DRINK WATER TREATMENT PLANT – DESALINATION of Mediterranean Sea.
Capacity of drink water – 50 m^3/hour (1200 m^3/day)

DESIGN BASIS

Proposal for the drink water treatment of the Mediterranean Sea water with membrane technologies utilizing Ultrafiltration and Reverse Osmosis processes to obtain high quality drink water. Equipment proposed herein is based on the information that raw surface Mediterranean Sea water quality. Plant is set to produce **1100 m^3/day** and would work 24 hours a day and 365 days a year.

STAGE of TECHONOLGY

Prefiltration – filtering of large parts and fibrous (algae) inclusions on automatic disc filters up to 200 microns in size.

Ultrafiltration – membrane technology of deep-water purification on ultrafiltration membranes. The degree of filtration is 0.02 microns. At this stage, the final purification of water from organic compounds, clarification of water, removal of microorganisms, bacteria and viruses.

Reverse Osmosis - desalination and decrease of hardness ultrafiltrate water.

Pressure Exchanger (PEX), which allows to recover concentrate pressure and add it to the pressure generated by the high-pressure pump

BRIEF DESCRIPTION PLANT

Capacity – 1200 m^3/day, Recovery – 50%, Rejection – 50%.

Water intake – 130 m^3/hour

Reject – 50-60 m^3/hour

Main electricity consumers of SWRO unit for source water temperature:

- minimum temperature of source water 12 C^0 – 2,7 kW/m^3
- average temperature of source water 19 C^0 – 2,5 kW/m^3

Quantity and size of containers:

40 foot –2 pcs. Size of container (HxLxW) – 2591-12192-2438 mm.

Feed Water Analysis/Guaranteed Outcome

Main Parameters	Feed Water	RO Permeate*	Unit
Calcium (Ca)	447	0,5-2,0	mg/l
Magnesium (Mg)	1400	1-3	mg/l
Sodium (Na)	12121	50-150	mg/l
Potassium (K)	431	3-7	mg/l
Sulfate (SO_4)	2862	2-4	mg/l
Chloride (Cl)	21740	80-220	mg/l
Boron (B)	4,6	<1,0	mg/l
Bicarbonate (HCO_3)	172	2-4	mg/l
pH	8,3	6,5-7,5	
Temperature	12-29	12-29	^{0}C
TDS	39200	100-500	mg/l

** water quality must comply with EU Standard specification for drink water*

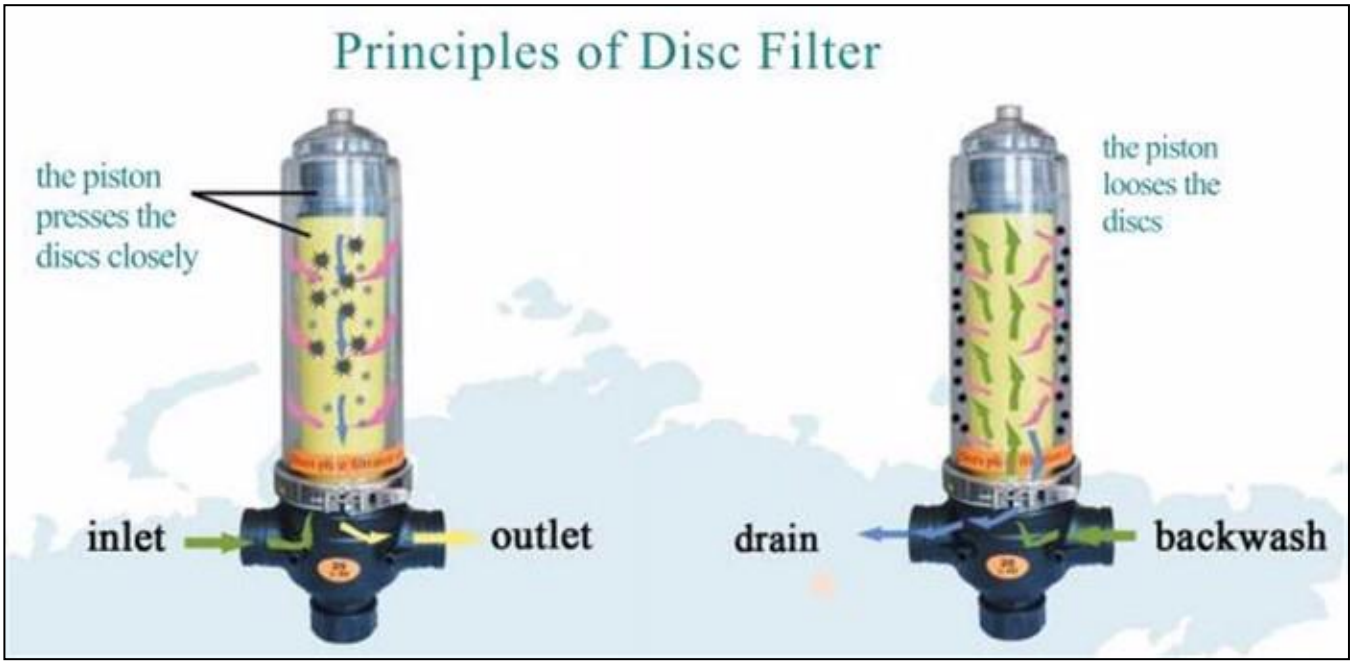
TECHOLOGY AND PROCESS DESCRIPTION – PRETREATMENT

- **Prefiltration (automatic disc filters);**
- **UF (Ultrafiltration);**

During Prefiltration stage on the automatic disc filter 200 micron and bigger particles rejected to protect membrane surface from sharp solid particles. This step immediately followed by the Ultrafiltration. All three technology phases synchronized in fully automated system that control the process to get the most from system operational.

Feed water enters disc filters, which are made from polymers. Outside surface of the filter element appears in cylinder shape after disc compression.

On each disc surface grooves are inflicted of the certain depth and width to achieve volumetric net structure, which is an actual filtration tool for smaller particles. During filtration phase discs are compressed by utilization of the spring. Compressed discs are creating the uniformed filtration structure.



During backwash (BW) stage, which starts after reception of the signal from the outside, pistons change direction of the water stream through the filter. Thus, disc packet expands. Under the skew stream that is created by special nozzles, discs start rotation and all particles from the surface are quickly and efficiently washed out into the drain under BW stream. At the end of the BW mode filters are rinsed by clean water.

After pre-filtration water entering **Ultrafiltration** membranes (UF).

Main advantage of the UF system is to achieve high level of product quality without any change of high permeate (product) quality. Ultrafiltration membranes allow you to retain fine and colloidal impurities, algae, unicellular microorganisms, cysts, bacteria, viruses. The degree of filtration of the membrane (pore size) is 0.02 microns. In this regard, there is no reagent disinfection of water - viruses and bacteria do not pass through the pores of the membrane.

The operating mode of the unit is a dead end, without discharge of concentrate during filtration.

For UF operation only 0.5-1 bar of the working pressure needed, therefore energy consumption of the process is low.

Filtration Spectrum:

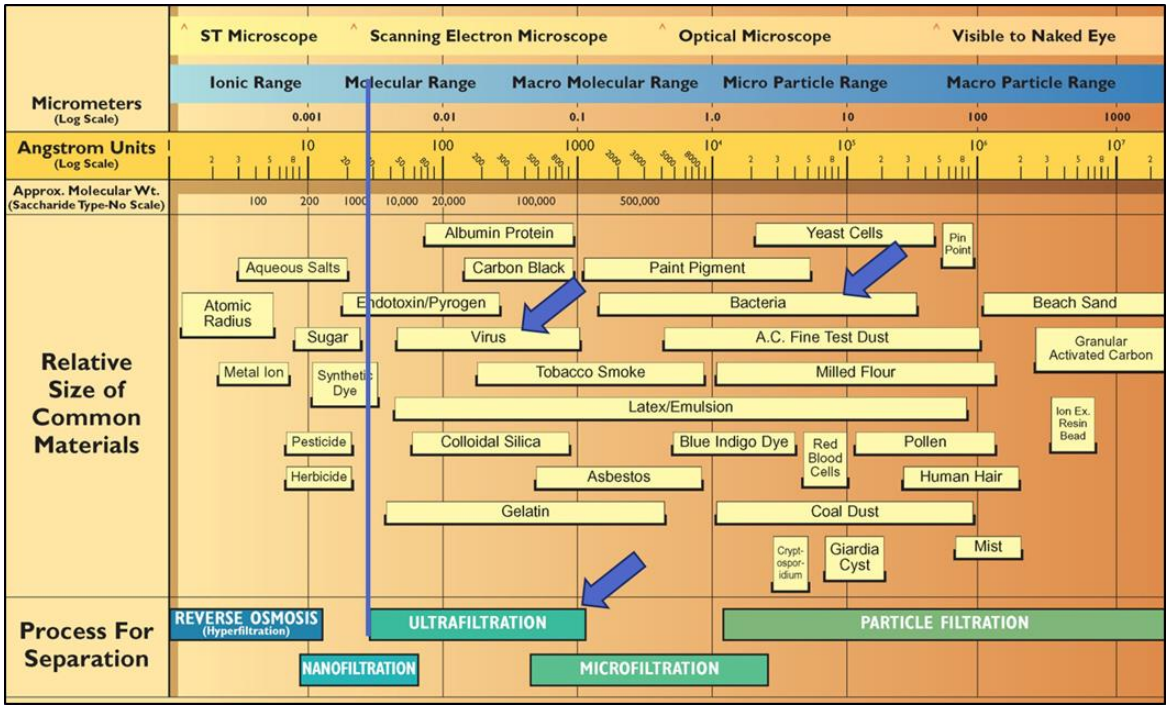


Table of comparative characteristics of ultrafiltration and multimedia (sand) filters.

№	Technological parameters	Ultrafiltration	Sand Filters
1.	The size of filtrated solids	All impurities larger than 0.02 μm in size. Retains colloidal parts	Solids up to 50 μm in size. Does not retain colloidal parts
2.	Removal of bacteria and viruses	**YES** Bacteria and viruses are retained by ultrafiltration membranes	**NO** Bacteria and viruses are not retained by Sand Filter Need a lot of more dosing of active chlorine are required for disinfection. The danger of creating toxic organochlorine compounds in the clean water.
3	Dependence of the quality of the filtrate on the amount of impurities in the incoming water	**INDEPENDENT** The quality of the filtrate does not change when the amount of impurities in the incoming water changes.	**IT DEPENDS** When the quality of the incoming water deteriorates, the quality of the filtrate also deteriorates.
4.	Design features	Compact, block-modular construction Does not require lifting mechanisms The quality and properties of the membranes do not change for a long time.	Bulky design. Requires additional lifting mechanisms for installation and maintenance. They have an internal filling of filter material - it needs periodic filling and replacement.

Permeate from each machine enters common pipe followed by the automatic valve that distribute water flow further to the RO machines. No intermediate tanks, transfer pumps and cartridge filter system is needed for this design.

Small portion of the UF permeate would be used for the BW and Chemical Enhanced Backwash (CEB) of the UF membranes.

These processes would be done in a fully automatic mode either. To clean membrane surface from absorbed contamination designed BW process by clean product water.

BW implemented by specially consigned pump. BW process designed to bring water in opposite to a filtration mode direction – “out-in”. BW volume usually make up 3-5% of the feed water volume. Time duration – 30 secs, every 40-70 min.

To clean membrane even further, every 24 hours or so, CEB is held. During CEB chemicals (normally acid and caustic) are used.

To enhance UF process even more, prior to UF normally used hypochlorite chlorination (in our case periodically) of the feed water.

TECHOLOGY AND PROCESS DESCRIPTION DESALINATION – REVERSE OSMOSIS (RO)

The main advantage of this design is that it uses French made **Knappe** housings, and is therefore much more compact than traditional round housing design. Victaulic couplings don't need to be used in this skid design except piping connections. We have attached presentation of the **Knappe** housings as an attachment to this proposal.

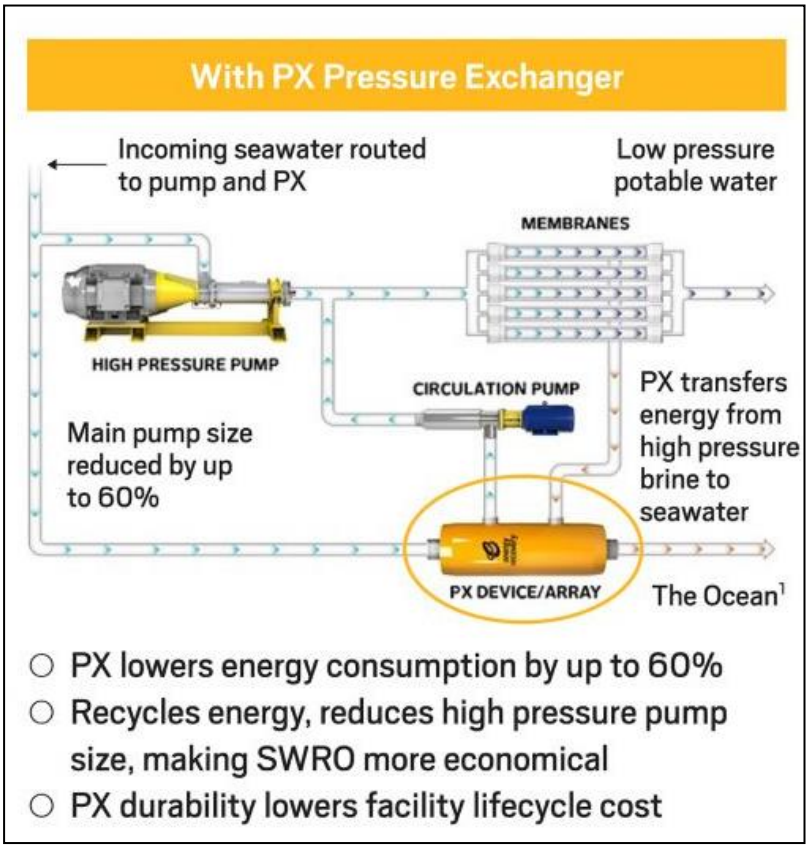
Operating RO is simple, especially in case of utilizing VFDs to control high pressure pumps, which we do. RO is operating in continuous mode, so programming of the RO portion of the system is basically control of the pressure drop to initiate timely cleanings in place (CIP) of the skids (each skid separately, when necessary)

Demanded variations of the product output will be additionally addressed by turning on/off skids based on a level in the product tank. Skid would have 3 enclosures: electrical, instrumentation, air-conditioned VFD enclosure. If necessary, information from the PLC, which would be displayed at local Panel View can be picked up by the main plant computer. Automatic valve actuator proposed to be electric. All flow, pressure, conductivity, and pH data would be shown on the Panel View screen.

Prior to the skid we'll have 2 chemical skids for Sodium metabisulfite (to avoid any possibility of oxidizers breakthrough, ORP analyzer would still be installed to check on this, RO membranes made from PA (polyamide), which is sensitive to oxidizing agents and will be destroyed overtime, if left unprotected and antiscalant to avoid any sulfate related fouling.

An important part of the design is the **Pressure Exchanger (PEX),** which allows to recover concentrate pressure and add it to the pressure generated by the high-pressure pump.

In our case we are proposing ERI PX set up, which would also require additional circulation pump. Anticipated energy consumption for the system would be below 3.0 kW per 1 m^3 of the product produced.



Main consumption of technological process

Consumers of electricity:

The main consumers of electricity of the technological process are:

- feed water pumps – work constantly;
- back wash pumps work periodically;
- dosing pumps work periodically;
- high pressure pump of reverse osmosis works constantly.

Variable Frequency drives (VFD) used for every pump, which helps to manage the process more effectively, reacting to requested flow and water temperature changes regardless of the nominal power of the pump

Power Consumption, while Producing Maximum Output, 1200 m^3/Day

Name of position	Working time per day, hour	Power consumption per hour, kW	Power consumption per day, kW
Pump of Source water	24	26	624
Back Wash UF	1,2	20	24
High pressure pump RO	24	101	2424
Booster RO pump	24	9	216

Chemical Usage

For CEB process we are using acid and caustic.

Caustic (NaOH 40%) – used to achieve high pH (9-9.5) for effective cleaning from organics and microbiological fouling. It will be done few times a week and depends on how quickly pressure UF skid high drop appears. It will be done more often during the summer and less often during winter time.

Sulphuric Acid (H2SO4 44%) – used to achieve low pH (2-2.5) for effective cleaning from inorganic fouling. Acid CEB likely to be performed once in 36 hours or so.

CEB performed by dosing chemical by means of dosing pump directly into the pipeline, while UF permeate for the BW tank pumped into the skid. After completion of the CEB cleaning, which may also include several minutes soaking step skid is rinsing by clean permeate water before bringing back to service.

Water with chemicals is pumped out from the skid and after neutralization with either acid or caustic to neutral pH will be dumped into the sewage system. Our technology suggests usage of Sulphuric Acid (44%), which is within the requirements of using it without any restriction

Antiscalant dosing - to avoid any sulfate or calcium related fouling.

Chemicals Usage, while Producing Maximum Output – 1200 m^3/Day:

Caustic, 40% - 1,2 kg/day

Sulphuric acid, 44% - 2.8 kg/day

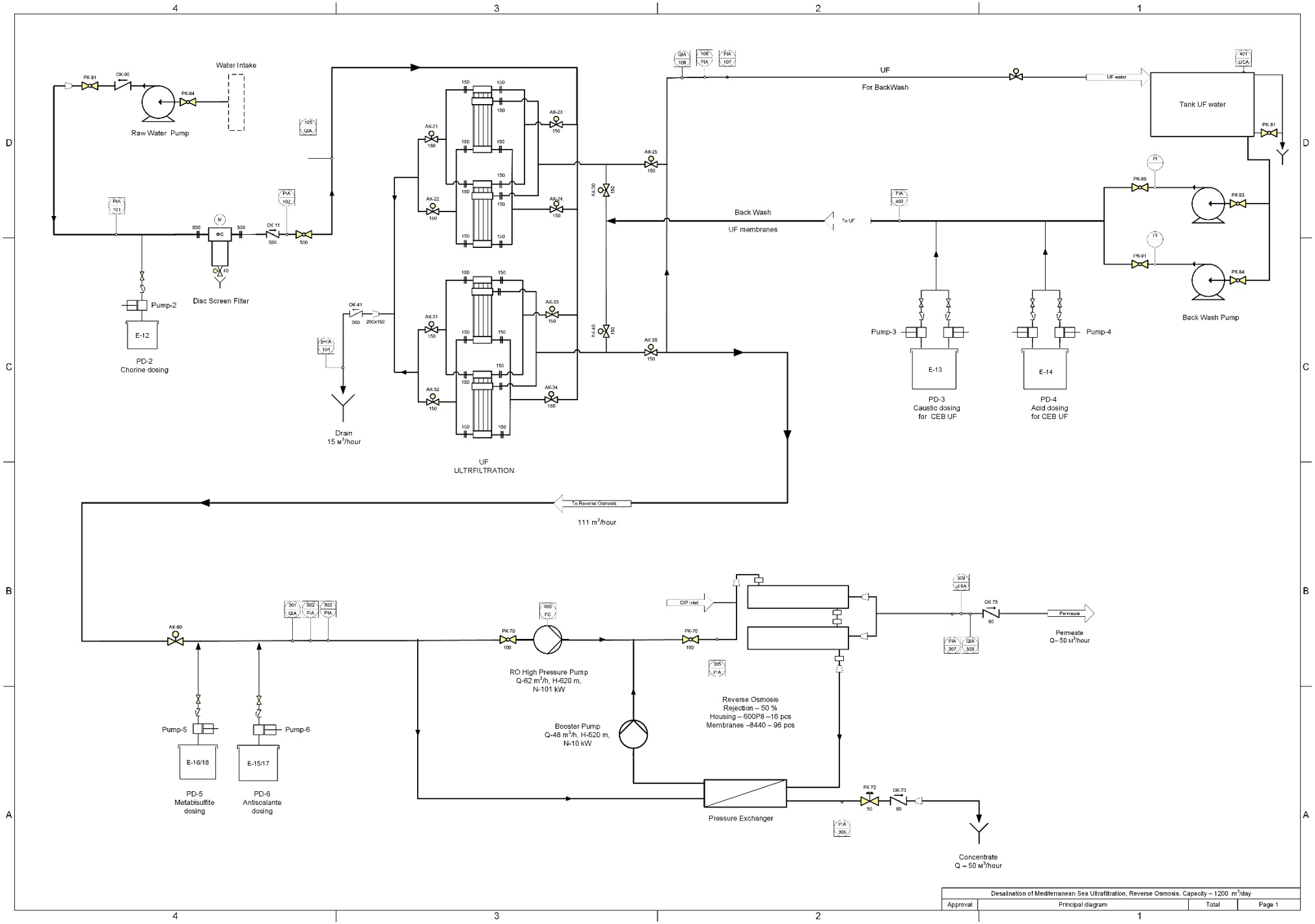
Antiscalant 100% - 2,3 kg/day

Specification of main equipment

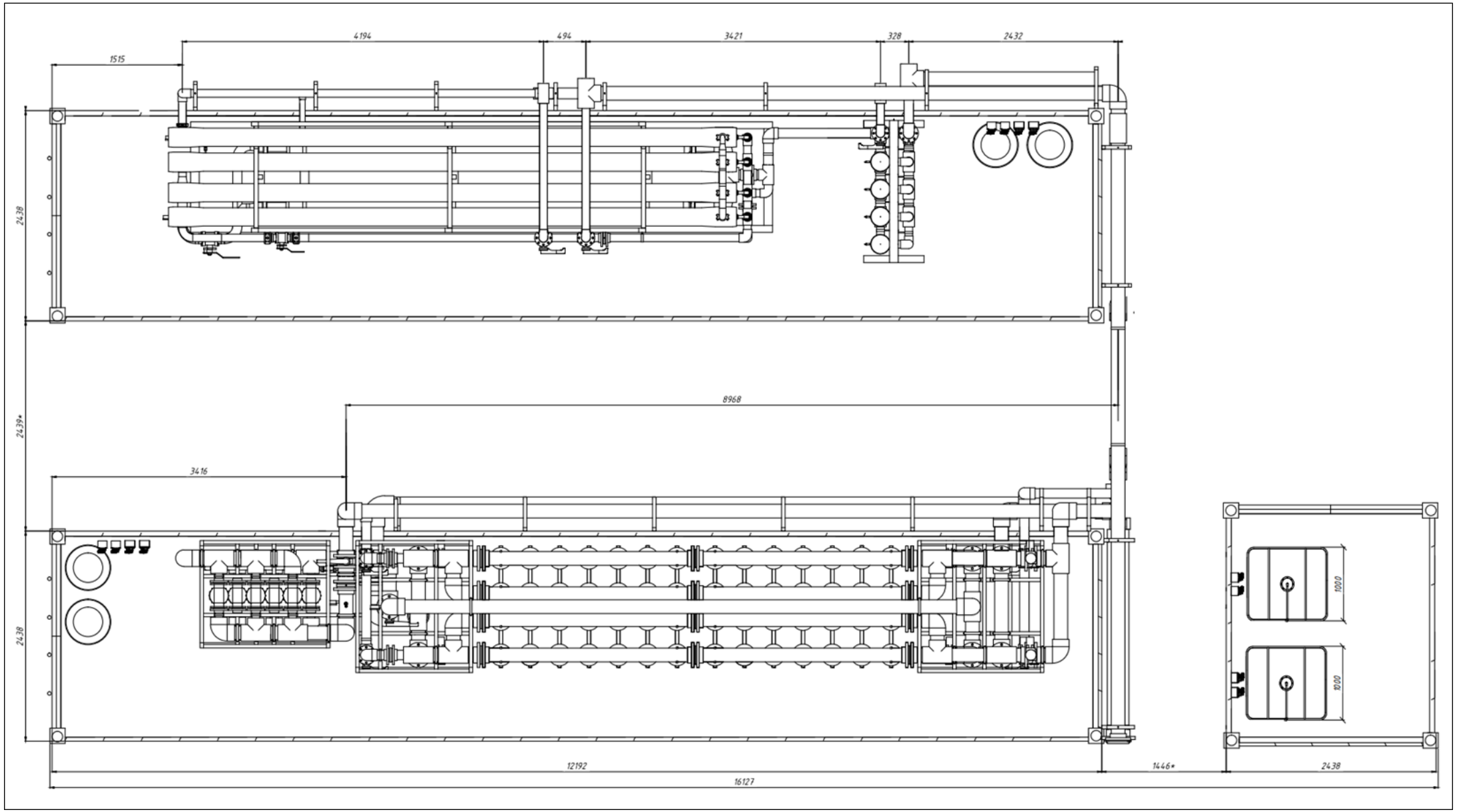
№ п/п	Name	Description	Q-ty
	Feed source water		
1	Feed pumps	Q-130 m^3/hour, H-60 m, N -30 kW	1
2	Frequency converter	N-30 kW	1
3	Motor cabinet for Pumps	N-30 kW	1
4	Dosing station of hypochlorite	Q-5 L/hour, H-50v, N-0,3 kW	1
5	Tank of coagulant	V-100 L	1
6	Automatic self-cleaned disc filter	Q-150 m^3/hour 2” Spin Klin, 200	1

	Ultrafiltration		
7	Ultrafiltration	MB 0,9-80	32
8	Automatic valves with electrical gearbox	Dn-150	set
9	Pipe and hand valves of ultrafiltration	PVC	set
10	Automatic pressure sensors	0-10 bar	2
11	Flow transmitter	0-200 m^3/hor	2
12	Turbidity transmitter	0-10 NTU	1
13	Back wash pumps	Q-165 m^3/hour, H-35 m, N -22 kW	2
14	Frequency converter	N 22 kW	2
15	Motor cabinet for Pumps	N 22 kW	2
16	Tank for Back Wash UF	PP V-5,0 m^3	1
17	Acid dosing station	Q-200 L/hour, H-50m, N-0,6 kW	1
18	Caustic dosing station	Q-200 L/hour, H-50m, N-0,6 kW	1
19	PLC station	Siemens	1
	Reverse Osmosis		
20	High pressure pump	Q-52m^3/hour, H-620 m, N -110 kW	1
21	Frequency converter	N-110kW	1
22	Motor cabinet for Pumps	N -110 kW	1
23	Booster Pump	Q-48 m^3/hour, H-620m, N -10 kW	1
24	Membranes Housing	1200 PSI	16
25	RO Membranes	SWRO 440	96
26	Automatic pressure sensors	0-16 bar	4
27	Flow transmitter	0-100 m^3/hour	2

28	Conductometer	0-1000 ppm	2
29	Dosing station of antiscalant	Q-1 L/hour, H-50m, N-0,6 kW	1
30	Dosing station of bisulfite	Q-1 L/hour, H-50 m, N-0,6 kW	1
31	Container insulated	40 HQ	2
32	Climatic cooling/heating system of container equipment		2
33	Control panel of container		2



Desalination of Mediterranean Sea water capacity 1200 m^3/day



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