UNITECH CO., LTD.

ระบบผลิตน้ำดื่ม

ขนาดกำลังการผลิต ๘๐๐ ลิตรต่อชั่วโมง

Ultrafiltration + Reverse Osmosis System

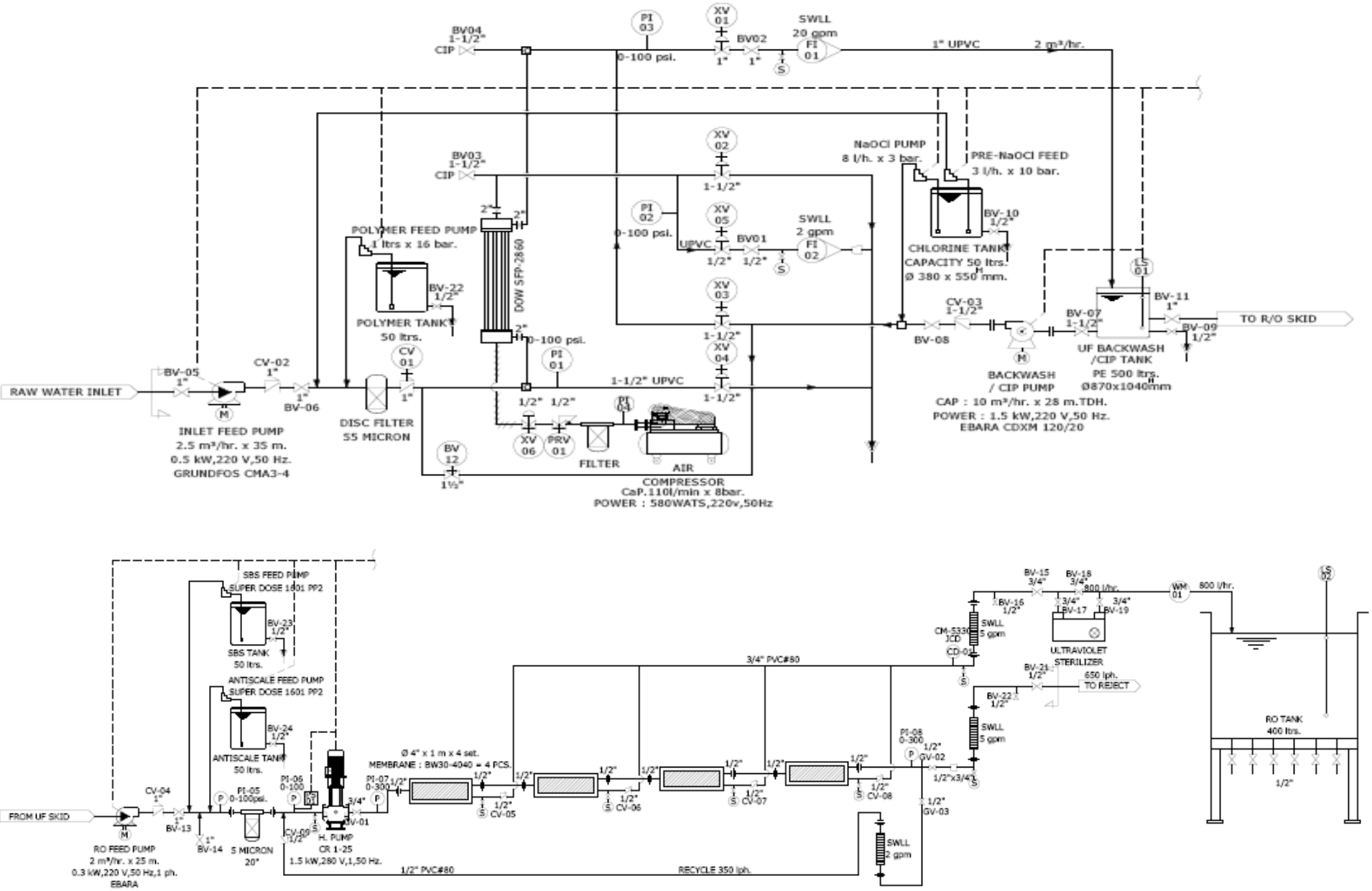
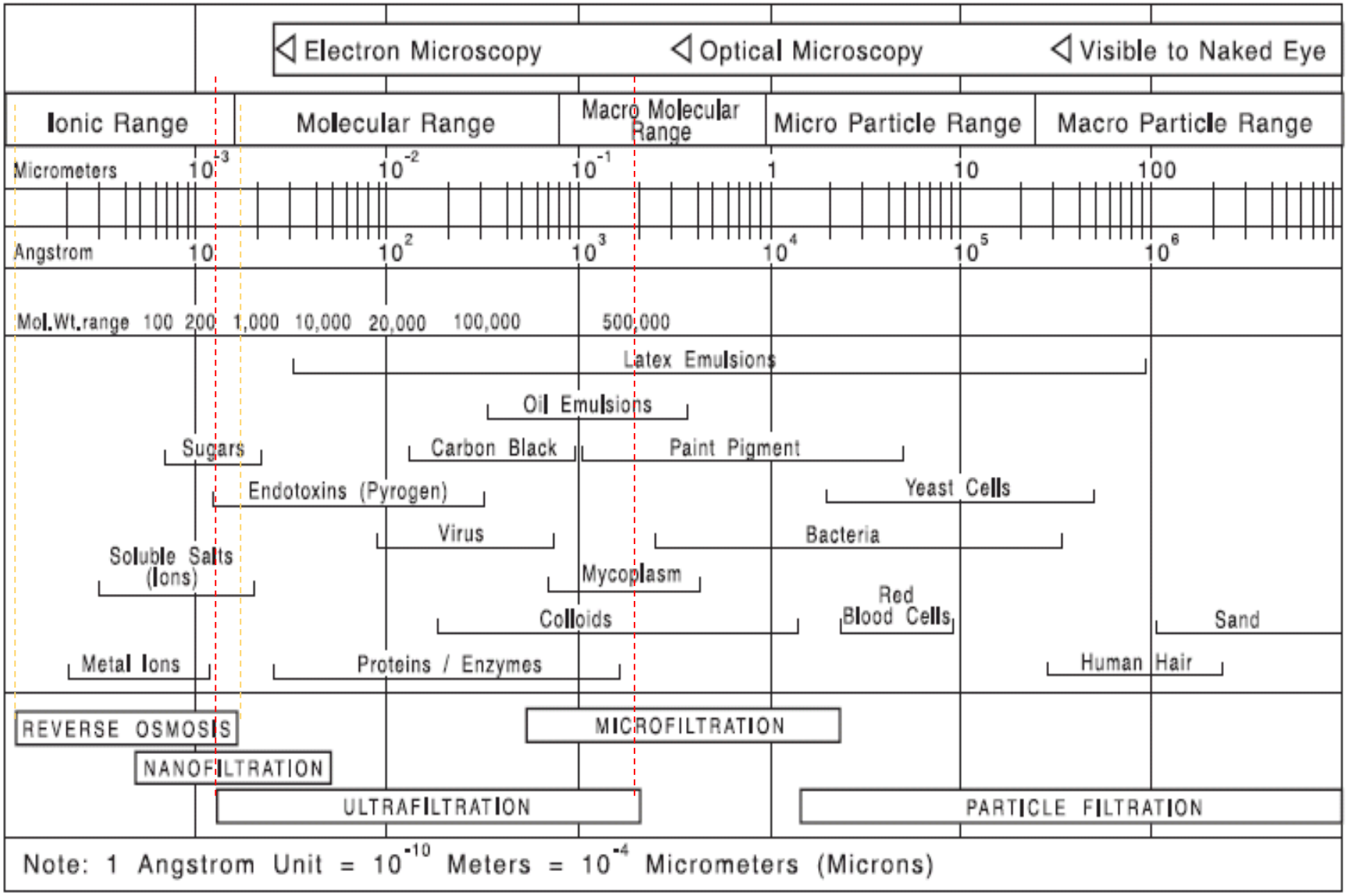


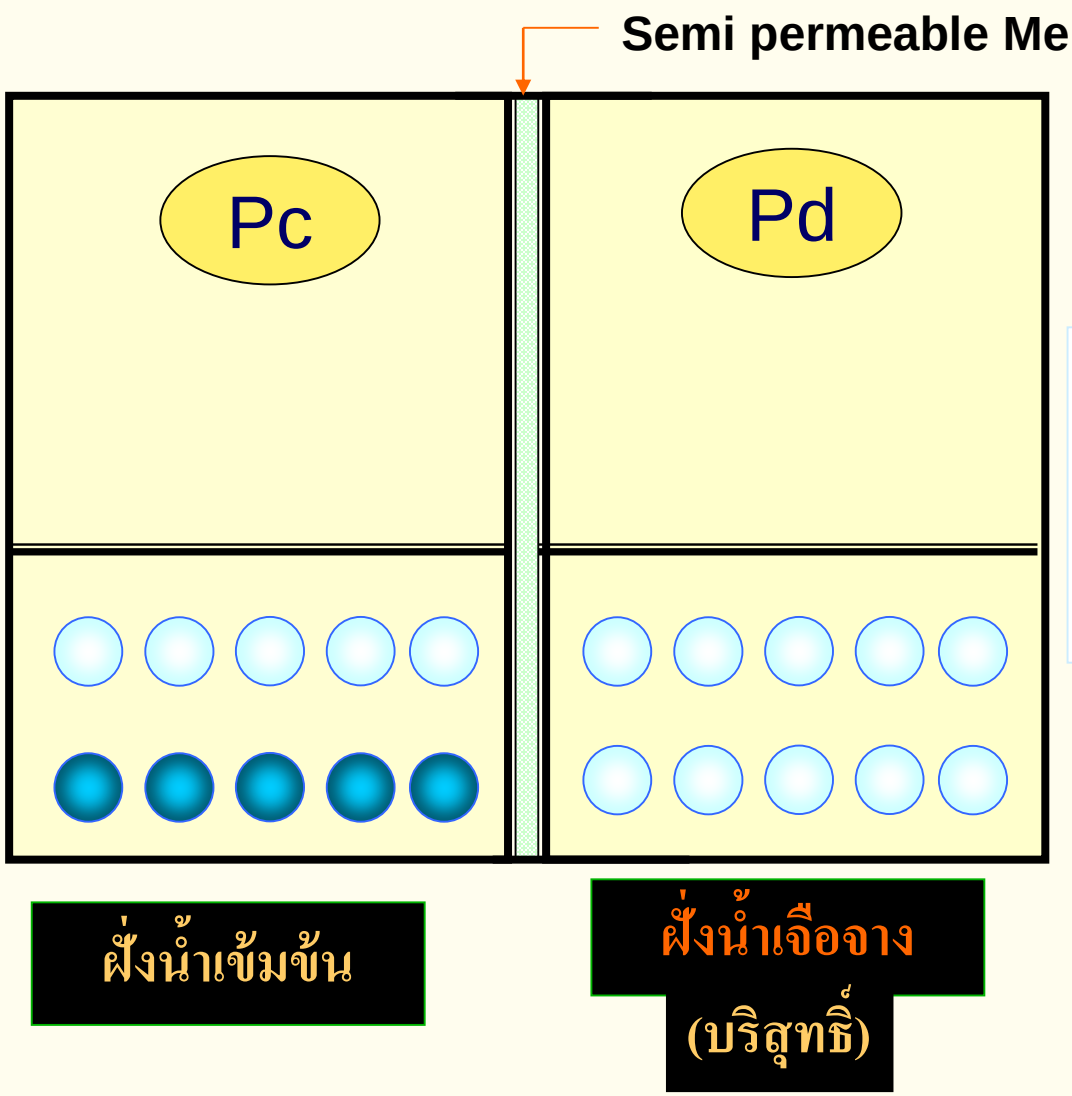
Figure 1.3 Ranges of filtration processes



IMPURITIES IN WATER

- 1. แร่ธาตุ ,สารอนินทรีย์ (Inorganics) : TDS, Conductivity
- 2. สารอินทรีย์ (Organics) : TOC
- 3. อนุภาค (Particulate) : Turbidity , SS , Colloids
- 4. จุลินทรีย์ (Microbiological) : Total Plate Count
- 5. แก๊ส (Gases) :O2 , CO_2

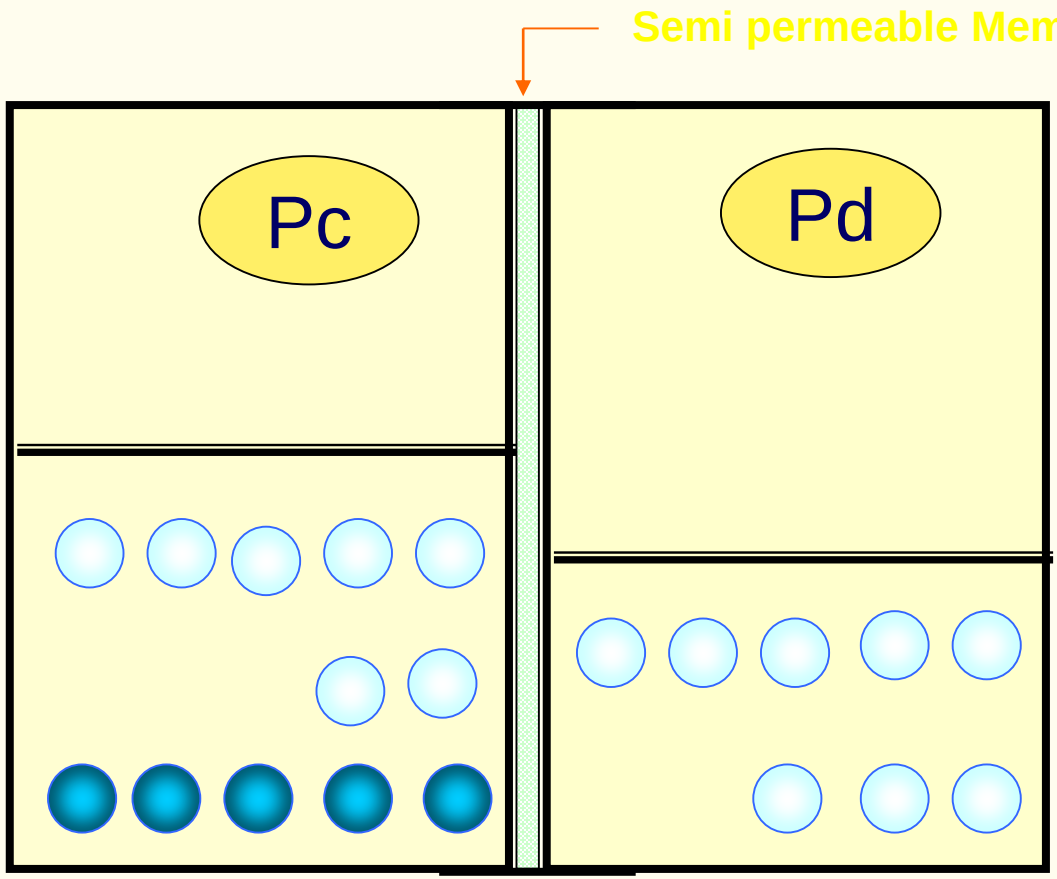
หลักการของ Osmosis (ธรรมชาติ)



Pd >Pc

Start

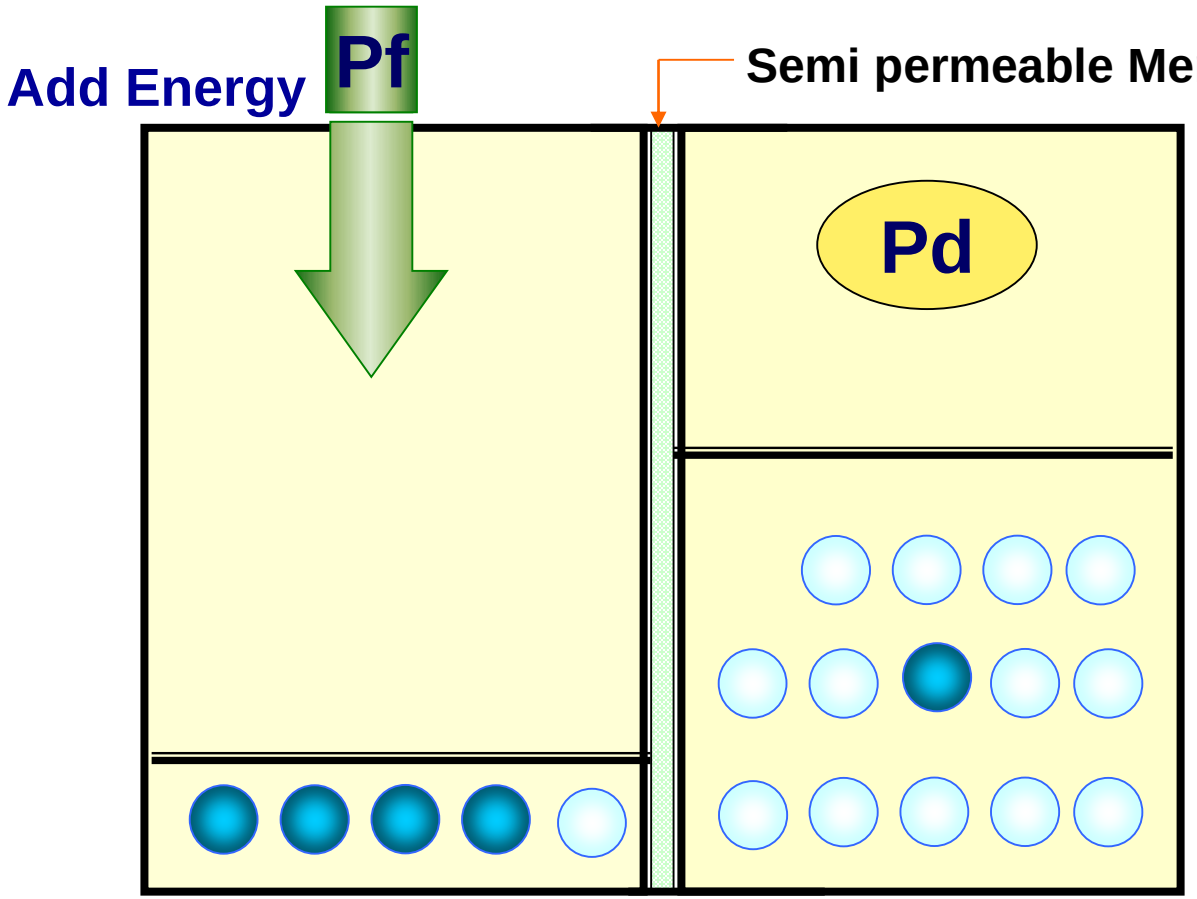
หลักการของ Osmosis (ธรรมชาติ)



Pd=Pc

End Osmosis

หลักการของ Reverse Osmosis : RO (ย้อนธรรมชาติ)



Pf > Pd

Reverse Osmosis

Pressure Feed to Membrane

Membrane Process	Typical Operating Pressure Range (bar)	Typical Operating pressure (psi)
Reverse Osmosis		
Seawater	55 – 76	800 - 1100
Brackish water	10 - 40	145 - 580
Nanofiltration	3.5 - 15	50 - 220
Ultrafiltration	2 – 7	30 - 100
Microfiltration	0.1-3	1.5 - 45

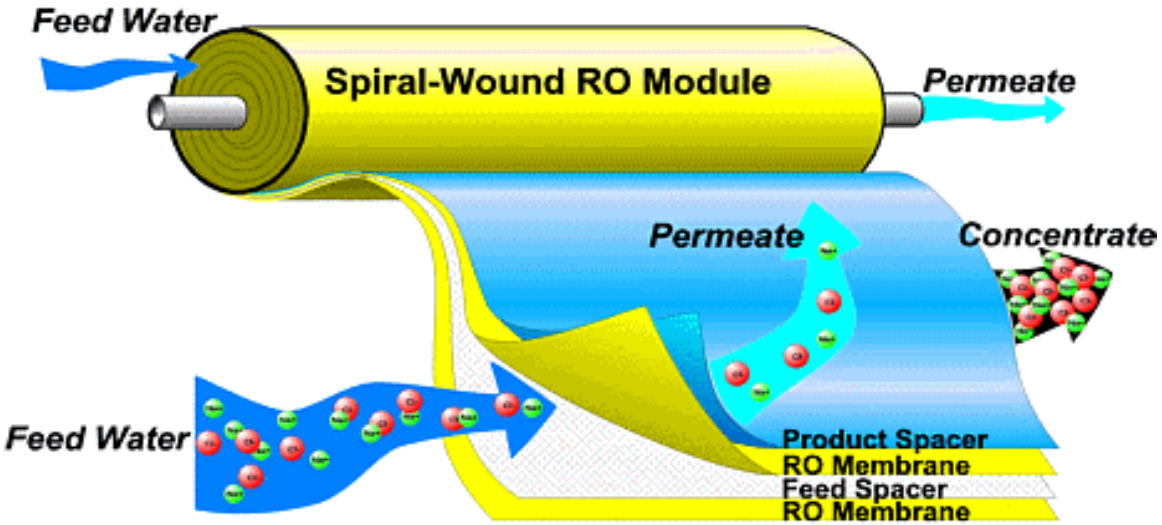
Factor Effect RO Performance

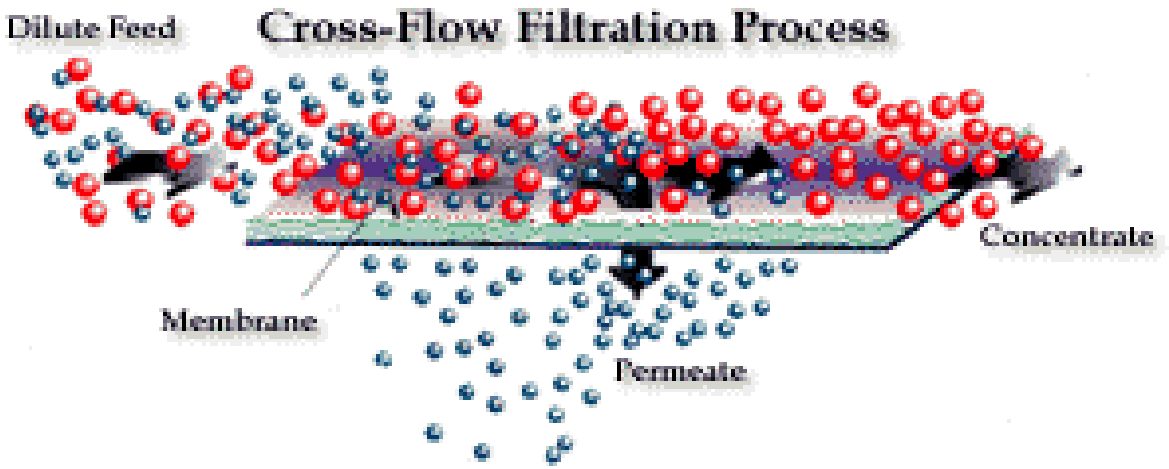
Factors which effect membrane performance

- Feedwater
  - Concentration
  - Temperature
  - Osmotic pressure
  - pH
- Operation parameters
  - Pressure
  - System recovery

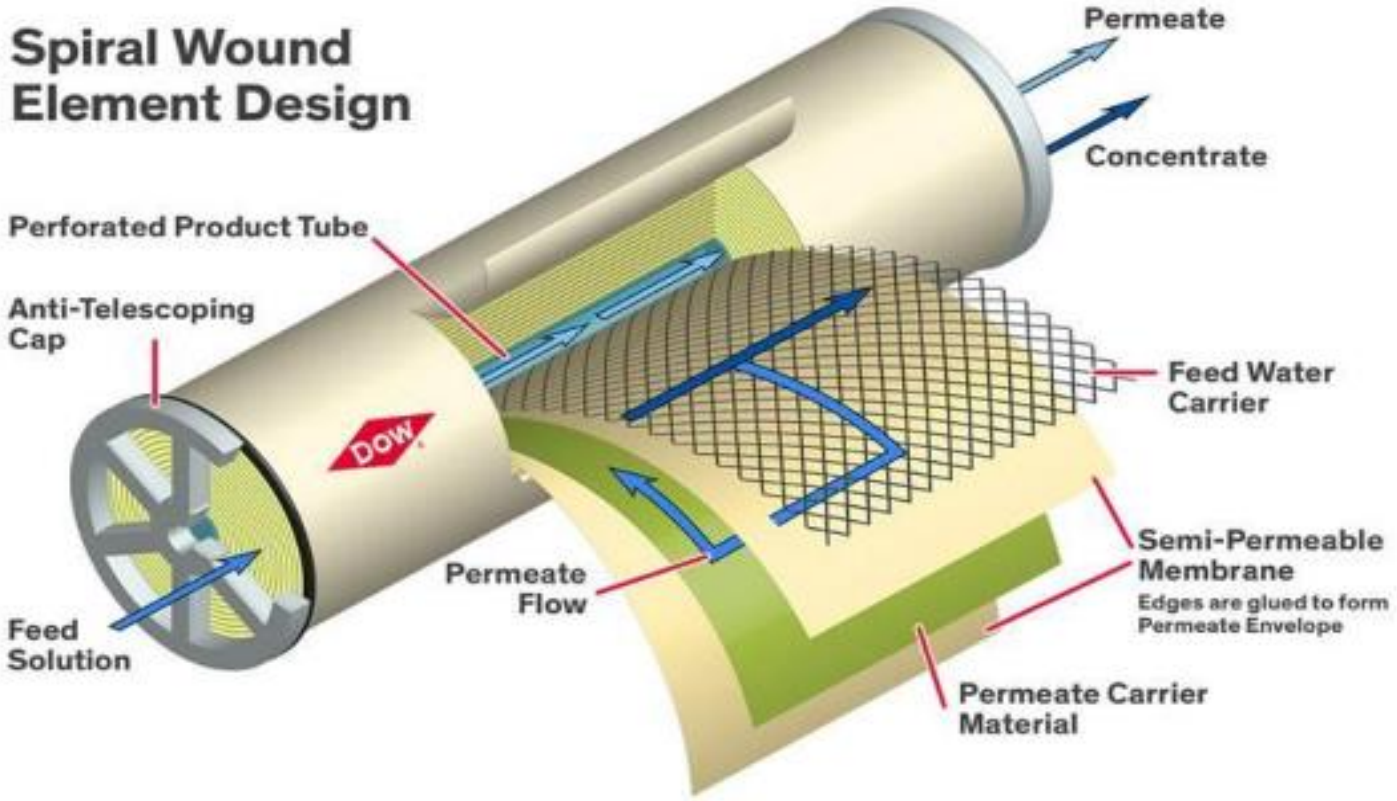
Purification: Reverse Osmosis

Membrane

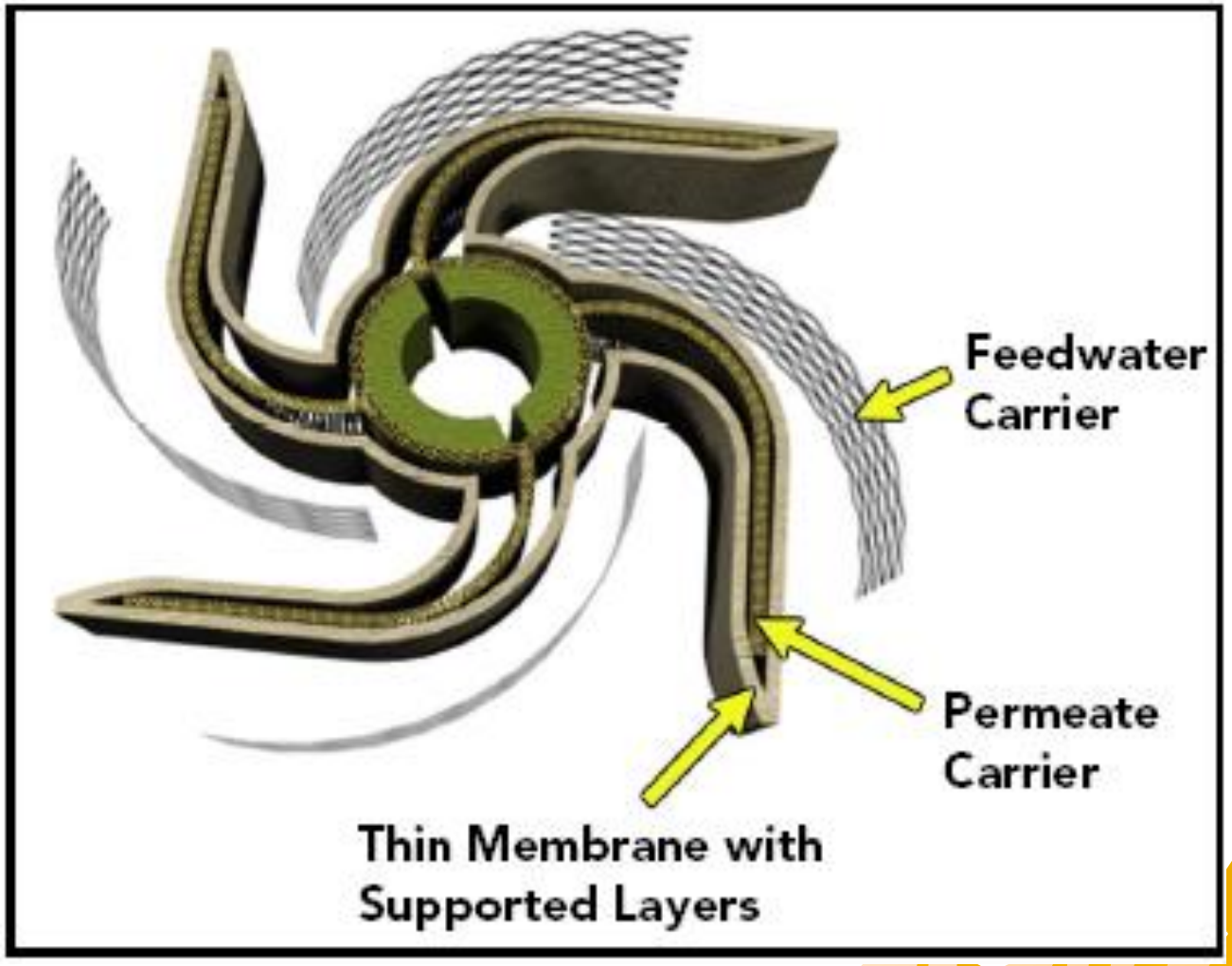




Spiral wound RO membrane element



Spiral Wound Membrane Leaves



RO's Feed Water Quality

Table 2.10 Guidelines for feedwater quality

Component	Unit	Max. level	Comments & conditions
SDI	1	5	See *System Design Guidelines (Section 3.9)*
$MFI_{0.45}$	1	4	Target: <1
Oil and grease	mg/L	0.1	See *Prevention of Fouling by Organics (Section 2.7)*
TOC	mg/L	3	Synthetic organic compounds (SOC) have generally more adverse effects on RO/NF membranes compared with natural organic matters (NOM). - See *Prevention of Fouling by Organics (Section 2.7)*
COD	mg/L	10	
AOC	µg/l Ac-C	10	Target: <5
BFR	pg/cm² ATP	5	Target: <1
Free chlorine	mg/L	0.1	Under certain conditions, the presence of chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. - See *Chlorination / Dechlorination (Section 2.6.3)*

R/O Unit Composition

- 1. Chemical Feed System : **Antiscale**, Acid,SBS
- 2. Safety Filter Unit : Cartridge 5 micron
- 3. High Pressure Pump :Multistage Centrifugal (Heavy Duty Type)
- 4. Pressure Vessel -FRP Side Port ; **300** psi
- 5. Membrane PA Type : **BW**
- 6. Instruments: **Pressure, Flow Rate,Conductivity**,pH
- 7. Auto flushing & Cleaning In Place System
- 8. Piping & Valve : Stainless Steel / UPVC Sch.80 / PP
- 9. Frame : Steel + Epoxy Coated / SUS304

Pretreatment System Choice

- 1. SDI (Silt Density Index) Control System
- *Remove colloid size 0.01 – 0.1 micron
- - Clarifier System + Media Filtration
- - In-Line Coagulation + Media Filtration
- - UF System
- 2. Scaling Control System
- - Softener
- - Antiscalant Feed system (@Flocon UK)
- - Acidification
- 3. De-chlorination System
- - Activated Carbon Filter
- - Sodium Metabisulfite Feed System

Pretreatment System Choice

- 4. Biofouling Control System
- Chlorination
- Activated Carbon Filter
- Biocide Dosing
- Frequency Cleaning &Sanitizations(Weekly)
- System Continuous Running (Circulation)

- 5. Silica Fouling Control System
- Control Recovery Limit
- Antifoulant Feed system (Flocon 260)
-

Pretreatment

Filtration

- Inline Coagulant Feed
- Multi-Media Filters , Activated Carbon Filter
- Ultrafiltration
- Cartridge Filters

Inline Coagulant Feed System

- Function
  - Up size of Suspended Particles (Colloids) from < 0.1 µm to Size > 10 µm
- Use PACH (High basicity type)

  (Dosage 1 ppm)

- Performance Criteria
  - RO Feed SDI < 5

Inline Coagulant Feed

Anti-Scalant Injection

- Function
  - Inhibits scale formation on RO membranes
  - Improves scale removal

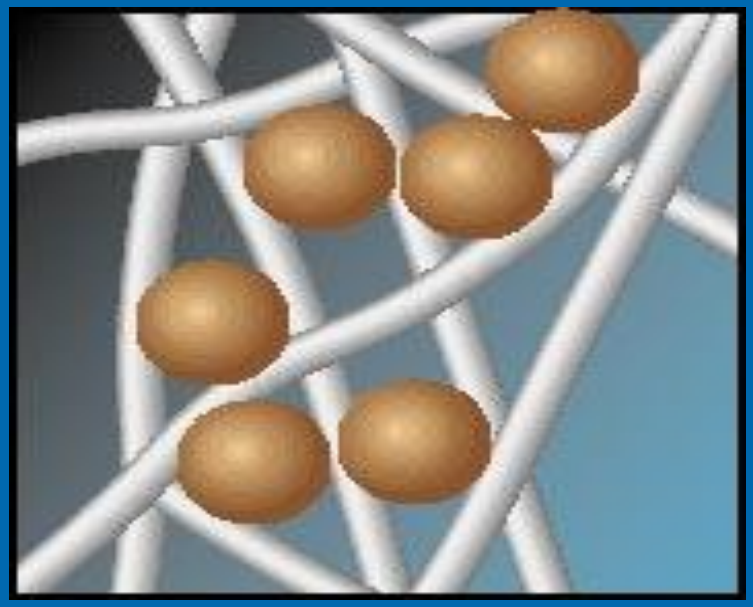
SBS / Antiscalant Feed

Cartridge Filters 1 – 5 Micron

- Function
  - Removes Suspended Particles (≥ 1 - 5 µm)
  - Mechanical Filters
  - Depth filters

- Operating Cost / Loss Improvement
  - Filter replacement (when outlet pressure < 10 psi)

Cartridge Filters 1 – 5 Micron



Particles trapped in depth-type cartridge filter micro-fibers

Depth cartridge filter

Membrane Cleaning

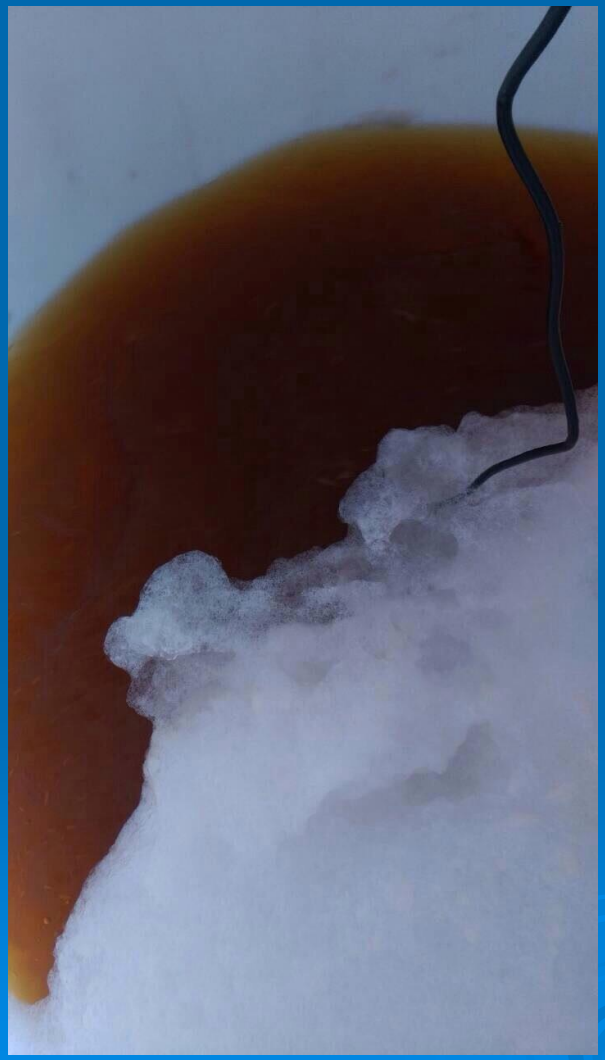
1. When Cleaning For Membrane (Scaling / Fouling)
   - Permeate Flow Drop 10-15%
   - Salt Passage Increase 30-40%
   - Differential Pressure Increase 10-15

2. Chemical For Cleaning
   - Acid Cleaning (pH 1.5-2.5) For Clean Scaling

   - Alkaline Cleaning (pH 11.5-12.5) For Clean Silt , Biofilm, Organics

Acid Cleaning for Membrane

Alkaline Cleaning for Membrane



System Monitoring

REVERSE OSMOSIS MINIMUM MONITORING REQUIREMENTS

PARAMETER	MONITORING FREQUENCY (MINIMUM)
Total residual chlorine concentration in the RO feed	Daily
Discharge pressure of any well or booster pumps	2X / Day
Pressure drop of all filters	2X / Day
Consumption of any chemicals	Daily
Calibration of all gauges and meters based on manufacturer's recommendation (method and frequency)	Not less than 1X / 12 months
Any unusual incidents (upset or shutdown)	As they occur
All RO operating parameters (pressure, flows, conductivity, normalized permeate flow, % recovery, % rejection)	1X / shift; take average of data and enter into spreadsheet

RO Trouble & Shooting

- **1. Low Product Flow , Increase P**
- **- Colloidal Fouling (High Conduct)**
- **- Metal Oxide Fouling (High Conduct)**
- **- Biofouling (Normal Conduct)**
- **- Organics fouling (Low Conduct)**
- **- Scaling (High Conduct)**

Figure 8.4 Picture of biofilm on membrane surface

Figure 8.5 Picture of feed spacer with biofilm

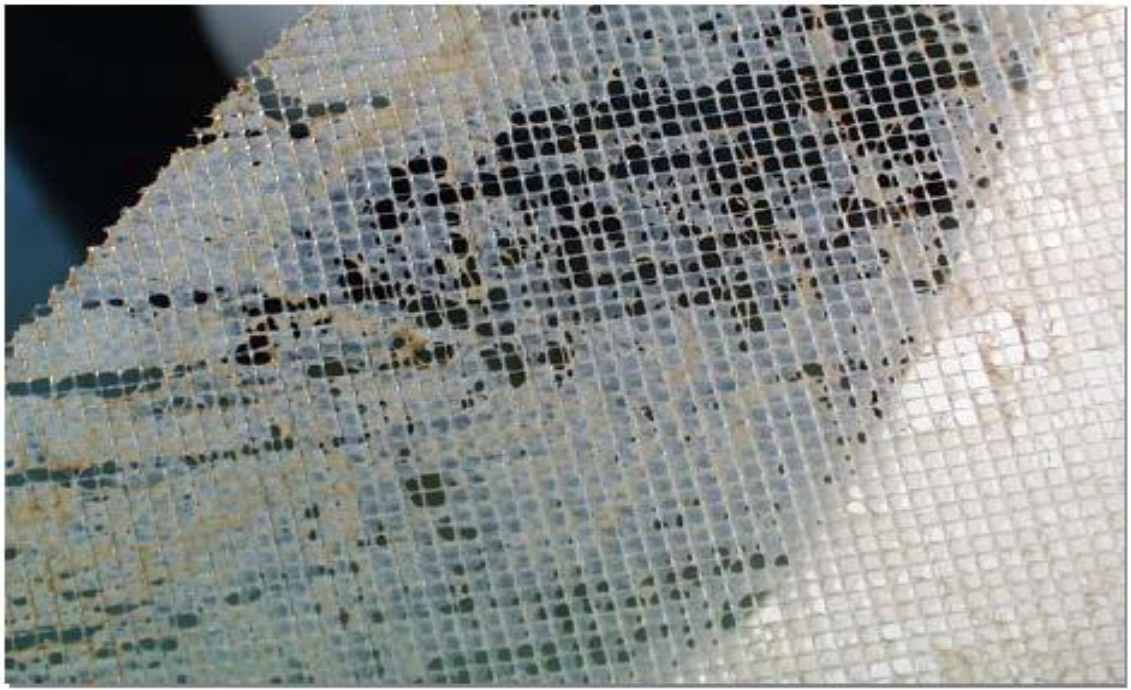


Figure 8.7 Picture of scaled membrane surface with imprints from the feed spacer

Figure 8.10 Picture of damaged fiberglass shell

Figure 8.9 The endcap has been pushed off

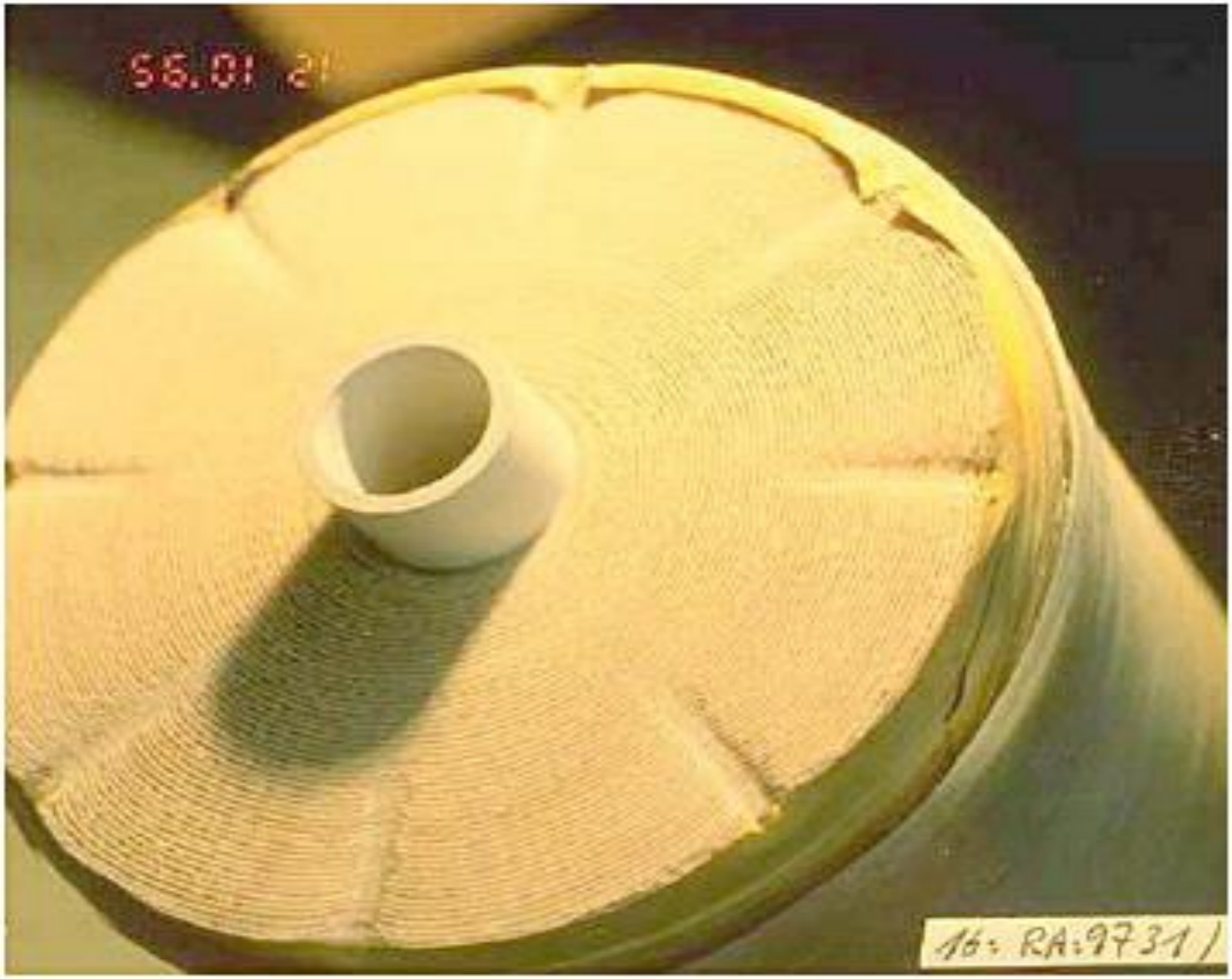
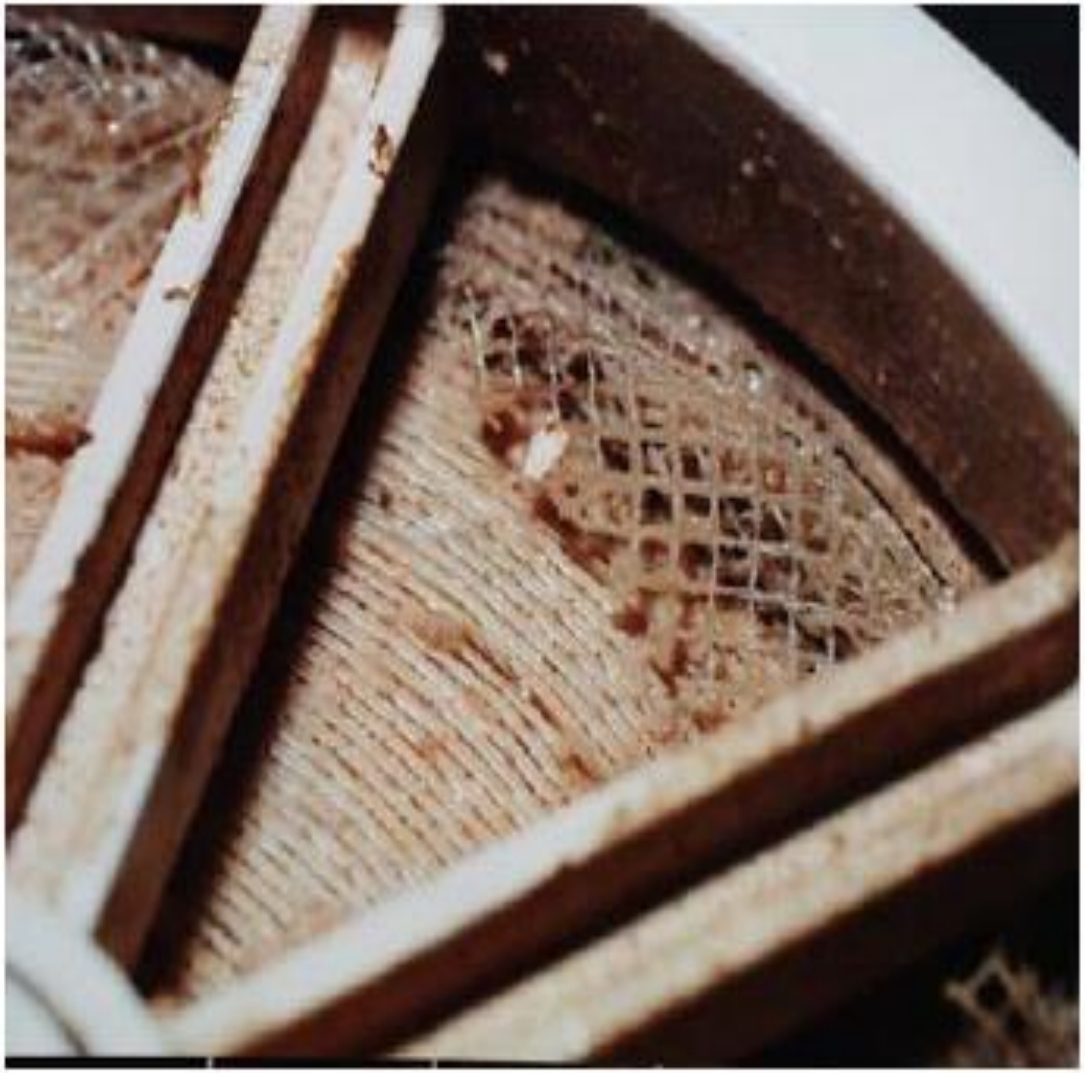


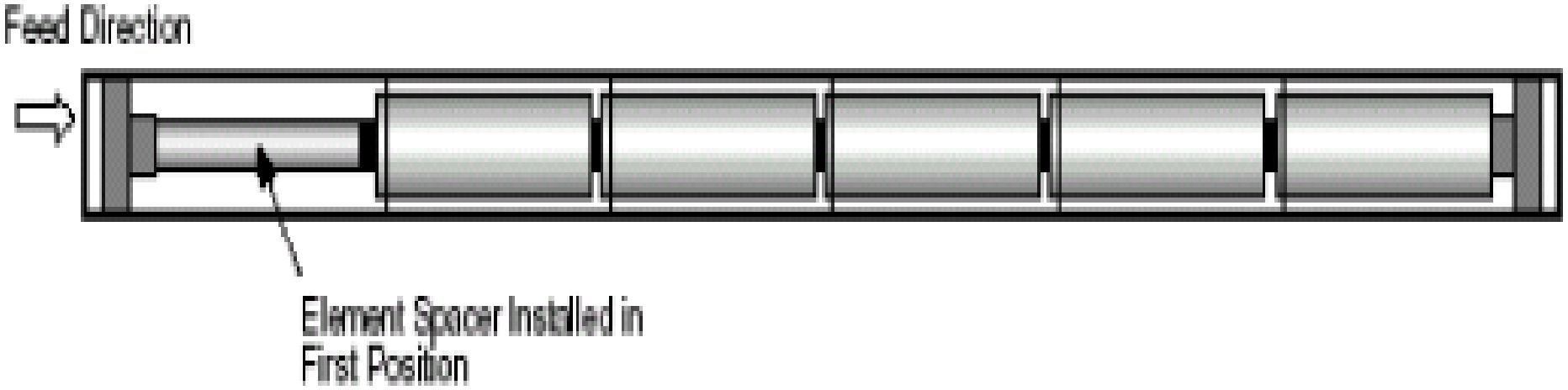
Figure 8.11 High pressure drop due to biofouling has pushed out the feed spacer

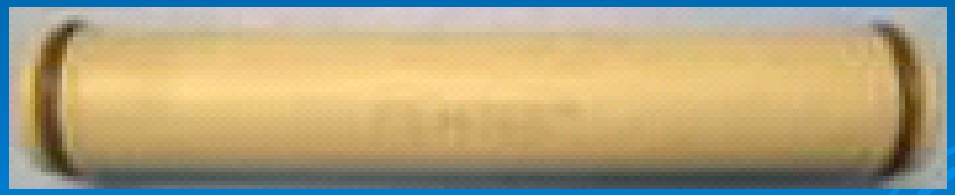


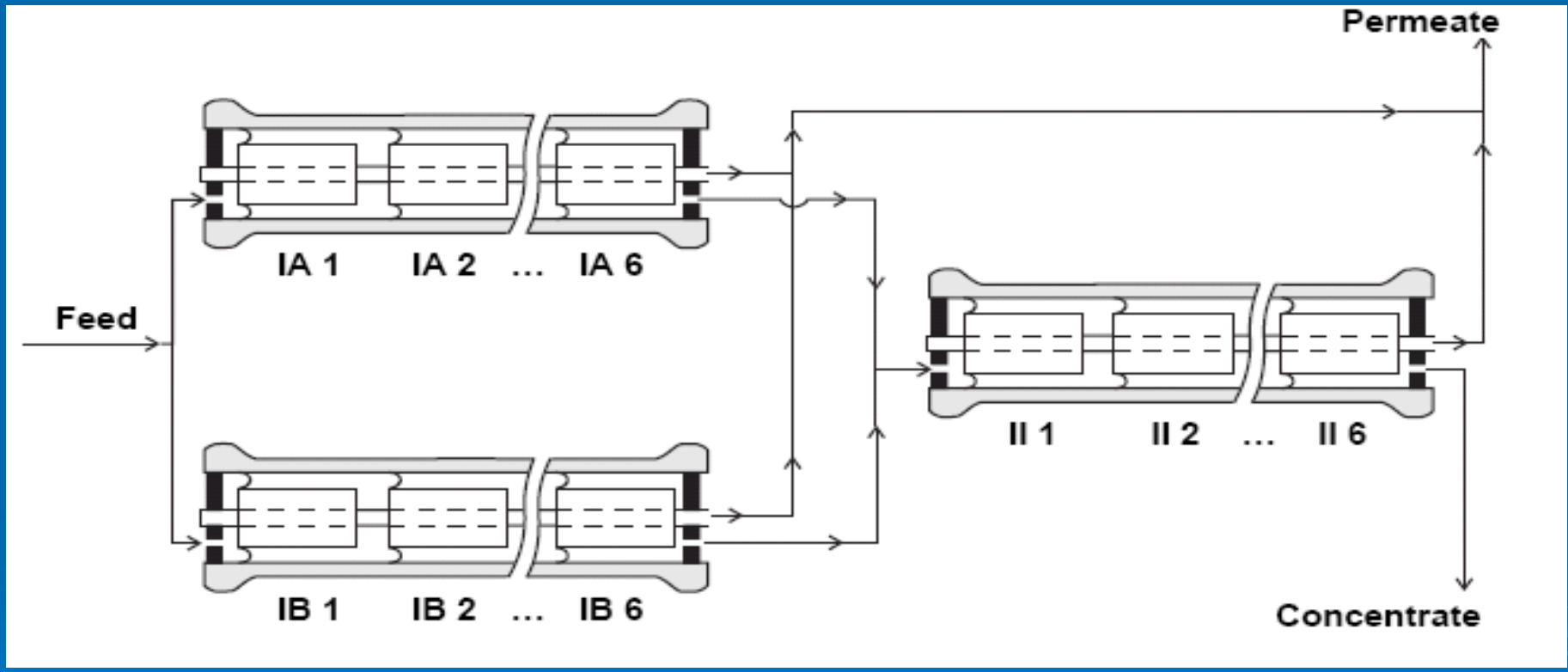
RO Trouble & Shooting

- **2. High Product Flow , Decrease Pressure**

- **- O-ring leak (High Conduct)**
- **- Membrane Degraded (High Conduct)**


Feed Direction
Element Spacer Installed in
First Position




Permeate
IA 1
IA 2
…
IA 6
Feed
II 1
II 2
…
II 6
IB 1
IB 2
…
IB 6
Concentrate