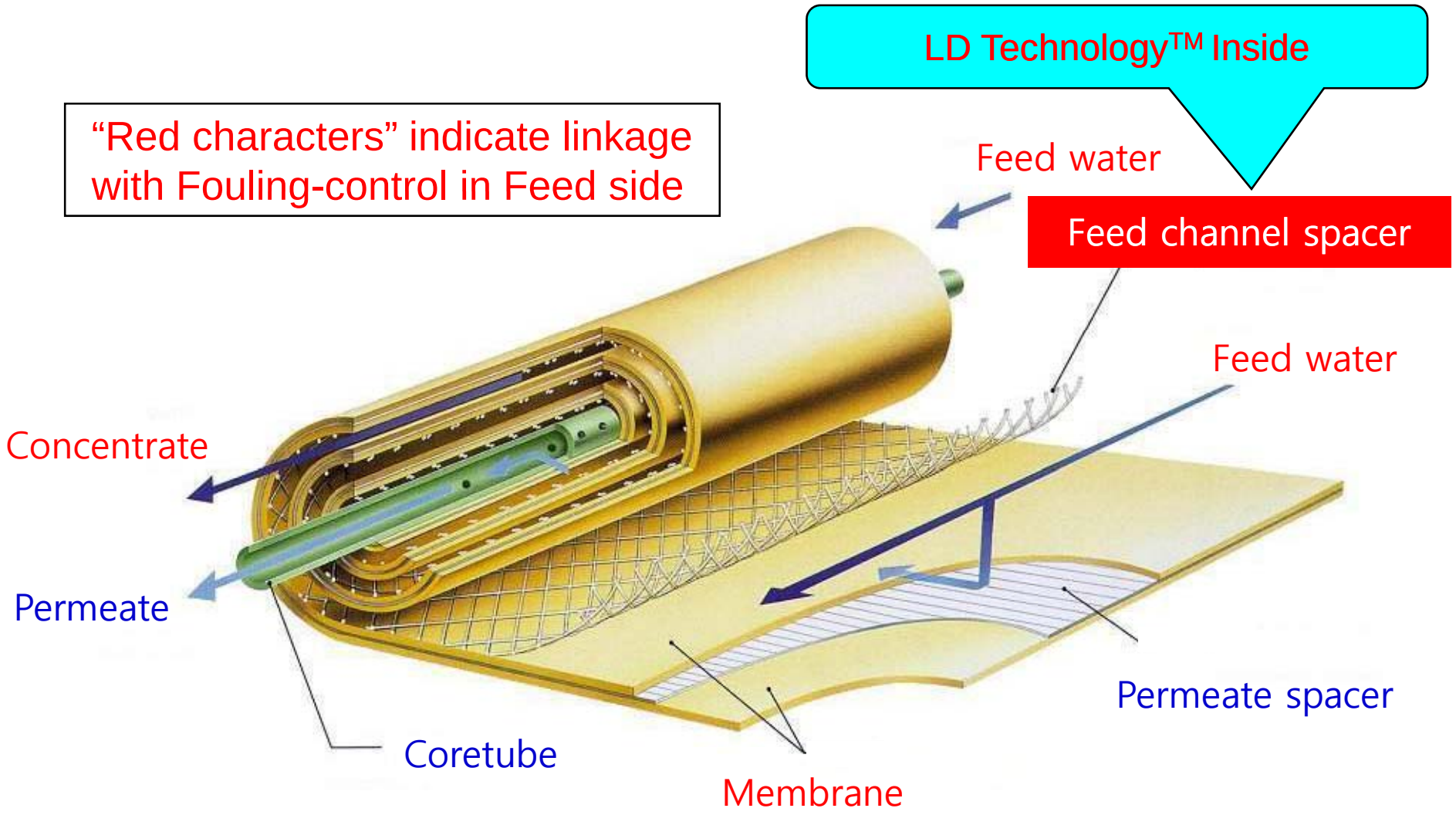
Structure of Spiral-wound Element

New Lower differential pressure Technology

LD Technology™ Inside

"Red characters" indicate linkage with Fouling-control in Feed side



What is LD Technology™ ??

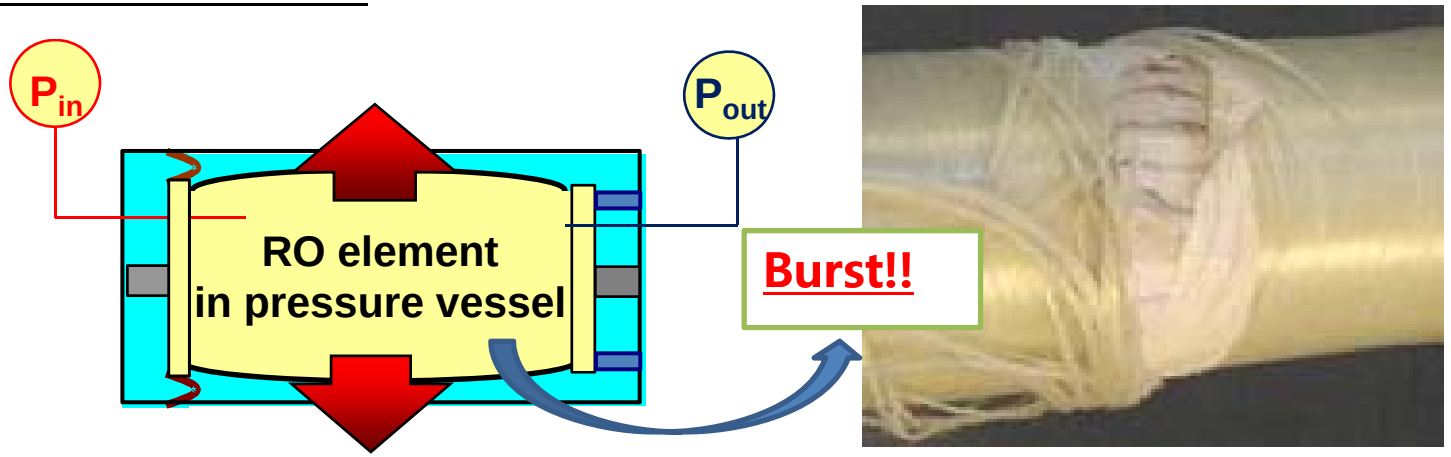
- LD Technology™ enables low differential pressure
- High differential pressure is bad for RO operation

Ex) increasing operation pressure

Delta-P = $P_{in} - P_{out}$ caused by flow passage drag

Ex) bio-fouling

The worst case is....



LD Technology™ ... reducing and keeping Lower Differential pressure

Thicker Spacer with Improved Geometry
Chemically Enhanced Feed Spacer

Lower Differential Pressure Technology (LD Technology™)

1. Thicker Spacer with Improved Geometry

Patented

- Decrease initial differential pressure
- Foulant delocalization effect of LD Technology™
- Improved foulant discharge performance in LD Technology™

2. Chemically Enhanced Feed Spacer

- Biofouling retardation by the combination of foulant delocalization and antibacterial property

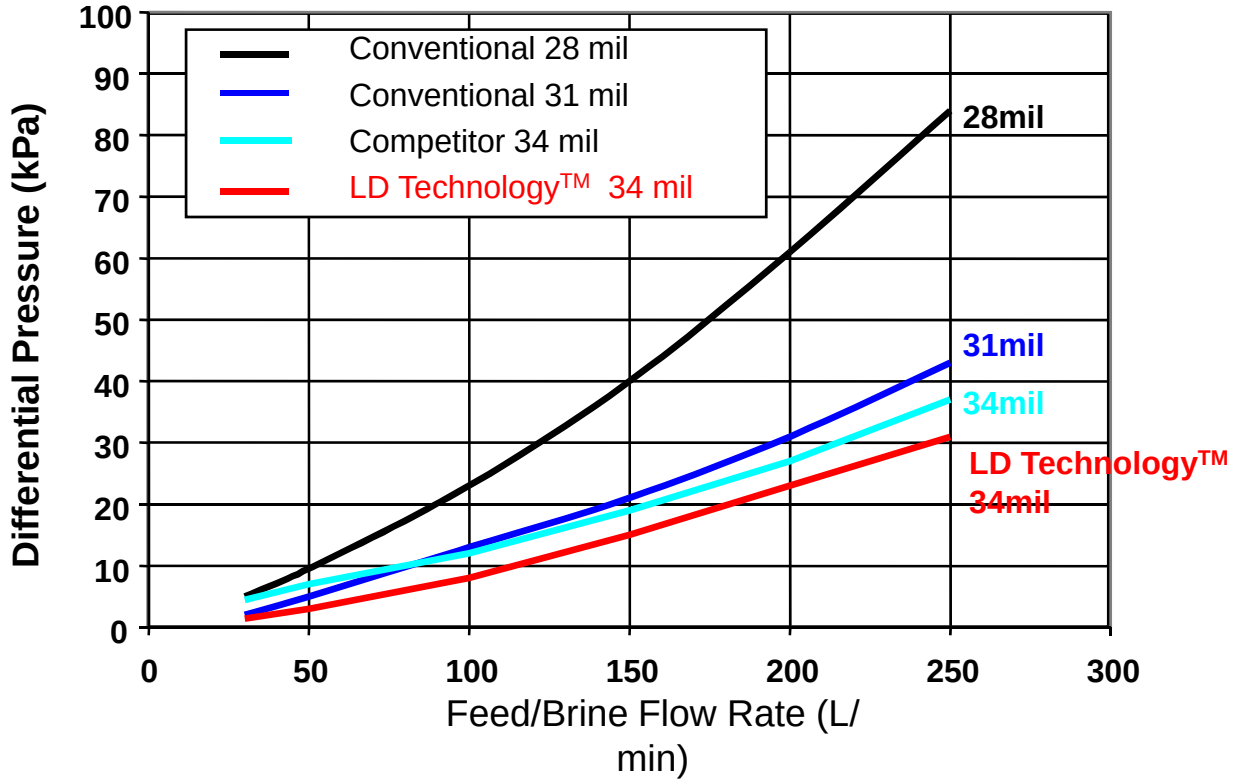
1. Thicker Spacer with Improved Geometry

1）Differential Pressure with Various Feed Spacers

Single element test

- Feed water: DI water with RO
- Net-driving- Pressure: nil
- Recovery ratio: 0%

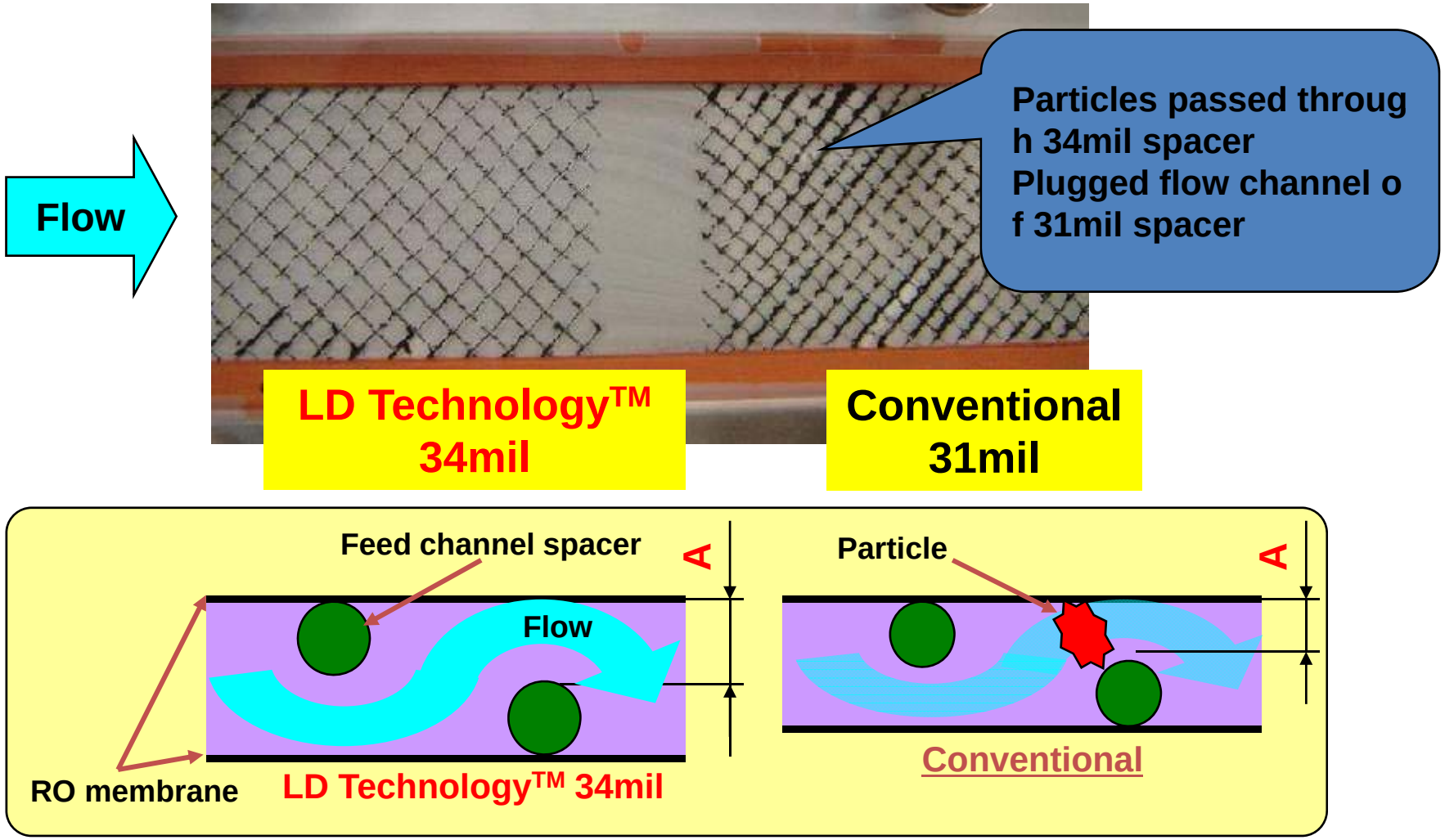
Comparison of Element Pressure Drop



➢ ***delta-P of 34mil is 20-30% drop than 31mil's (Thickness of 34mil is 10% wider than 31mil's）***

1. Thicker Spacer with Improved Geometry

2）Comparison between 34 mil and 31 mil SP

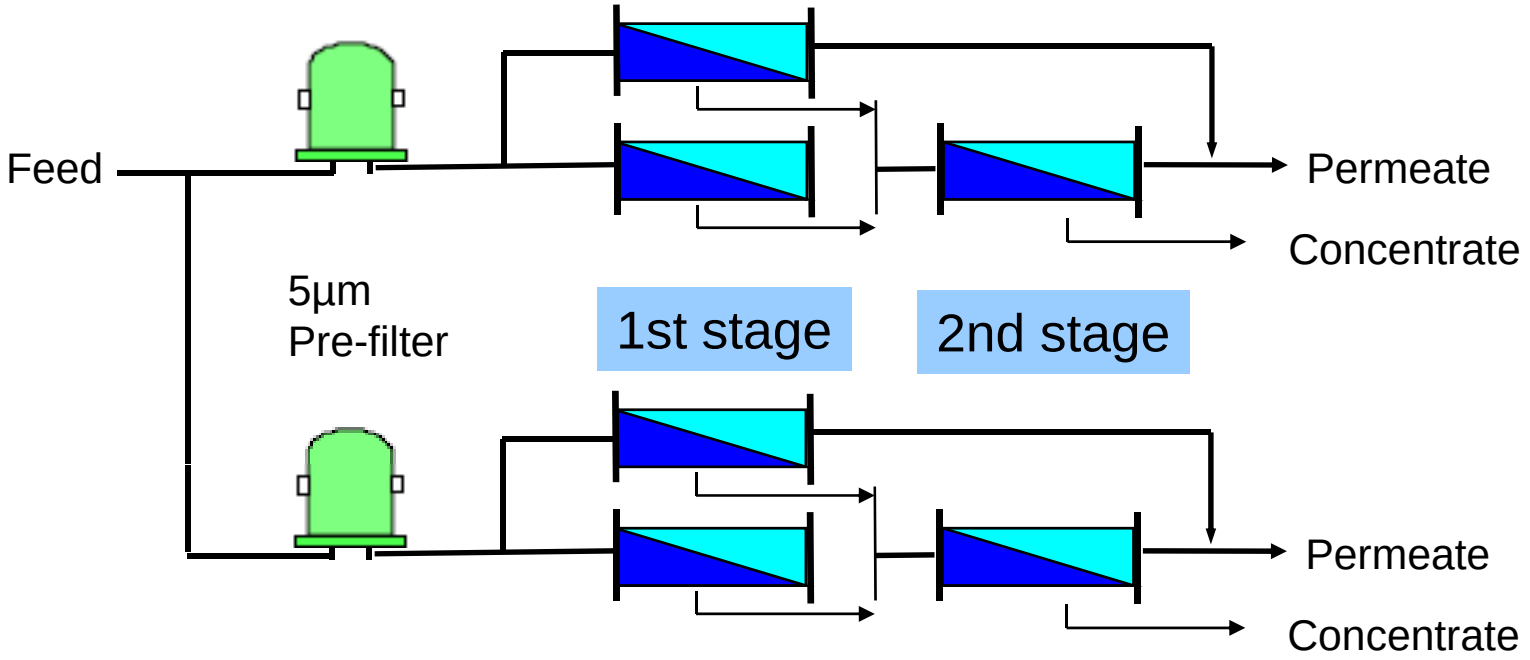


1. Thicker Spacer with Improved Geometry

3）Demonstration Test with LD Technology™

System flow

- 1 Pass two stage RO
- 2 units



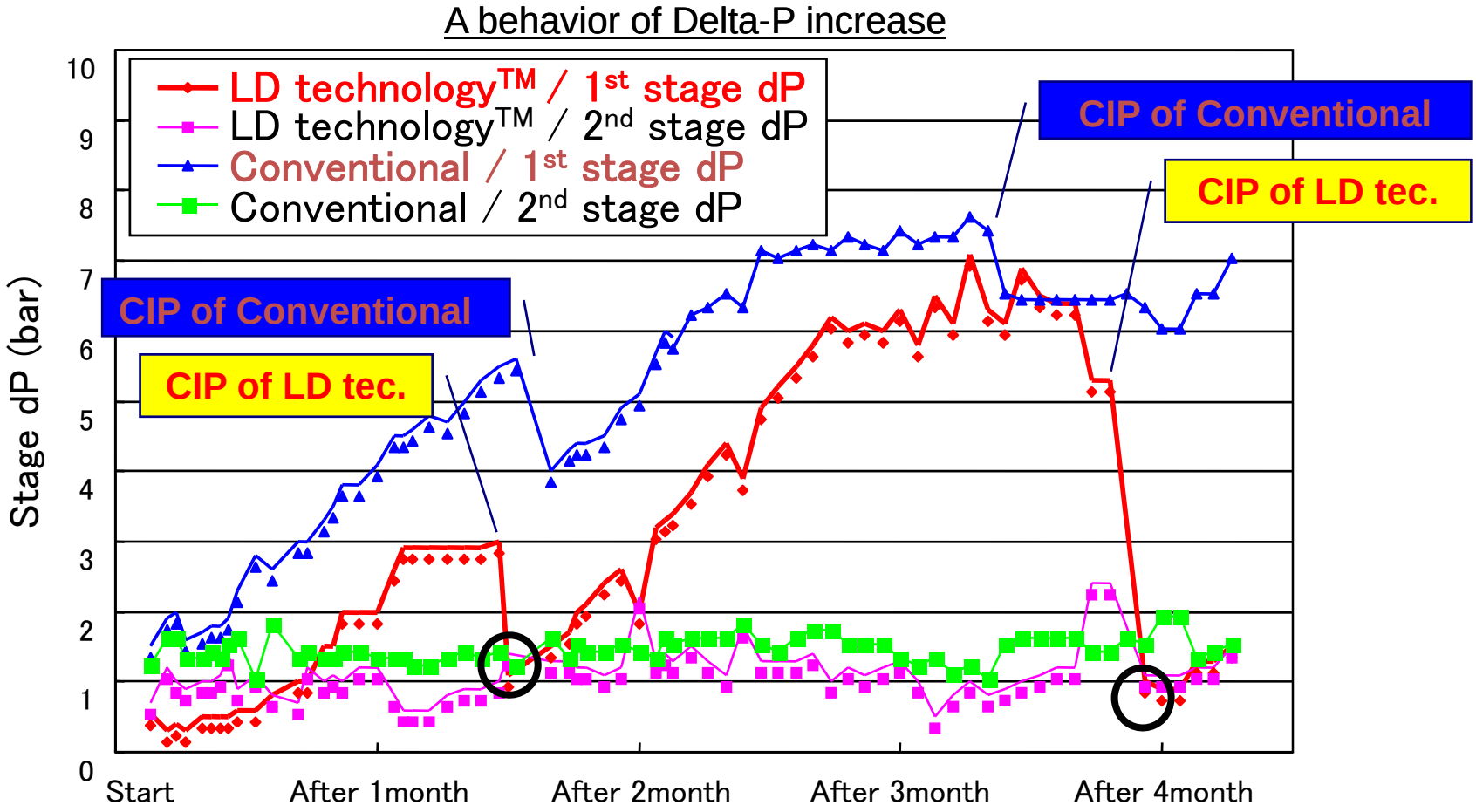
Test conditions

Feed: Wastewater
Permeate flow: 50 m^3/hr;
Array: 6-3 (6 pcs/vessel)

Feed EC: 500-1,000 µs/cm;
Recovery: 75%
Element: 54 pcs/unit

1. Thicker Spacer with Improved Geometry

3）Demonstration Test with LD Technology™



- ***The new spacer reduced delta-P increasing***
- ***The delta-P was restored to the initial value with a chemical cleaning***

Lower Differential Pressure Technology (LD Technology™)

1. Thicker Spacer with Improved Geometry

- Decrease initial differential pressure
- Foulant delocalization effect of LD Technology™
- Improved foulant discharge performance in LD Technology™

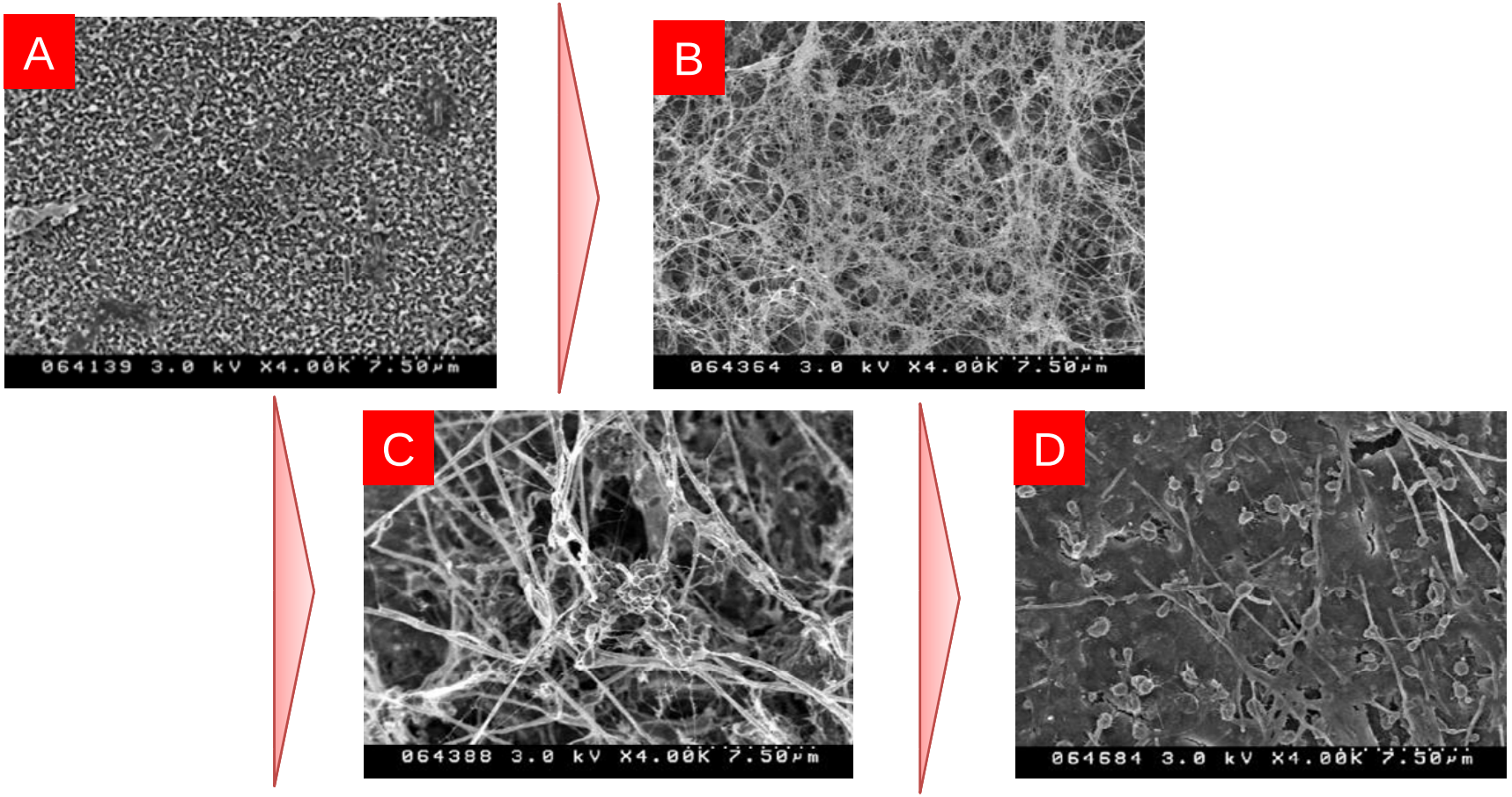
2. Chemically Enhanced Feed Spacer

Patented

- Biofouling retardation by the combination of foulant delocalization and antibacterial property

2. Chemically Enhanced Feed Spacer

1）SEM image of membrane surface in transition of biofouling



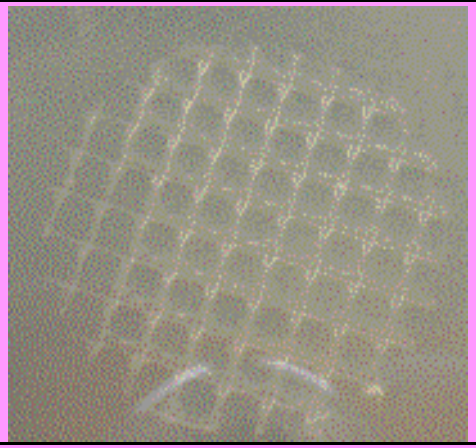
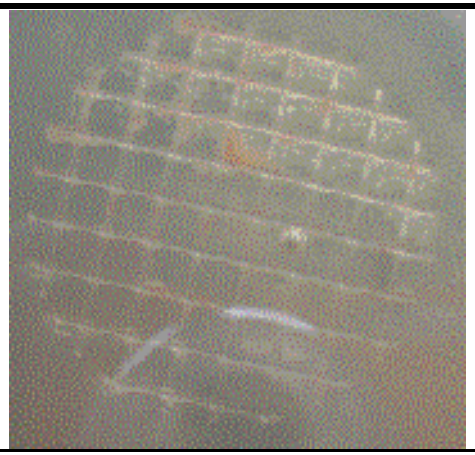
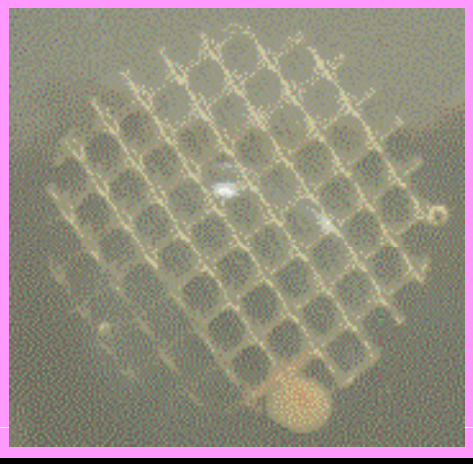
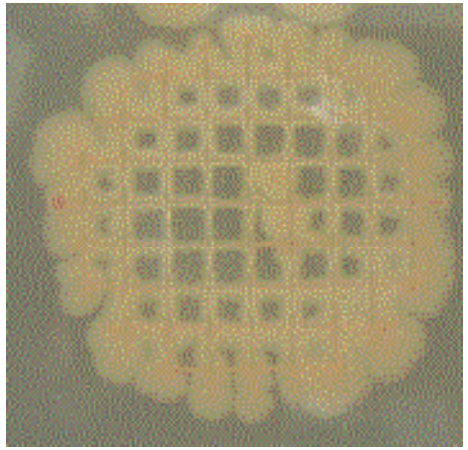
Countermeasure against biofouling

- ***Making bacteria not to accumulate***
- ***Deactivation of bacteria***

2. Chemically Enhanced Feed Spacer

2）E-coli. Incuvation Test

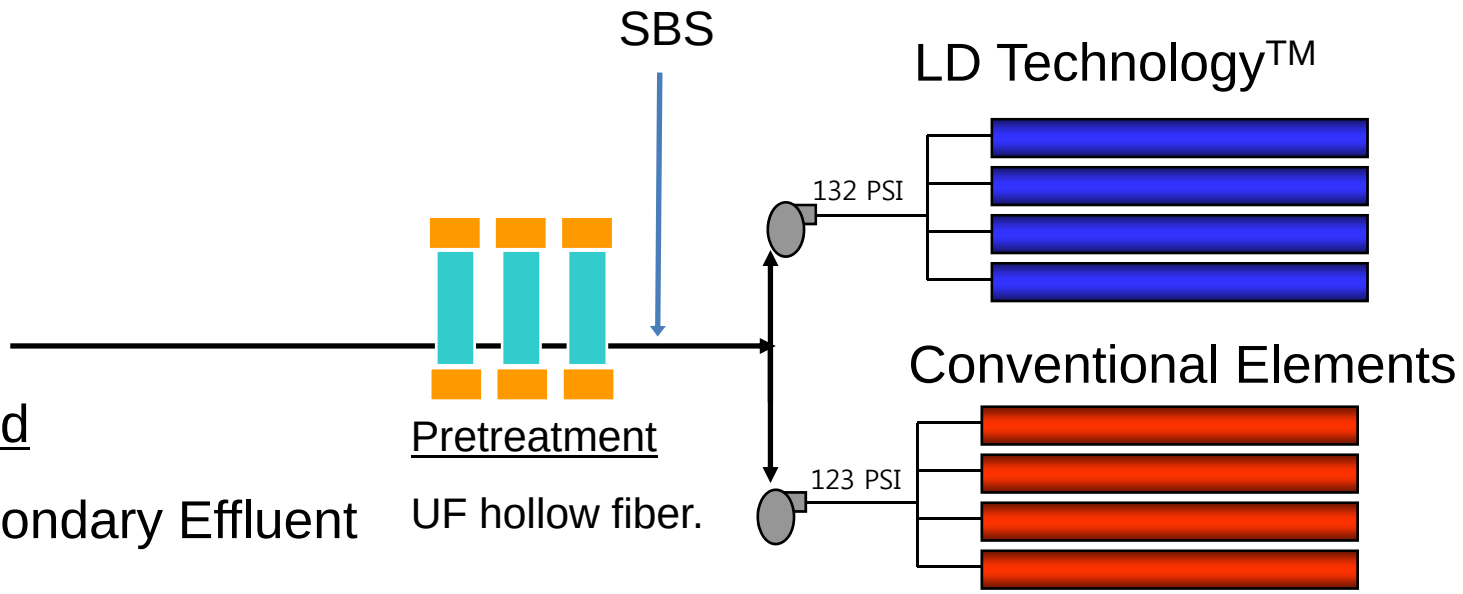
Test conditions : 35deg/C, Nutrient agar

	LD Technology™	Conventional
After 3days		
After 5days		

➢ ***The New Spacer controlled Bio-growth***

2. Chemically Enhanced Feed Spacer

3）Demonstration test of Chemically Enhanced Feed Spacer at Plant A



Feed

Secondary Effluent

Na = 195 ppm

Cl = 201 ppm

SiO2 = 15 ppm

Pretreatment

UF hollow fiber.

Test conditions

Trains = 2

Stage = 1

Vessels = 4

Elements / Vessel = 6

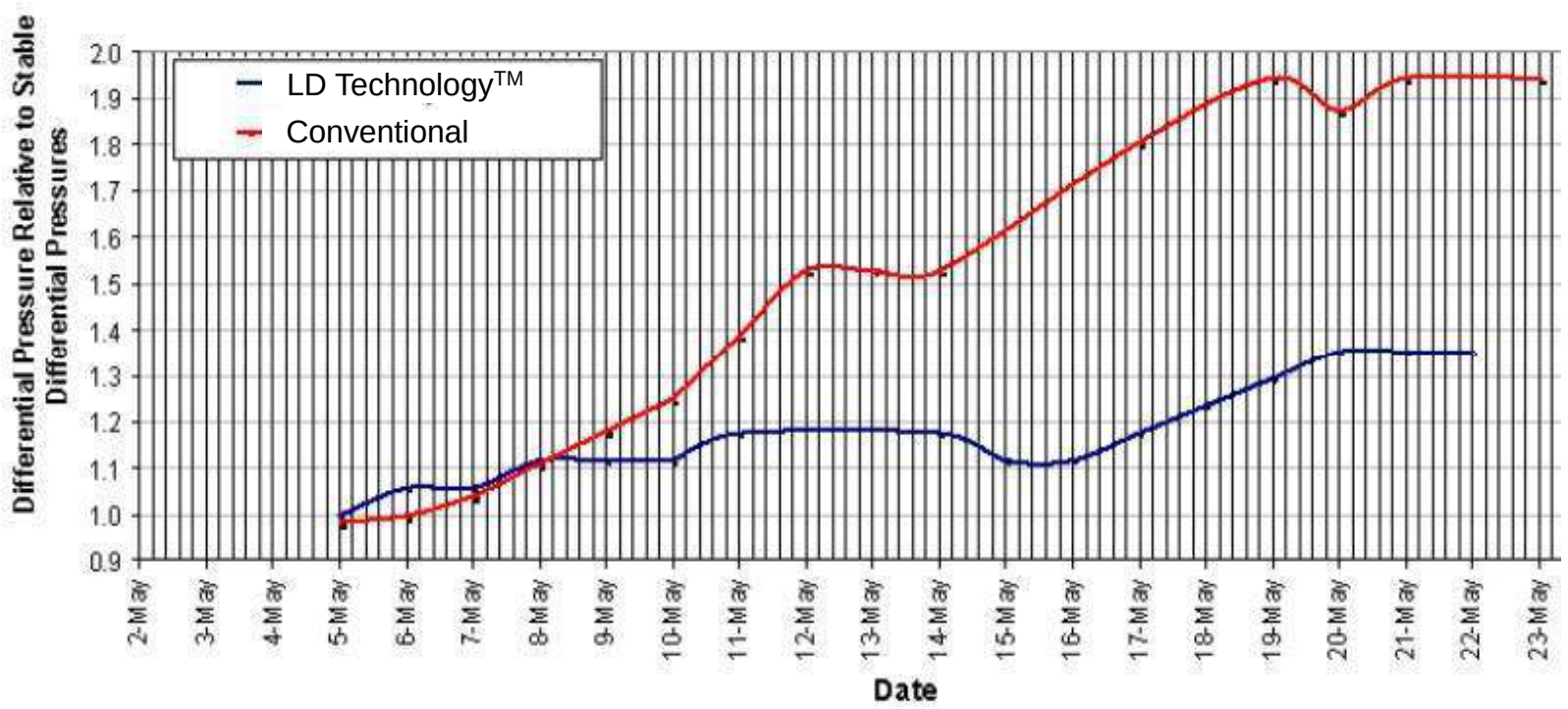
Recovery = 50%

Flux = 12 gfd

2. Chemically Enhanced Feed Spacer

3）Demonstration test of Chemically Enhanced Feed Spacer at Plant A

A behavior of Delta-P increase at Plant A

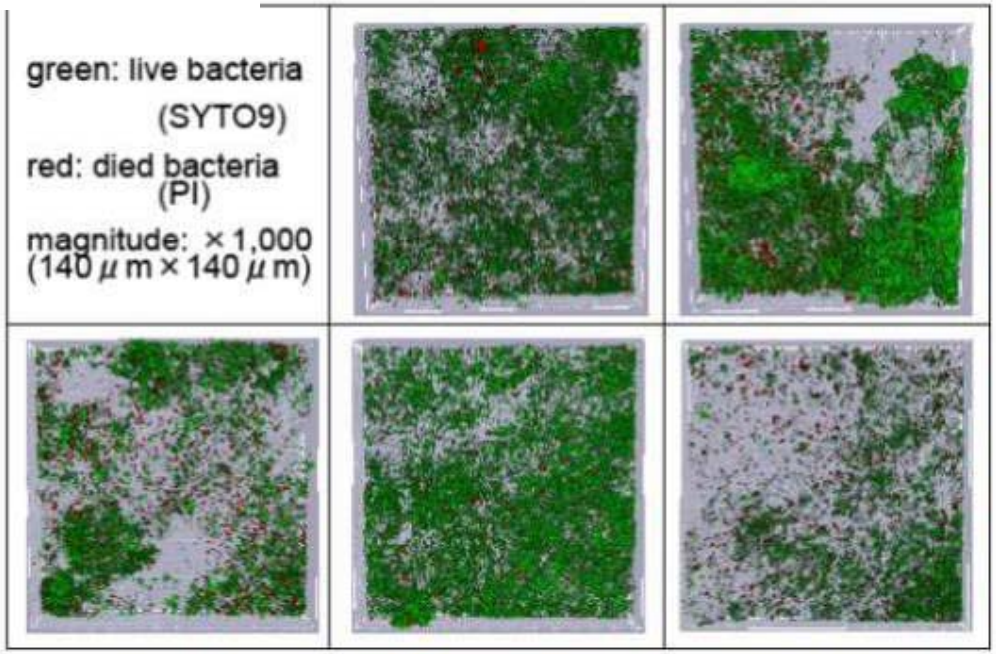


➢ ***The new spacer controlled Delta-P increase by Bio-fouling in Fee d-side***

3）Demonstration test of Chemically Enhanced Feed Spacer at Plant A

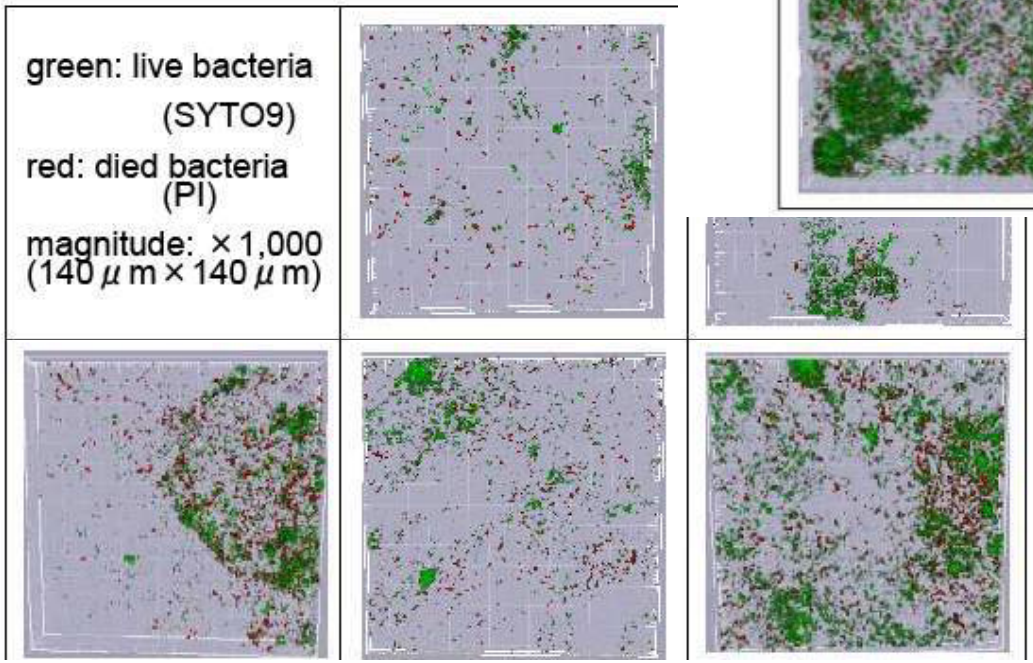
Imaging Analysis of Bacteria on Membrane Surface

Conventional



◆**Attached bacteria on membrane**

LD technology™



Product lineup having LD Technology™

Element type / Specification		*Energy saving*	Low pressure	*Low fouling membrane*	*Sea water desalination*
		ESPA2-LD	CPA5-LD	LFC3-LD	SWC5-LD
		LD Technology™ Inside			
NaCl Performance	Rejection (nom.)	99.6 %	99.7%	99.7 %	99.8 %
	Permeate flow (nom.)	10,000 gpd	11,000gpd	11,000 gpd	9,000 gpd
Test conditions		1500 ppm NaCl solution 150 psi (1.05 Mpa) 77 F (25 C) 15% Recovery pH 6.5 – 7.0	1,500 ppm NaCl solution 225 psi (1.55 MPa) 77 F (25 C) 15 % recovery pH 6.5 – 7.0		32,000 ppm NaCl solution 800 psi (5.5 MPa) 77 F (25 C) 10% Recovery pH 6.5 – 7.0
Feed channel spacer		*Chemically Enhanced* 34 mil			
Membrane Area		400 ft^2			