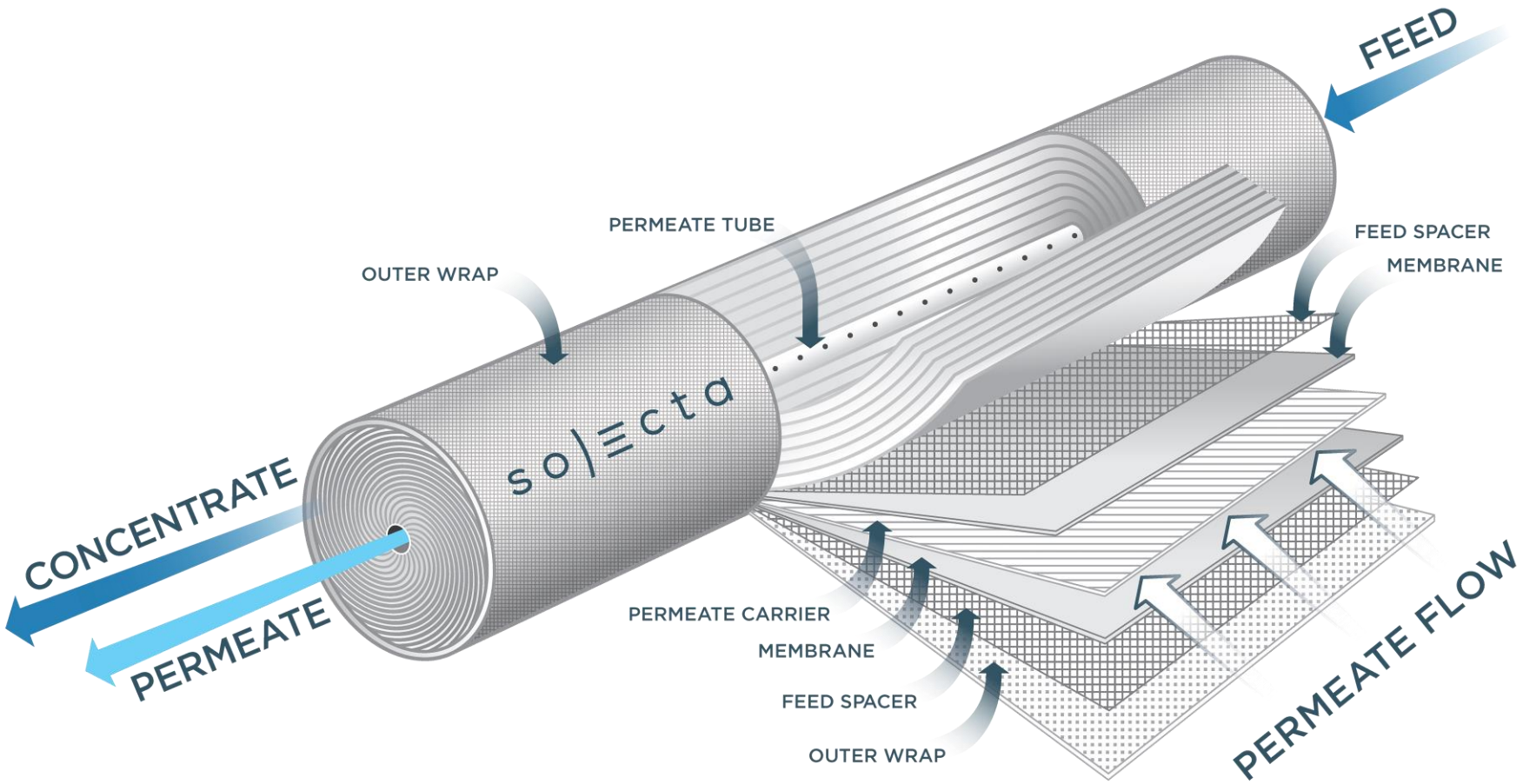
Feed Spacer

Permeate Carrier (aka – Tricot)



Glue

Anatomy of an Element



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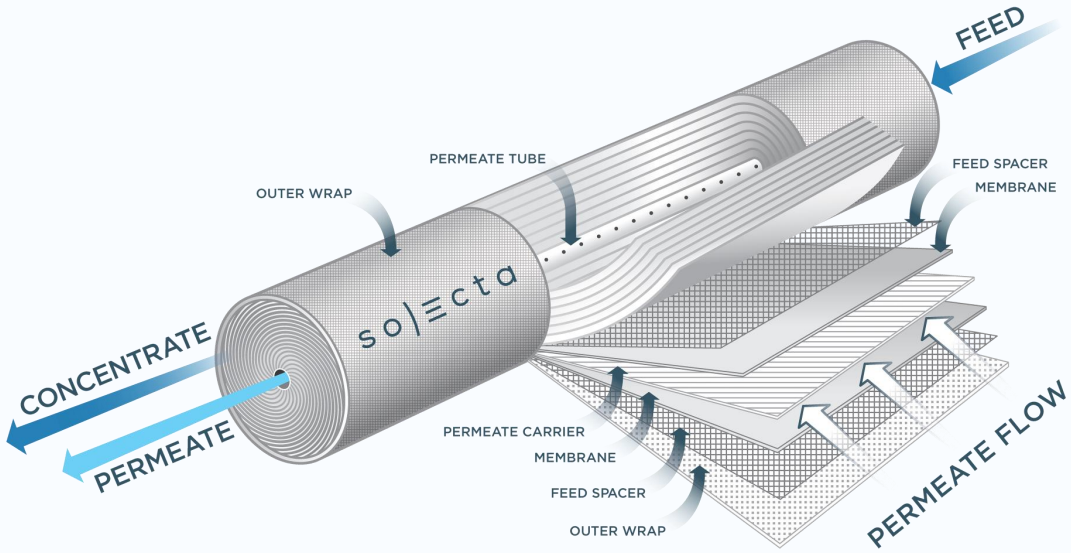
What Components are Varied & Why?

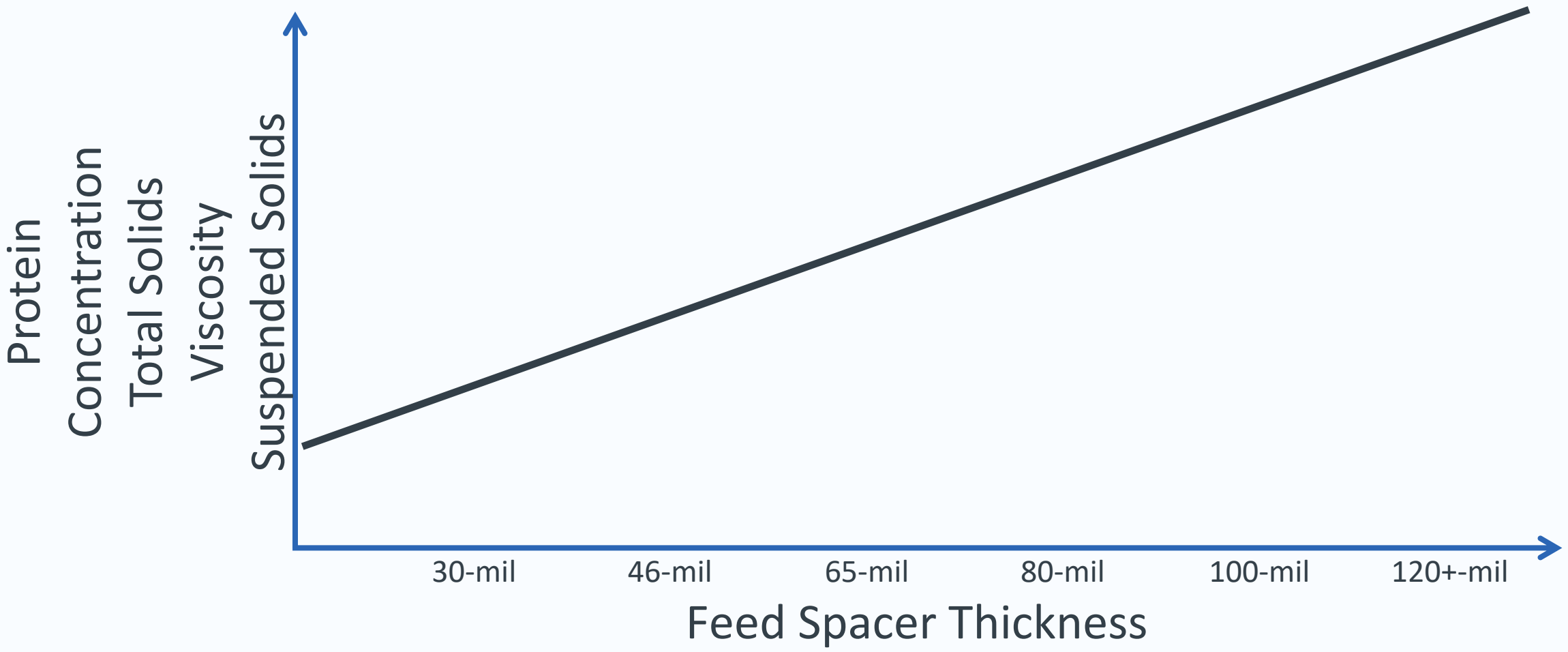
- Element size to fit in the vessels/housings
  - 3838, 6438, 8038
- Feed spacer based on viscosity
  - 30 mil, 46 mil, 65 mil
- Membrane itself
  - RO, 300Da, 5kDa, 10kDa, 0.3µm



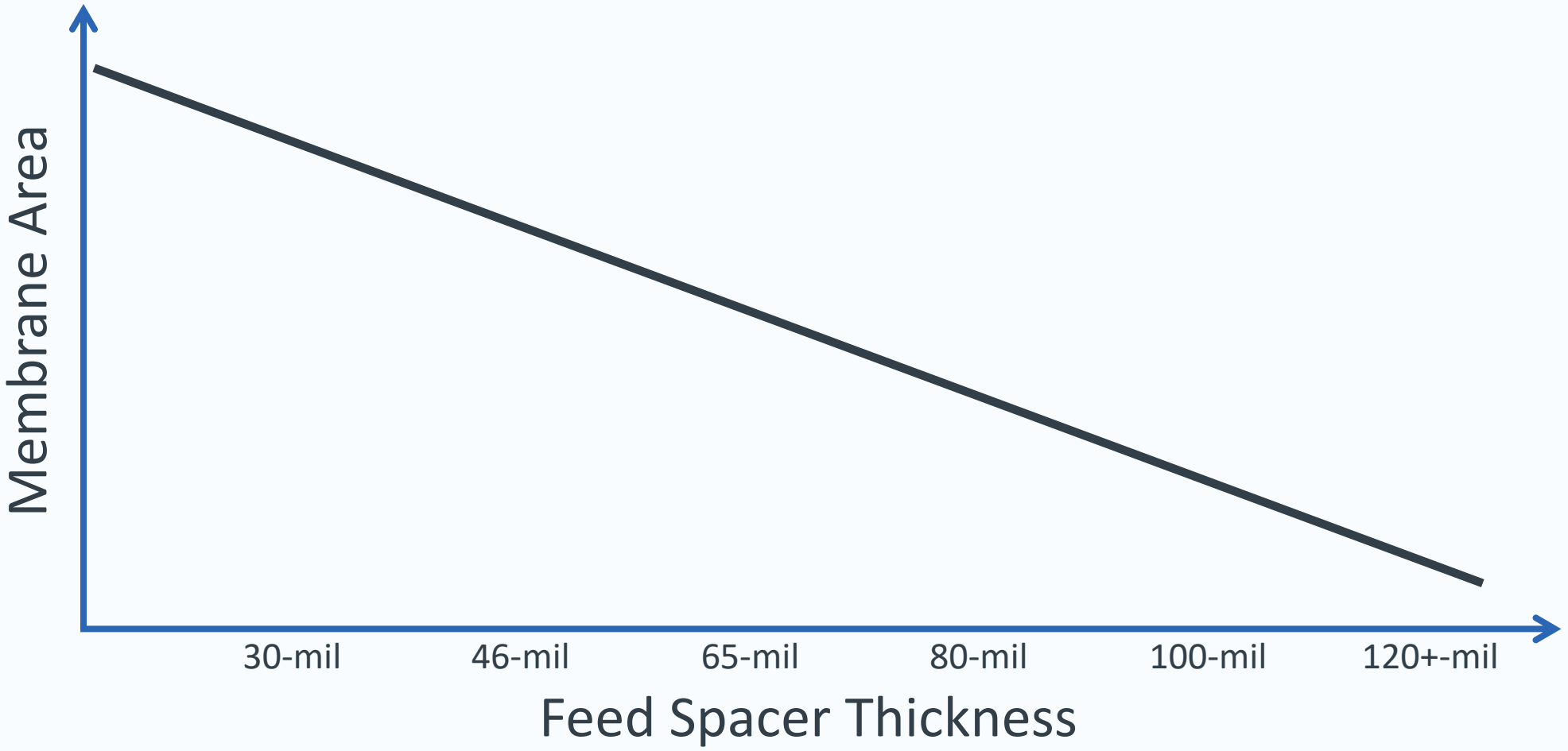
Nomenclature (Product Naming)

solecta	Synder Filtration	KOVALUS Separation Solutions™
PE10-8038-30	ST-2B-8038	8038-K131-NYV
Membrane Type | Physical Dimensions | Feed Spacer	Membrane Type | Feed Spacer | Physical Dimensions	Physical Dimensions | Membrane Type | Feed Spacer

Why Different Feed Spacers?



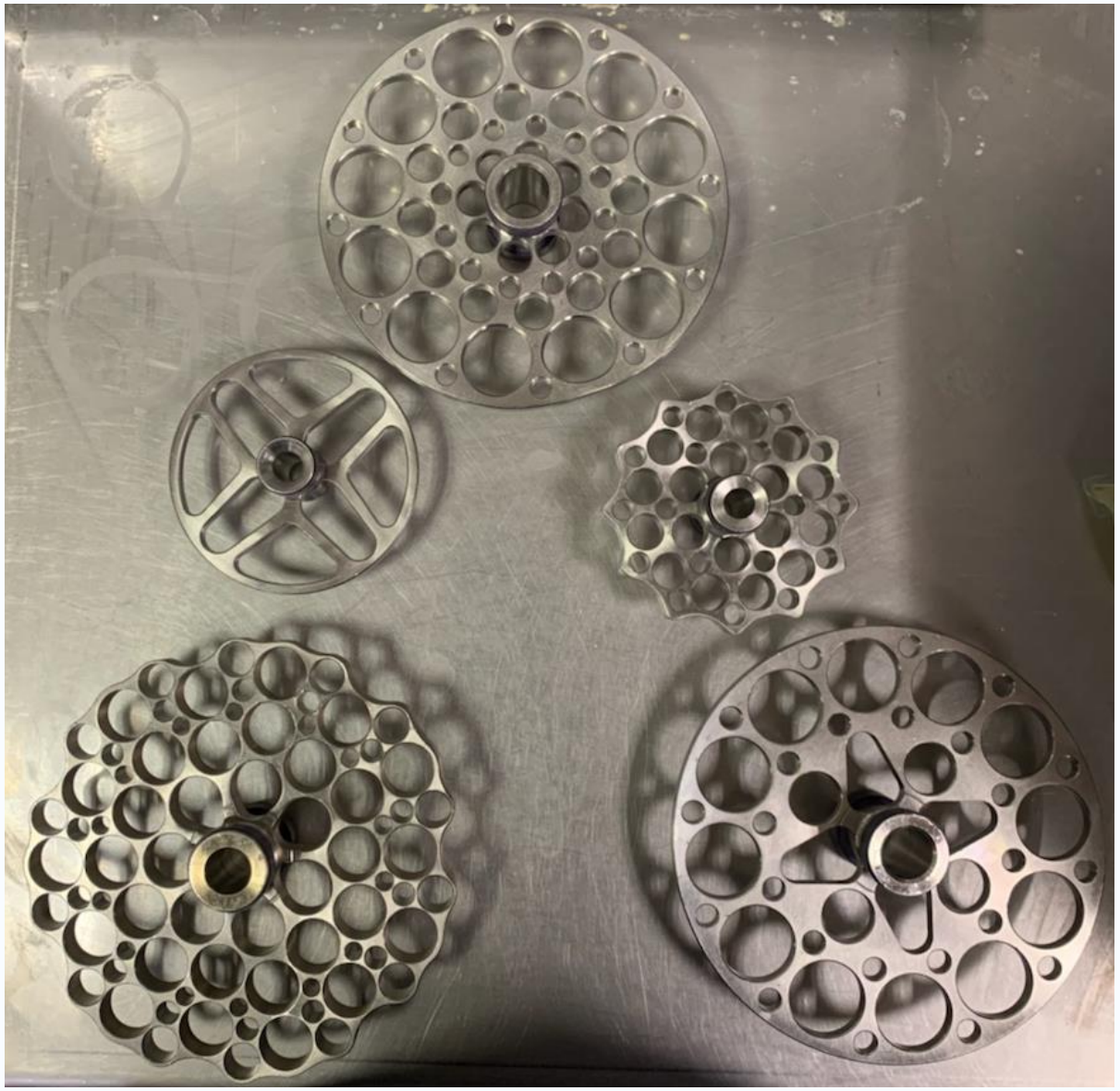
Membrane Area vs. Feed Spacer Thickness



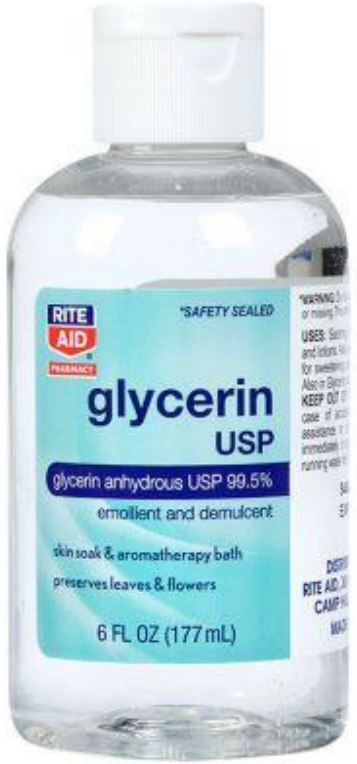
INSTALLATION

ATD/Interconnector

- Provides barrier between permeate & feed side
  - Via lip seals or O-rings
- Prevents element from telescoping

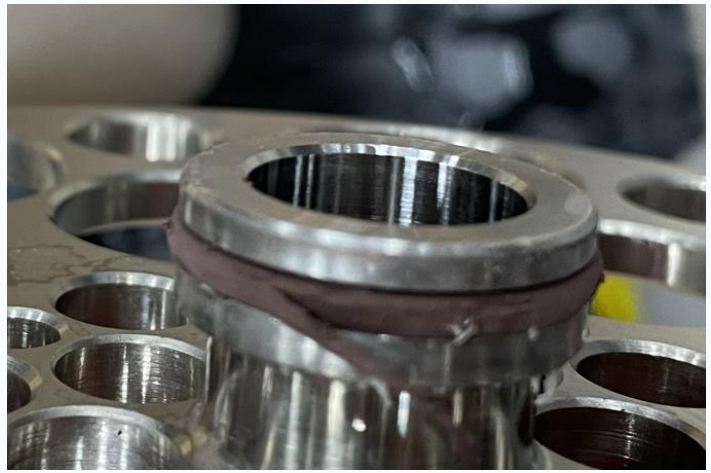


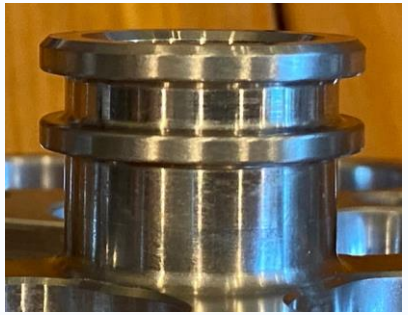
Lip Seals & O-rings



Which O-ring Should You Use?

- Like most plants, if a housing has cloudy permeate the O-rings are replaced
- Mis-matching O-rings will cause issues
  - Generic O-rings
  - Across ATD designs
  - Incorrect O-ring size





Need to match the O-ring to the ATD

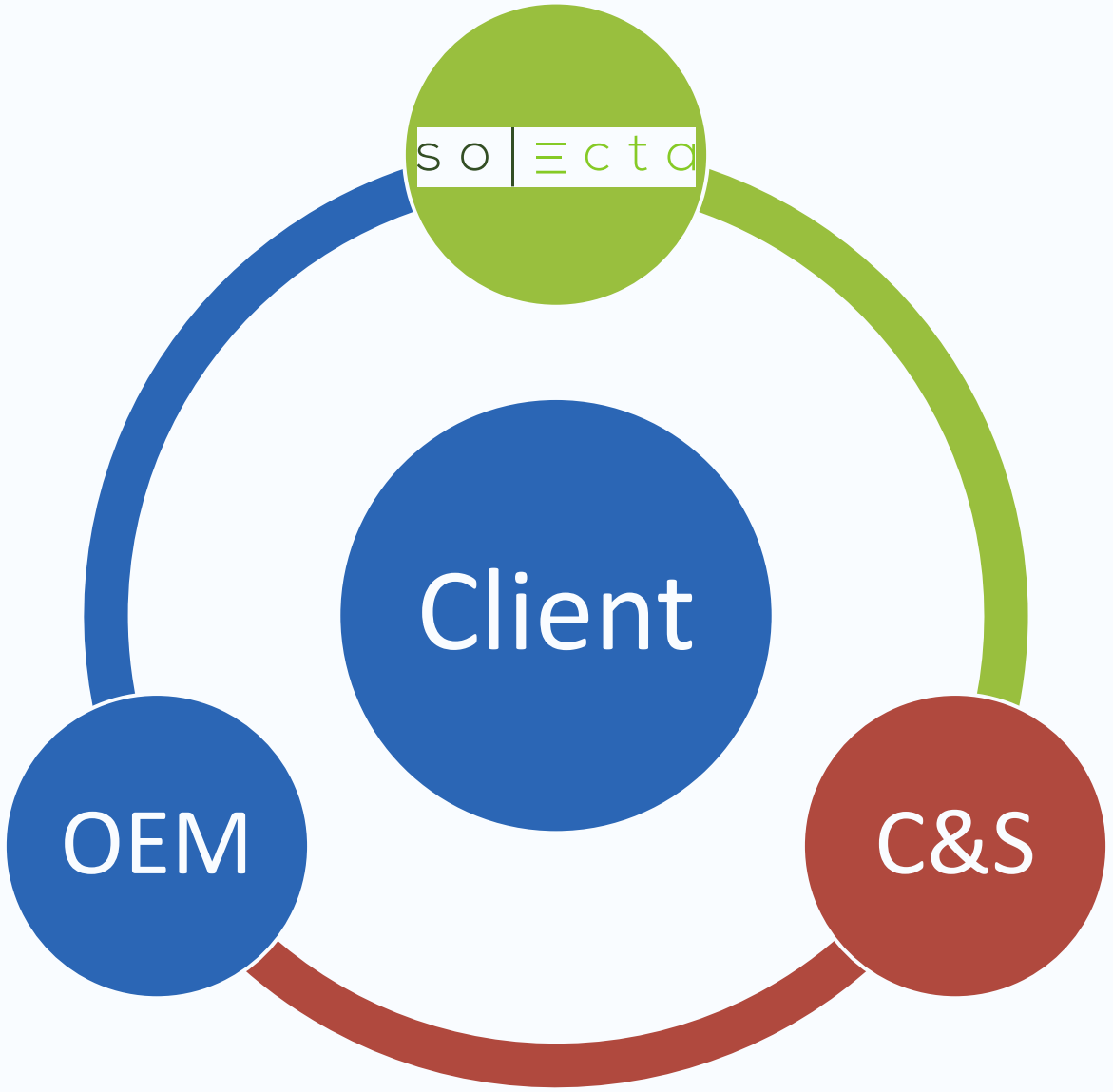
Membrane Map

- Required by USDA
- Membrane maps record element installation information
  - Location, element type, element serial number, installation date, element age (months left), supplier

UF 35 B					Months warranty:	12
Membrane Map						
						Membrane size
Loop 0A	POSITION	1	2	3	4	
Vessel 3	DATE INSTALLED	1/18/2021	1/18/2021	1/18/2021	1/18/2021	
	SERIAL NUMBER	94878	94872	94877	94800	10K 31 ml
	Manufacturer	Solecta	Solecta	Solecta	Solecta	6 inch
	MONTHS LEFT	4.8	4.8	4.8	4.8	
Loop 0A	POSITION	1	2	3	4	
Vessel 4	DATE INSTALLED	1/18/2021	1/18/2021	1/18/2021	1/18/2021	
	SERIAL NUMBER	94864	94881	94865	94868	10K 31 ml
	Manufacturer	Solecta	Solecta	Solecta	Solecta	6 inch
	MONTHS LEFT	4.8	4.8	4.8	4.8	
Loop 0A	POSITION	1	2	3	4	
Vessel 5	DATE INSTALLED	1/18/2021	1/18/2021	1/18/2021	1/18/2021	
	SERIAL NUMBER	94871	94866	94870	94854	10K 31 ml
	Manufacturer	Solecta	Solecta	Solecta	Solecta	6 inch
	MONTHS LEFT	4.8	4.8	4.8	4.8	

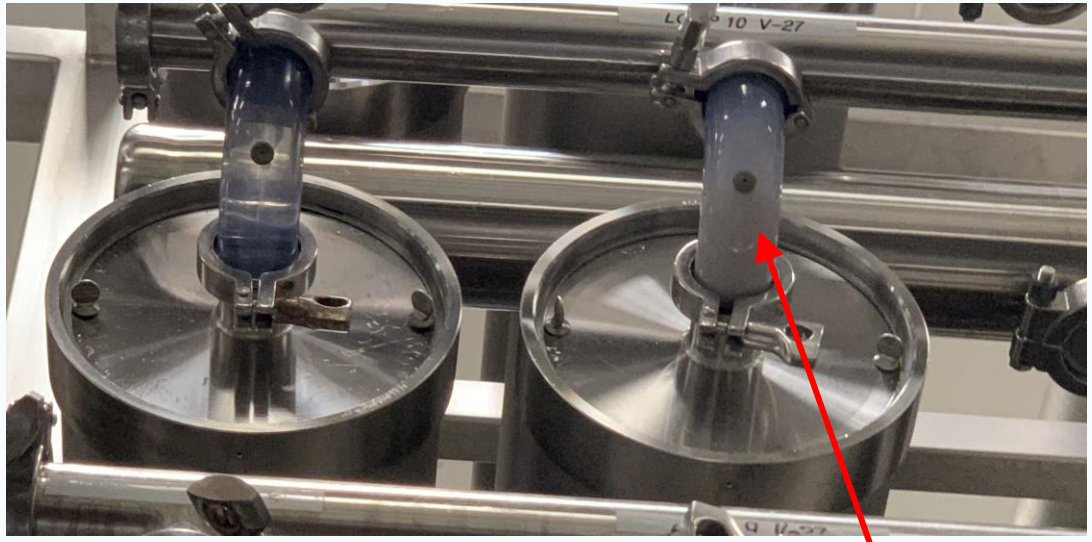
TROUBLESHOOTING

What is required to address more complex issues?

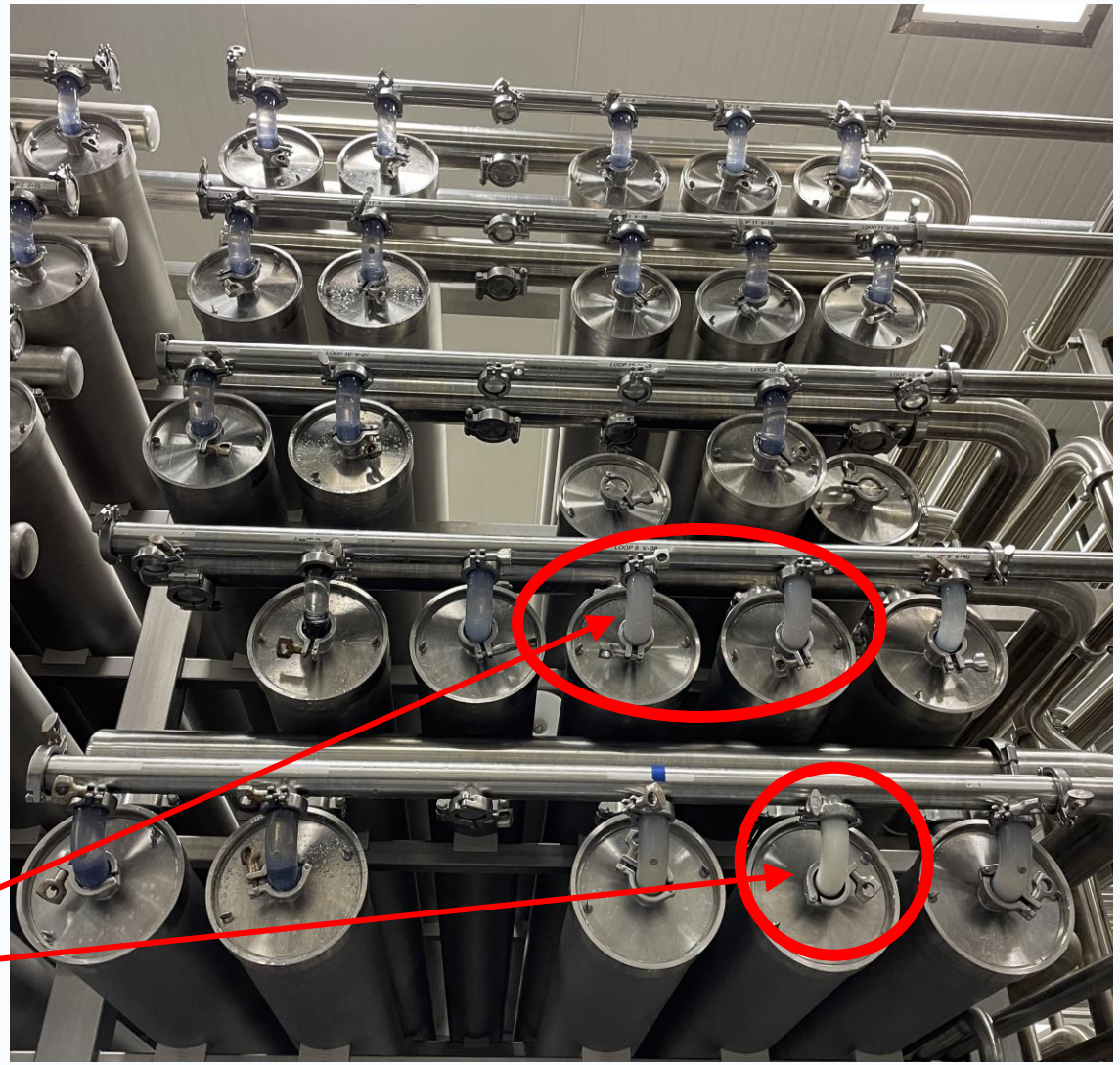


Cloudy Permeate

- What does cloudy permeate indicate?
  - Large leak (fat + protein)



Cloudy Permeate



What to Look for: Pressures

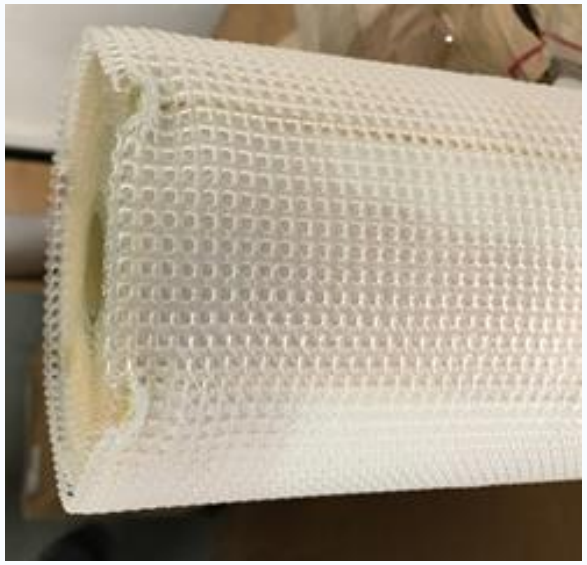
- Membrane separation is a pressure-driven process
  - Excessive pressures will damage elements & shorten membrane life

Element Channeling

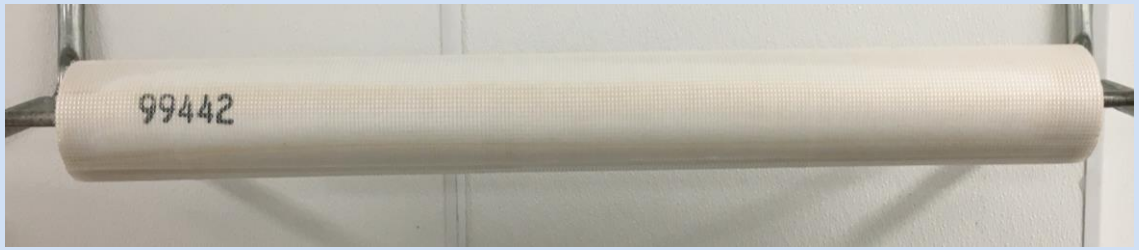
Feed Spacer Extrusion

Telescoping

Outer Wrap Migration



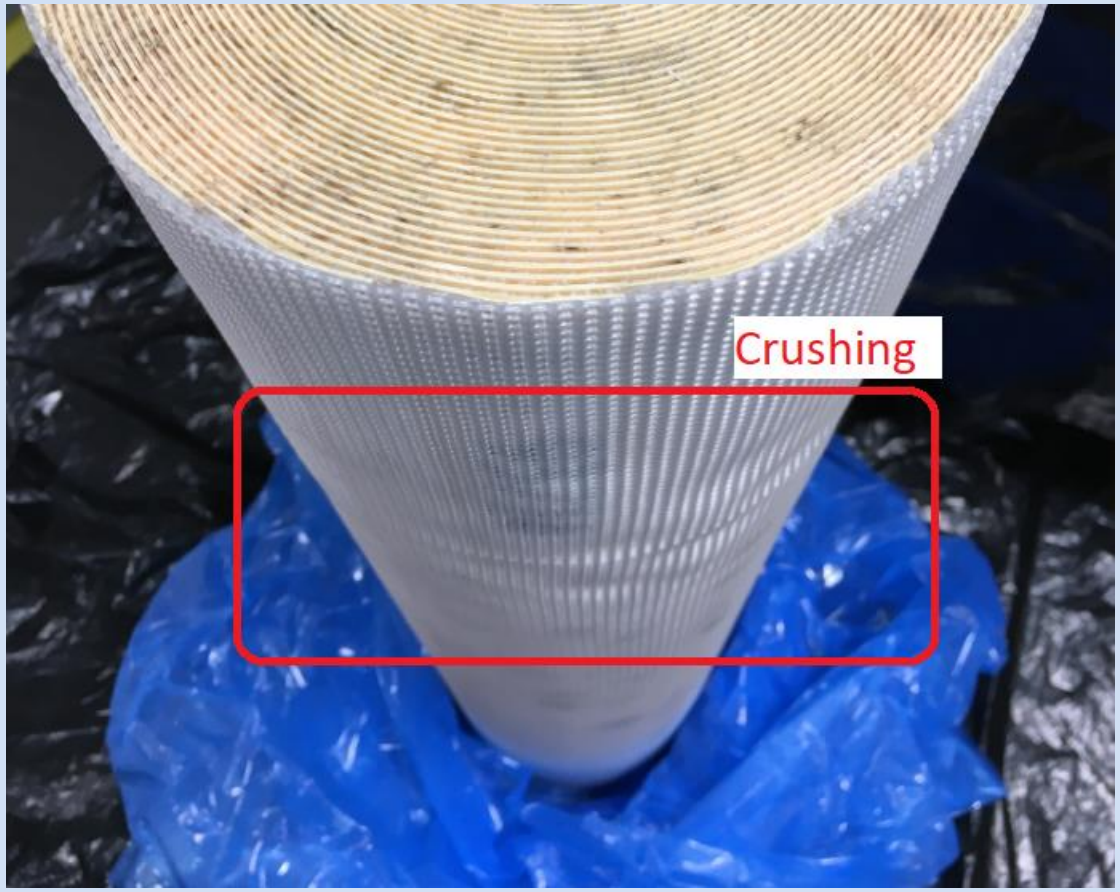
Element Autopsy

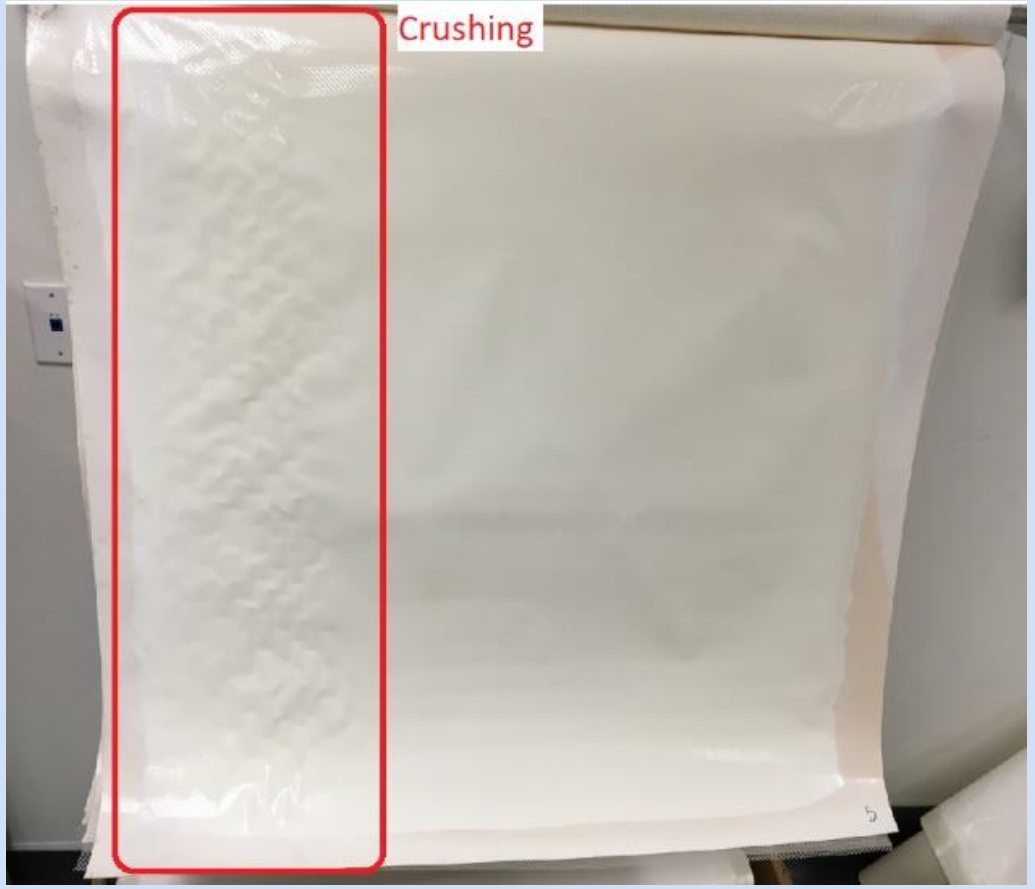


- Why do an autopsy?
  - Proactively to understand element condition
  - USDA/State Inspection
    - Is there residual soil?
  - Trouble-shooting
  - Tracking down micro-issues
  - End of life

What Can We See During an Autopsy?

- Once an element is cut open, we can see the effects more clearly





What Can We See During an Autopsy?

- Once an element is cut open, we can see if there is residual soil in the element

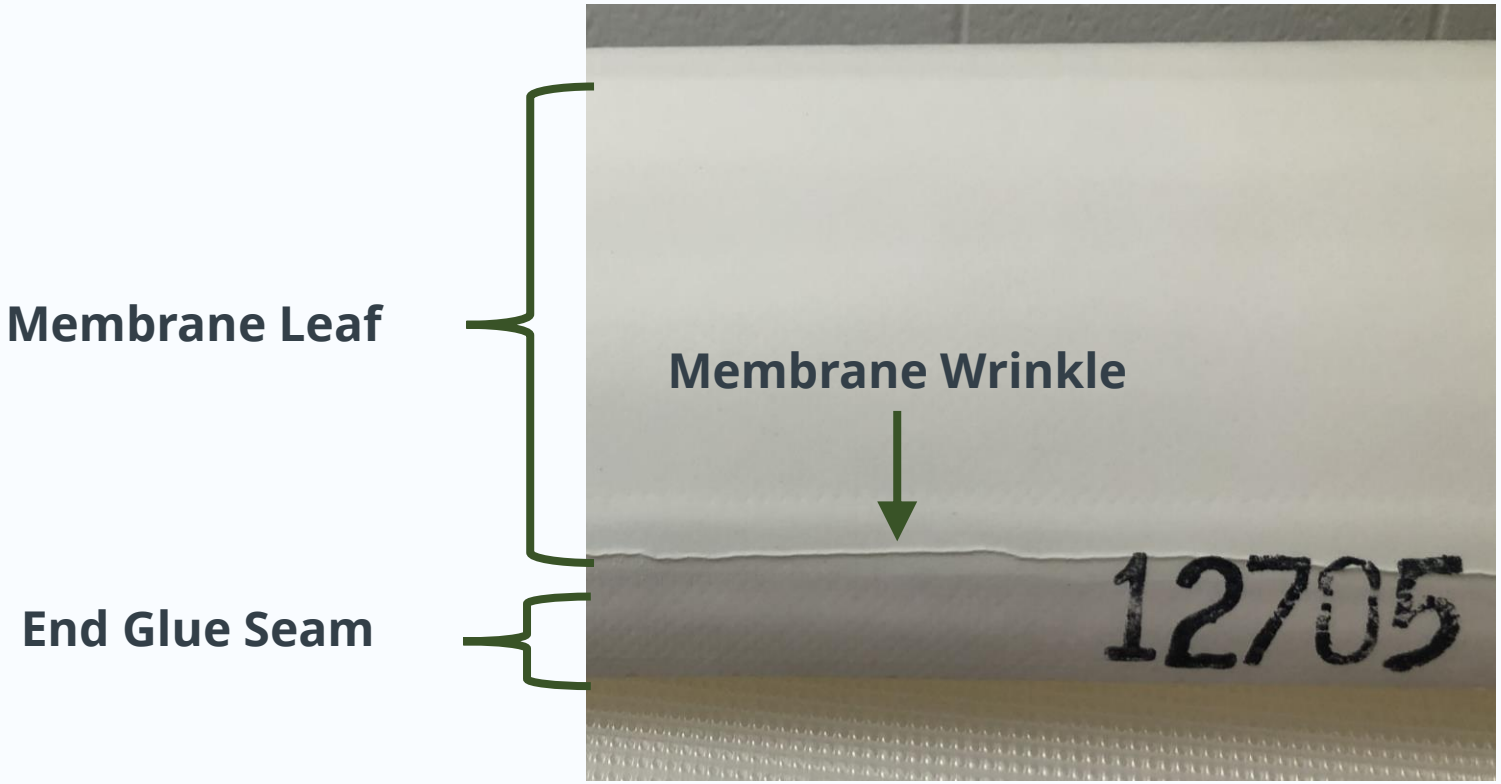
Residual Soils om Membrane

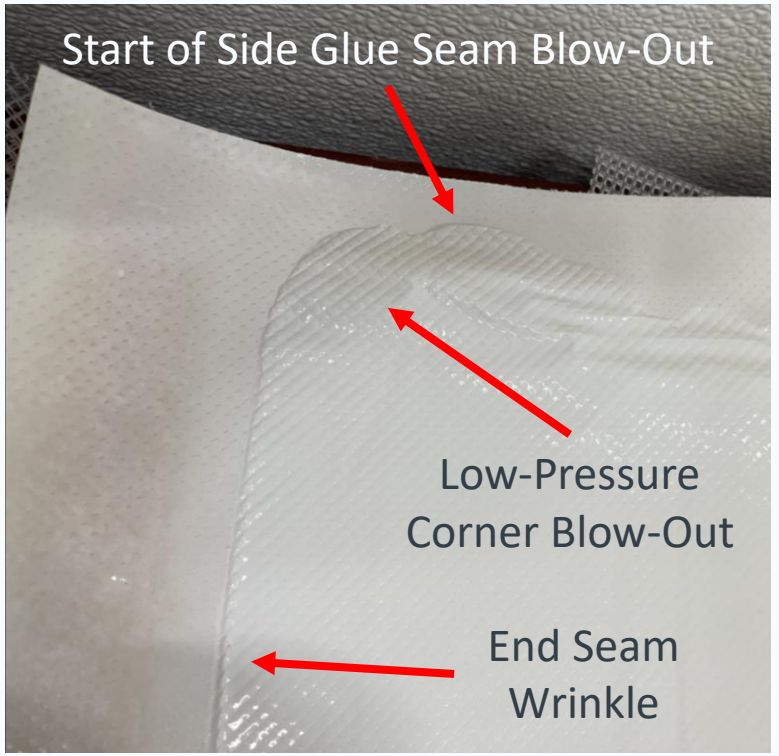
Soil Pattern on Membrane

Feed Spacer Plugged with Soil

Why is the Permeate Cloudy? – Membrane Damage

- Membrane wrinkles will result in protein passage
- Typically caused by low baseline pressure (<5 psi on UF)
  - Permeate pressure can be higher than baseline pressure





PERFORMANCE MONITORING

The Diagnostic Process

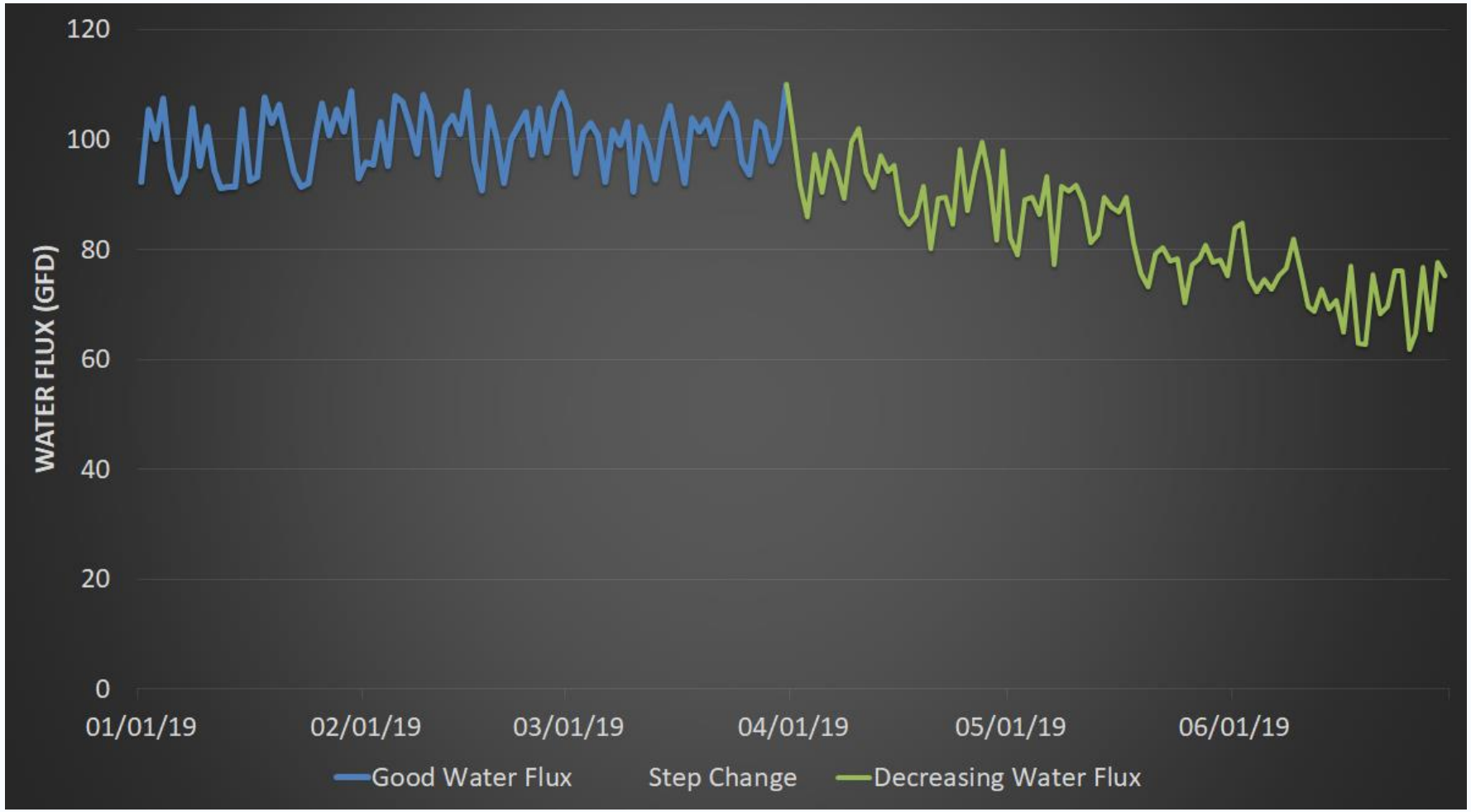
Two metrics for evaluating membrane performance:

THROUGHPUT

PERMEATE QUALITY

Throughput Tracking: Clean Water Flux

- "Good" Water Flux
  - Varies around an average
- "Step Change" Water Flux
  - What happened on April 1st?
- "Decreasing" Water Flux
  - Why did decreasing start on April 1st and why does it continue to decrease?



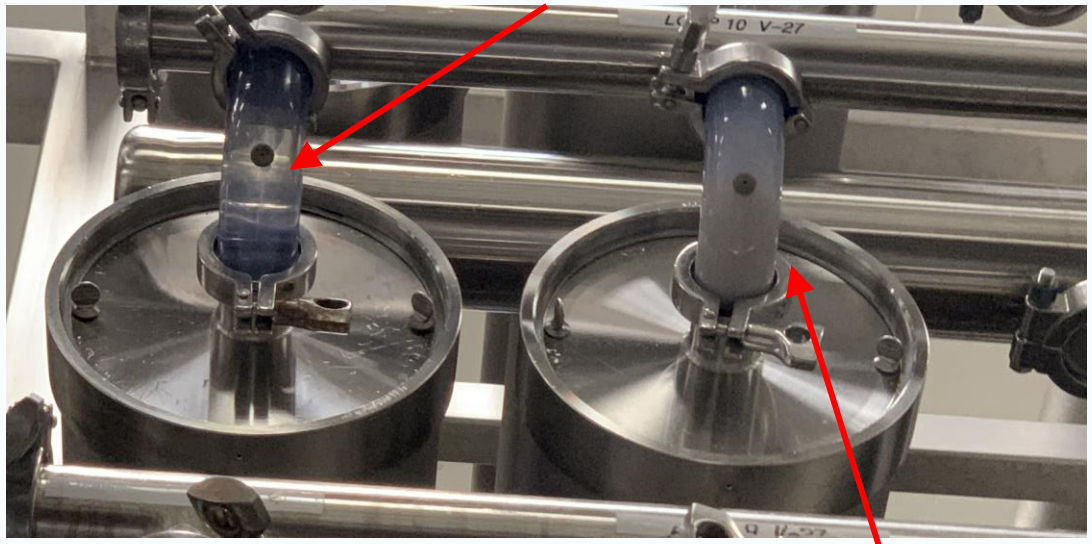
The Cost of Leakers

1. Big “L” Leaker:
   - **Cloudy permeate**
   - Typically >0.35% protein
   - Major integrity breach: check lip seals & elements for structural damage
   - Issue probably only stemming from a small number of elements in the system
   - Costs $1,000’s per day until remedied

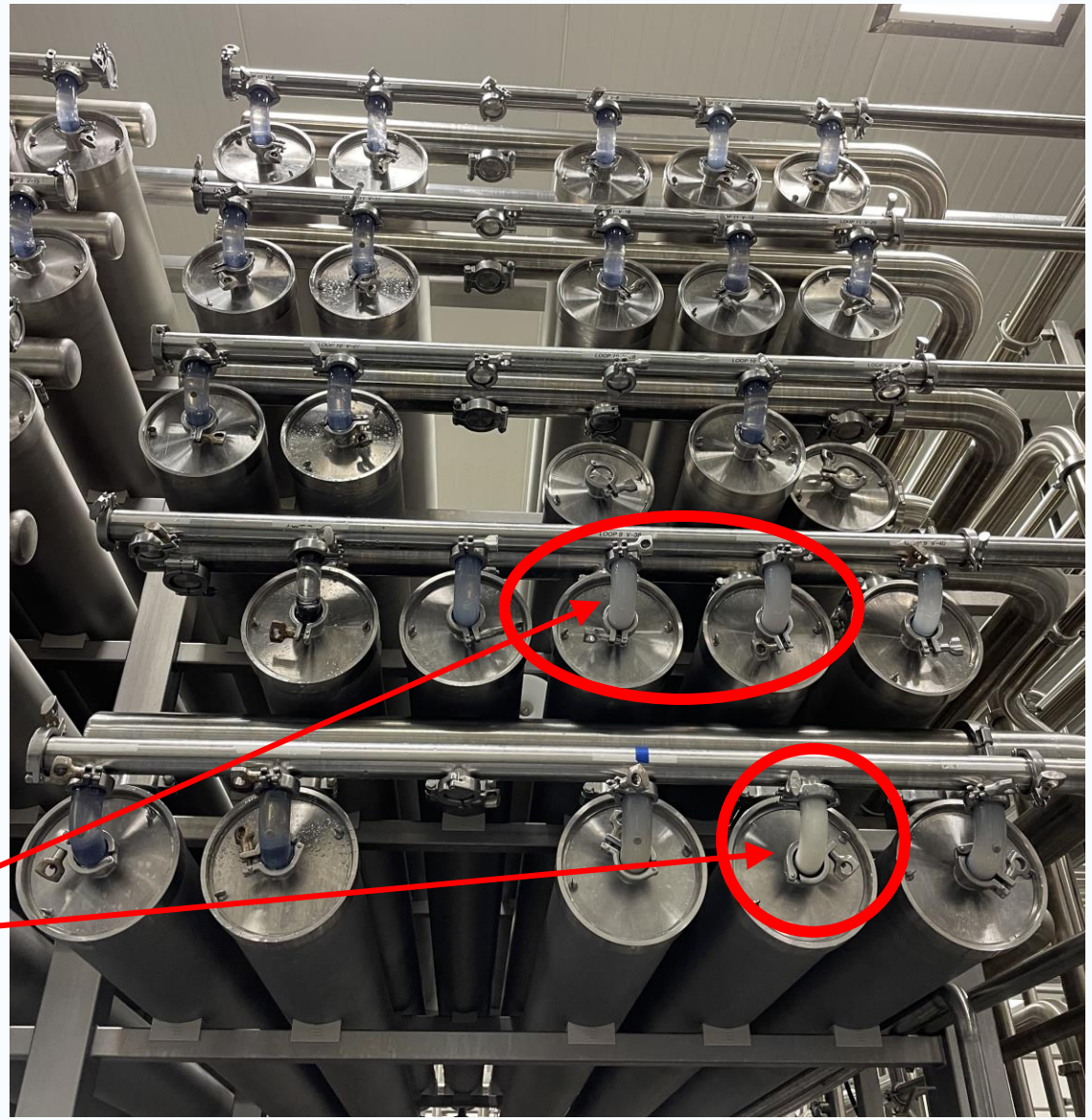
2. Little “L” leaker:
   - **Clear permeate**
   - Typically still <0.35% protein
   - Normal wear and tear, time to replace elements
   - Issue is probably system or loop-wide
   - Costs $1,000’s per day until remedied

Identifying Leaks

- Clear permeate could still hide a Little “L” leaker
  - Weekly lab testing needed to identify



Cloudy Permeate



Protein Loss Calculations

Permeate Flow	Permeate Protein
100 gpm	0.01%

$$Permeate\ Flow = 100\ \frac{gal}{min} \times 1{,}200\ \frac{min}{day} \times 8.34\ \frac{lb}{gal} = 1{,}000{,}000\ \frac{lb\ permeate}{day}$$

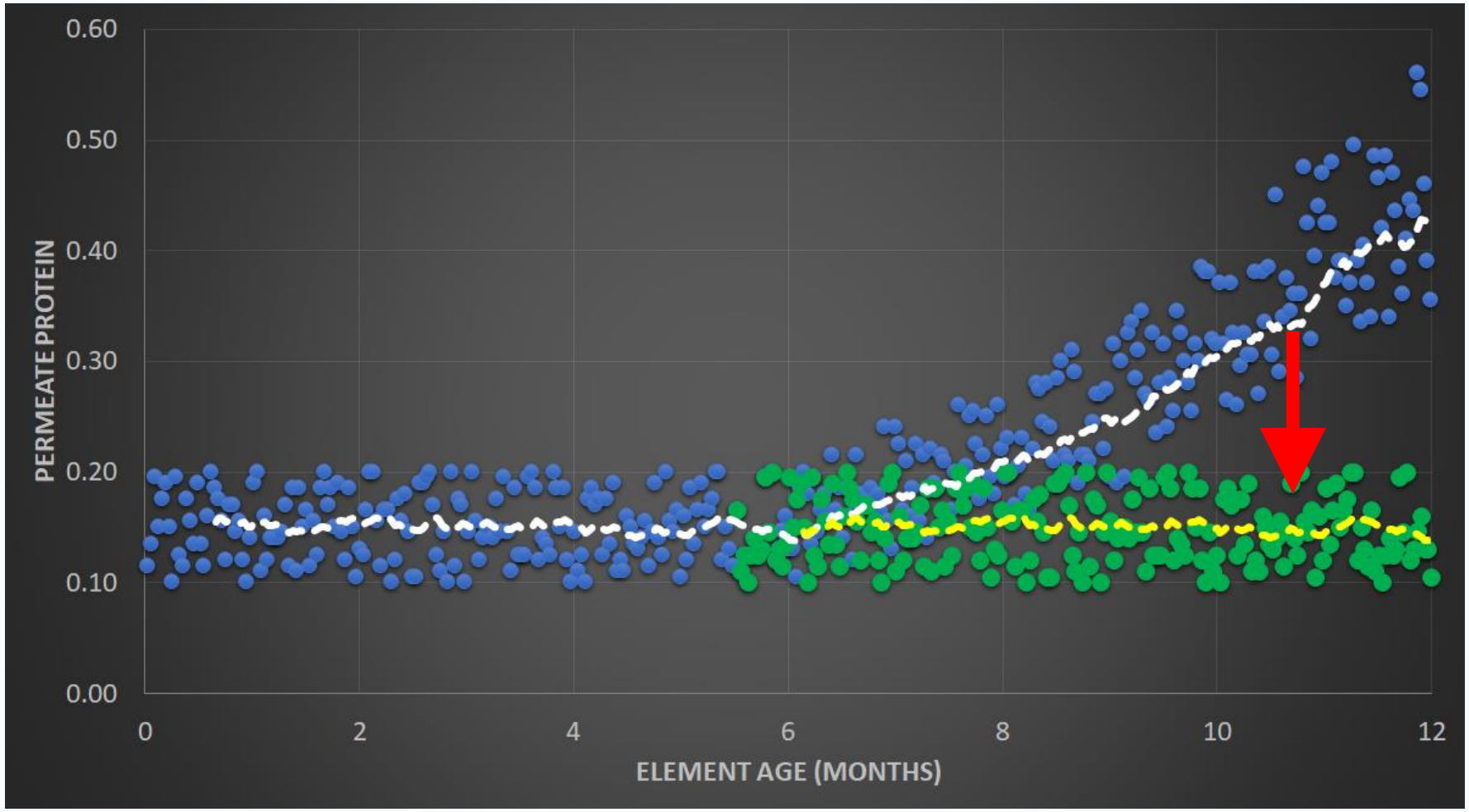
$$Protein\ Loss = \frac{0.01\ lb\ protein}{100\ lb\ permeate} \times 1{,}000{,}000\ \frac{lbs\ Permeate}{day} = 100 \frac{lbs\ Protein}{day}$$

$$Lost\ Protein\ Value = 100\ \frac{lbs\ Protein}{day} \times \frac{1\ lb\ WPC80}{0.8 lb\ Protein} \times \frac{\$4.50}{lb\ WPC80} = \$562/day$$

$200,000 IN ANNUALIZED PROTEIN LOSS

Membrane Wear & Tear

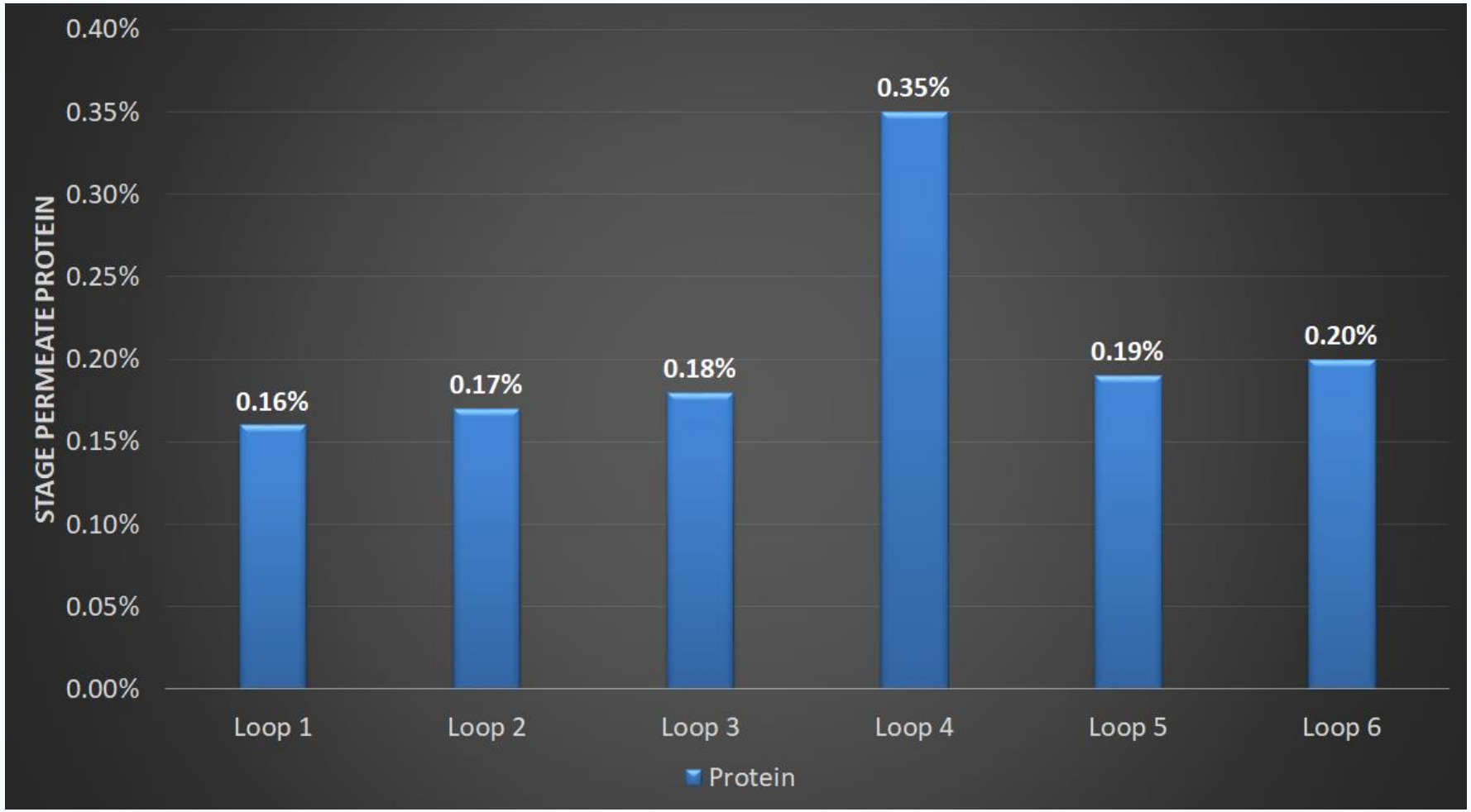
- Permeate protein is flat for the first six months of element life & then increases
- Stable protein over time means
  - Higher protein yields
  - Higher revenue & profit
  - Easier downstream → Lower cost



WHAT SHOULD DRIVE ELEMENT REPLACEMENT?

Dig Whey Deeper: Stage Protein Levels

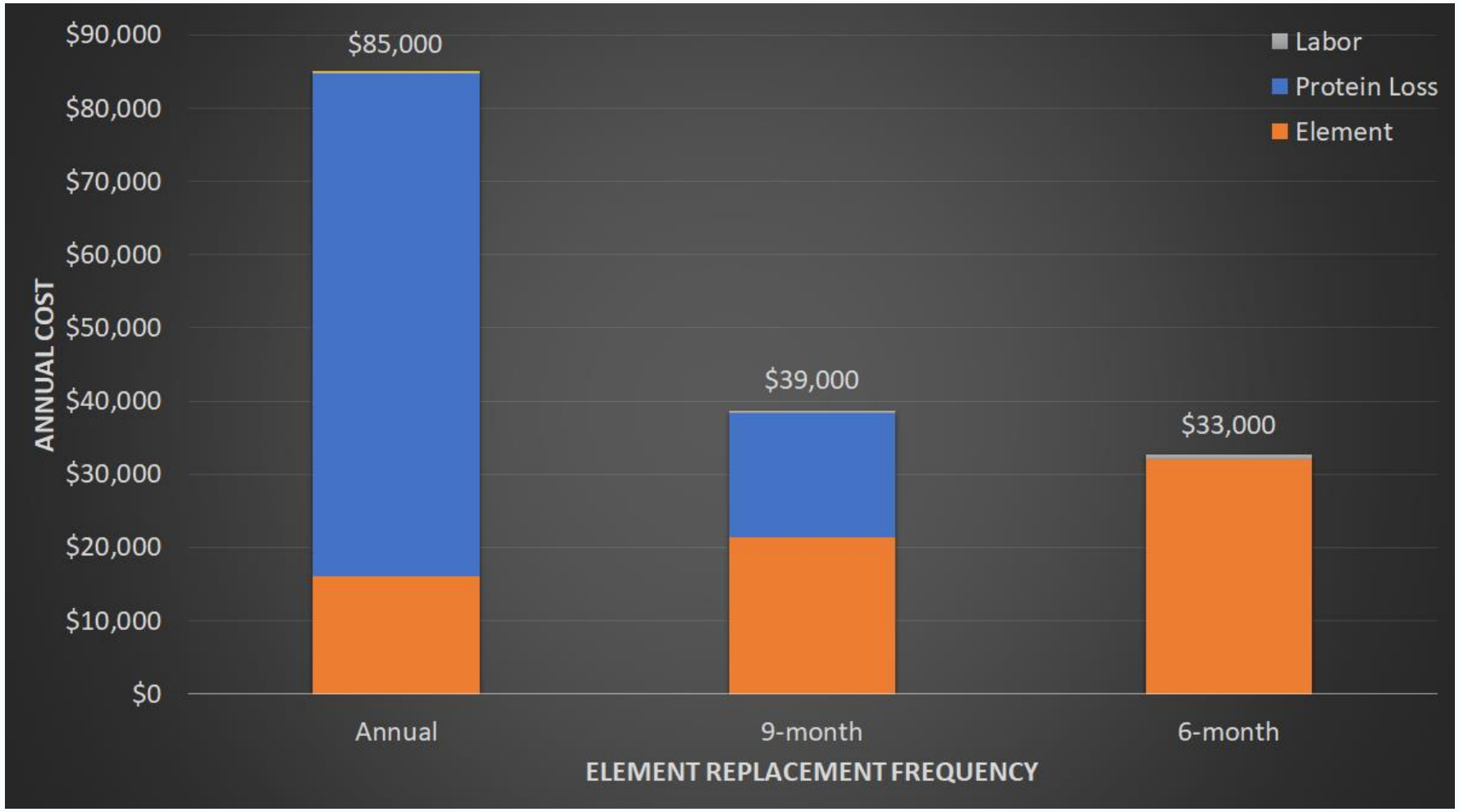
- If you aren't plotting out protein data, compare the readings with the other loops
- Why would Loop 4 protein concentration be so much higher than the other stages?



Example: Changeout Frequency

- What are the annual costs & benefits based on different replacement cycles?

- Increased protein yield has the most benefit
  - Overcomes the additional element cost & installation labor



MINIMIZE PROTEIN LOSS TO MAXIMIZE PROFIT

Thank You

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