DOW™ Ultrafiltration

Features and Product Range

The Dow Chemical Company

UF Program Summary

- DOW™ UF Video
- UF Fundamentals
- DOW™ UF Features and Product Range
- DOW™ UF Offering

(Break)

- DOW™ UF Operation Philosophy, Design Guidelines and Troubleshooting

(Break)

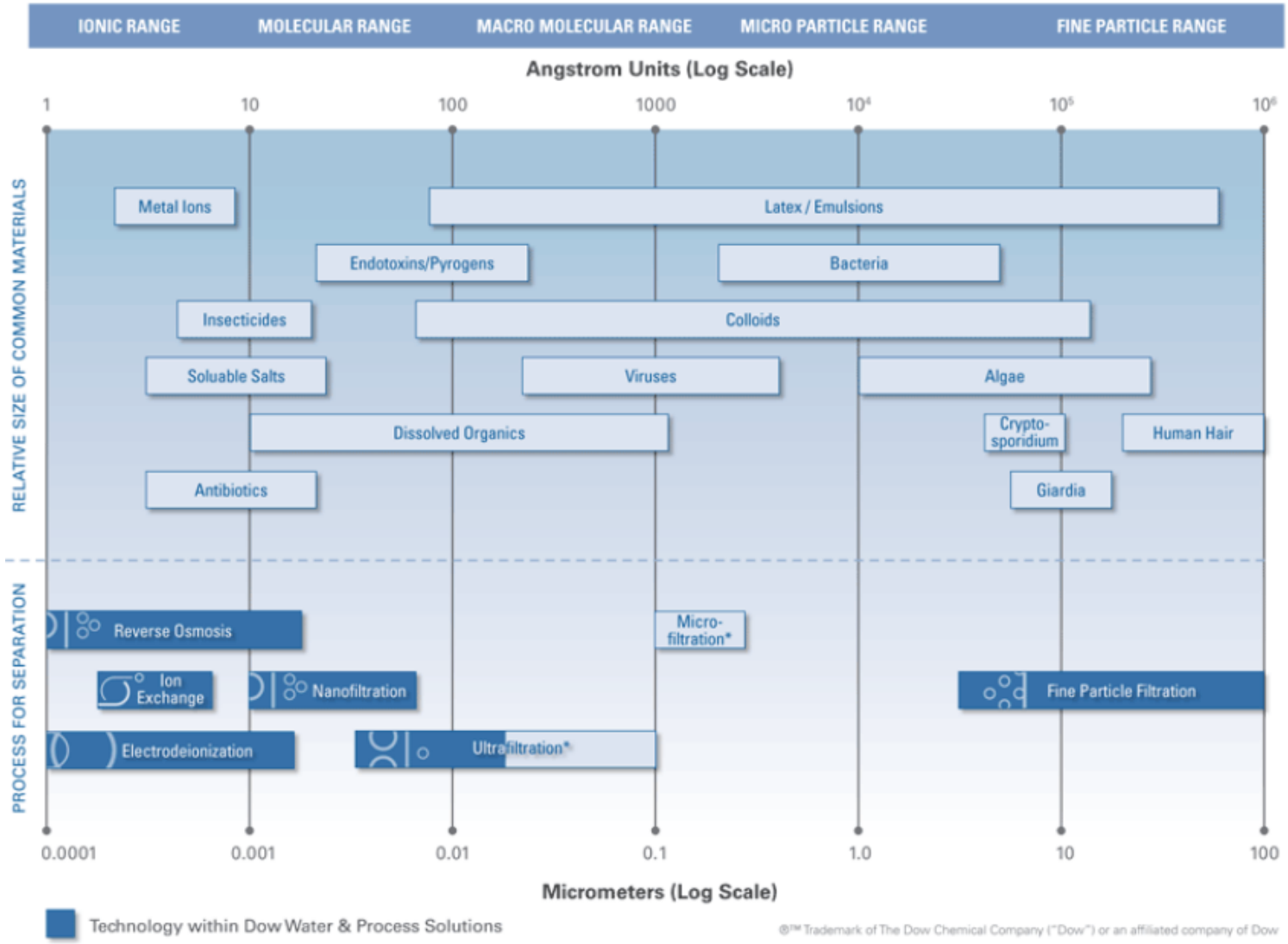
- DOW™ UF Case Studies

DOW™ UF Video

Ultrafiltration

Fundamentals

Filtration Spectrum



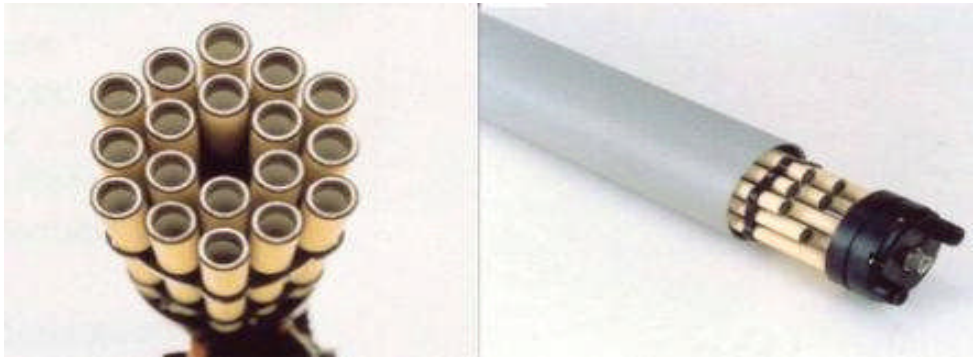
The Benefits of UF vs. Conventional

- **Lower footprint and weight.**
- **Less sensitive to feed water quality upsets.**
- **Higher and more consistent filtrate quality** (e.g. turbidity, SDI, LRV).
- **Lower chemical use** (polymer, coagulant, pH adjustment,…) and associated costs for disposal.
- Possibility to do on-line **Membrane Integrity Check** (plus membranes can be individually isolated)
- **Integrated UF+RO System** (single source of responsibility).

Advantages of UF for RO pretreatment

- **Lower fouling** in RO membranes.
- **Reduce chemical cleaning** frequencies → longer life of RO
- Posibility to operate the **RO at higher flux** → Less Membranes & Vessels

Membrane Configurations



Tubular

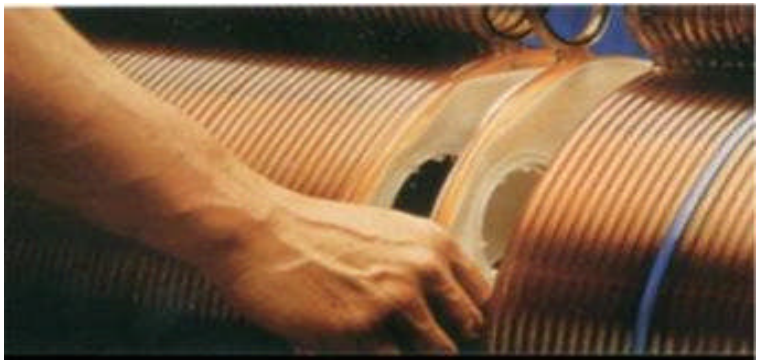


Plate & Frame

Spiral Wound

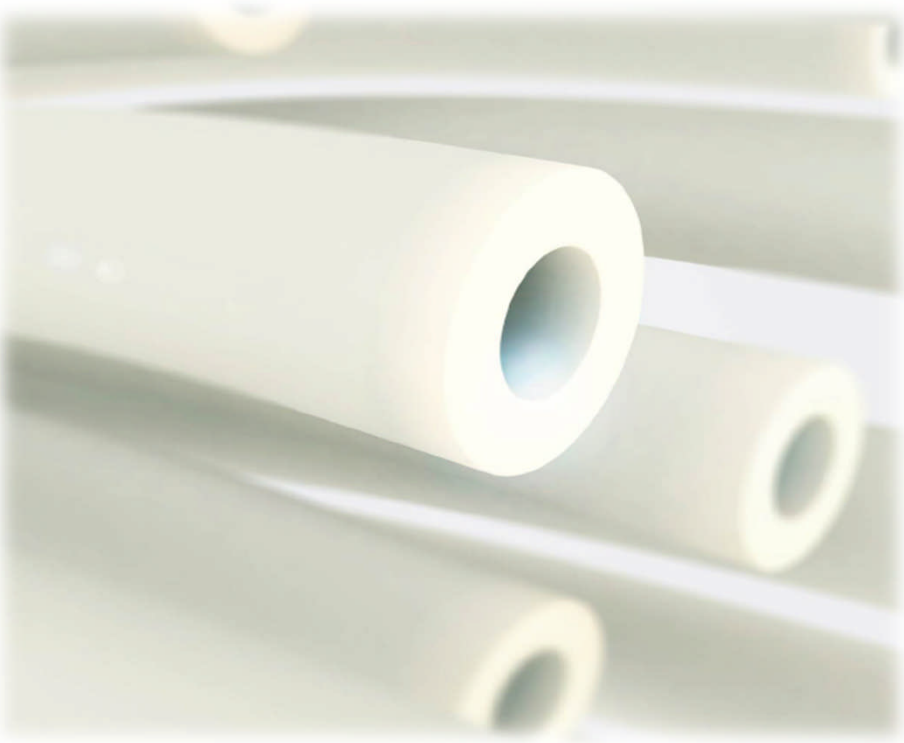
Hollow Fibers

UF System Configurations

- **Pressurized**
  Hollow fiber modules where water is forced either into or out of the lumen under pressure.

- **Submerged (or Immersed)**
  Hollow fiber configurations where water is pulled into the fiber lumen by suction.

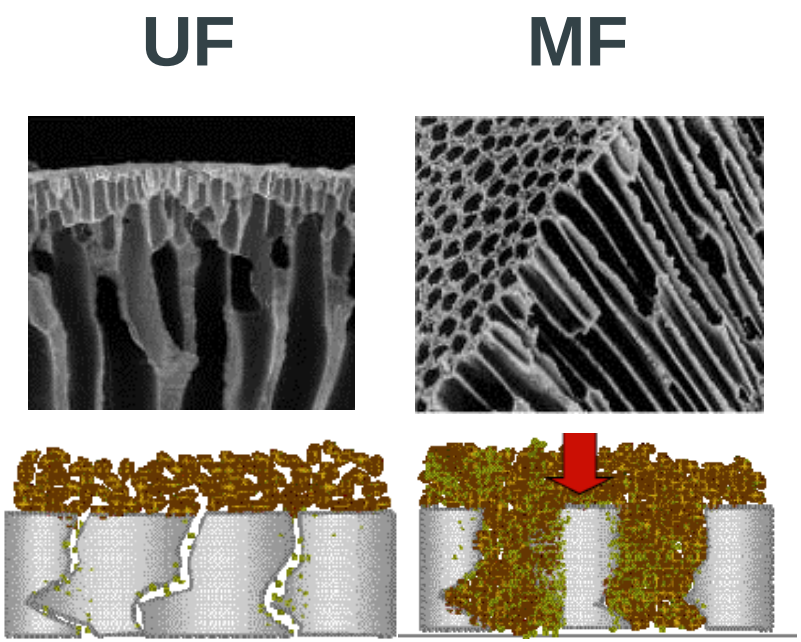
Are all membranes the same?



- **Pore Size**: UF vs MF
- **Membrane material**: Physical and chemical properties
- **Flow pattern**: Outside-In vs Inside-Out

UF vs MF

- UF has a thin active layer and a high porosity sub-structure. An asymmetric membrane will have higher stable permeability due to **better backwash efficiency**.
- MF membranes typically operates in a depth filtration pattern with eventual pore blocking, compared to UF's cake filtration pattern (easily removed by BW).



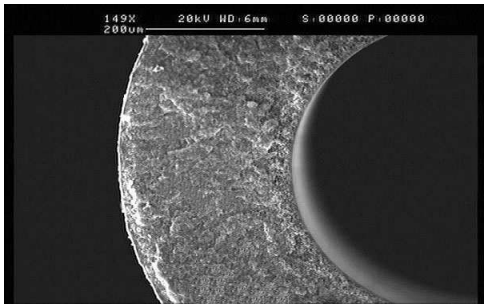
- Due to smaller pore size, **UF provides better filtrate water quality** (e.g. SDI, turbidity,…)
- **UF has higher removal of Microorganisms** (especially virus).

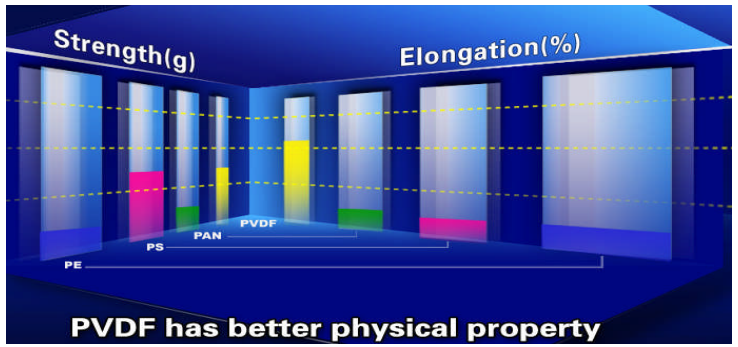
Membrane Properties – Physical and Chemical Stability

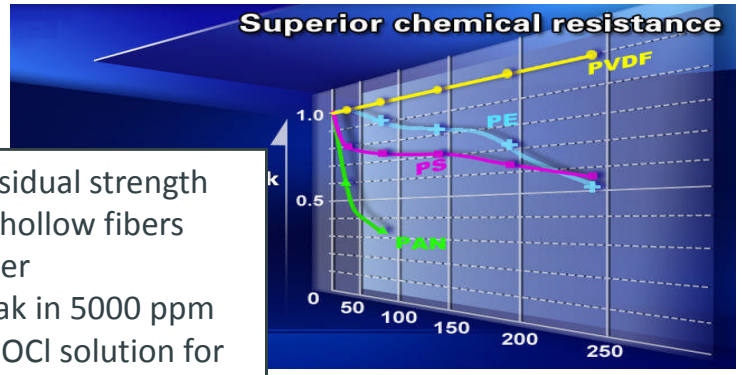
- **High strength, high resistance** sponge like porous membrane structure. Double-Wall.

- DOW Ultrafiltration membrane uses High strength, high molecular weight Polyvinylidene Fluoride **(PVDF) material with excellent combination of strength and flexibility**, less prone to fiber breakage. More robust material, long membrane life.

- PVDF Fibers maintain their strength under continuous harsh chemical cleaning conditions, better than any other membrane material. **PVDF has an incomparable tolerance to oxidants**.



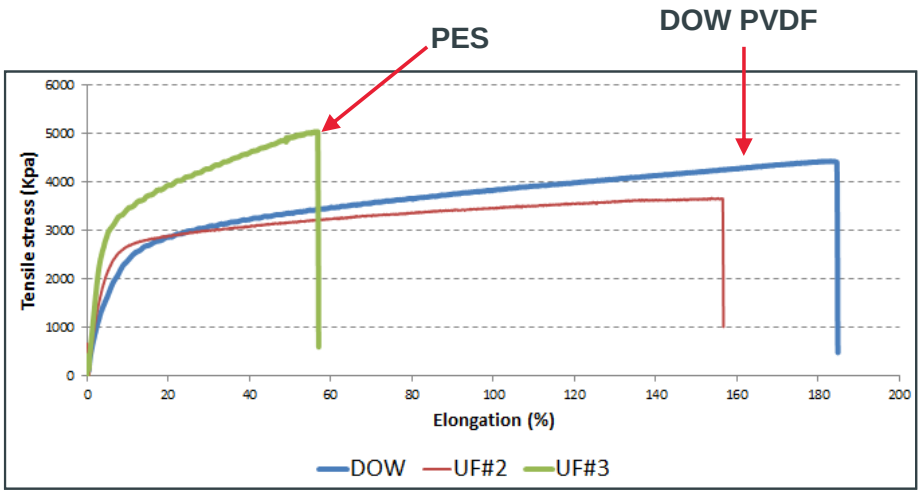




Residual strength of hollow fibers after soak in 5000 ppm NaOCl solution for 250 hours

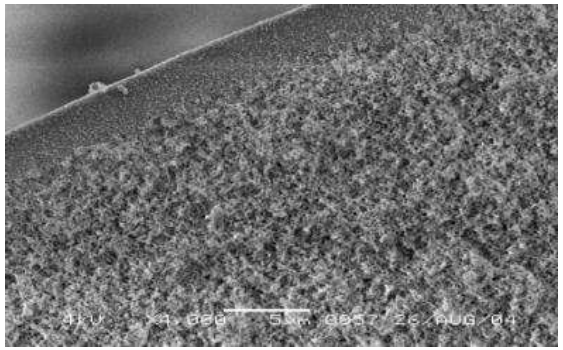
PVDF vs PES

- PVDF has an excellent combination of strength and flexibility, less prone to fiber breakage. More robust material, long membrane life.



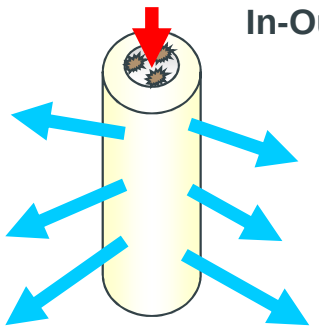
- PVDF has an incomparable tolerance to oxidants (e.g. >10X for chlorine vs. PES).

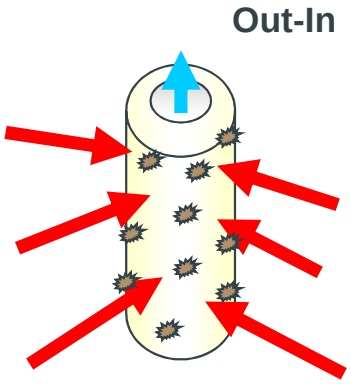
- PVDF usually associated to Out-In fibers.

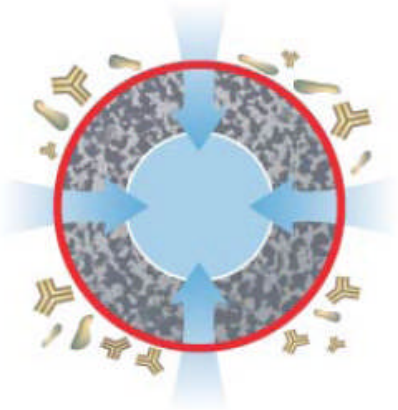


Out-In vs In-out Configuration

- Out-In (O/I) configuration **can cope with worse feed conditions**. No fiber plugging risk.
- O/I provides **larger membrane area** (~2X).
- O/I **can use Air Scour for higher cleaning efficiency**.
- O/I **requires lower Backwash flow** (~50-60% vs I/O).
- O/I provides **lower ΔP** through the module.
- O/I fibers usually have only one open end, which makes **fiber repair easier**.







DOW UF

Features & Product Range

DOW™ Ultrafiltration Features and Advantages

- **0.03 µm Nominal Pore Size**

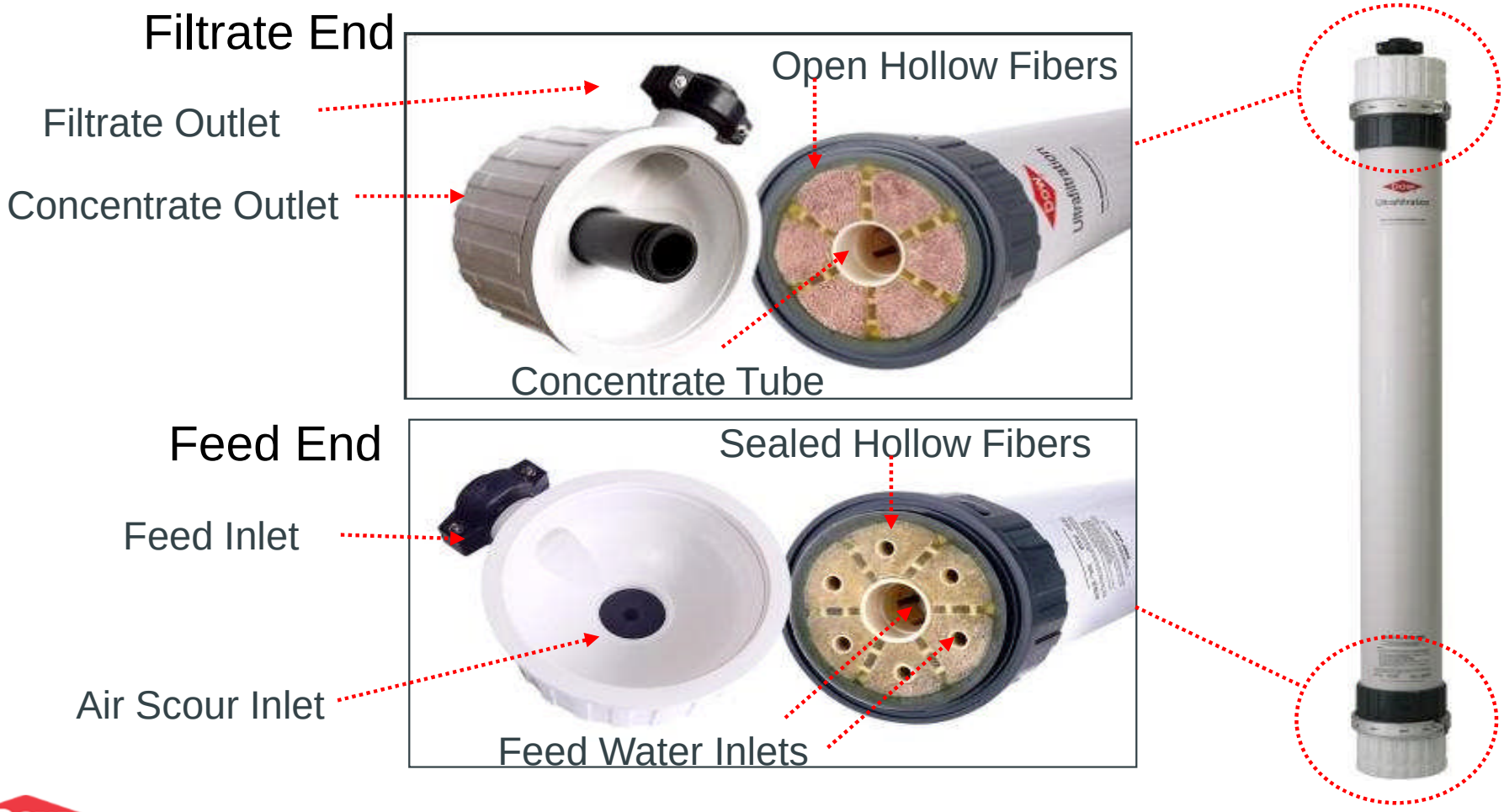
- **Pressurized Outside/In** Modular Membrane
  - Tolerance to wide range of Feed Water quality
  - Simple Vertical Shell Design (no PV needed)

- 1.3 mm x 0.7 mm **PVDF Hollow Fibers**
  - Mechanically strong fibers
  - High Chemical tolerance
  - High fouling resistance (Treated for Increased Hydrophilicity)
  - Asymmetric structure for high filtration efficiency

DOW™ UF Specifications & Operating Conditions

		DOW™ UF Model		
		SFP/SFD -2660	SFP/SFD -2860	SFP/SFD -2880
Module Specifications	Height	1,860 mm	1,820 mm	2,320 mm
	Fibers Length	1,500 mm	1,500 mm	2,000 mm
	Module Diameter	165 mm (6.5")	225 mm (8.9")	225 mm (8.9")
	Module Surface Area	33 m^2	51 m^2	77 m^2
	Volume	16 L	35 L	39 L
	Weight (water filled)	41 kg	83 kg	100 kg
	Shipping Weight	25 kg	48 kg	61 kg
	Flow Range	1.3 - 4.0 m^3/h	2.0 - 6.1 m^3/h	3.1 – 9.3 m^3/h
Fibers Features	Flow Configuration	Out to In		
	Fibers Material	Hydrophilic-PVDF		
	Nominal Pore Size	0.03 µm		
Operating Conditions	Temperature	1 - 40ºC		
	Max. Inlet Pressure	Up to 6.3 bar @ 20ºC; 4.8 bar @ 40ºC		
	Max. Operating TMP	2.1 bar		
	pH, Operating	2-11 (continuous); 2-12 (cleaning)		
	NaOCl Max.	2,000 ppm		
	Backwash Flux	100-150 L/m^2.h		
Feed Requirements	Max. TSS	100 mg/L		
	Max. Turbidity	300 NTU		
	Max. Particle Size	300 µm		

DOW™ Ultrafiltration – Feed & Filtrate Ends



Images of DOW™ UF Systems (SFP-2860)

Images of DOW™ UF Systems (SFP-2880)

Double Floor DOW™ UF System

DOW UF

IntegraPac™ and IntegraFlo™

DOW IntegraPac™

What is a DOW IntegraPac™ Skid?

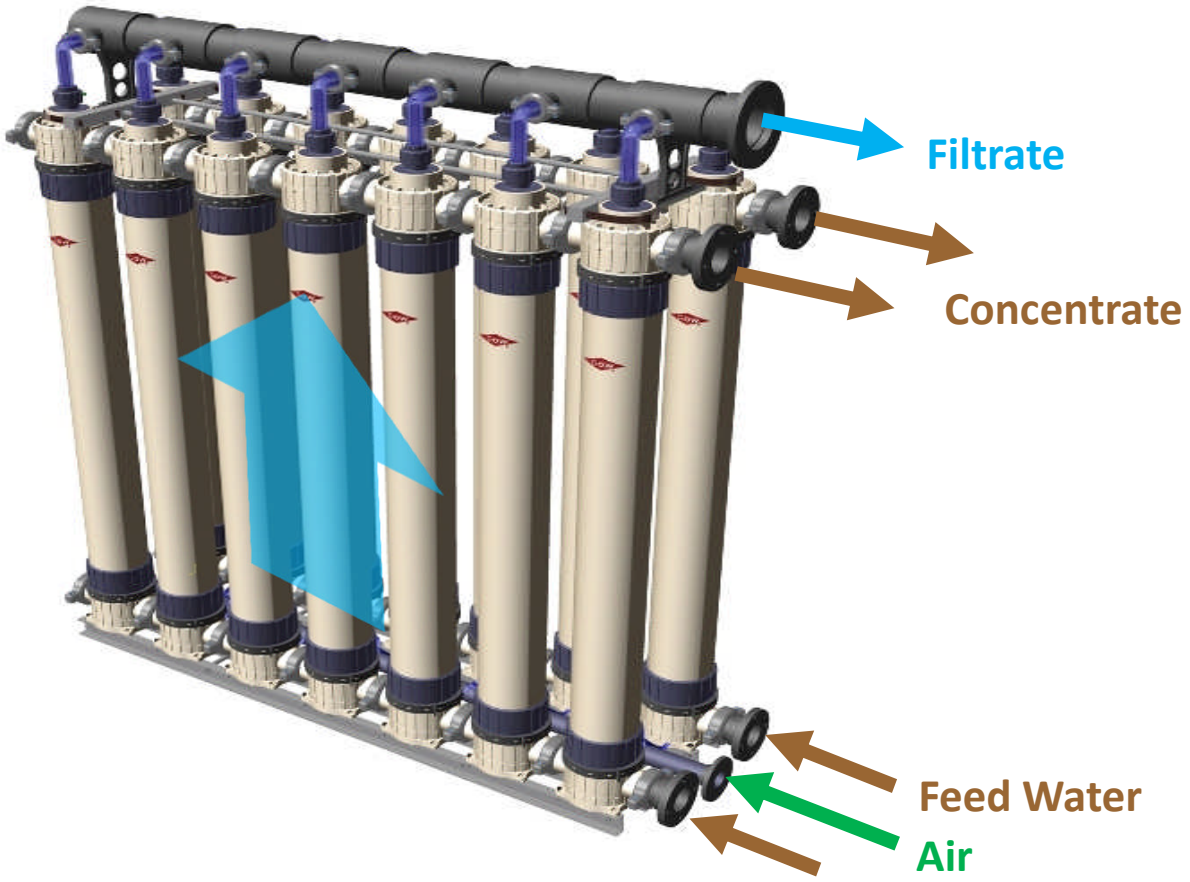
A pre-engineered, streamlined skid design consisting of DOW™ IntegraPac™ Ultrafiltration modules, auxiliary parts, and piping

A Fitting Expansion to Dow's Ultrafiltration Product Offering

DOW IntegraPac™ Features

- Modular and scalable
- Integrated end cap design
- Modules easily accessible
- Clear filtrate pipes
- High pressure rating
- Compact footprint
- Pre-fabricated components and parts
- SFX 2860/2880 Adaptable (6-22 modules)

DOW IntegraPac™ Flow Scheme



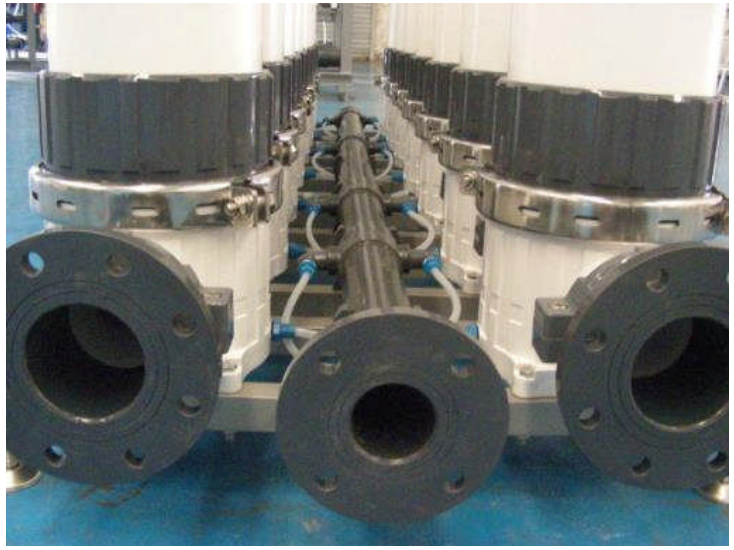
Traditional UF skids

DOW IntegraPac™ Skid

Innovative end caps with built-in interconnectivity cut down needs for manifolds, resulting in much simpler frame design and lower material costs.

Traditional UF skids

DOW IntegraPac™ Skid



Innovative end caps with built-in interconnectivity cut down needs for manifolds, resulting in much simpler frame design and lower material costs.

Customer Benefits

(Compared to traditional UF skids)

Savings on design, engineering, fabrication & assembly time.

Significant reduction in footprint

Modules Highly accessible

Reduction in skid CAPEX

Modular and easily expandable

Transparent tubes for visual inspection

Purchasing Options

Option I: Skids including modules, frame, auxiliary parts and piping*.
Assembly required.

Option II: Modules only.
Customers build skids to custom project specifications.

* Valve stack is not provided by Dow.

Scope of Supply

Module Scope:

- IntegraPac modules with couplings, bolts, and gaskets
- Clear PVC filtrate pipe and couplings
- Standard warranty for IntegraPac™ modules

Skid Scope:

- Module Scope, plus:
- PVC filtrate and air scour pipes
- Air scour tubing and connectors
- Connecting flanges
- Supporting frames with fastening nuts and bolts
- Standard warranty for IntegraPac modules and skids

Valve stack is not provided.

Other materials of construction available. Please consult your local representative with a quotation.

Specifications

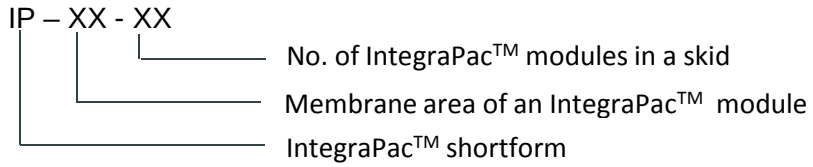
Performance specifications unchanged

	SI units	US units
IP-51 Filtrate Flux @ 25ºC	50 - 115 l/m^2/hr	29 - 68 gfd
IP-77 Filtrate Flux @ 25ºC	60 –140 l/m^2/hr	35-82 gfd
pH, Operating	2 - 11	
pH, Cleaning	2 - 12	
Temperature	1 - 40ºC	34 - 104ºF
Max. Inlet Module Pressure (@ 20° C)	6.25 bar	93.75 psi
Max. Operating TMP	2.1 bar	30 psi
Max. Operating Air Scour Flow	12 Nm^3/hr	7.1 scfm
Max. Backwash Pressure	2.5 bar	36 psi
NaOCl (max)	2,000 mg/L	
TSS (max)	100 mg/L	
Turbidity (max)	300 NTU	
Particle Size (max)	300 µm	
Flow Configuration	Outside In, Dead End Flow	
Expected Filtrate Turbidity	≤ 0.1 NTU	
Expected Filtrate SDI	≤ 2.5	

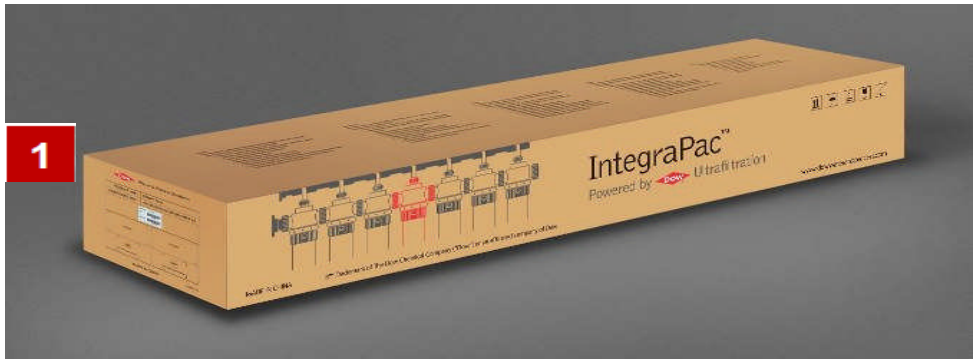
Skid Configurations

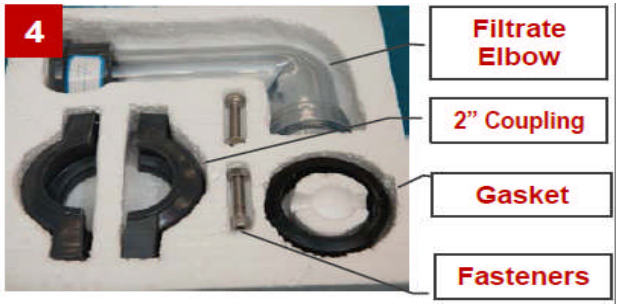
(With IP-77 Modules)

Skid Configurations with IP-77 Modules																	
Number of modules	IntegraPac Skid	Total Membrane Area		Flow @ 65 lmh (38 gfd)		Length (L)		Width		Height (H)		Weight, dry (incl. modules)		Weight, filled (incl. modules)		Hold-Up Volume	
		m^2	ft^2	m^3/hr	gpm	mm	ft.	mm	ft.	mm	ft.	kg	lbs.	kg	lbs.	m^3	US gal
6	IP-77-06	462	4974	30	132	1241	4.1	764	2.51	2875	9.43	496	1093	840	1852	0.32	84.0
8	IP-77-08	616	6632	40	176	1604	5.3	764	2.51	2875	9.43	644	1420	1102	2429	0.42	112.0
10	IP-77-10	770	8290	50	220	1967	6.5	764	2.51	2875	9.43	791	1744	1364	3007	0.53	140.0
12	IP-77-12	924	9948	60	264	2330	7.6	764	2.51	2875	9.43	939	2070	1626	3585	0.64	168.0
14	IP-77-14	1078	11606	70	309	2693	8.8	764	2.51	2875	9.43	1091	2405	1893	4173	0.74	196.0
16	IP-77-16	1232	13264	80	353	3056	10.0	764	2.51	2875	9.43	1249	2754	2165	4773	0.85	224.0
18	IP-77-18	1386	14922	90	397	3419	11.2	764	2.51	2875	9.43	1401	3089	2432	5362	0.95	252.0
20	IP-77-20	1540	16580	100	441	3782	12.4	764	2.51	2875	9.43	1554	3426	2699	5950	1.06	280.0
22	IP-77-22	1694	18238	110	485	4145	13.6	764	2.51	2875	9.43	1706	3761	2966	6539	1.17	308.0



Labeling and Packaging





Shipped unassembled in individual boxes.

IntegraPac™ Pictures

Pictures of DOW™ UF Systems (IntegraPac™)

DOW IntegraFlo™

IntegraFlo: Features and Benefits

- **IW102**: Surface area as high as 102.5 m^2,i.e. +30% vs. 2880, with similar size & weight.
- **IW74**: Height studied to allow containerization. +45% area vs. 2860 with smaller size/weight.
- Smaller footprint systems.
- Reduces UF system CAPEX by reducing nos. of trains, valves, fittings and frames.
- **Same robust performance. Improved economics.**

IW102 IW74

IntegraFlo™ Pictures

Testing and Qualification

A rigorous testing plan was implemented to qualify the product, including:

- Dynamic pressure testing over thousands of cycles at elevated T & P.
- Endurance air tests to confirm potting layer strength.
- Thermal shock testing to evaluate CIP cycles.
- Chemical integrity tests.
- Up to 12 months of application testing across a wide range of feed waters.

Be assured that Dow has tested the product extensively.

DOW UF

Offering

DOW™ Ultrafiltration Offering

Ultrafiltration Modules

System Design & Engineering Support

- Design Projections
- P&ID Drawings
- General Arrangement Drawings
- Equipment List

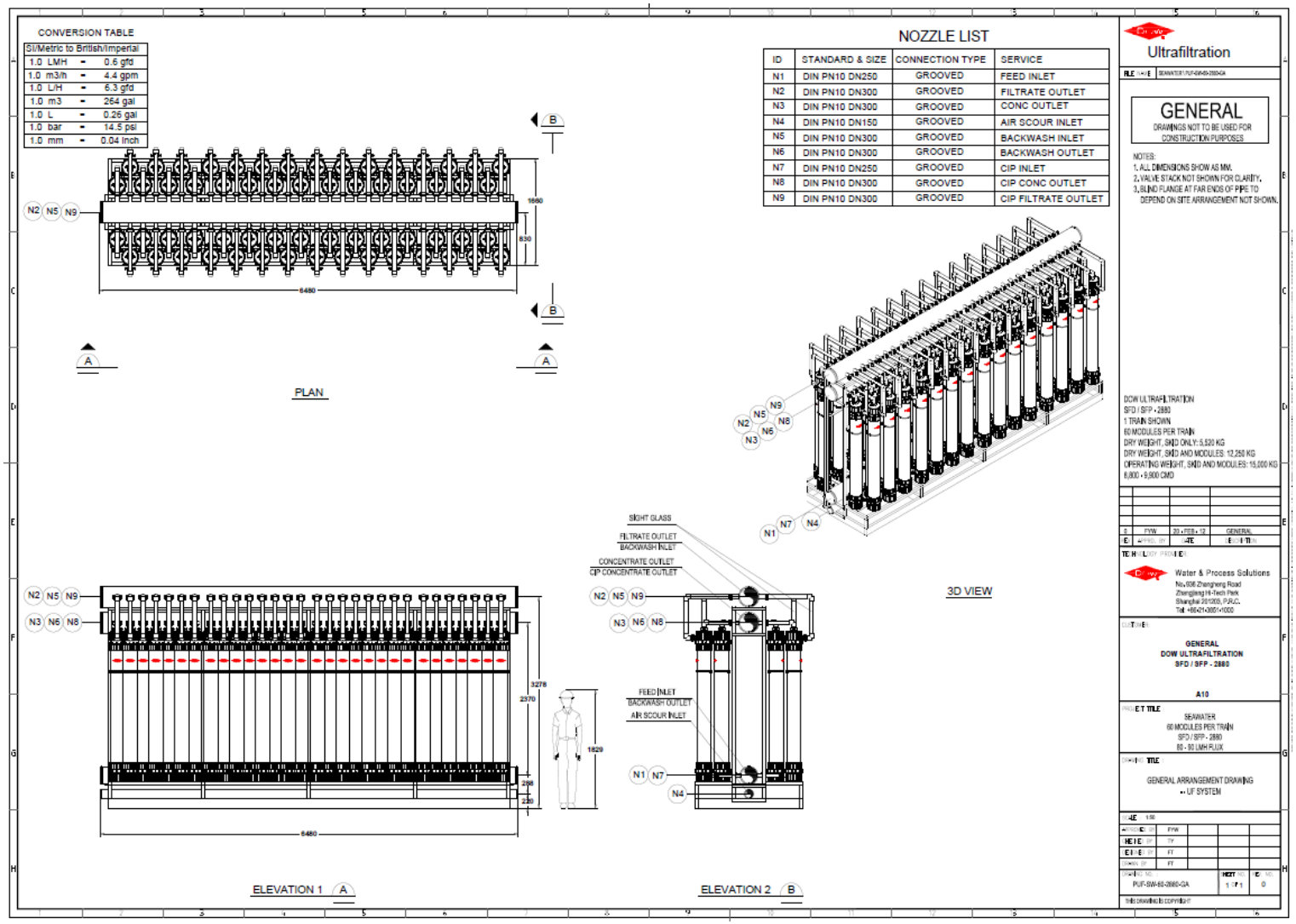
Pilot Testing

- Design
- Technical Support – Performance Follow-Up
- Testing Protocol

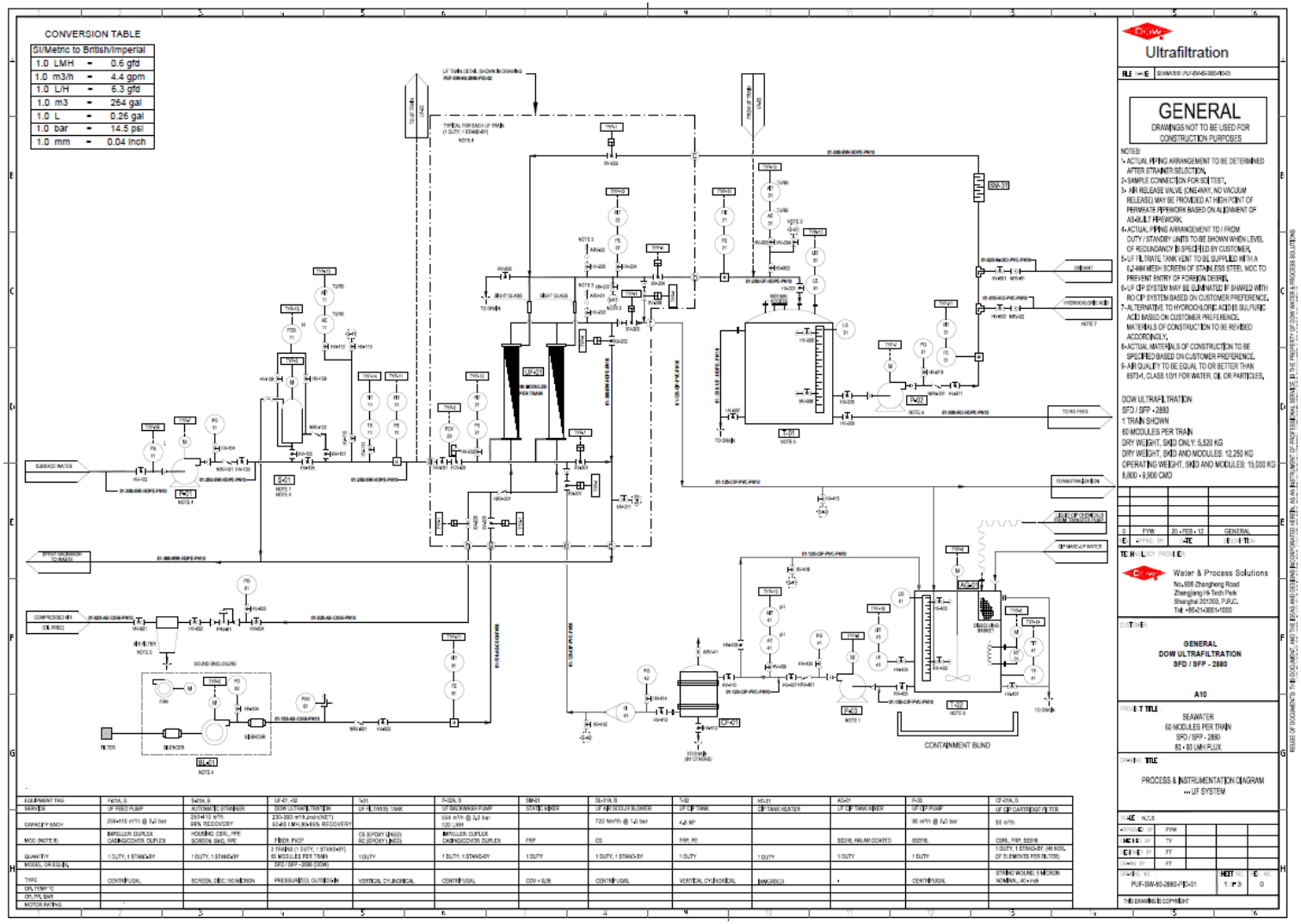
After Sales Service

- Installation, Start-Up, and Operations Assistance
- Operator Training
- Troubleshooting and Cleaning

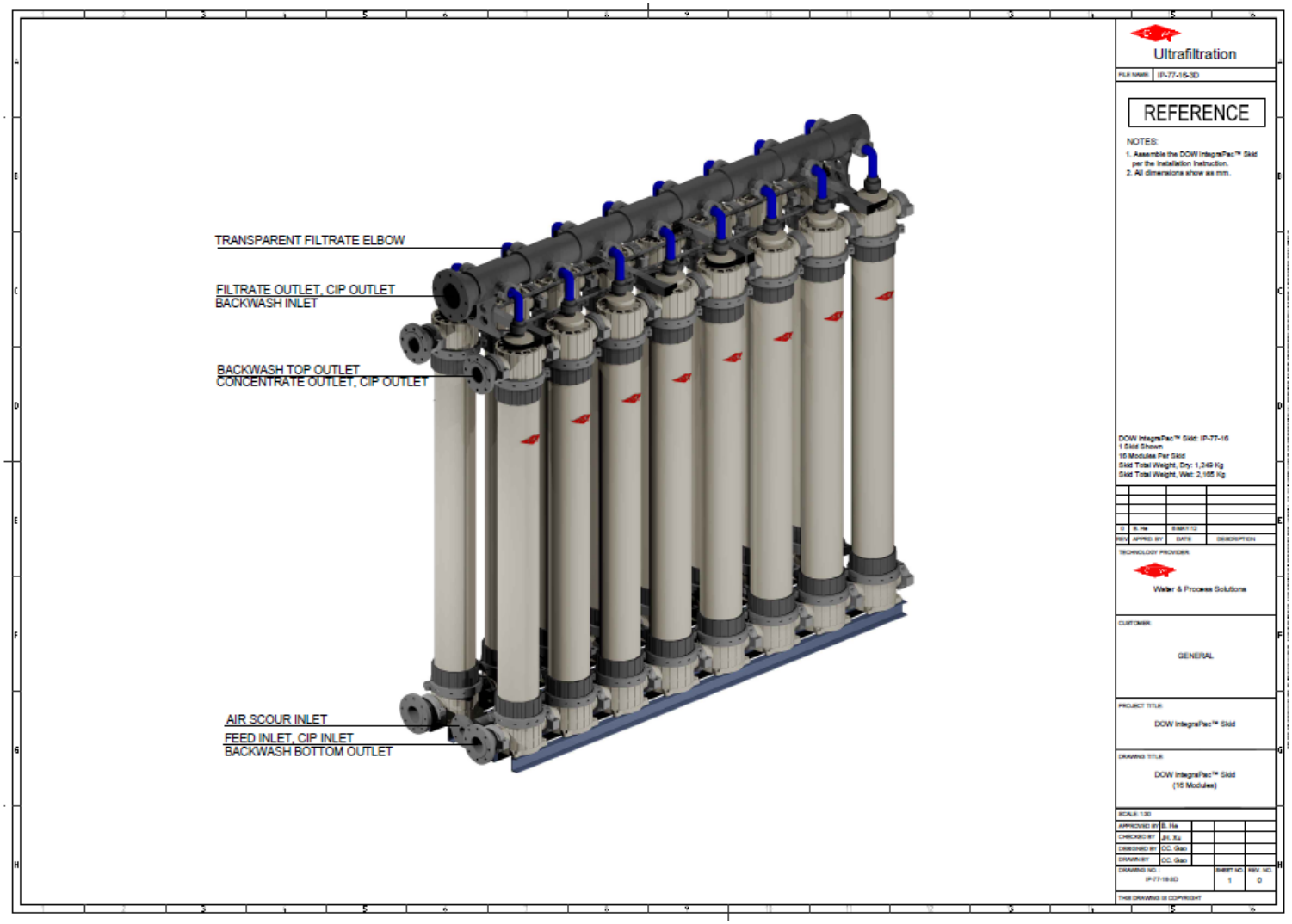
GA Drawing


CONVERSION TABLE
SI/Metric to British/Imperial
1.0 LMH = 0.6 gfd
1.0 m3/h = 4.4 gpm
1.0 L/H = 6.3 gfd
1.0 m3 = 264 gal
1.0 L = 0.26 gal
1.0 bar = 14.5 psi
1.0 mm = 0.04 inch
NOZZLE LIST
ID | STANDARD & SIZE | CONNECTION TYPE | SERVICE
N1 | DIN PN10 DN250 | GROOVED | FEED INLET
N2 | DIN PN10 DN300 | GROOVED | FILTRATE OUTLET
N3 | DIN PN10 DN300 | GROOVED | CONC OUTLET
N4 | DIN PN10 DN150 | GROOVED | AIR SCOUR INLET
N5 | DIN PN10 DN300 | GROOVED | BACKWASH INLET
N6 | DIN PN10 DN300 | GROOVED | BACKWASH OUTLET
N7 | DIN PN10 DN250 | GROOVED | CIP INLET
N8 | DIN PN10 DN300 | GROOVED | CIP CONC OUTLET
N9 | DIN PN10 DN300 | GROOVED | CIP FILTRATE OUTLET
PLAN
3D VIEW
ELEVATION 1
ELEVATION 2
SIGHT GLASS
FILTRATE OUTLET
BACKWASH INLET
CONCENTRATE OUTLET
CIP CONCENTRATE OUTLET
FEED INLET
BACKWASH OUTLET
AIR SCOUR INLET
Ultrafiltration
GENERAL
DRAWINGS NOT TO BE USED FOR CONSTRUCTION PURPOSES
NOTES:
1. ALL DIMENSIONS SHOW AS MM.
2. VALVE STACK NOT SHOWN FOR CLARITY.
3. BLIND FLANGE AT FAR ENDS OF PIPE TO DEPEND ON SITE ARRANGEMENT NOT SHOWN.
DOW ULTRAFILTRATION
SFD / SFP - 2880
1 TRAIN SHOWN
60 MODULES PER TRAIN
DRY WEIGHT, SKID ONLY: 5,520 KG
DRY WEIGHT, SKID AND MODULES: 12,250 KG
OPERATING WEIGHT, SKID AND MODULES: 15,000 KG
8,800 - 9,900 CMD
Water & Process Solutions
No.936 Zhangheng Road
Zhangjiang Hi-Tech Park
Shanghai 201203, P.R.C.
Tel: +86-21-3851-1000
GENERAL
DOW ULTRAFILTRATION
SFD / SFP - 2880
A10
SEAWATER
60 MODULES PER TRAIN
SFD / SFP - 2880
80 - 90 LMH FLUX
GENERAL ARRANGEMENT DRAWING
- UF SYSTEM
PUF-SWA-60-2880-GA
SHEET NO. 1 OF 1
REV. NO. 0

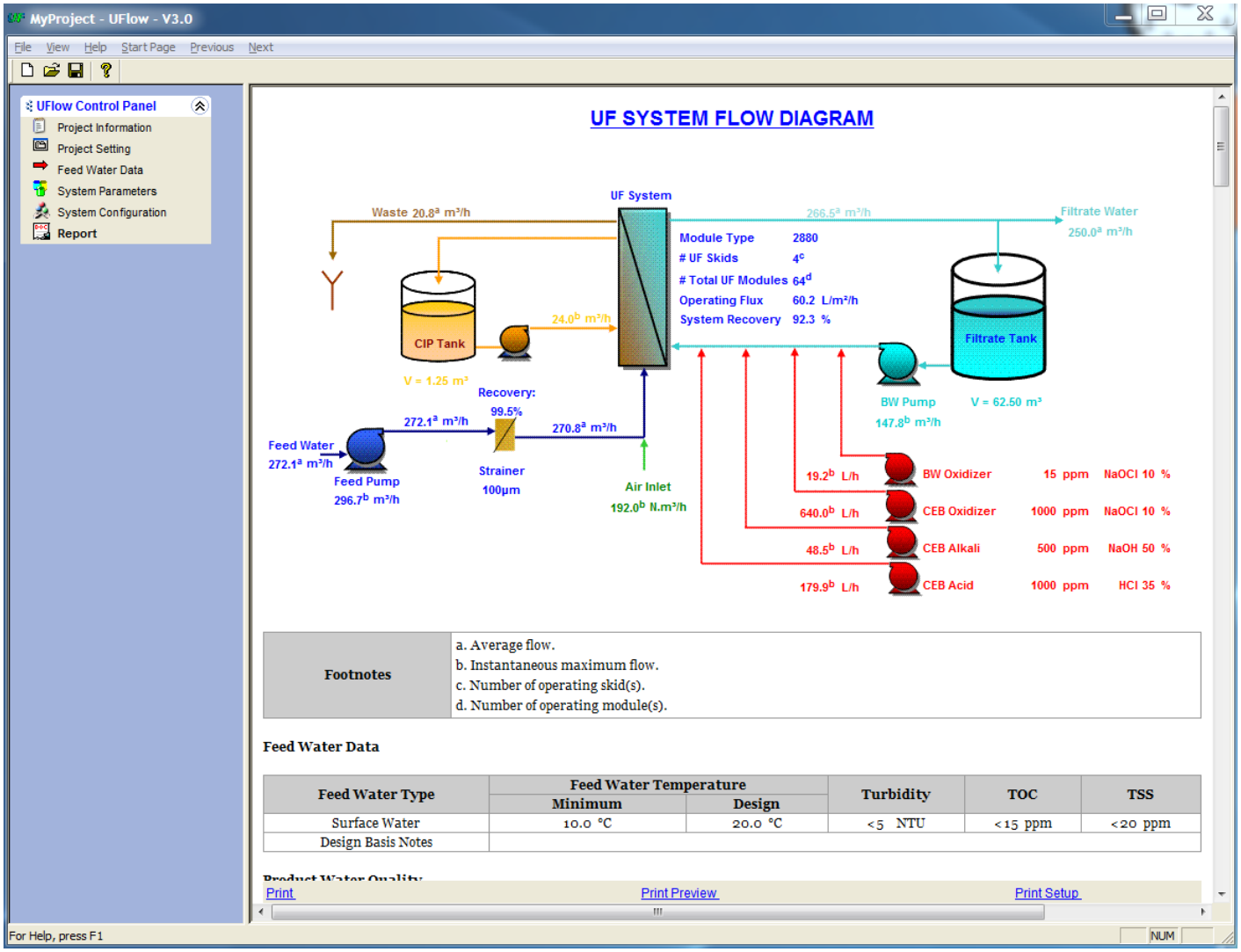
P&ID



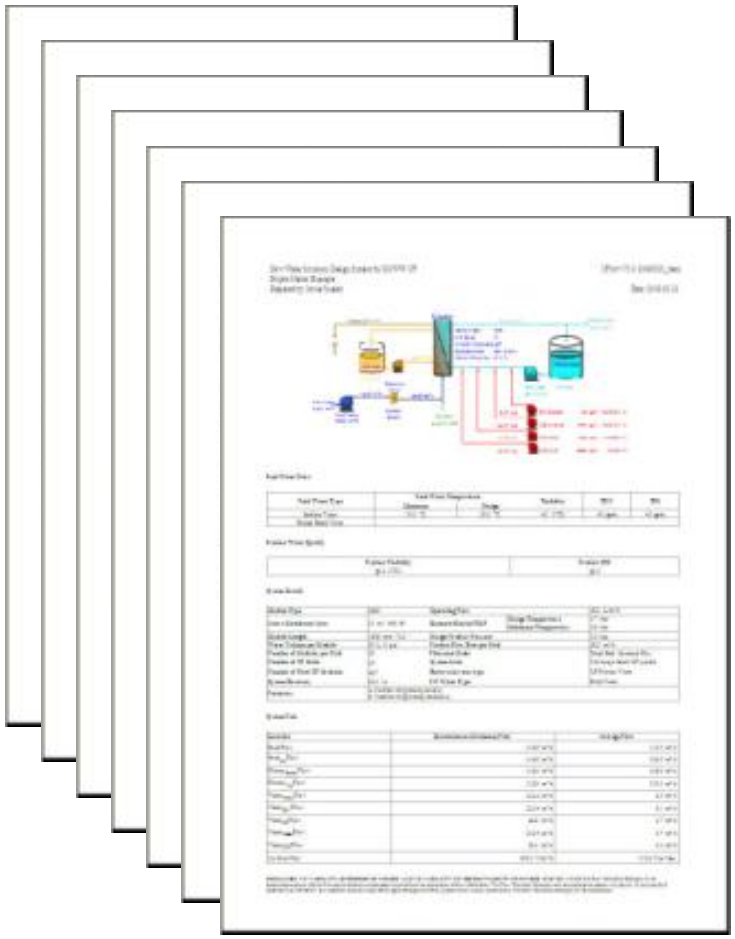
3D Drawing


TRANSPARENT FILTRATE ELBOW
FILTRATE OUTLET, CIP OUTLET
BACKWASH INLET
BACKWASH TOP OUTLET
CONCENTRATE OUTLET, CIP OUTLET
AIR SCOUR INLET
FEED INLET, CIP INLET
BACKWASH BOTTOM OUTLET
Ultrafiltration
REFERENCE
NOTES:
1. Assemble the DOW IntegraPac™ Skid per the Installation Instruction.
2. All dimensions show as mm.
DOW IntegraPac™ Skid: IP-77-16
1 Skid Shown
16 Modules Per Skid
Skid Total Weight, Dry: 1,249 Kg
Skid Total Weight, Wet: 2,165 Kg
Water & Process Solutions
GENERAL
DOW IntegraPac™ Skid
DOW IntegraPac™ Skid
(16 Modules)

Design Software - *UFlow*



Design Software - *UFlow*



10-Page detailed report, including:

- System Flow Diagram.
- Plant design details (#UF racks, #UF modules per rack, recovery, UF module main features, etc.)
- Instantaneous and Average system flows.
- Sizing of tanks, valves, piping.
- Chemical consumption and cost.
- Energy consumption and cost.
- Operating Tables.

Applications & References

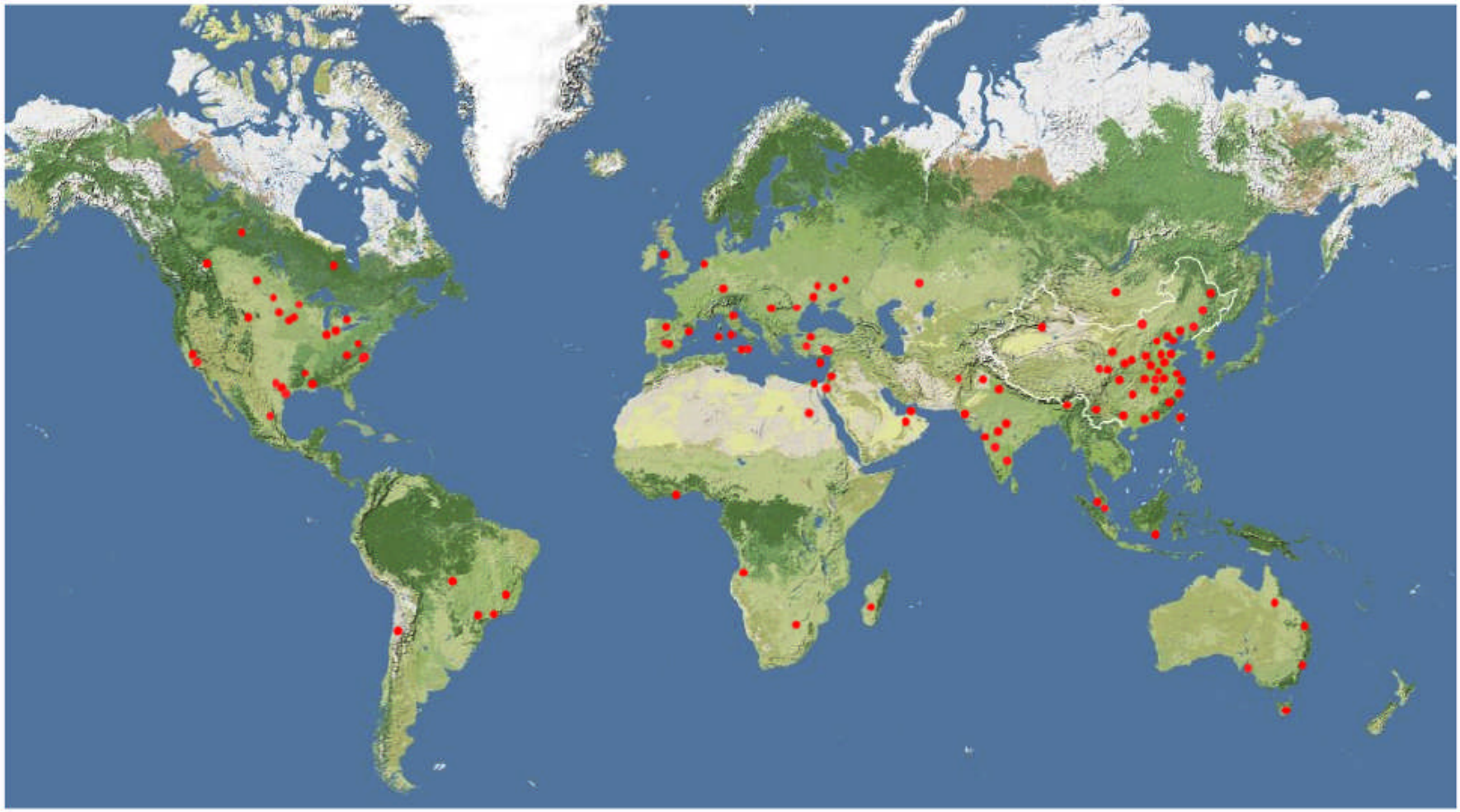
World wide **DOW™ UF** References:

- ~ **800 systems installed worldwide**
- ~ **4,500,000 m^3/day** of installed UF water treatment capacity.
- ~ **100 systems** over 10,000 m^3/day

Applications include:

- ✓ **Surface Water** Treatment for industrial or municipal use
- ✓ Municipal **Wastewater** Treatment/Reuse
- ✓ **Industrial** Wastewater or Process Water treatment
- ✓ **Seawater** RO pretreatment

DOW™ UF References



DOW™ Ultrafiltration Global Installation Map

Thank You

People and Technology Putting Quality Water Within Your Reach

www.dowwatersolutions.com

Water & Process Solutions