Nitto HYDRANAUTICS
Nitto Group Company

Membrane Technology

Design, Selection, Operation & Maintenance

IWMA, Erode.

SOLUTIONS YOU NEED, TECHNOLOGY YOU TRUST

Corporate Info. of Nitto

Nitto HYDRANAUTICS Nitto Group Company

Confidential

Company name : **Nitto Denko Corporation**

Date of foundation : **25th Oct 1918**

Head Office : **Kita dist. Osaka pref. Japan.**

Capital : **26.7B JPY** (as of Mar 2017)

Consolidated sales : **768B JPY** (FY 16/ ended 31st Mar 2017

Number of employees : **29,617** (Consolidated base)

CEO/COO:	**Hideo Takasaki**
Board	**Toshiyuki Umehara(CTO)**
	Toru Takeuchi (CFO)
	Yasushi Nakahira
	Nobuhiro Todokoro
	Yosuke Miki
	Yoichiro Furuse
	Takashi Hatchoji
	Hiroshi Sato

Mr. Takasaki
President of Nitto Denko Corporation

History of Membrane Division

Nitto has over 40 years experience of membrane development since 1970's

1973	Start R&D for industrialization of separation membrane
1978	Commercialized prototype of capillary & spiral
1986	Shiga Plant started up as the world first RO/UF plant
1987	Acquire Hydranautics in California, USA
1991	Release Seawater desalination aromatic PA RO product
1995	Release ultra-low pressure RO product
1997	Release fouling-resistant RO product
2002	Spiral membrane assembly started in Shanghai
2008	SWC5 wins Nikkei Superior Products and Services Awards
2009	Start new plant operation in Shiga Plant

Membranes: Key Drivers & VOC

Key Drivers

- Diminishing Water Resources
- Increasing Regulations
- Stringent water quality requirements

VOC

Consistent Quality & Quantity @ Lower Opex

- Higher Recovery
- Higher Membrane Life
- Lower Energy Consumption
- Low Fouling →
  - Extended Mean Time Between Cleanings

Our Product Offering

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- Reverse Osmosis (RO) Membrane Elements
- Nanofiltartion (NF) Membrane Elements
- Ultrafiltration (UF) Membrane Modules
- Membrane Bio Reactor (MBR) Modules
- Specialty Process Separation Products

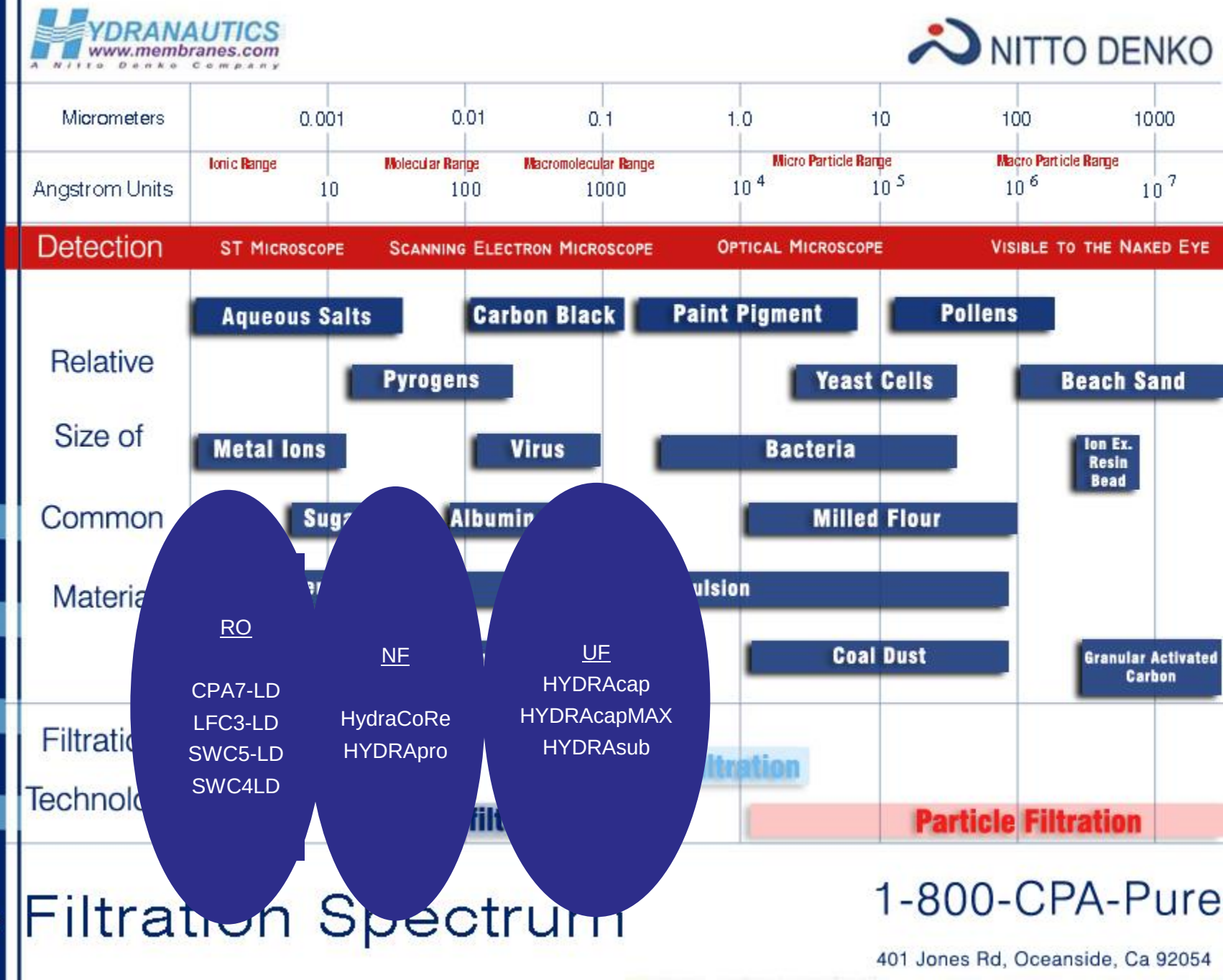
Product Overview (RO/NF)

Application	SWC	CPA	LFC	ESPA	ESNA	PS* Mem.
Seawater Desalination	●					
Ultra Pure Water		●		●		●
Municipal Wastewater Reclamation		●	●	●		
Industrial Wastewater Reclamation	●	●	●	●		
Potable Water	●	●		●	●	
Industrial Process Separation Applications						●

*PS: Process Separation

Textile Industry

Membrane Technology Applications


HYDRANAUTICS
www.membranes.com
A Nitto Denko Company
NITTO DENKO
Micrometers
0.001
0.01
0.1
1.0
10
100
1000
Angstrom Units
Ionic Range
Molecular Range
Macromolecular Range
Micro Particle Range
Macro Particle Range
10
100
1000
10 4
10 5
10 6
10 7
Detection
ST Microscope
Scanning Electron Microscope
Optical Microscope
Visible to the Naked Eye
Relative
Size of
Common
Materia
Filtrati
Technolo
Aqueous Salts
Carbon Black
Paint Pigment
Pollens
Pyrogens
Yeast Cells
Beach Sand
Metal Ions
Virus
Bacteria
Ion Ex. Resin Bead
Sug
Albumin
Milled Flour
ulsion
Coal Dust
Granular Activated Carbon
ltration
Particle Filtration
RO
CPA7-LD
LFC3-LD
SWC5-LD
SWC4LD
NF
HydraCoRe
HYDRApro
UF
HYDRAcap
HYDRAcapMAX
HYDRAsub
The Filtration Spectrum
1-800-CPA-Pure
401 Jones Rd, Oceanside, Ca 92054

TEXTILE INDUSTRY

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Characteristics

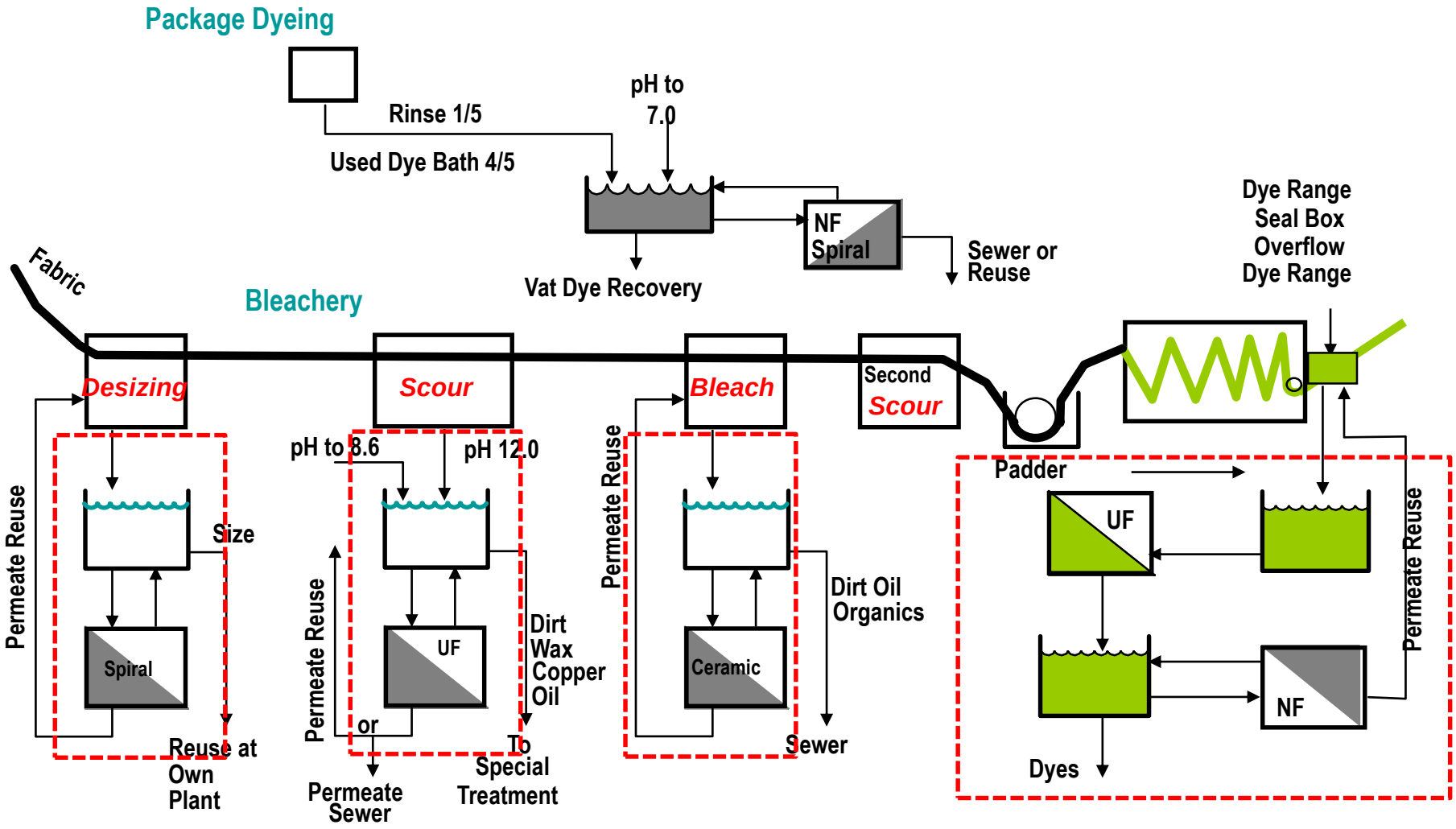
- ✓ Is complex and diversified
- ✓ Consumes large quantities of water
- ✓ End- Users are many
- ✓ Consumption is a small fraction of total usage

Hence recycle of effluent is feasible

❖ TEXTILE PROCESSING

- Sizing & de-sizing
- Scouring
- Bleaching
- Mercerizing
- Dyeing
- Washing

❖ Potential UF/NF Applications at Textile Mill



HYDRACoRe Series

Product PERFORMANCE Description

Products -

- HYDRACoRe 10
- HYDRACoRe 50
- HYDRACoRe 70

Operating Specification (1)

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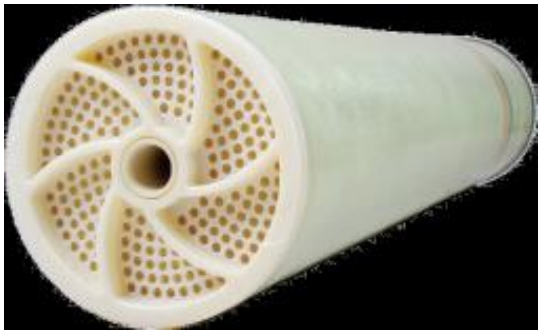
HYDRACoRe10 and 50

- ***HYDRACoRe10*** is rated at approximately 3,000 Daltons
  - ✓ Rejection profile: 10-15% of NaCl , 4% of glucose, and 15% of sucrose

- ***HydraCoRe50*** is rated at approximately 1,000 Daltons
  - ✓ Rejection profile : 50-60% of NaCl, 18% of glucose, and 41% of sucrose

- pH Range of 2-11 Operating and 1-12 for Cleaning
- Maximum continuous chlorine concentration: 10 PPM
- Maximum chlorine concentration for cleaning: <100 ppm



Operating Specification (2)

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HYDRACoRe70 pHT

- ***HydraCoRe70pHT*** is a temperature and pH-tolerant version of the membrane and is rate at approximately 700 Daltons.
  - ✓ Rejection profile: 70-80% NaCl, 39% of glucose, and 88% of sucrose

- Max. operating temperature: 158 F or 70 ℃
- Max chlorine concentration: 200 ppm
- Operating pH range: 1-13.5 pH
- Max. cleaning temperature of 90 ℃

Membrane Characterization (5)

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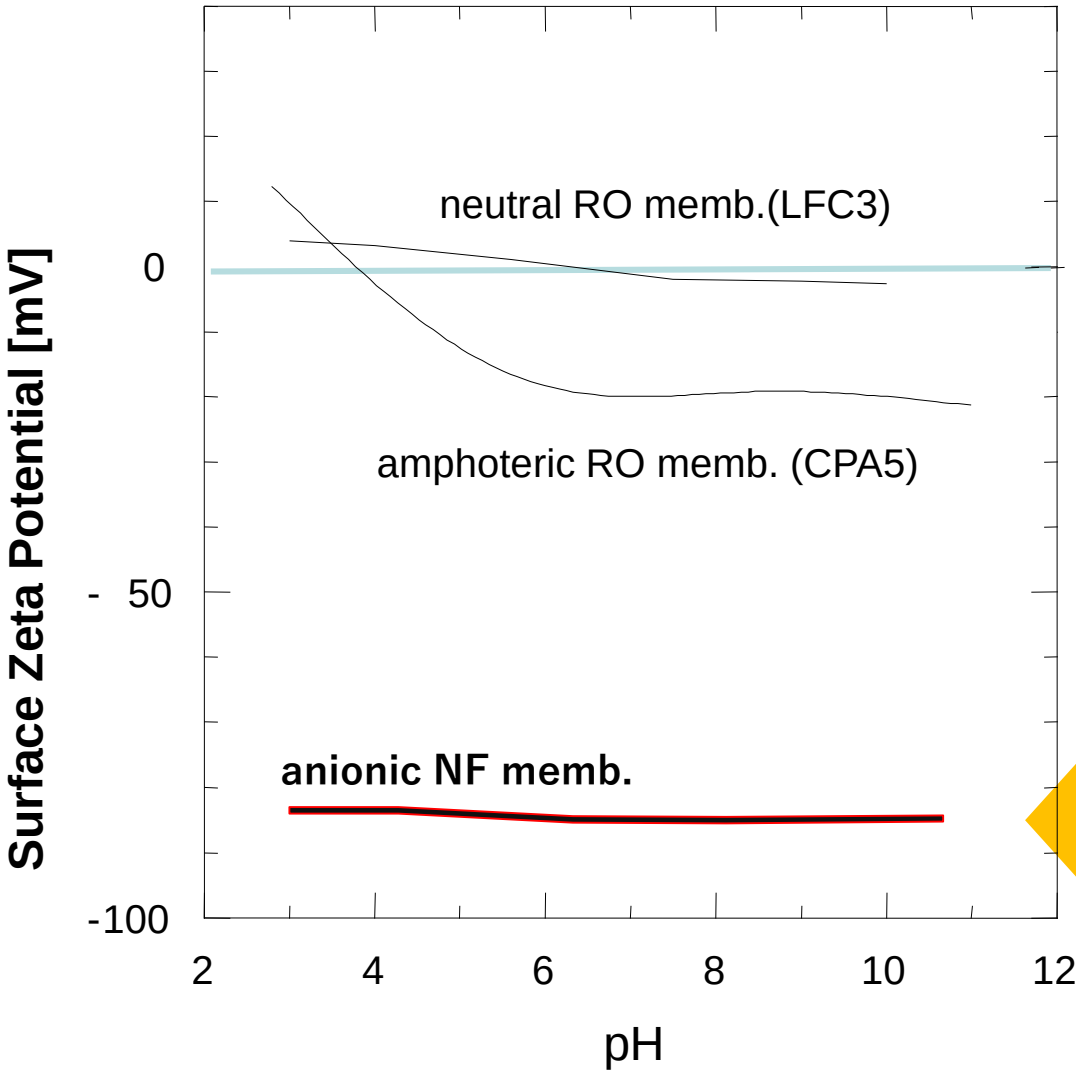

Strong Negative Charge
+ Hydrophilic Membrane

Membrane Characterization (6)

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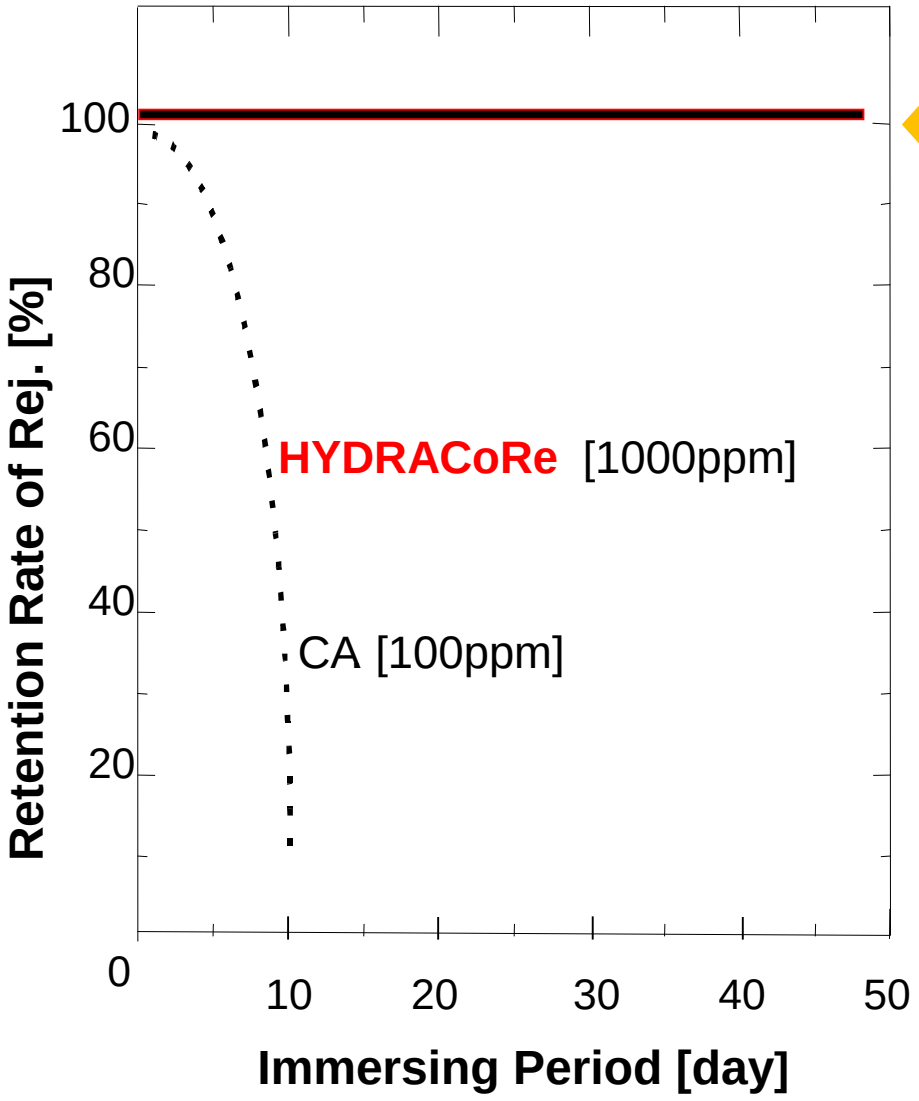

True Chlorine tolerance Membrane

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HYDRACoRe

Color Removal

/Adjustment

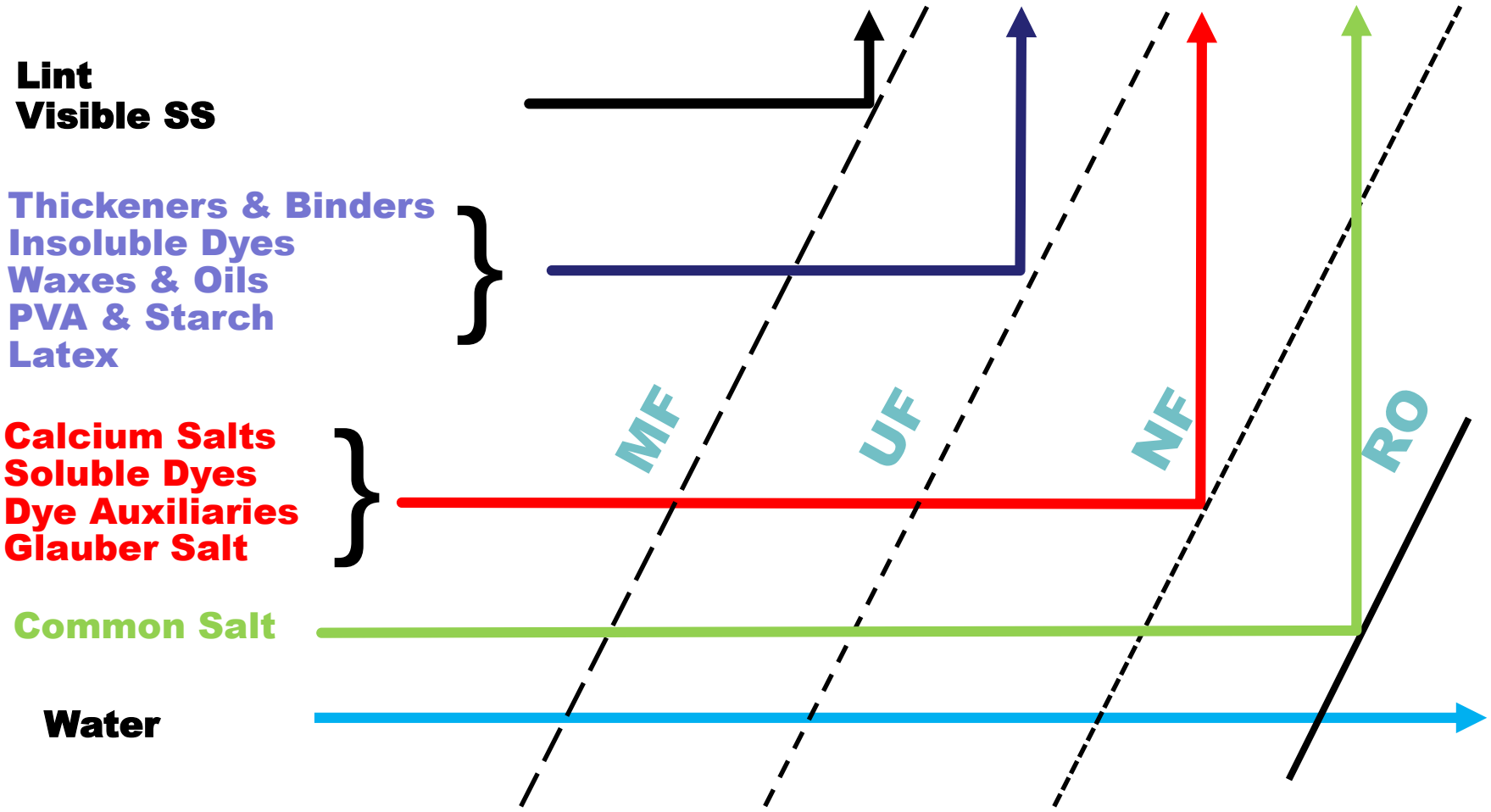
- Soy Sauce
- Grape Juice
- Red Wine
- Black Tea
- Coffee
- Pulp Wastewater
- Brine Recovery
- Ground water
- Dye waste water
- Dye Desalting
- Dye Concentration
- OBA Concentration

DYE TREATMENT AND WASTE WATER RE-USE IN TEXTILE INDUSTRY

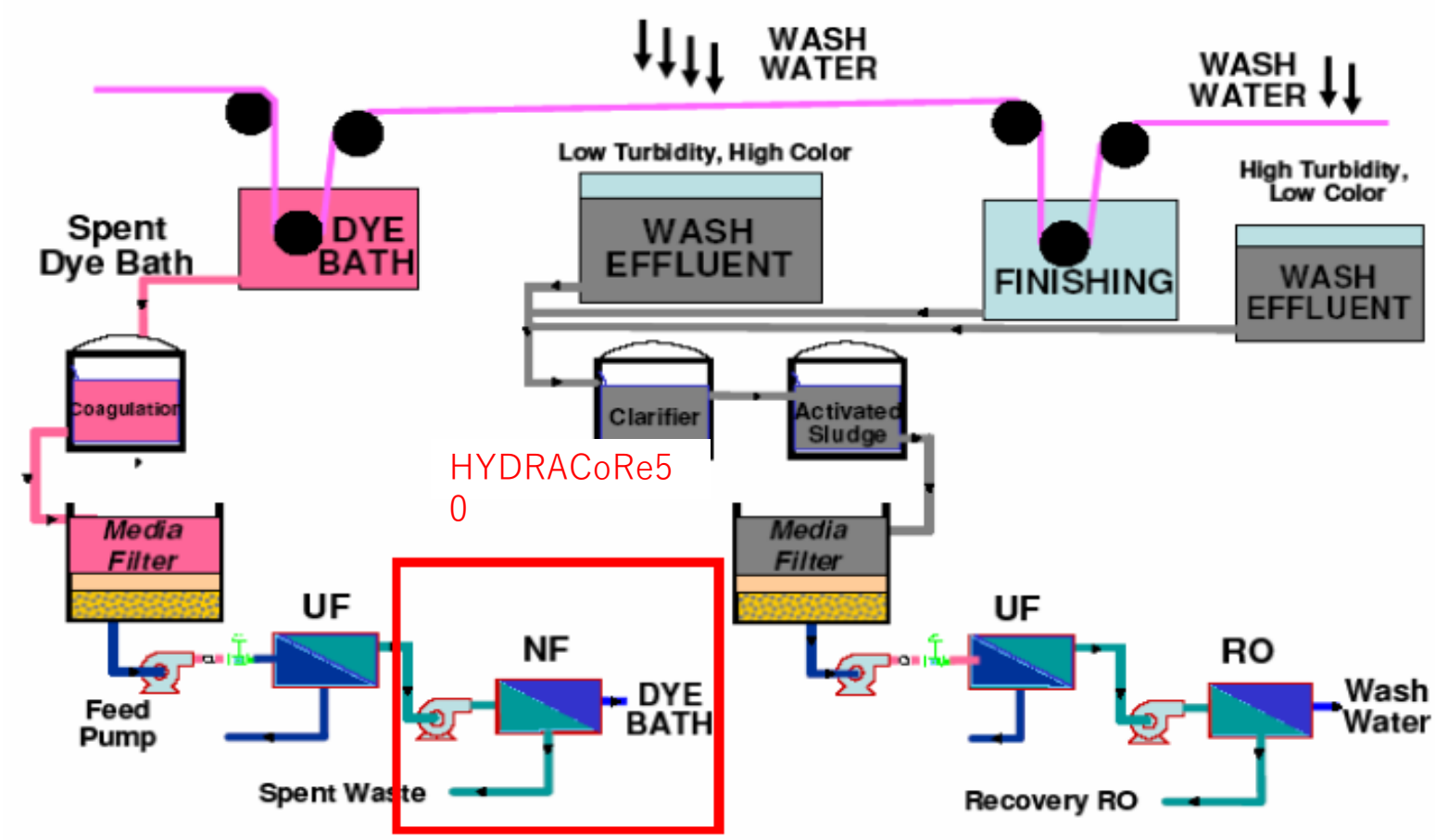
Water Usage, %

- ***Processing 70***
- ***Steam Generation 15***
- ***Cooling 10***
- ***Others 5***

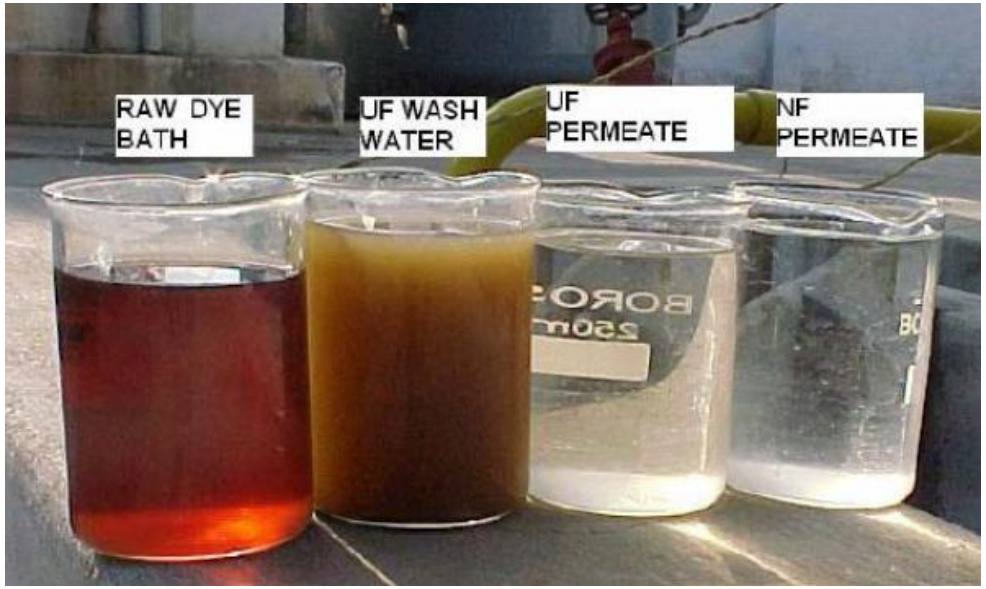
Separation of Textile Chemicals



❖ Recylce of Wastewater at Dying process



❖ Recylce of Wastewater at Dying Process Water quality



Parameter	Wastewater	HYDRACoRe permeate
pH	11-12	5.8-6.2
TDS ppm	25000-100000	24500-99500
Hardness ppm	100-500	15-50
Colour	Dark	Colorless

Summary

In textile wastewater recycle plants, the dye bath waste and wash water are generally mixed and treated together.

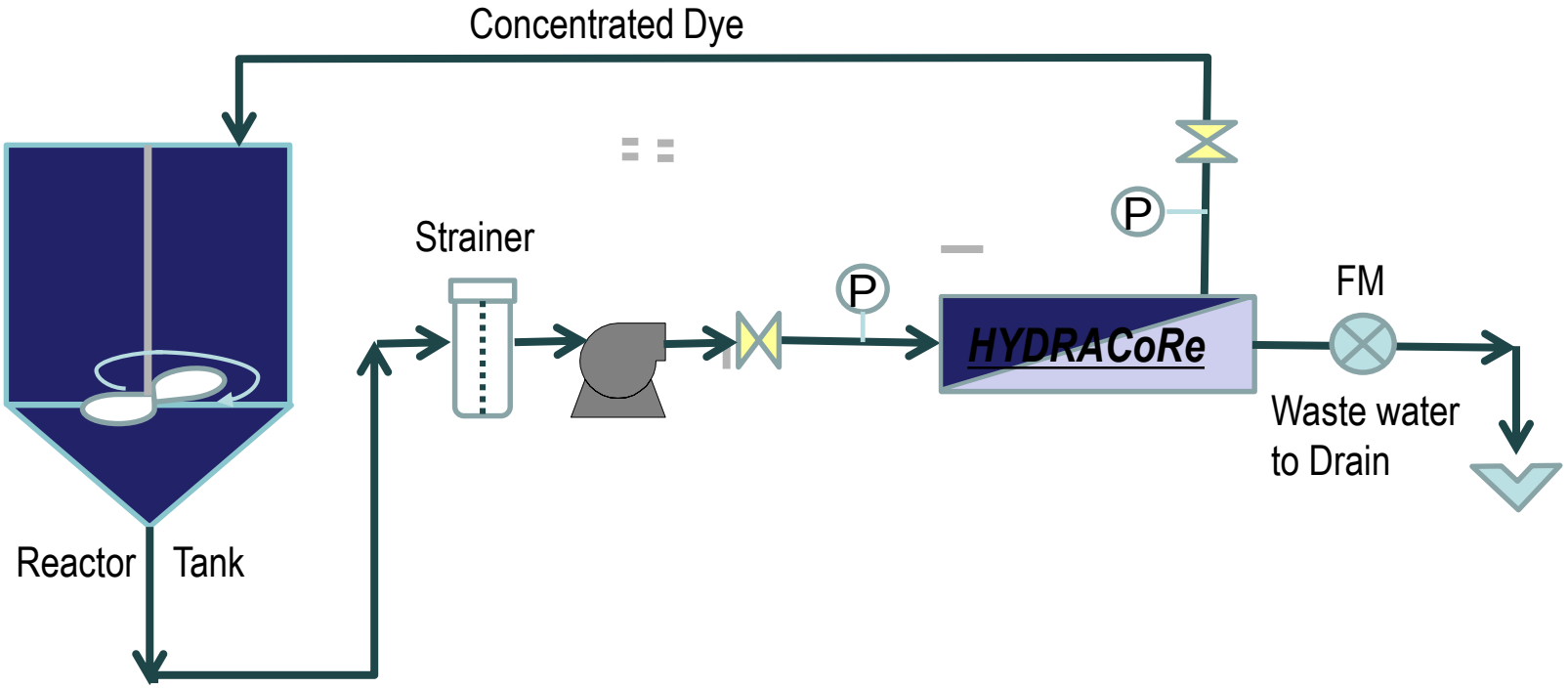
The salinity to RO feed is high as the salt appears in the RO feed. The RO feed pressure is higher due to that. This also limits recovery and membranes are prone to fouling.

An attempt was made to segregate the dye bath and wash water streams and treat them separately. The dye bath waste is treated through NF membrane (HYDRACoRe50).

NaCl in the NF permeate is recovered and recycled back to the process.

The wash water stream is treated through a low fouling RO (LFC3) to produce low TDS product water. A plant designed with this concept has been in operation successfully for the last more than10 years.

Dye & OBA Concentration Flow Chart



Case Study- Colourtex

- Type of Dye: Reactive Dyes
- Element: HYDRACoRe 50
- Initial Concentration – 5-10 %
- Final Concentration – 25-30 %
- Typical Duration : 10-20 hours
- Dye used: Red, Blue, Orange, Black, Yellow

Spot Paper Results

OBA Concentration – Deepak Nitrate

- Element: HYDRACoRe 50 (1000 D)
- Initial Concentration of OBA solution– 16%
- Final Concentation – 27-28%
- Typical Duration : 8-10 hrs
- Initial Salt concentration : 4% (chlorides & sulphate)
- Final Salt concentration : 0.4%

Feed

Permeate

Hydranautics UF & RO Membranes For High Fouling Waters

HYDRAcapMAX – Product offering

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Element	Membrane area (m^2)	Diameter (mm)	Height (cm)	ID fiber (mm)	OD fiber (mm)
HYDRAcapMAX4040	9	100	113.3	0.6	1.2
HYDRAcapMAX40	52	250	120	0.6	1.2
HYDRAcapMAX60	78	250	120	0.6	1.2
HYDRAcapMAX80	105	250	170.8	0.6	1.2

HYDRAcap® MAX – Strength Advantage

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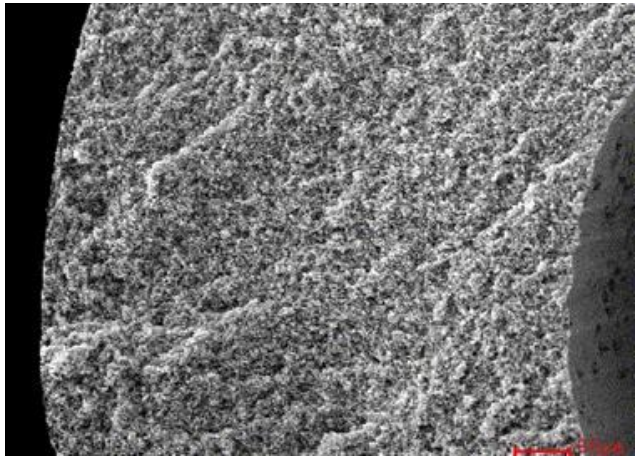

Cross section of the TIPS fiber

TIPS Fiber Technology:

Microporous, crystalline structure resulting from thermally induced phase separation (TIPS) provides:

- Increased chemical resistance
- Increased mechanical strength

TIPS Fiber Characteristics:

Tensile strength: 7 – 9 MPa (3 - 4 times more than conventional PVDF fibers)

Burst pressure 0.8 MPa (3 times more than conventional PVDF fibers)

Key Benefits:

- **Lower OPEX**
- **Reliability**

HYDRAcap® MAX – Process Simplicity Advantage

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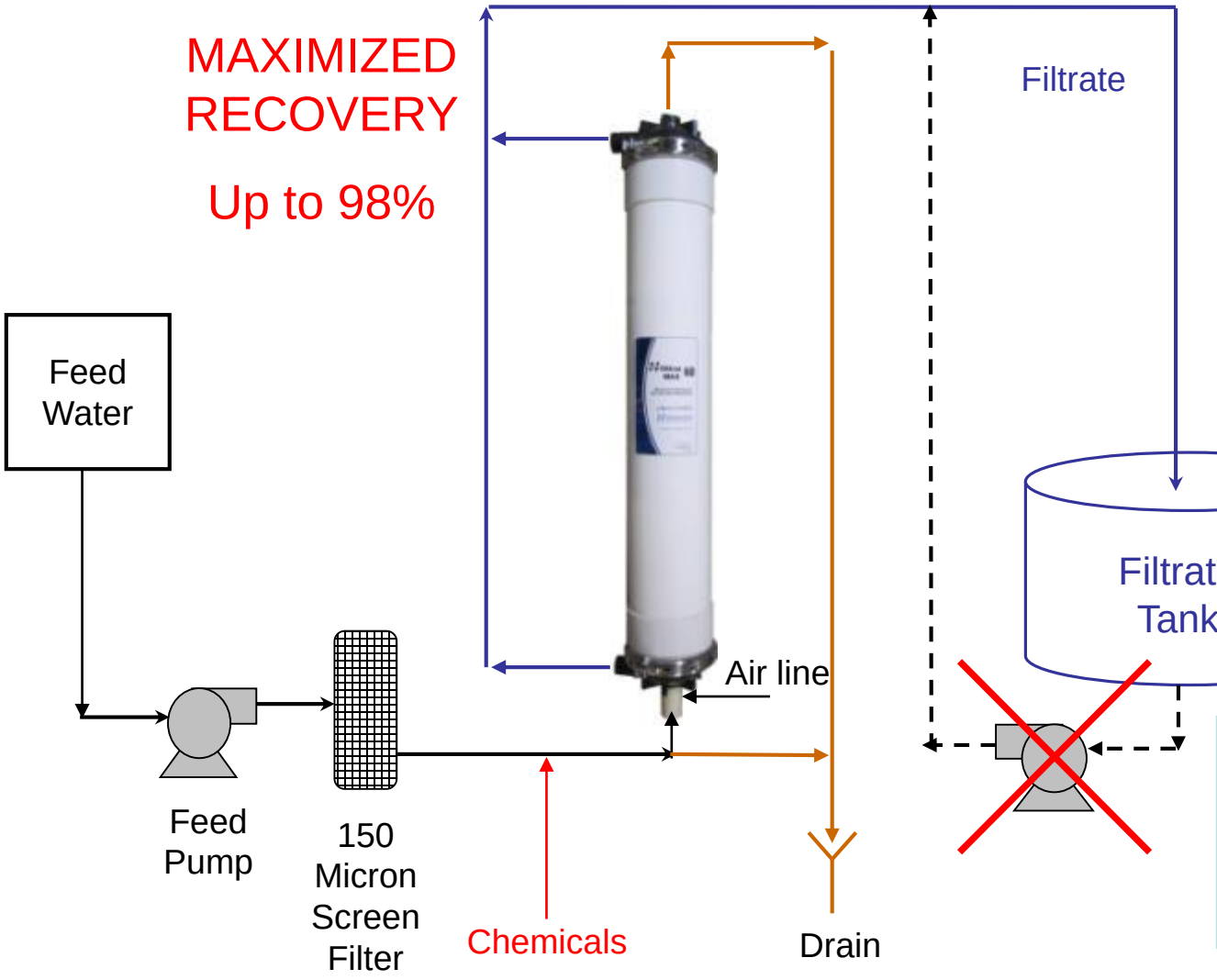
MAXIMIZED RECOVERY

Up to 98%



No backflush pump requirement

Air scouring cleans

Chemicals injected on line

Key Benefits:

- **Lower CAPEX**
- **Simplicity**

HYDRAcap® MAX Advantage Summary

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Features	Advantages	Benefits			
		Lower CAPEX	Lower OPEX	Simplicity	Reliability
High membrane area	Smaller footprint / Fewer skids	√		√	
	Reduced skid cost	√			
	Fewer seals / connections				√
TIPS fiber technology	Reduced fiber breakage		√		√
	Increased tolerance to aggressive cleans		√		√
No backwash requirement	Higher recovery		√		
	No pump nor ancillary equipment necessary	√		√	
Internal air diffuser	Even distribution of air within the module				√
	Even flux distribution along fiber length		√		√
Dual layer potting	Delamination prevention		√		√
	Minimal fiber breakage		√		√
PVDF membrane material	Increased tensile and fatigue strength				√
	Chlorine and other oxidant tolerant		√		√
OUT/IN technology	Ability to treat high turbidity feed water	√		√	
	Higher surface area per module volume	√	√		

HYDRAcube® Introduction

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- Simple
  - One piece to convey all 3 fluids
- Compact
  - 30-50% footprint reduction compared to conventional HYDRAcap® MAX racks
  - 25% higher output capacity than nearest competitor
- Robust
  - High strength TIPS PVDF fiber

HYDRAcube® Introduction

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Conventional UF Rack Design

Conventional Racks are:

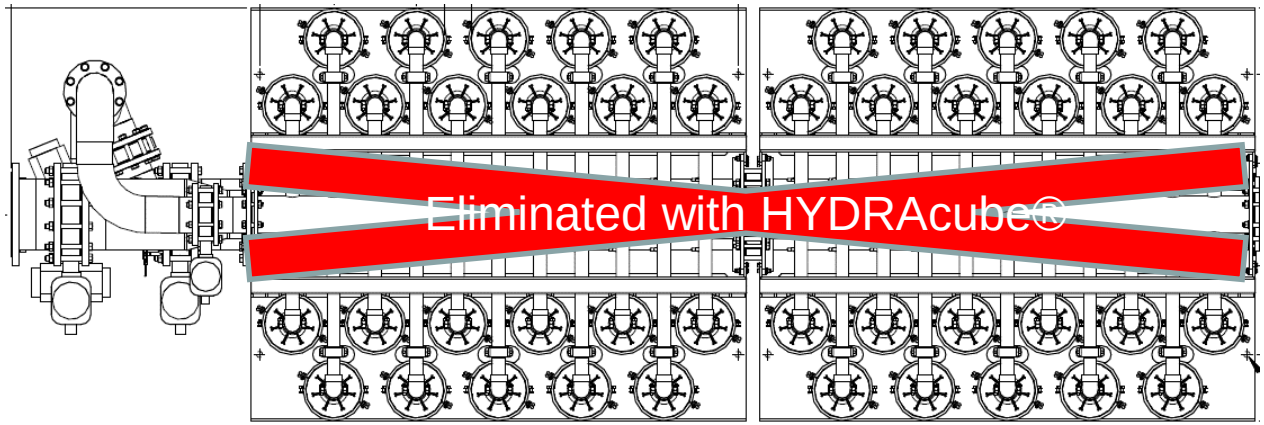
Complicated

- Top Filtrate connection to Header
- Top Concentrate connection to Header
- Bottom Filtrate connection to Header
- Bottom Feed connection to Header
- Bottom Air Line connection to Header
- Top Filtrate Header
- Top Concentrate Header
- Bottom Filtrate Header
- Bottom Feed/Drain Header
- Bottom Air Header

Costly for small/medium systems

- 3-5X Higher per m2 membrane area

Large Footprint



Issue of Composite Fouling in RO

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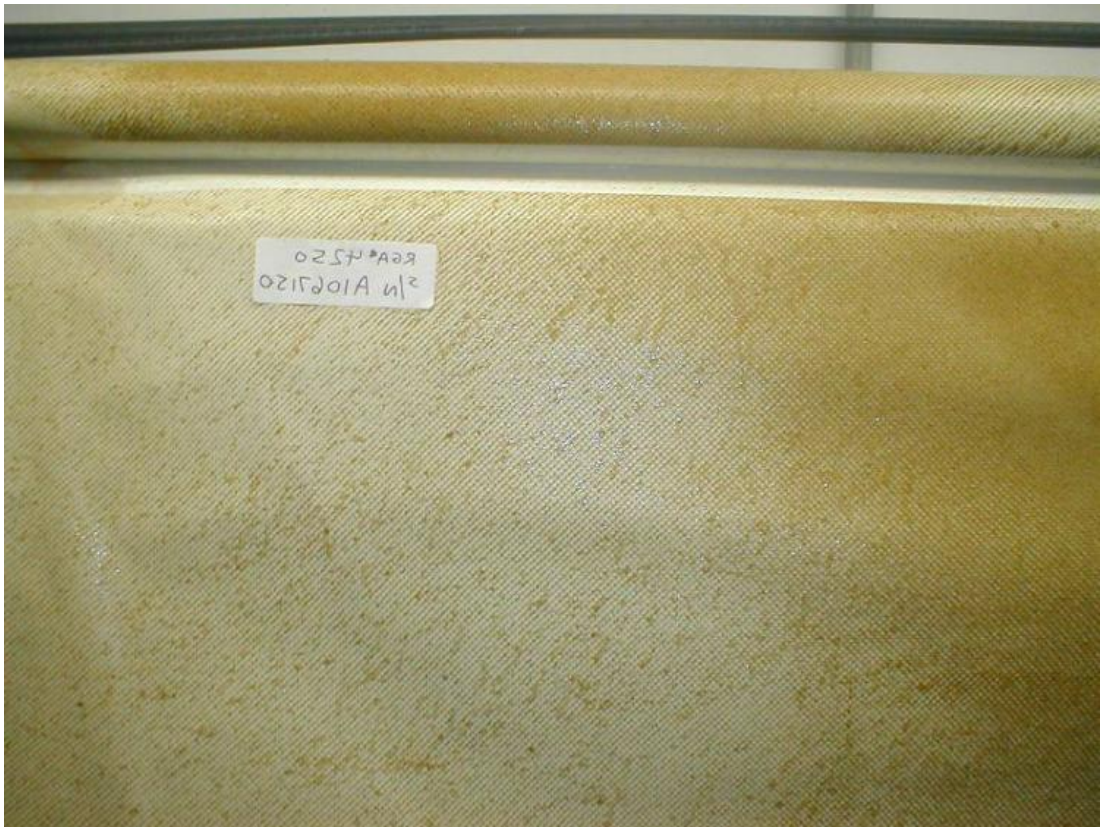
- Colloidal
- Particulate
- Organic
- Biological
  - Polysaccharides
  - Proteins
  - Lipids



Keys to Reducing Fouling Rates

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Spacer Design

- Minimize colloidal fouling
- Reduce pressure losses
- Increase system efficiency

Biostatic Properties

- Prevent Adhesion of Bacteria
- Retard Growth of Bacteria

Membrane Robustness

- Increase chemical resistance
- Increase element life

Field Studies on Biofouling Feed water

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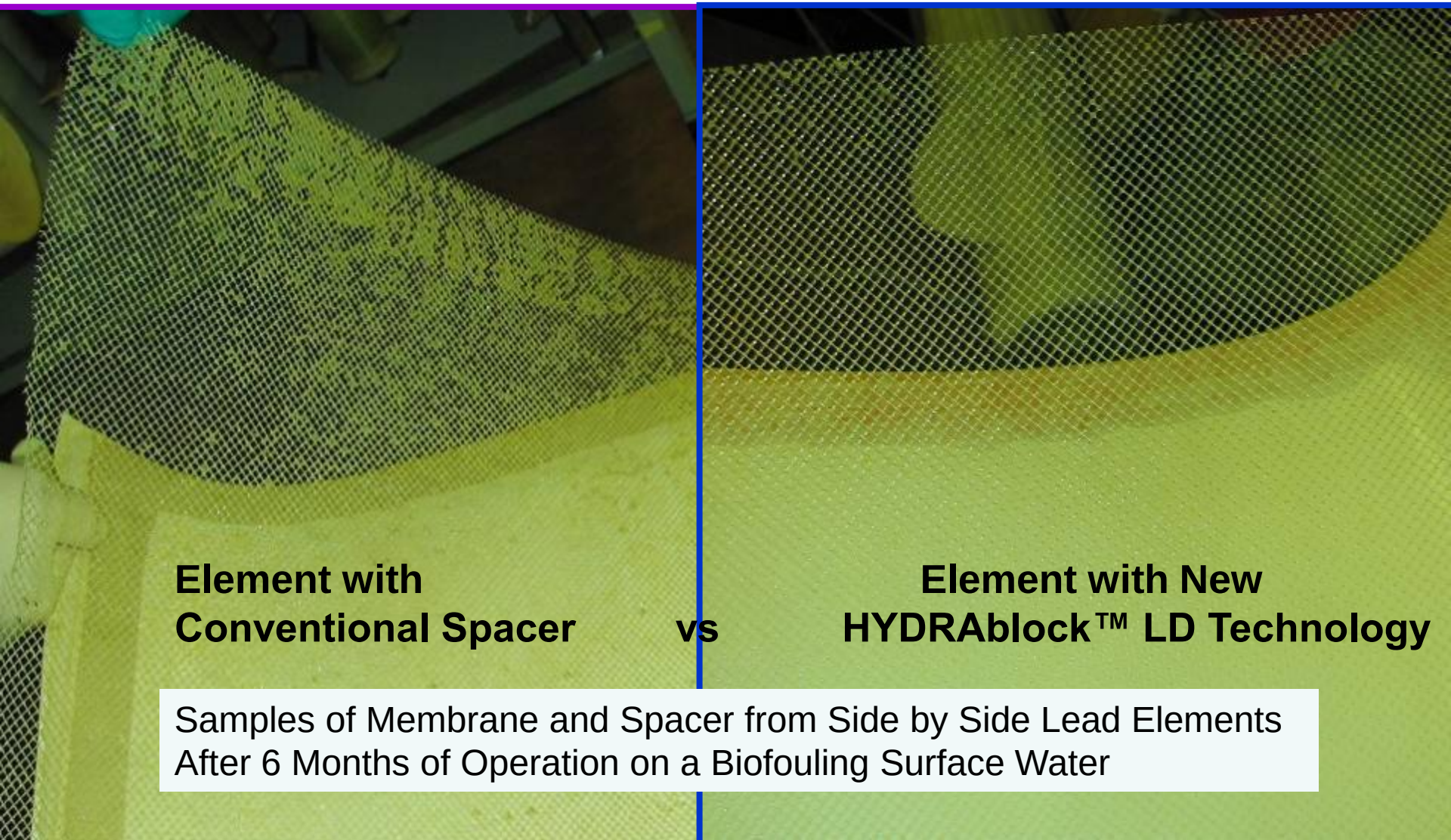

Samples of Membrane and Spacer from Side by Side Lead Elements
After 6 Months of Operation on a Biofouling Surface Water

The LD Technology™: Features Enhanced Membrane Chemistry

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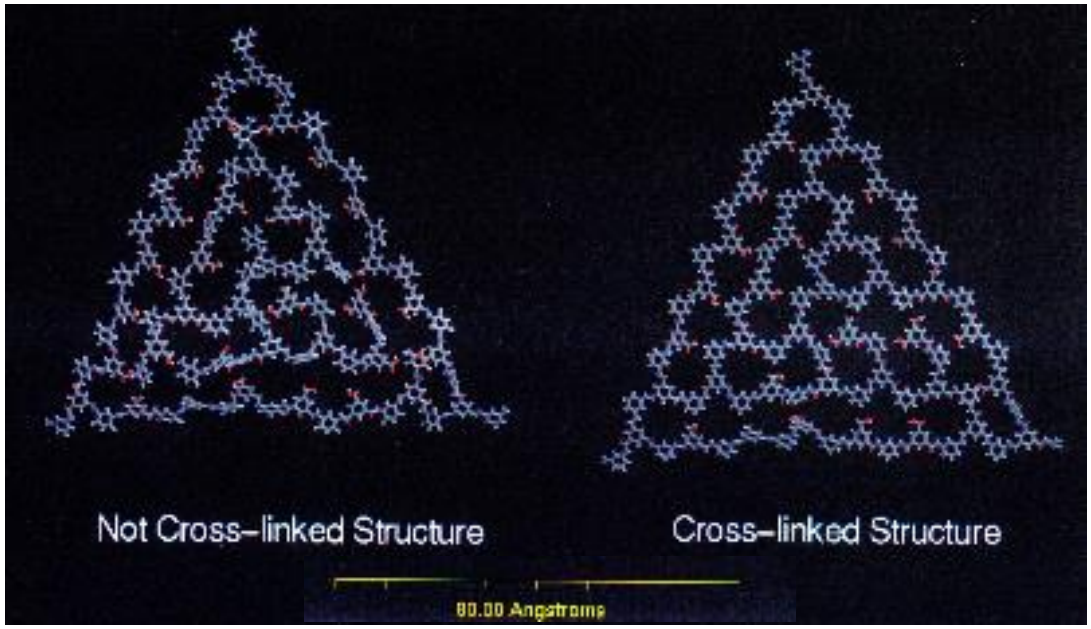
Evolved membrane chemistry achieves the highest salt rejection on the market

Our chemical reaction control technologies realized higher cross-linked structure

Chemically more robust to allow cleaning from pH 1 to 13



The LD Technology™: Benefits Improved Membrane Durability

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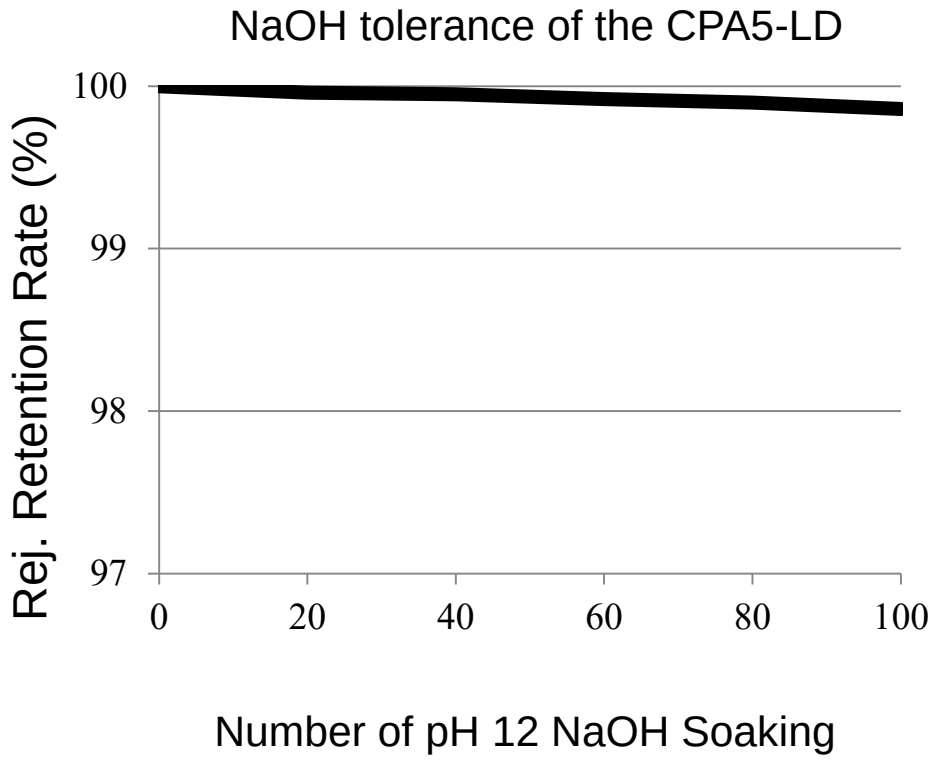

Testing Conditions:
- **pH 12 NaOH soln.**
- **3 hrs/soaking**
- **Temp 20° C**
- **NaCl Conc.: 2000 mg/l**
- **Pressure: 225 psi (1.55 MPa)**
- **Recovery: 15%**

The LD Technology™: Features Patented Vented Seal Carrier

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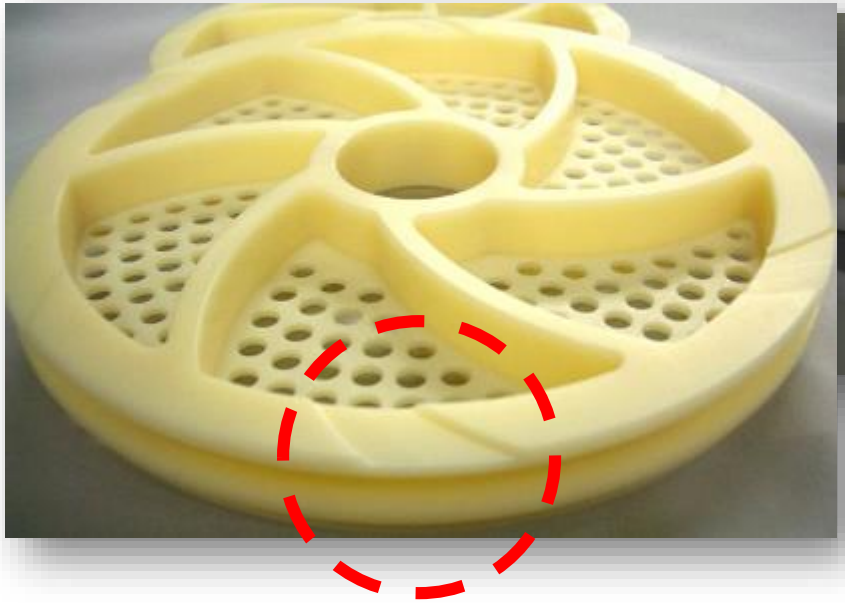
- Patented air release vent on the seal carrier
- Allows to release the air from the membrane during startup, reducing the risk of element burst during start up



Pressure Profile After Start Up

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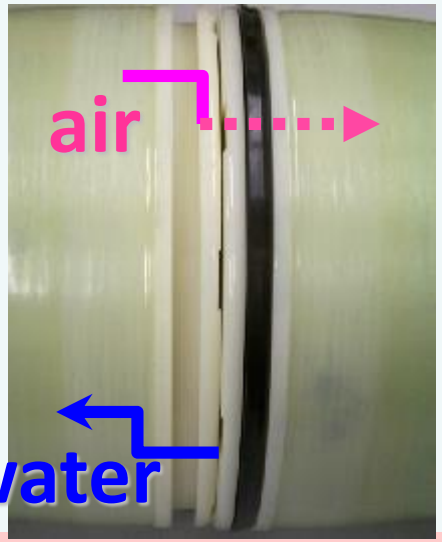
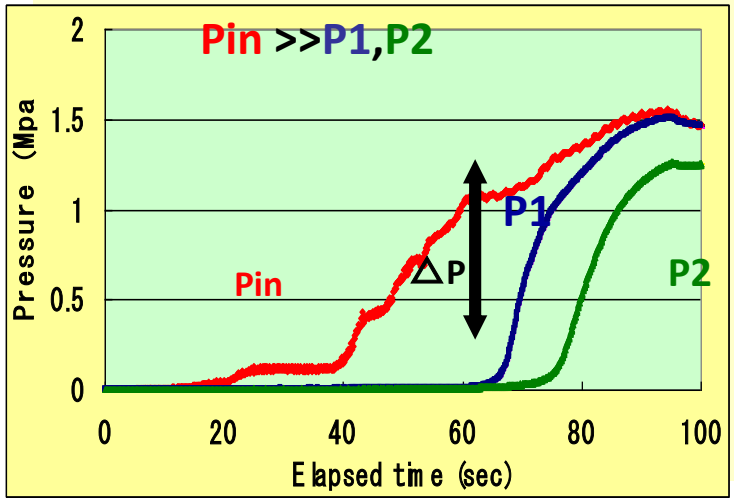
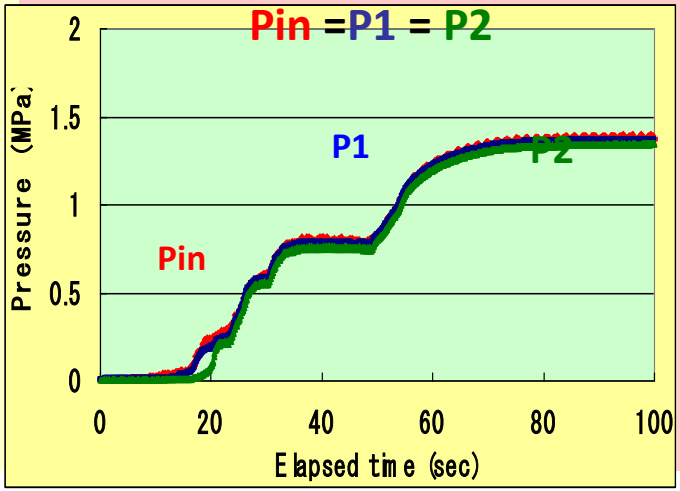
	Conventional	CPA5-LD
Connecting portion		
Pressure profile after start up		

Pin inside pressure of the 1st element

P1: outside pressure of the 1st element

P2: outside pressure of the 2nd element

The LD Technology™: Core Products

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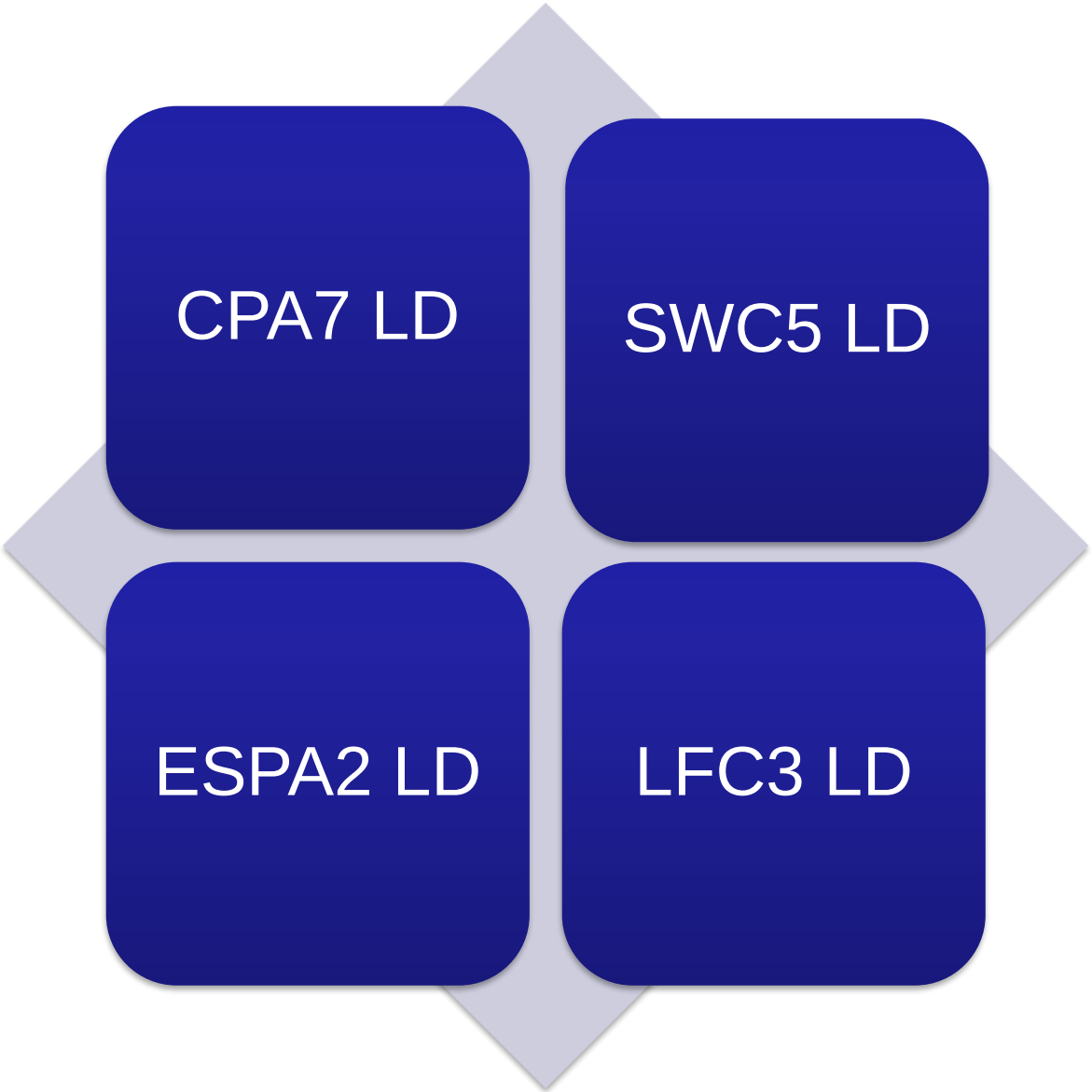
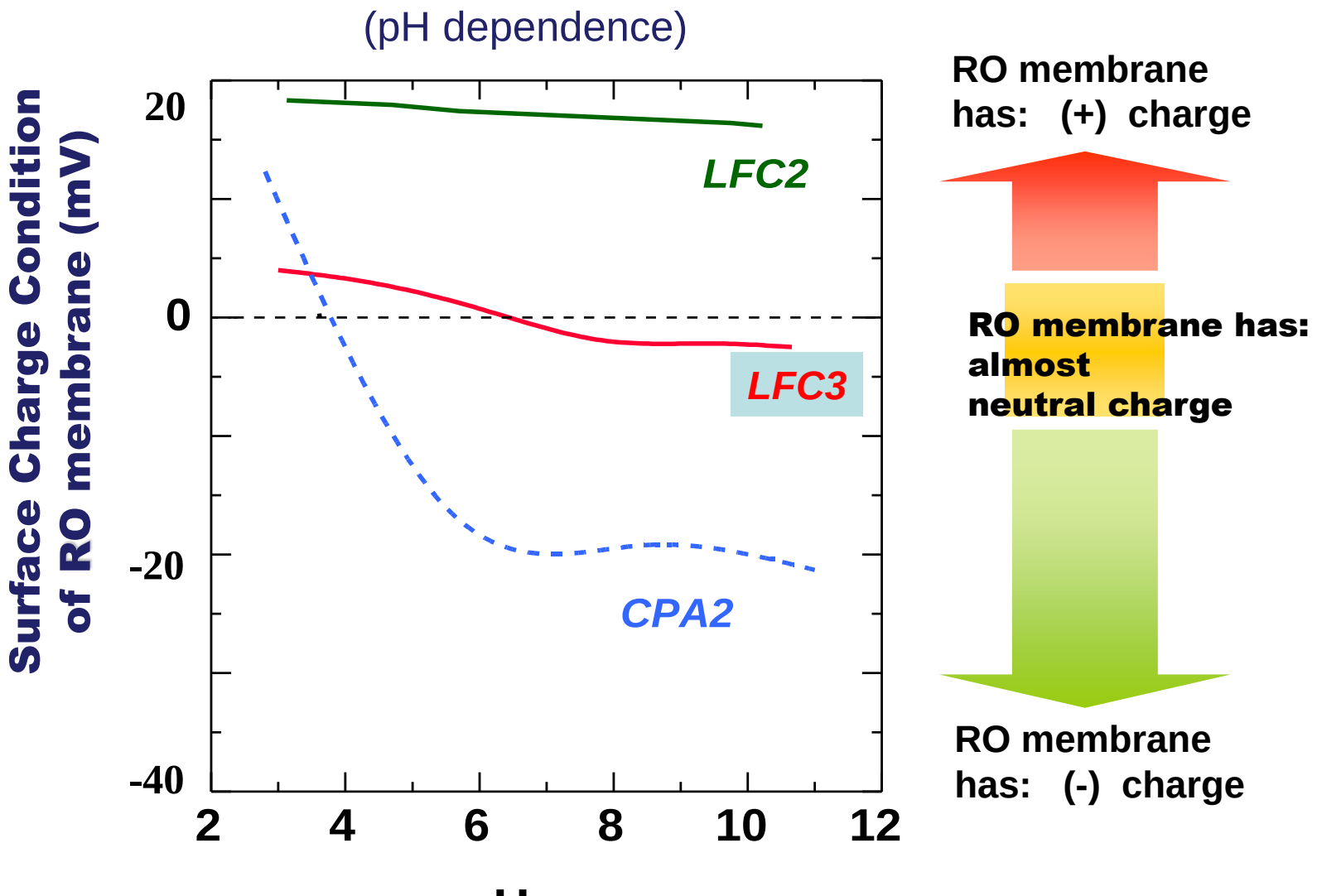


LFC® – True Hydrophilic Membrane Chemistry

Name	Flow		Salt rejection %		Membrane area ft2
	gpd	M3/d	Nominal	Minimum	
LFC3-LD-4040	2100	7.95	99.7	99.5	80
LFC3-LD	**11000**	**41.6**	**99.7**	**99.5**	**400**

Standard Test Condition : 1500 ppm NaCl, 15% recovery, 225 psi, 25 deg C

Surface Charge condition of LFC



SWC® – Purifying the Oceans of the World

Name	Flow		Salt rejection %		Membrane area ft2
	gpd	M3/d	Nominal	Minimum	
SWC4-LD	6500	24.6	99.8	99.7	400
SWC5-LD-4040	1750	6.62	99.7	99.5	80
SWC5-LD	**9000**	**34.1**	**99.8**	**99.7**	**400**

Standard Test Condition : 32000 ppm NaCl, 10% recovery, 800 psi, 25 deg C

Membrane Bio Reactor (MBR)

Hollow Fiber Membranes for Membrane Bioreactor Applications in Wastewater Treatment. Both Fibers use the same PVDF on a fabric support and can operate at the same flux and cleaning frequency

MF - HYDRAsub®

- 0.4 micron pore size
- 2.8 mm OD
- 1 mm ID

UF - HYDRAsub MAX®

- 0.05 micron pore size
- 1.65 mm OD
- 1 mm ID

Conventional Process and MBR

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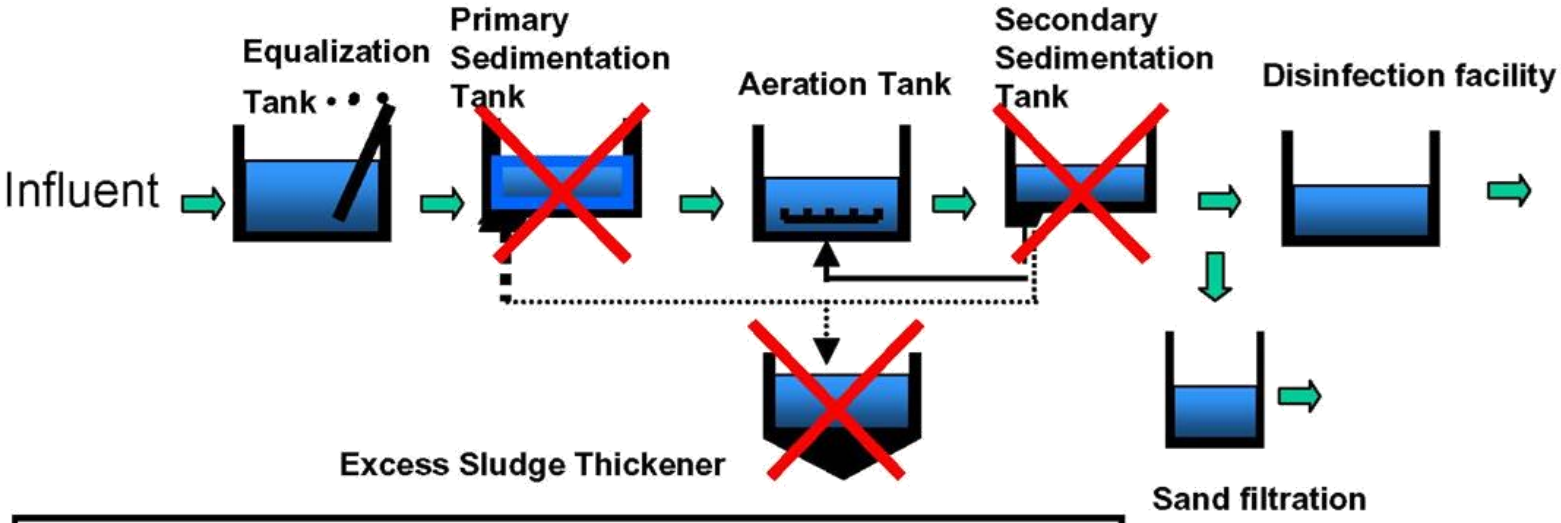
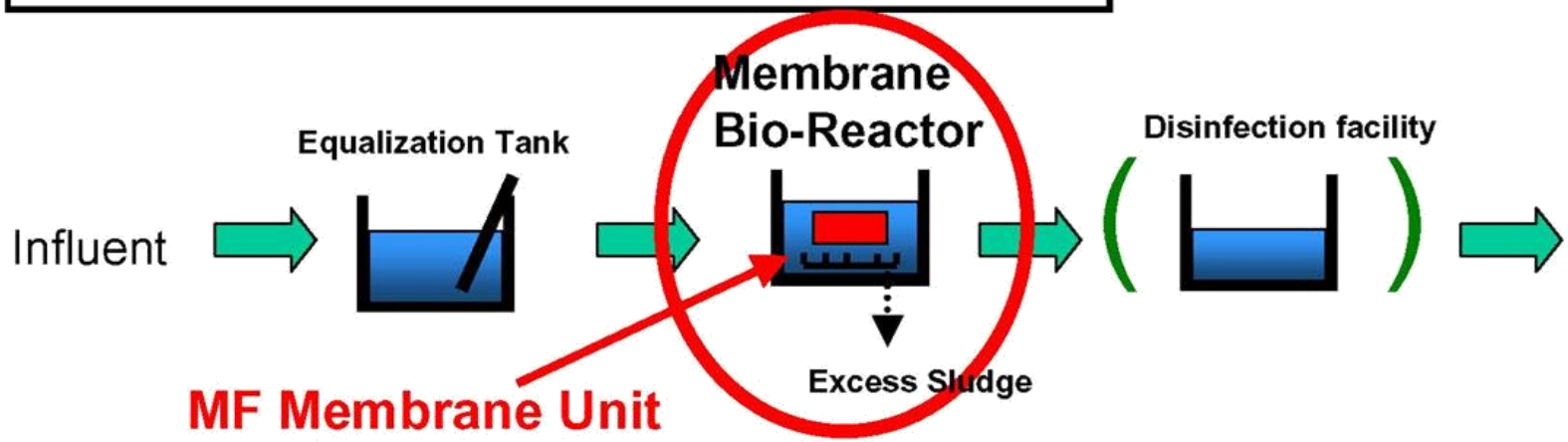
Conventional Activated Sludge Process with Filteration



Membrane Bio-Reactor (MBR) Process



Why MBR ?

1. Elimination of Sedimentation Tanks :

-> Less Foot Print Requirement

2. High MLSS, Shorter HRT:

-> Compact Space
-> Less Excess Sludge
-> Treat High BOD Waste Water

3.Good Quality of Treated Water:

-> Produce Recyclable Water
-> Reduce Disinfection Cost

4. Solution to Sludge Bulking Problem

Nanofilteration

HYDRApro 400/ HYDRApro 500
NF & RO membranes made for special applications

HYDRACoRe
Membranes for extreme conditions

IMSD2017 : RO design software
Salient Features

Can be downloaded from membranes.com

User friendly

Can feed multiple analysis.

Custom ions

Compare performance of various membranes.

Hybrid & split partial designs.

Power & Chemical dosing calculations.

Costing calculations.

HYDRAcapMAX Simulator

Web based design software. Access can be provided on request.

Pre-feed water analysis of various sources.

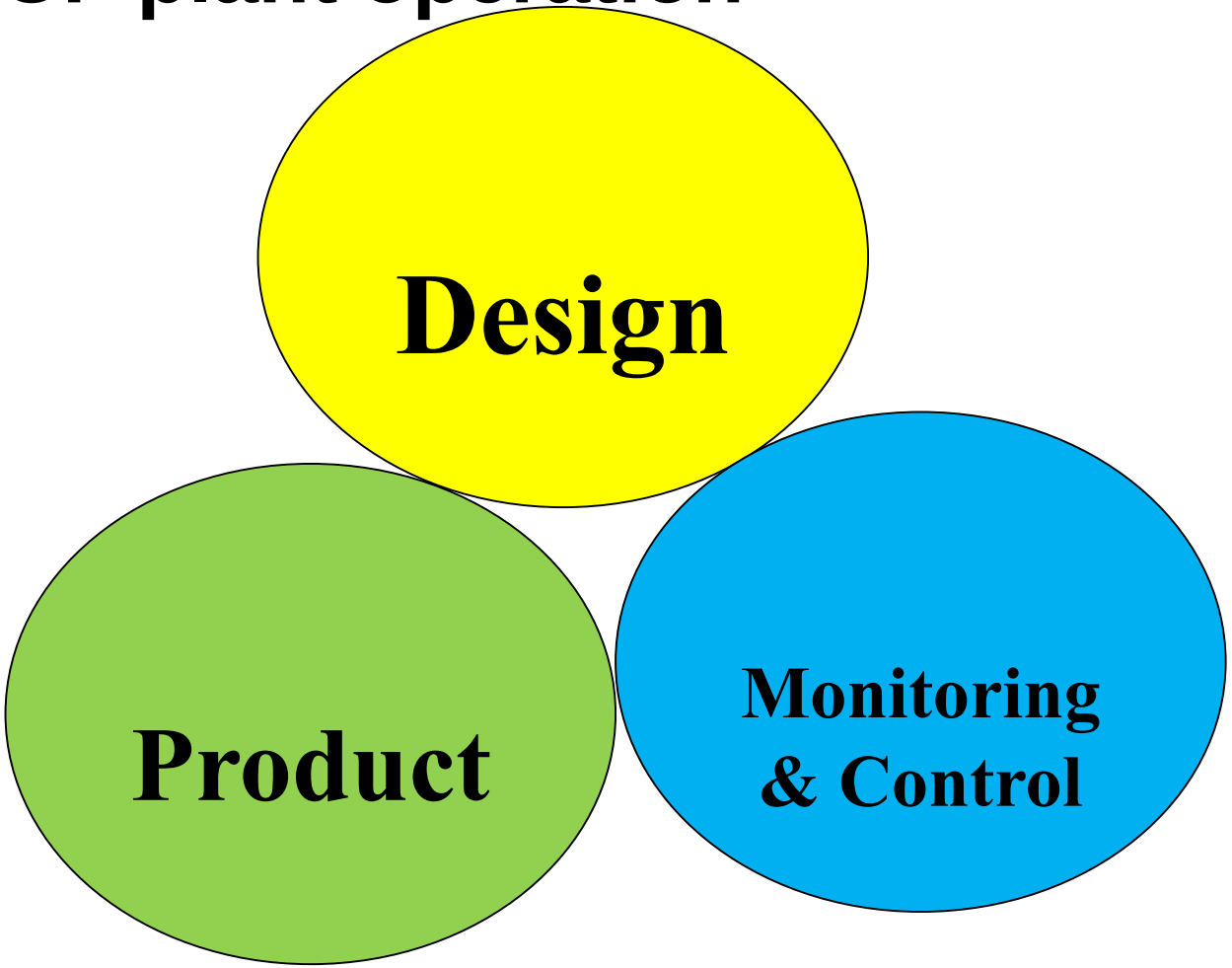
User friendly, minimum inputs required.

Provide detailed time, chemical & power calculations.

Provides pump & valve sizes.

Generate sequence tables for purpose of control logic.

Key to success of RO/UF plant operation



Design

Know the worst condition.

Follow guidelines from flux and other parameters.

Keep provision for

- Inter stage pressure gauge
- Reverse cleaning.
- Cleaning at warmer temperature
- Two cartridge for cleaning.

Product

Parameters for selection of RO membrane

- Membrane area
- Feed/brine spacer thickness.
- Salt rejection minimum/ nominal & flow.
- Special properties like surface charge.

Parameters for selection of UF membrane.

- Membrane area.
- Ability to handle suspended solids.
- Chemical tolerance.
- Mechanical strength.
- Waste water generated.

Select supplier that can support you during design & troubleshooting.

People :
Plant operation & Maintenance

Maintain plant log sheets. Use tools like normalization software.

Check SDI & tube profile periodically.

Check feed water analysis periodically.

Be vigilant about change in plant parameters.

Clean membranes on time. Follow 10% rule.

Keep cleaning chemicals & other spares in stock

Thank You
from
Nitto/Hydranautics

Innovations. Flexible Solutions. Real Relationships.
Global Responsibility. Unwavering Integrity.

Contact: Mr. A. Venkatesan - 9500190319
venkatesan.arunachalam@nitto.com