HOLLOW FIBER VS. FLAT SHEET TECHNOLOGY

(A CASE STUDY)

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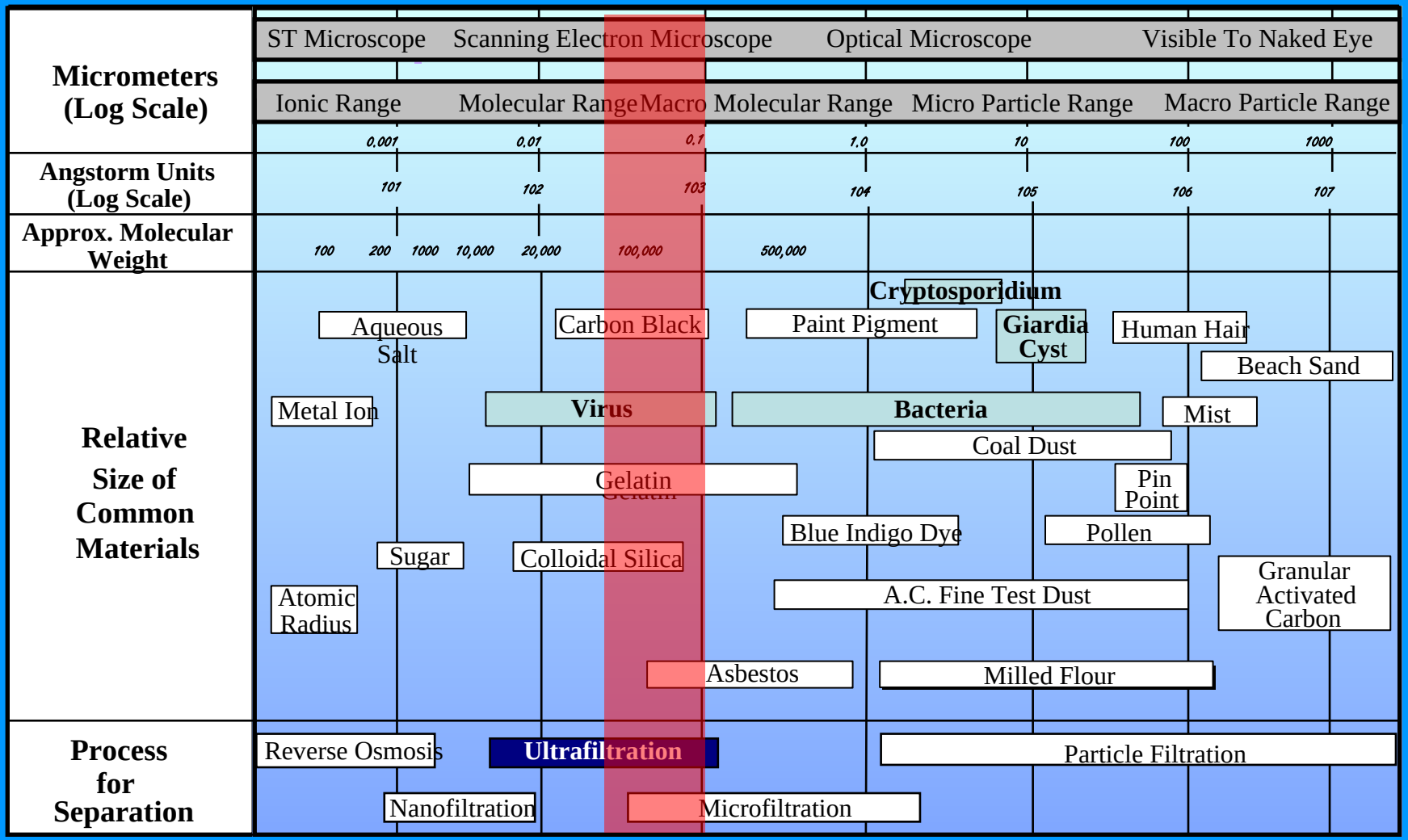
OVERVIEW

- MEMBRANE TECHNOLOGY OVERVIEW.
- ACTUAL DESIGN CASE STUDY COMPARISON.

MEMBRANE TREATMENT SPECUTRUM

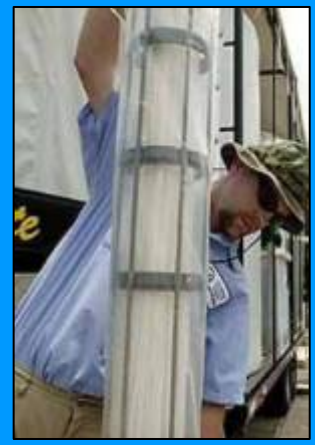


Hollow Fiber Membrane Range

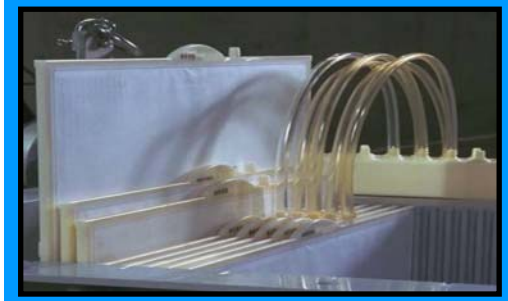
MEMBRANE CONFIGURATIONS

Reinforced Hollow Fiber

Non-Reinforced Hollow Fiber

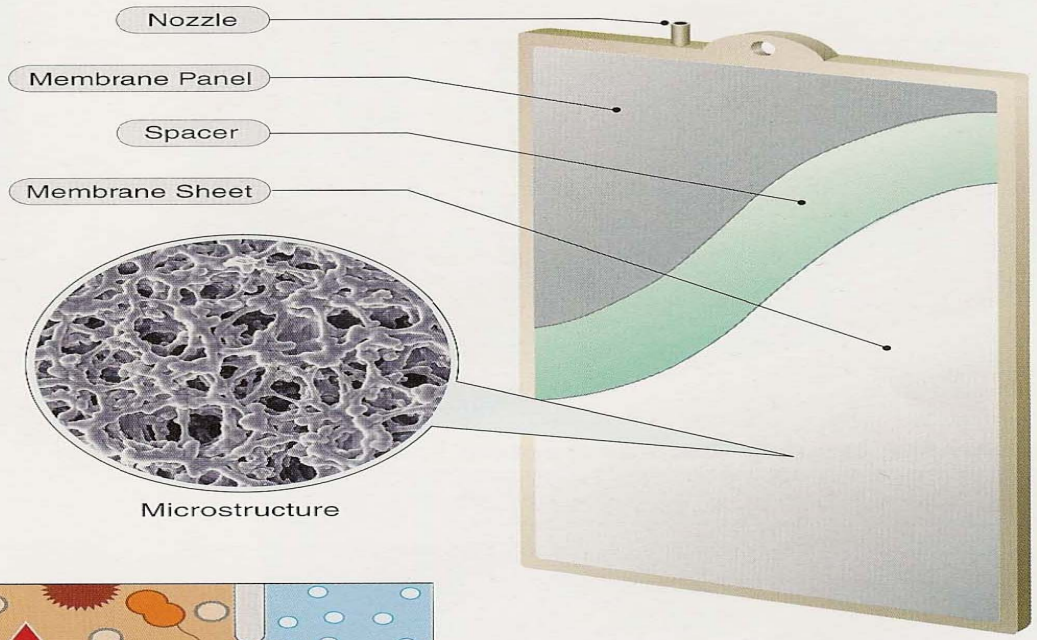


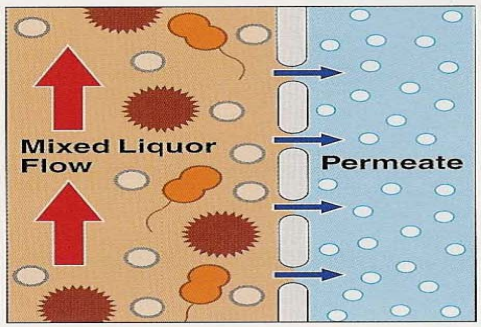
Flat Plate Sheet



Spiral Wound Sheet

FLAT SHEET TECHNOLOGY



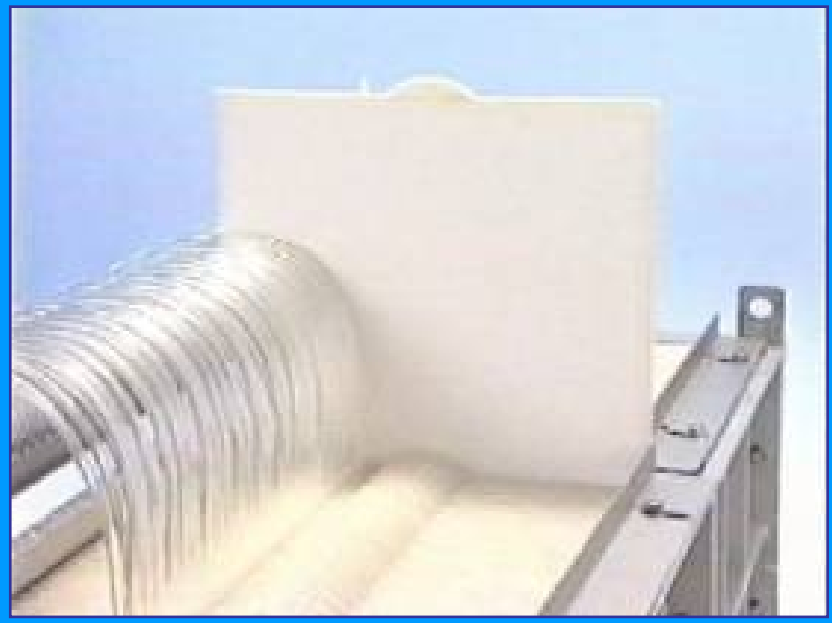


◀◀◀ Cross Flow Filtration

Mixed liquor flows parallel to the membrane surface, while water permeates through the membrane.
Cross flow prevents the membrane surface from fouling.

- Immersed Membrane
- Microfilter (0.4 Nominal Pore Size)
- PVC Membrane Chemistry.
- Recognized for Title 22 in California (Water Re-use)

MEMBRANE PLATES

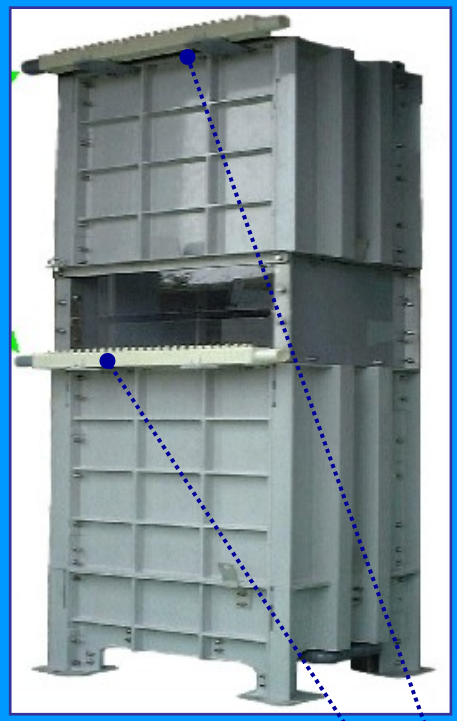


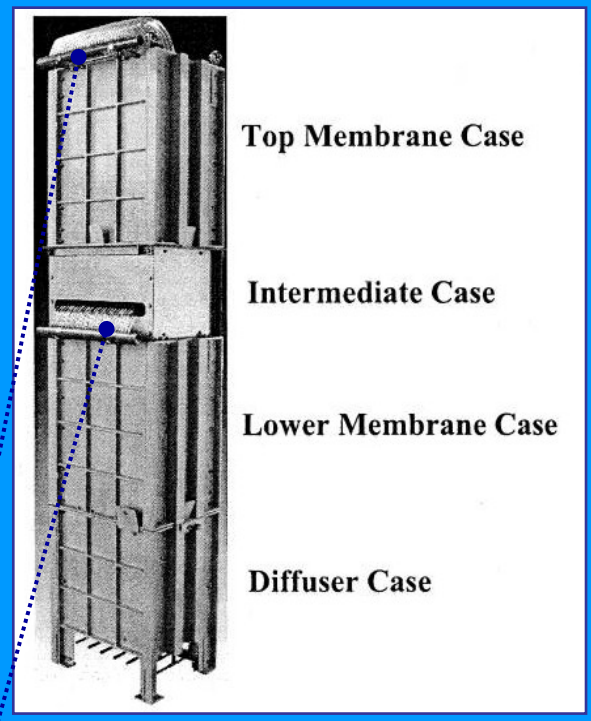
- Both types of cartridges are placed into the case as shown.
- Both types of cartridges are used for the same type applications.

FLAT SHEET CONFIGURATION

E-150 Single Stack

K-400 Double Stack

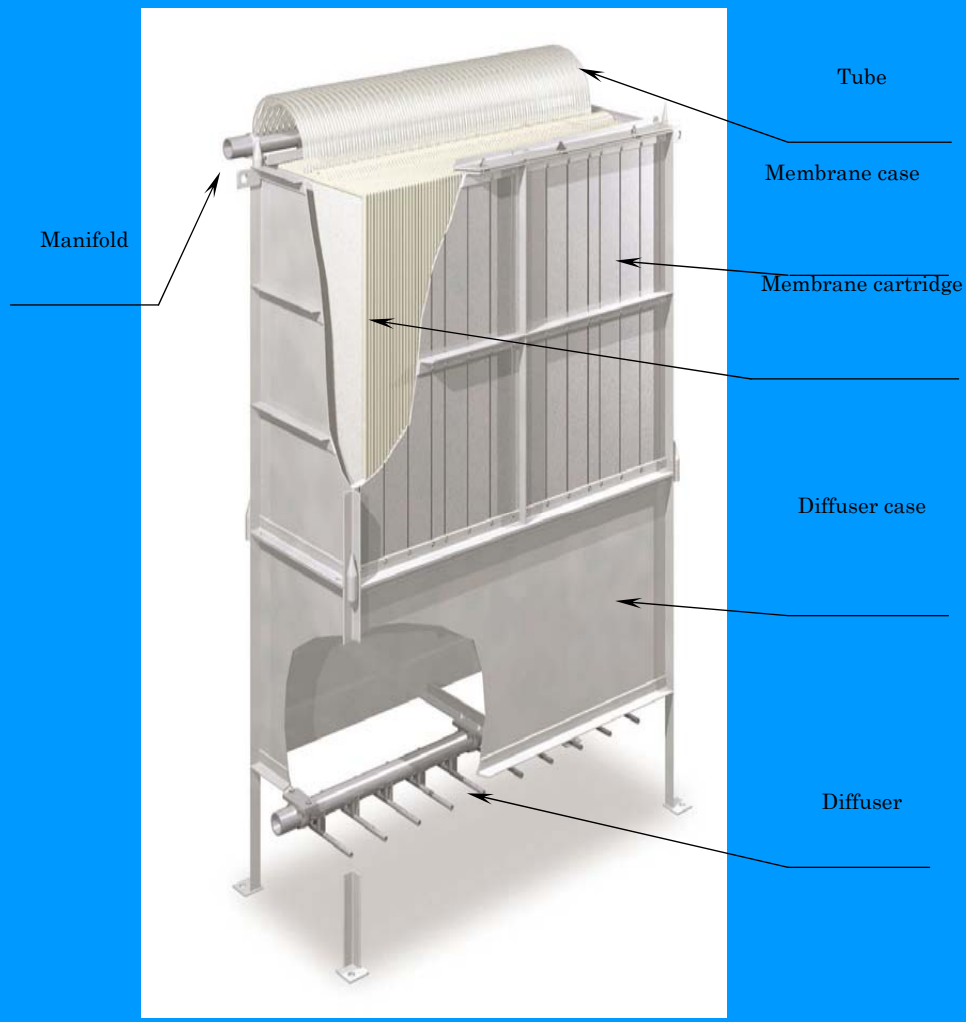




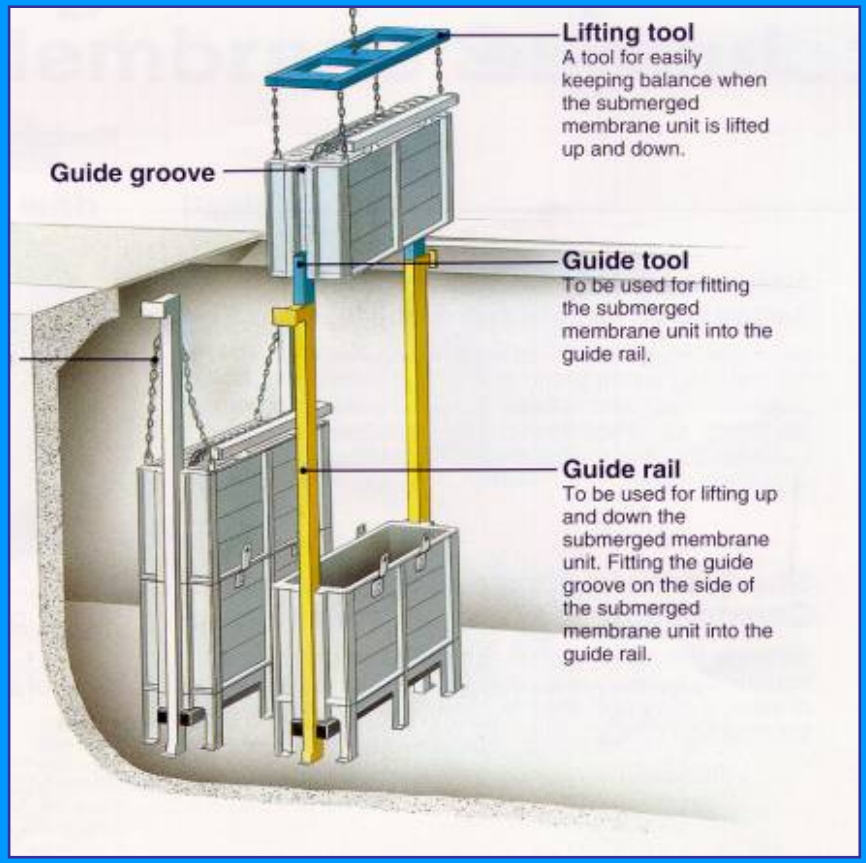
Separate Headers for
top
& bottom membranes

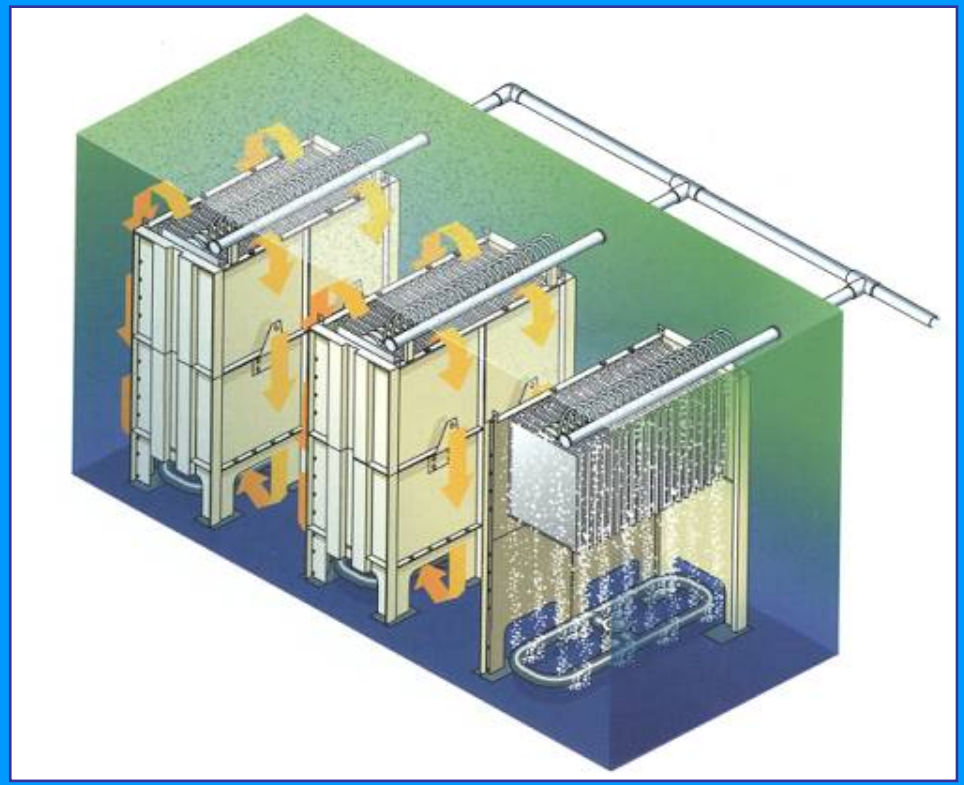
FLAT SHEET MEMBRANES

Single Plate Membrane Case



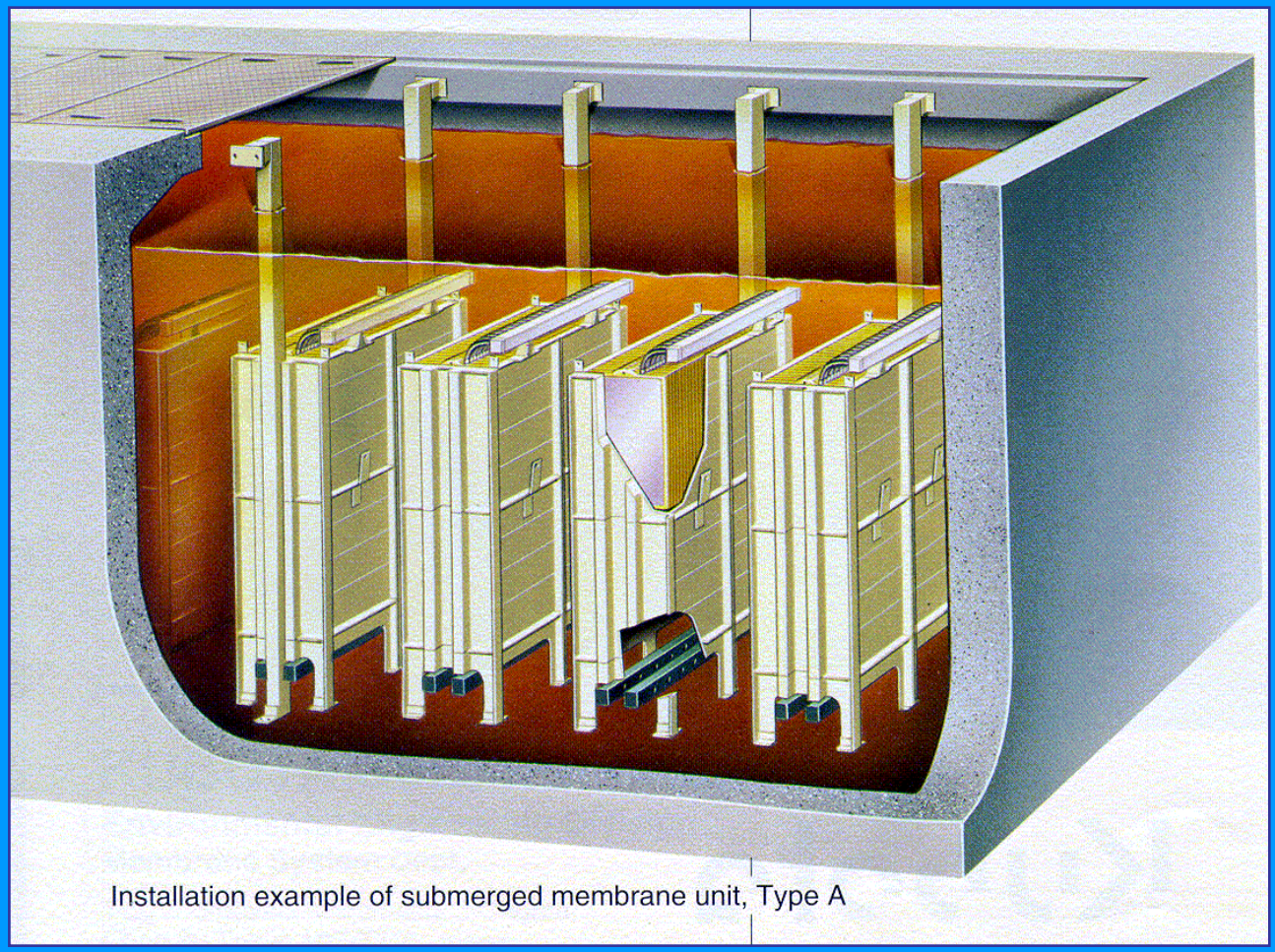
INSTALLATION AND ORIENTATION





Single Plate Membrane Case

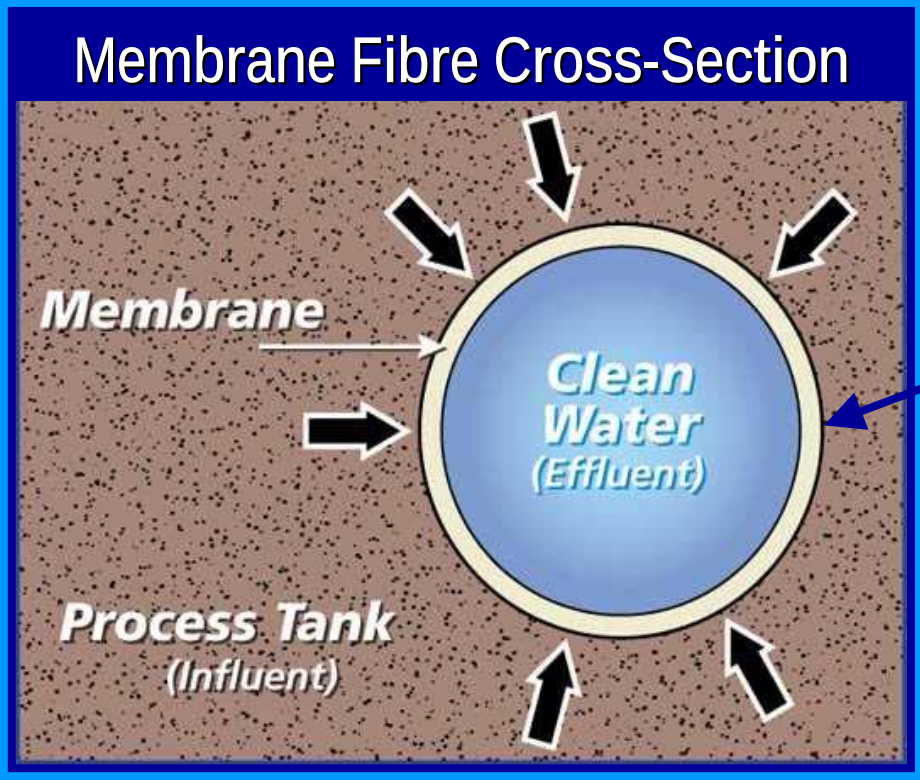
FINAL ARRANGEMENT

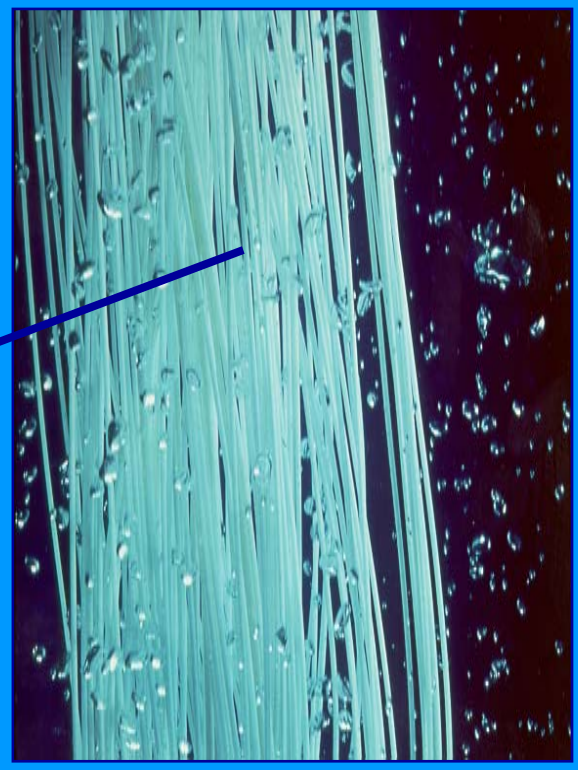


Installation example of submerged membrane unit, Type A

Single Plate Membrane Case

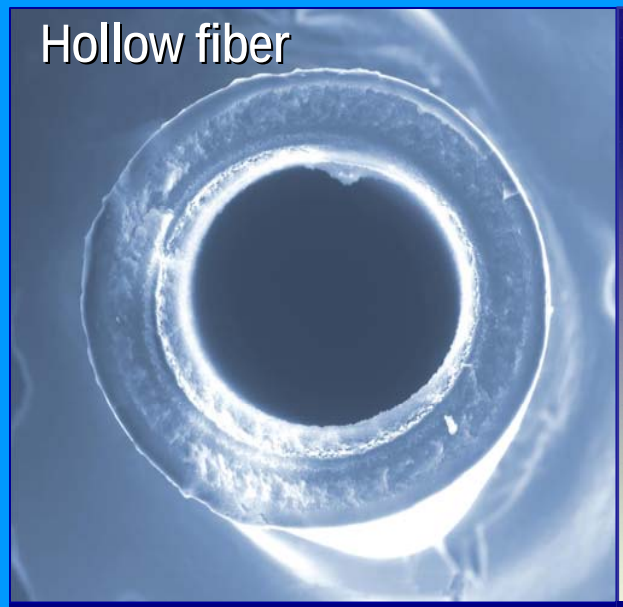
HOLLOW FIBER CONFIGURATIONS





- Minimal prescreening
- Infrequent cleaning
- Mild cleaning required to keep fiber exterior clean

HOLLOW FIBER TECHNOLOGY



HOLLOW FIBER ELEMENT

HOLLOW FIBER GROUP

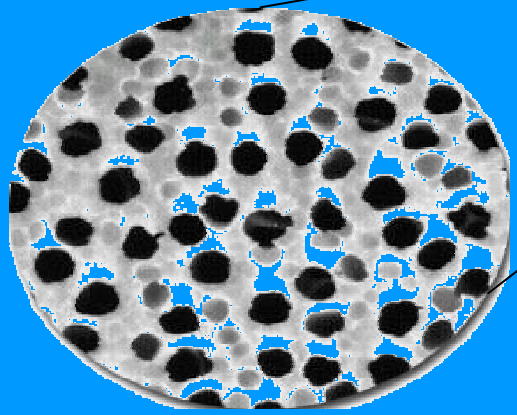
- Reinforced Hollow Fiber
- NSF Certified Ultrafiltration (UF)
- Outside – In Flow
- Immersed Shell-less Technology
- Recognized for Title 22 in California (Water Re-use)

HOLLOW FIBER MAGINFICATION

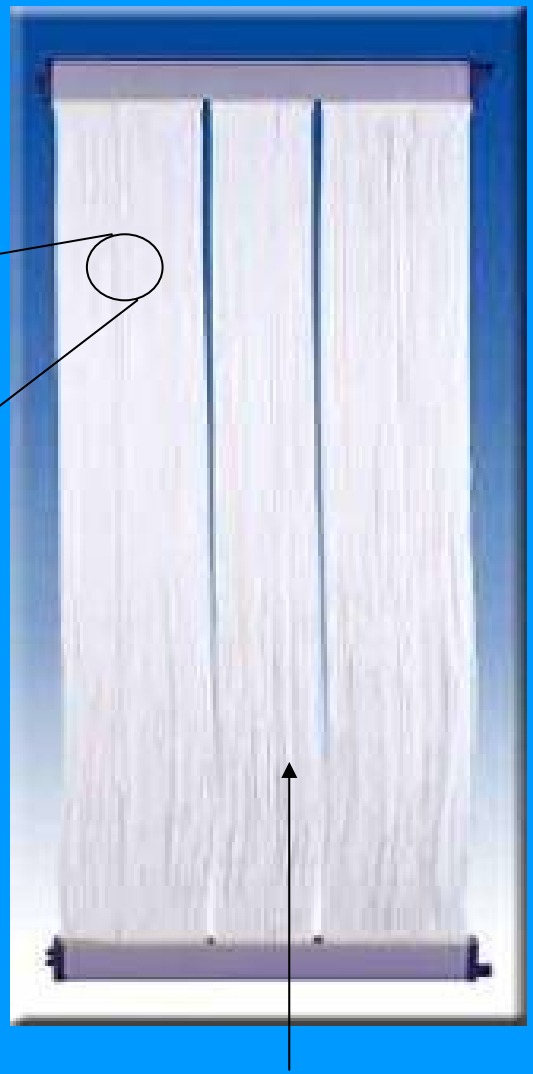
PORE SIZE

0.04 micron (average)

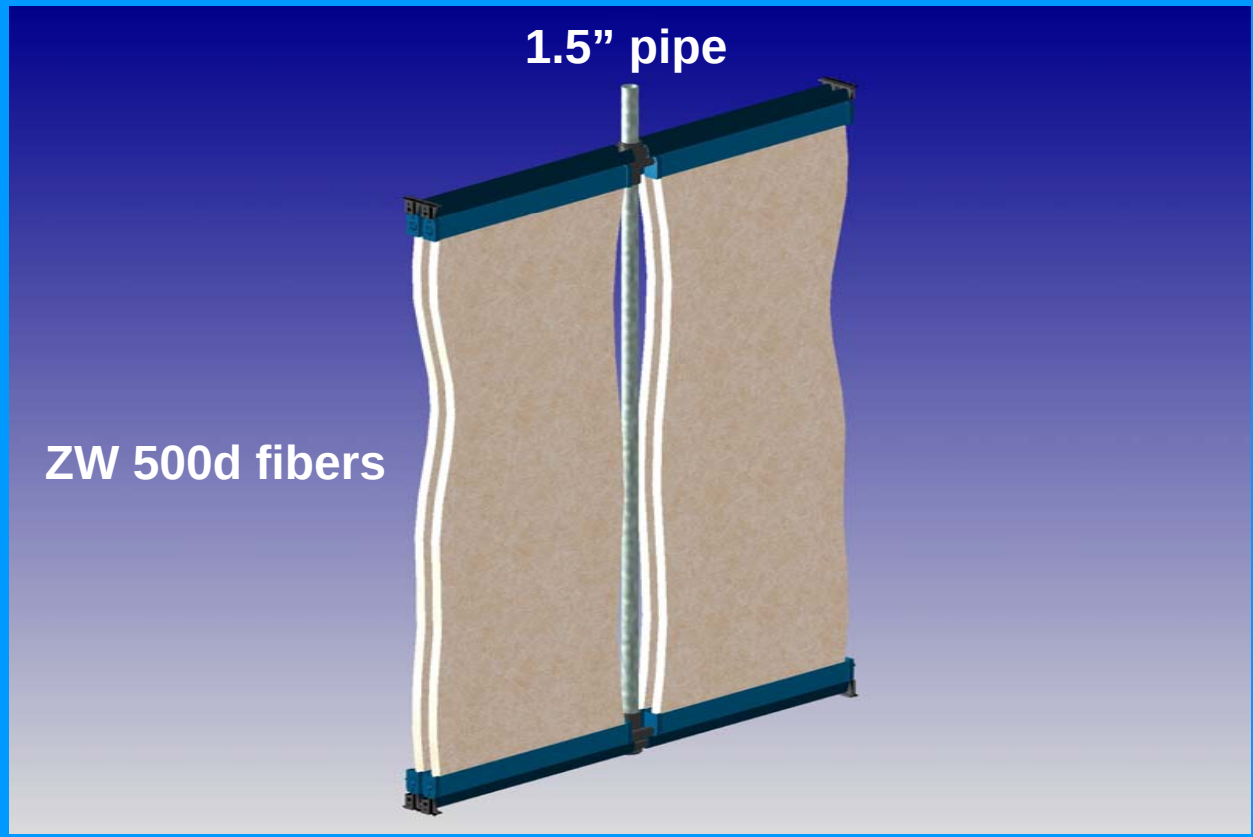
0.1 micron (maximum)



Electron microscope view of the UF membrane surface

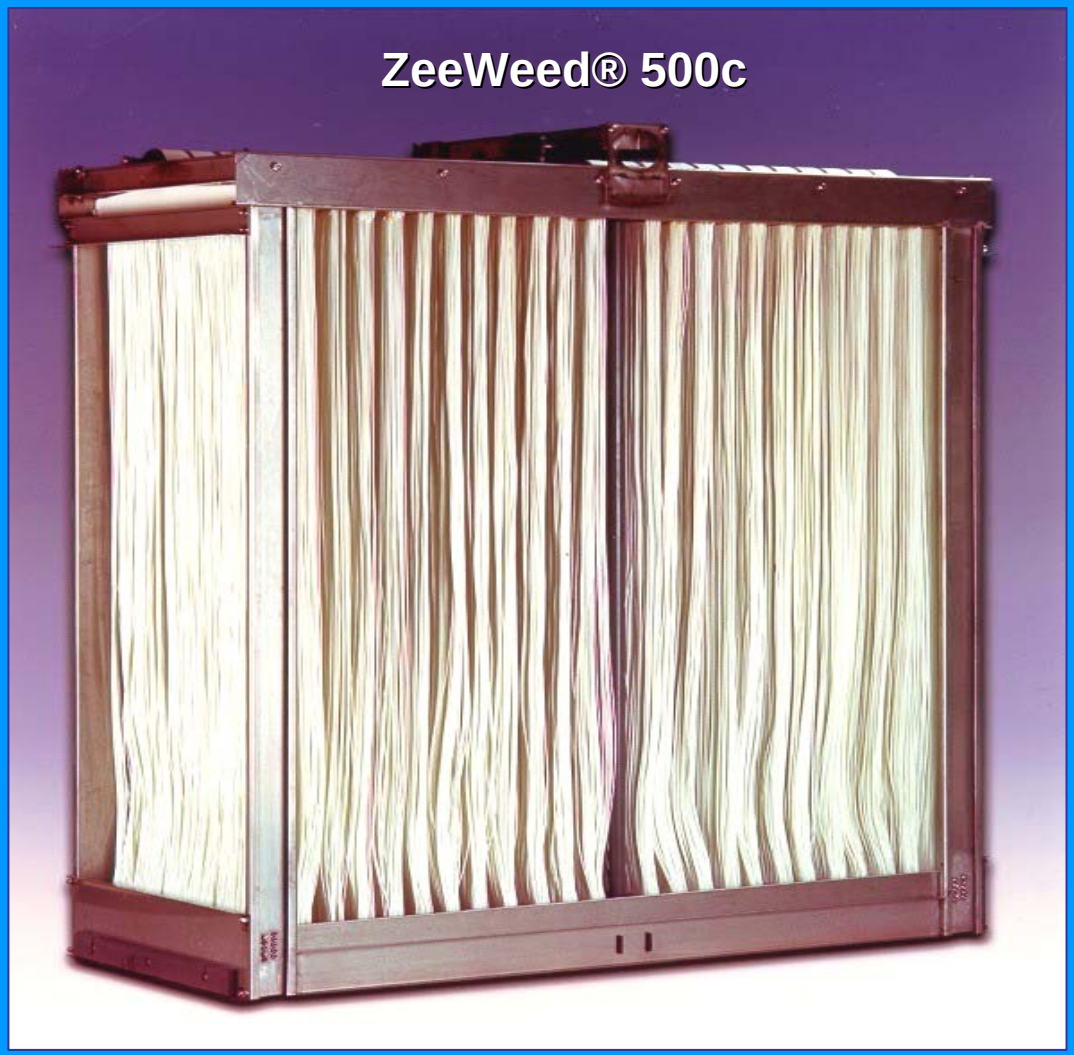


BASIC HOLLOW FIBER MEMBRANE MODULE

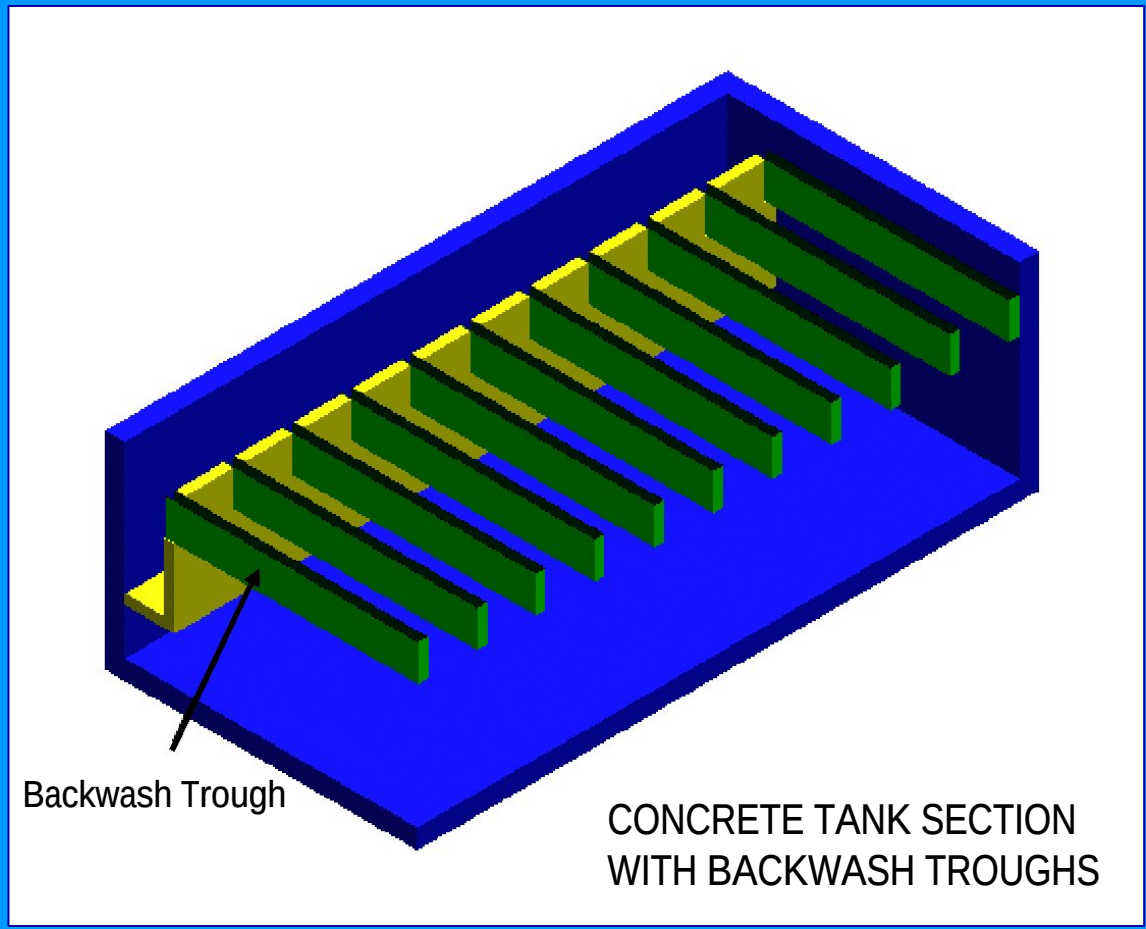


Cassette Building Block (4 Hollow Fiber Elements)

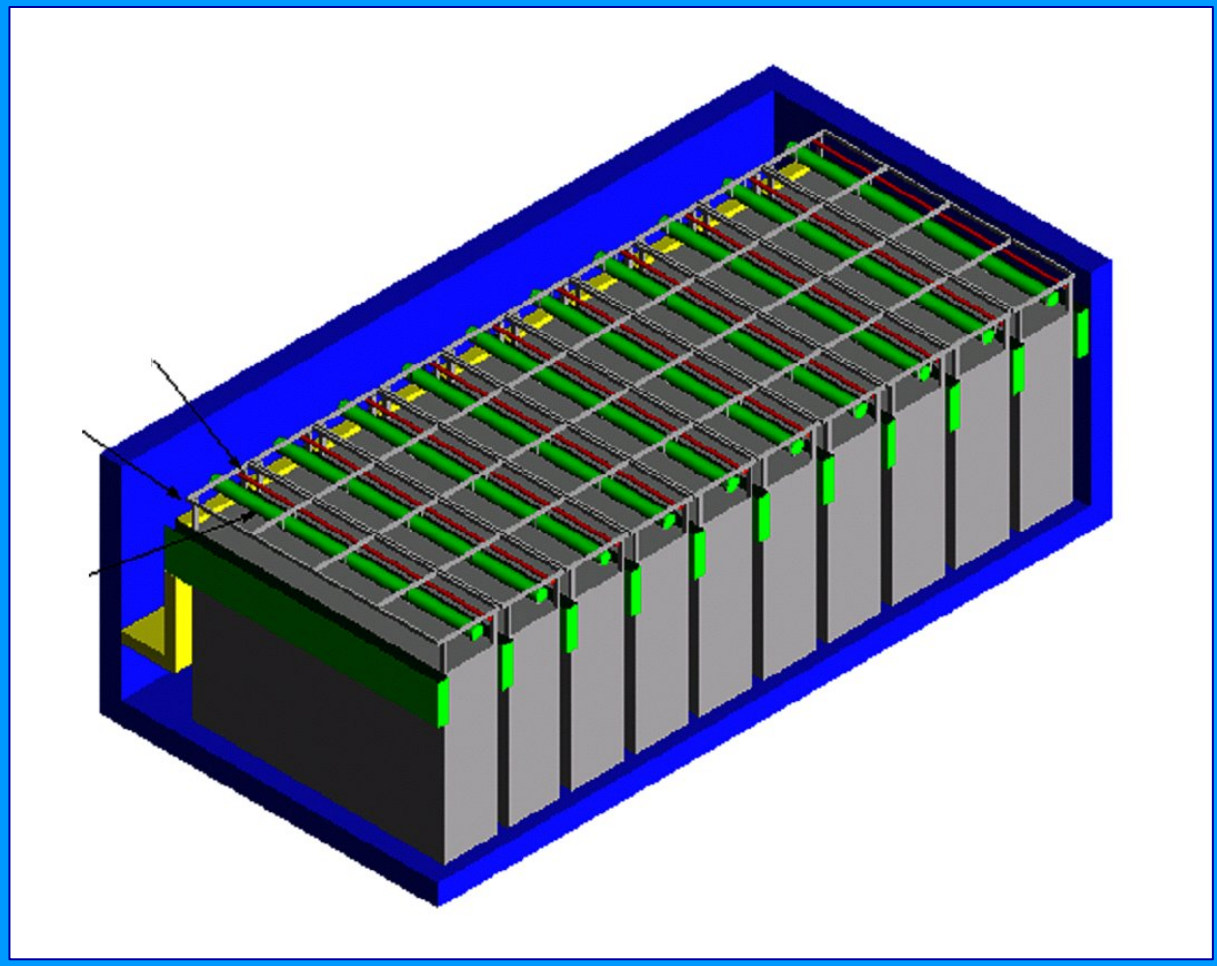
HOLLOW FIBER SLIDING ELEMENT ARRANGEMENTS



HOLLOW FIBER MEMBRANE INSTALLATION



HOLLOW FIBER MEMBRANE INSTALLATION



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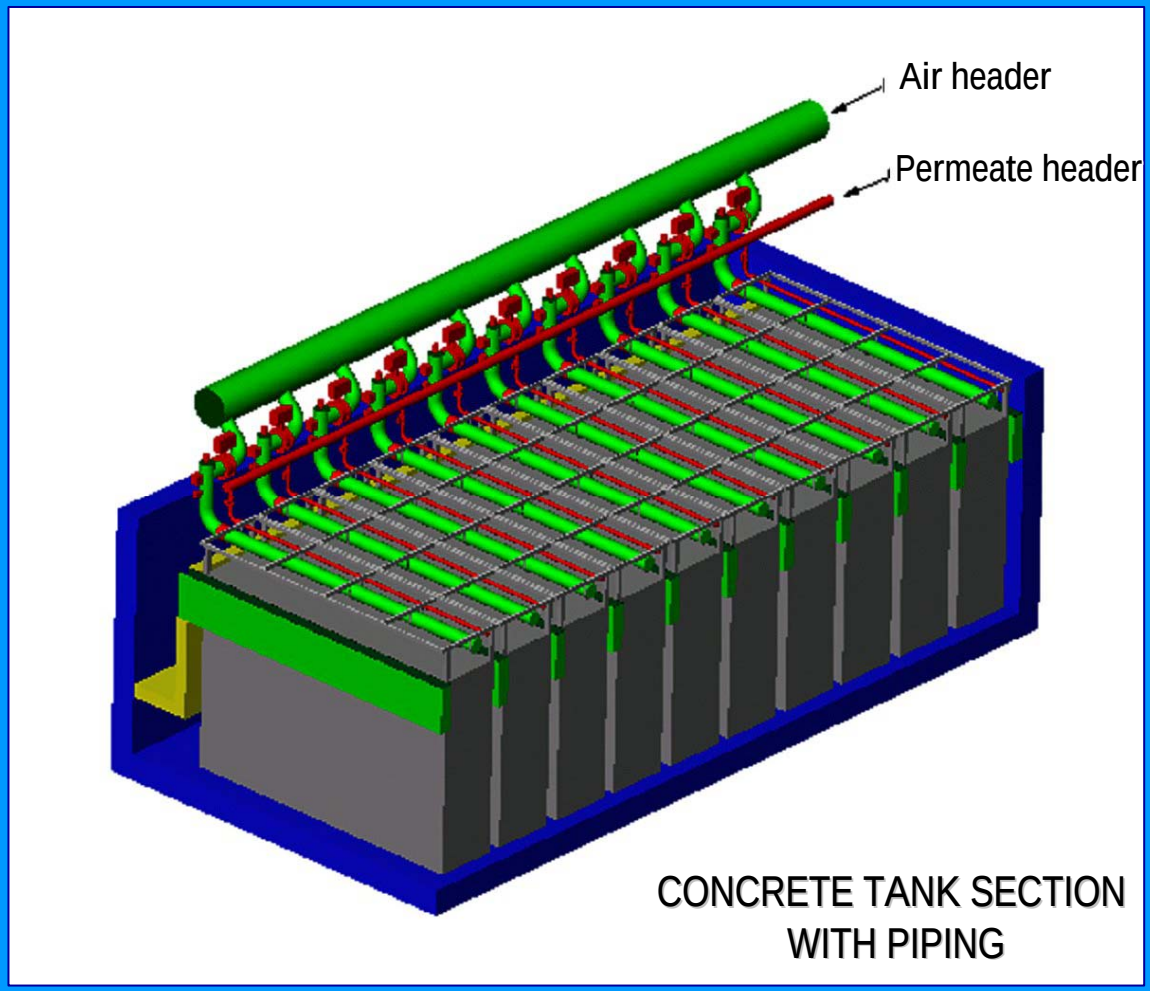
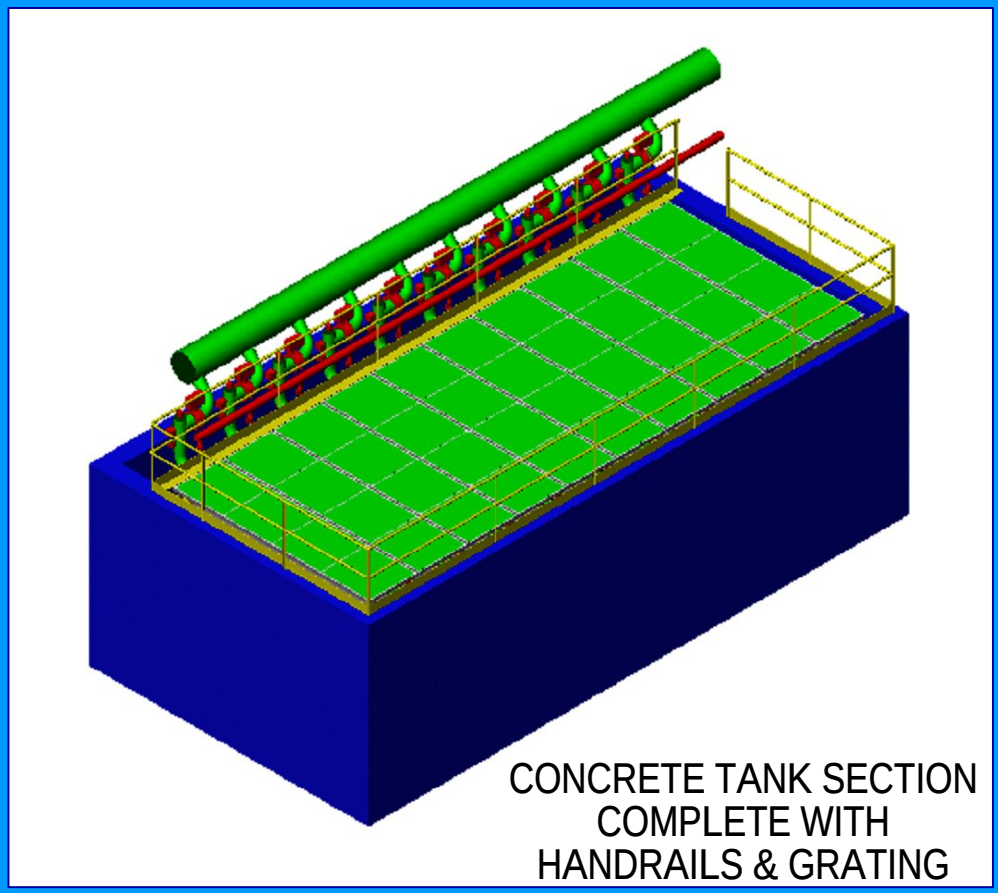
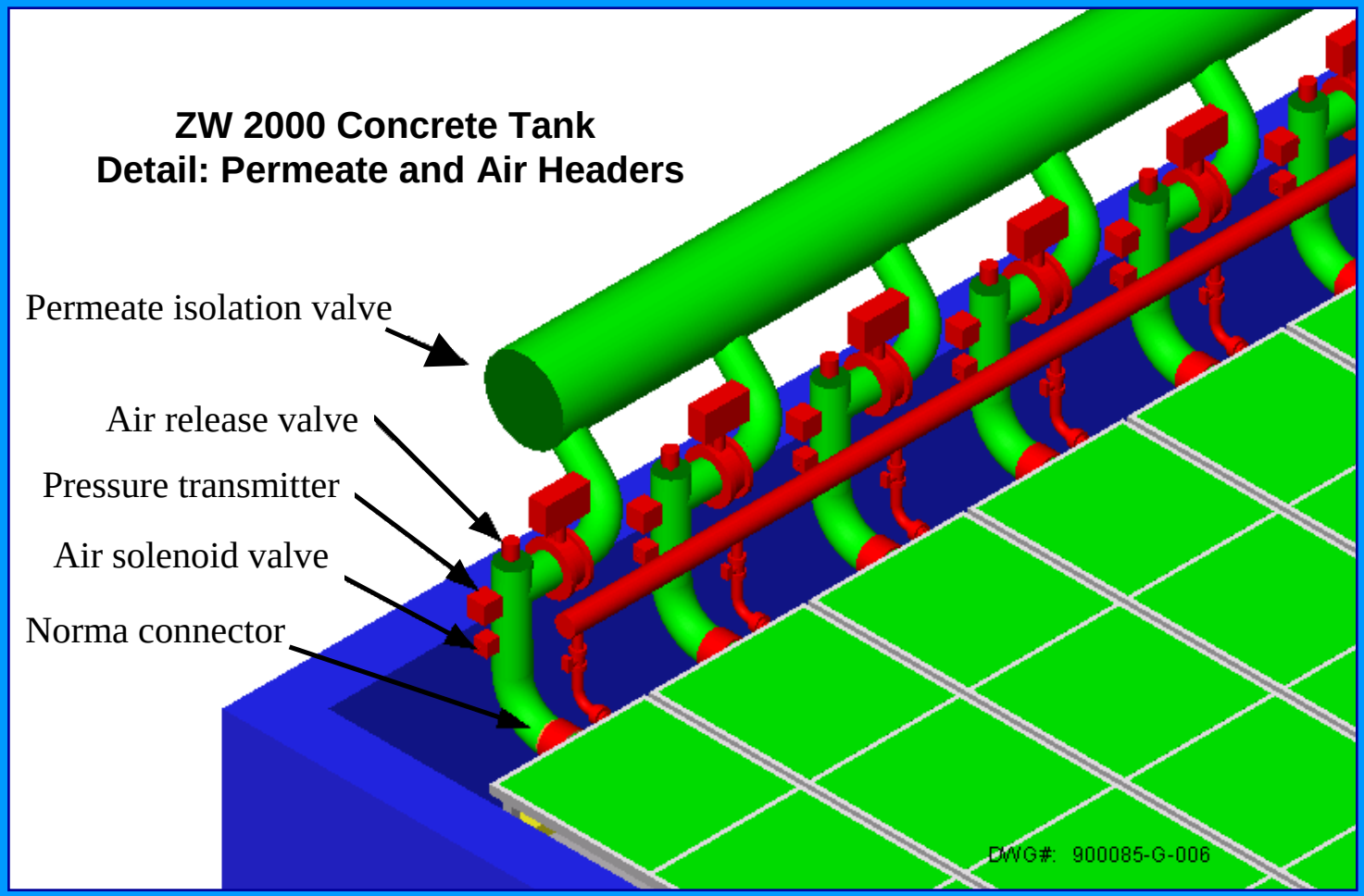


HOLLOW FIBER MEMBRANE INSTALLATION



CONCRETE TANK SECTION
COMPLETE WITH
HANDRAILS & GRATING

HOLLOW FIBER MEMBRANE INSTALLATION



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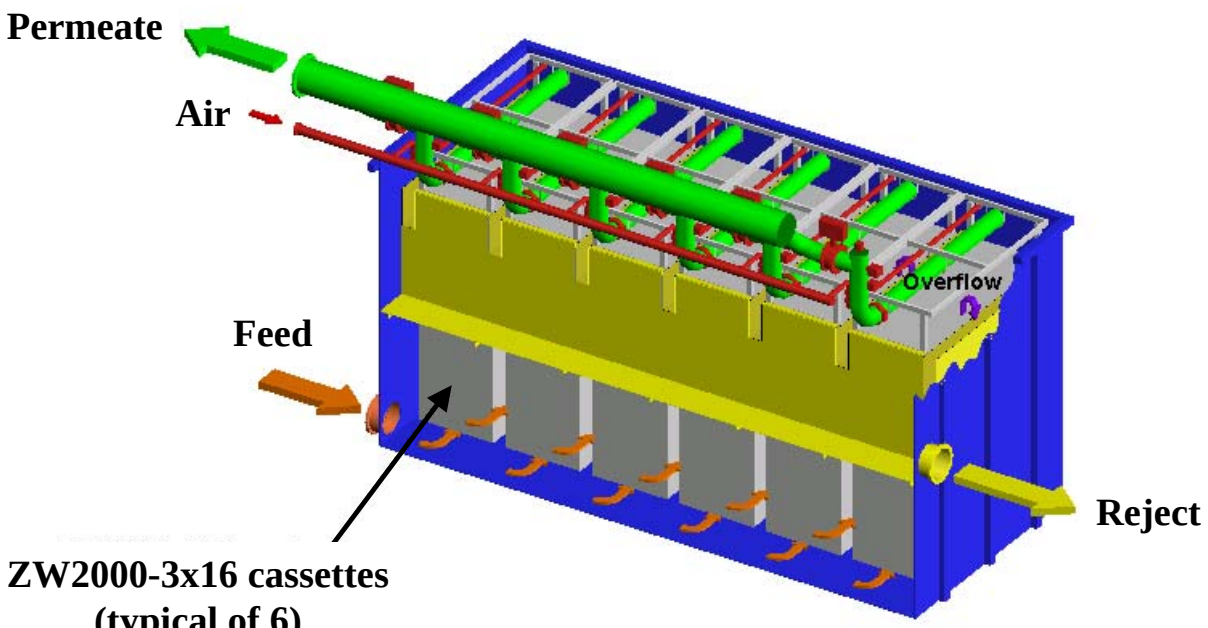
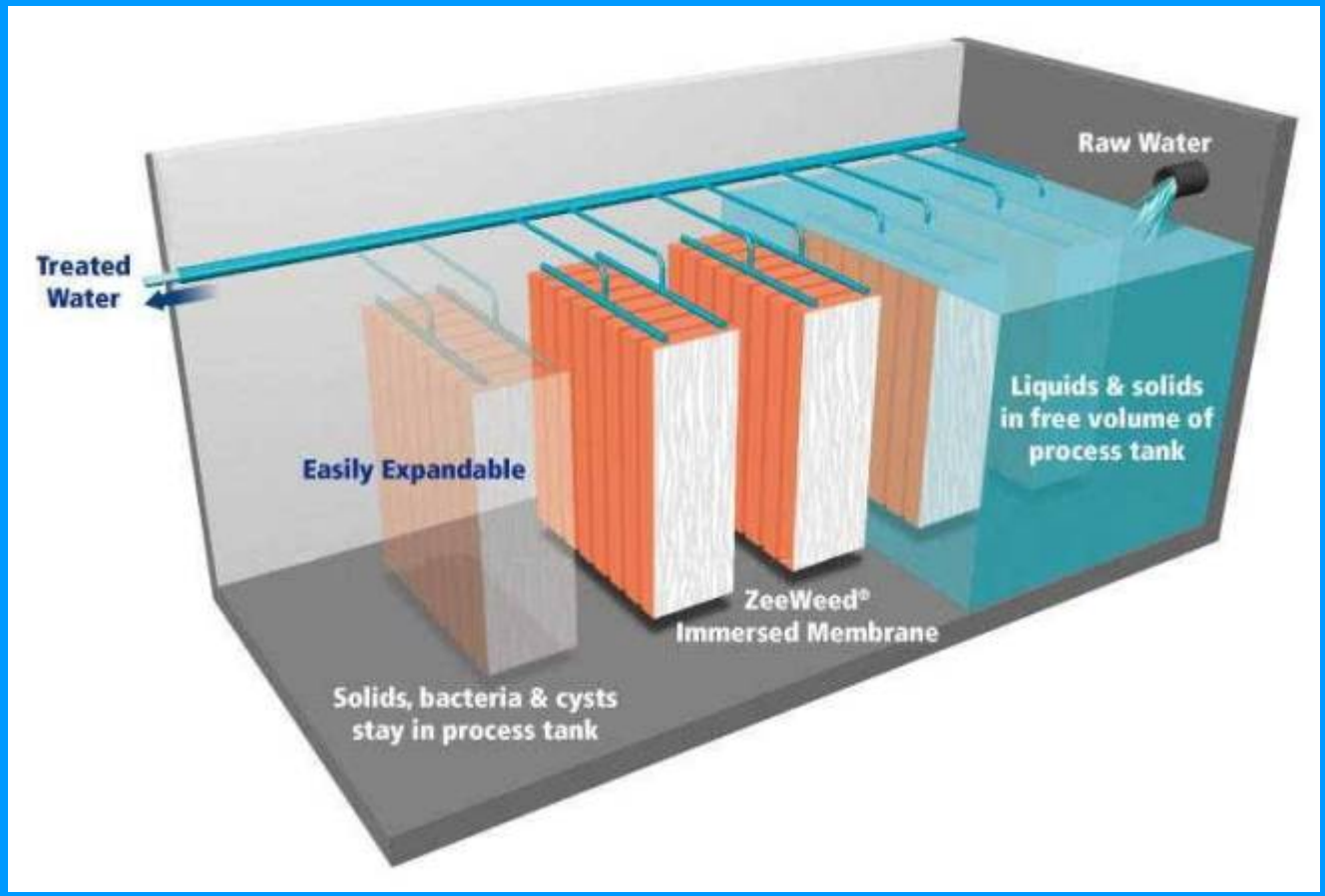


ZW 2000 – ZenoBox Design

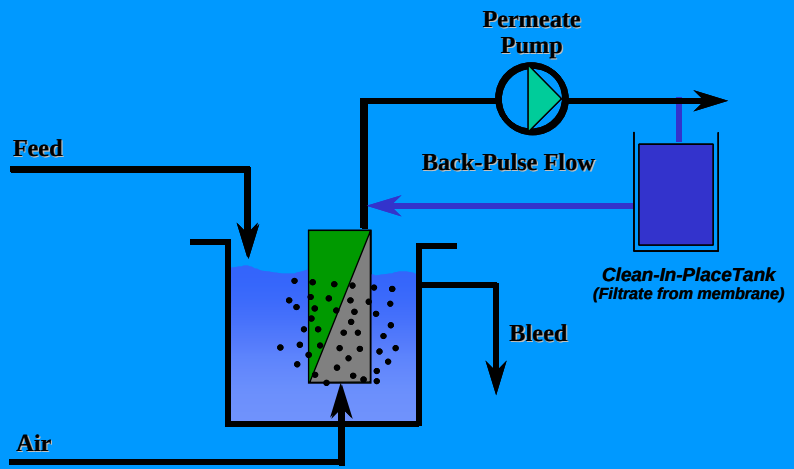
FINAL ARRANGEMENT



BACKPULSE CAPABILITY

Reinforced Hollow Fibre

- Full Backpulse Capability (if needed) to control fouling
- Air Scouring is used to control fouling



Flat Sheet

- Unable to backpulse membranes
- Air Scouring is used to control fouling

MEMBRANE CLEANING

Reinforced Hollow Fiber

- Up to 2000 ppm NaOCl
- Citric Acid
- Maintenance Cleaning once per 1-2 weeks
- Recovery Cleaning 2-3 times per year

Flat Sheet

- Up to 5000 ppm NaOCl
- Oxalic Acid
- Recovery Cleaning 2-3 times a year

BASIC MEMBRANE TERMINOLOGY

- Flux
  - Flow rate per membrane area
  - Measured as Liters per m^2 per hour (lmh) or gallons per ft^2 per day (gfd)
- Trans-membrane Pressure (TMP)
  - Pressure difference across the membrane
  - Measures the relative degree of membrane fouling
- Permeability
  - Flux rate per unit pressure (lmh/bar or gfd/psi)

ACTUAL CASE STUDY

- Project Name: Almarai CPP2 ETP
- Location : Alkharj – Haradh Road
- Type : Dairy Waste Treatment

  The Existing conventional system handles maximum peak flow of 2000 m3/day and 4100 KgCOD/day

  The upgrade strategy is to allow to handle the following design, keeping minimum footprint and optimum cost.

ALMARAI DESIGN CRITERIA

	2011		2016	
	Average	**Peak**	**Average**	**Peak**
CPP1, Volume m^3/day	1,520	1,900	1,940	2,430
CPP2, Volume m^3/day	1,040	1,300	1,340	1,670
Total Volume m^3/day	2,560	3,200	3,280	4,100
CPP1, Load kgCOD/day	4,800	7,000	5,640	8,550
CPP2, Load kgCOD/day	2,200	3,000	2,760	3,450
Total Load kgCOD/day	7,000	10,000	8,400	12,000

DESIGN COMPARISON

No.	*Parameter*	***Hollow Fiber***	*Note*	***Flat Sheet***	*Note*
	Design Basis				
1	Average flow 2011	2,560 m3/day	permeate	2,560 m3/day	feed
2	Peak flow 2011	3,200 m3/day	permeate	3,200 m3/day	feed
3	Average flow 2016	3,280 m3/day	permeate	3,280 m3/day	feed
4	Peak flow 2016	4,100 m3/day	permeate	4,100 m3/day	feed
5	Average COD 2011	7,000 Kg/day		7,000 Kg/day	
6	Peak COD 2011	10,000 Kg/day		10,000 Kg/day	
7	Average COD 2016	8,400 Kg/day		8,400 Kg/day	
8	Peak COD 2016	12,000 Kg/day		12,000 Kg/day	
9	Liquid feed temperature	20 ^{o}C		37 ^{o}C	
10	Max liquid feed Temp.	42 ^{o}C		42 ^{o}C	

MEMBRANE OFFER COMPARISON

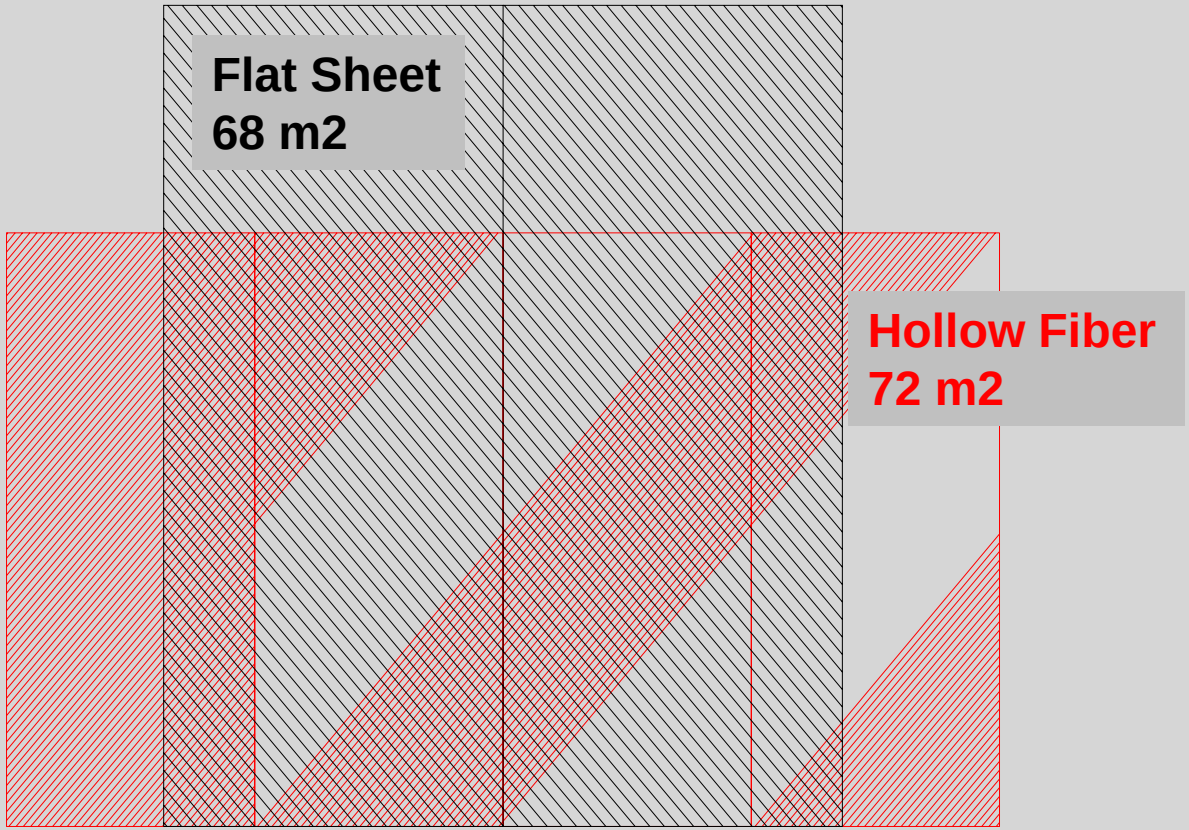
No.	*Parameter*	***Hollow Fiber***	*Note*	***Flat Sheet***	*Note*
	Membranes spec				
1	Membrane type	ZeeWeed 500C		EK- 400	
2	unit surface area	23 m^2		320 m^2	
3	No. of units per cassette	22		1	400 memb
4	No of cassets per train	3	expandable to 4	6	expandable to 8
5	no of trains	4		2	
6	Total effective area	6072 m^2		3840 m^2	
7	pore size	0.04 um		0.4 um	0.01 operation
8	Design Net flux at Average flow	17 L/m2.hr	0.408 m3/m2.day	0.67 m3/m3.day	27.9 L/m2.hr
9	Design Net flux at Peak flow	21.7 L/m2.hr	0.5208 m3/m2.day	0.83 m3/m2.day	34.5 L/m2.hr
10	Design net flux at chemical cleaning (Average Flow)	22.7 L/m2.hr	0.5448 m3/m2.day (one train - 3 cassettes)	0.89 m3/m2.day	37.037 L/m2.hr (one deck - 3 units)
11	Design net flux at chemical cleaning (Peak Flow)	29.27 L/m2.hr	0.7026 m3/m2.day (one train - 3 cassettes)	1.11 m3/m2.day	46.25 L/m2.hr (one deck - 3 units)
12	Maximum TSS in MBR tank	15,000 mg/l		20,000 mg/l	

EQUIPMENT COMPARISON

No.	*Parameter*	***Hollow Fiber***	*Note*	***Flat Sheet***	*Note*
	Equipment spec				
1	MBR air blowers	3 No. (2d/1s) - 1367 Nm3/hr @ 31 Kpa - VSD controlled (1025 Nm3/Hr for 2011)		3no. (2duty/1std. by) - 1250 Nm3/hr @ 55 Kpa - VSD controller	
2	Recycle pumps	4 no. (1 for each tank) - 274 m3/hr @ 120 Kpa TDH (221m3/hr for 2011)		3 no. 39 l/s @ 2m Head	
3	Vaccum pumps	2nos 17m3/hr @74 Kpa vaccum		N/A	
4	Permeate pumps	4 nos. one for each tank - duty point ranges from 31 m3/hr @ 105 kpa TDH to 72 m3/hr @ 105 Kpa TDH		N/A	

MBR BASIN COMPARISON

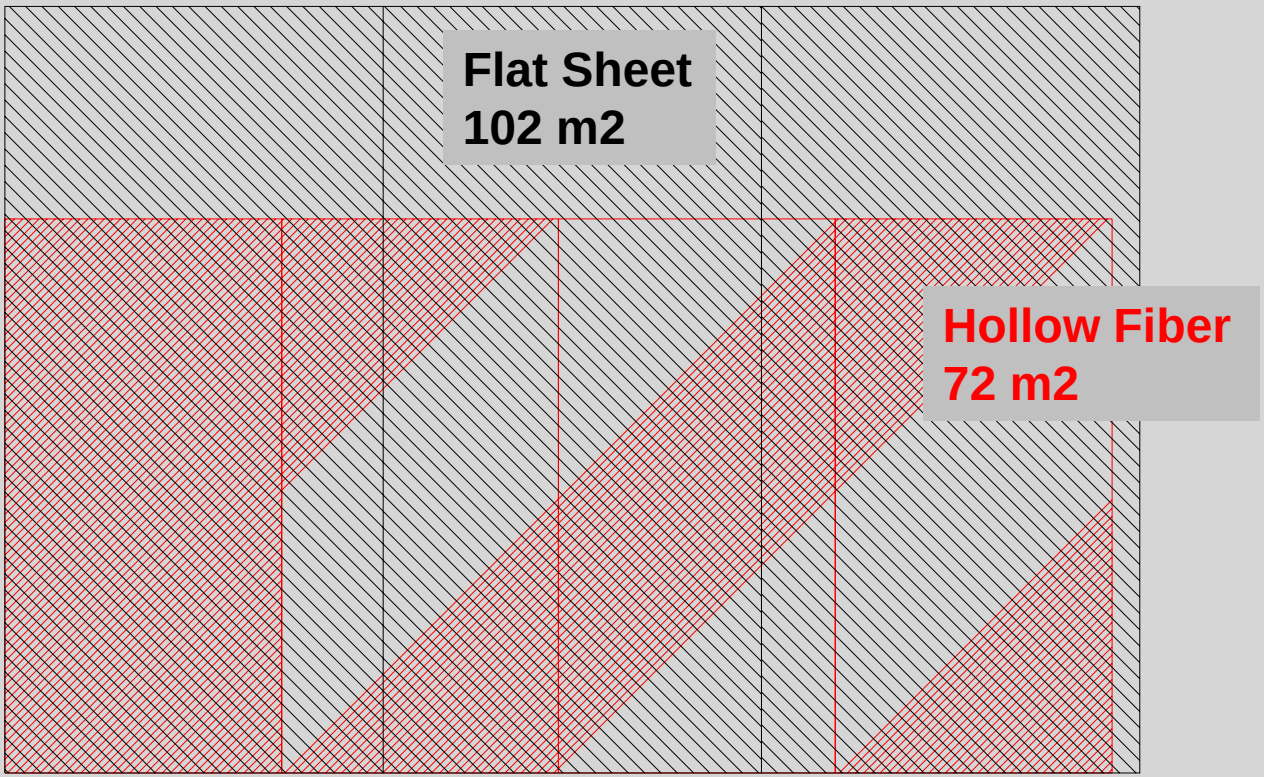
No.	*Parameter*	***Hollow Fiber***	*Note*	***Flat Sheet***	*Note*
1	MBR Tanks	4 Nos (6mX3mX3.5m)	LXWXH	2 Nos(8.3mX4.1mX4.8m)	LXWXH



MBR BASIN COMPARISON

For same average flux consideration(0.408 m3/m2.day), Flat Sheet would require :

(2560 m3/day)/[(320 m2)*0.408(m3/m2.day)]= 19.6 elements, say 18 elements , which would result in a third basin as follows



THANK YOU

Q & A