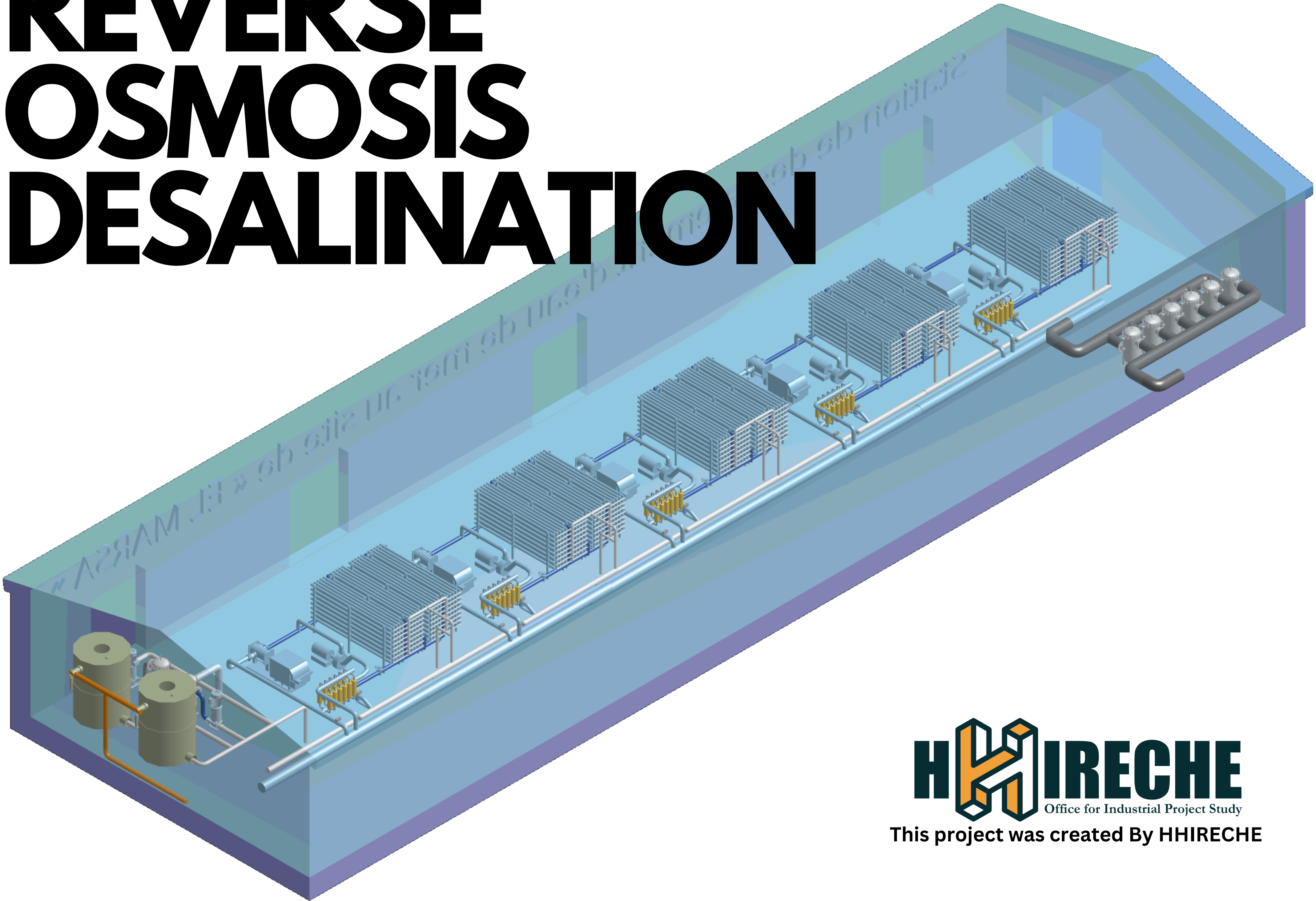
REVERSE OSMOSIS DESALINATION



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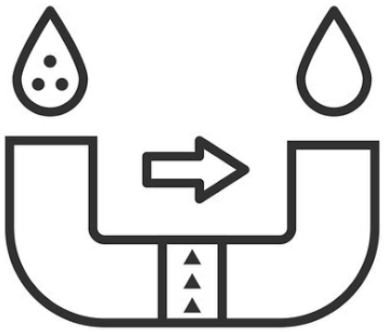
WHAT IS REVERSE OSMOSIS DESALINATION?

98% of the Earth's water is saltwater, found in seas and oceans. The other 2% is freshwater, for use by homes, farms and industry, but 40% of people cannot access it. Some people have to travel miles to find freshwater. Could we, however, use saltwater to supply the places that most need it? Yes. Desalination technology makes that possible.
The most advanced and efficient system is reverse osmosis.

Osmosis is a physical phenomenon by which two liquids, in different concentrations, separated by a semi-permeable membrane, come into contact and tend to even themselves out. The liquid with the lower concentration crosses the membrane toward that with highest concentration.
This process is inverted in reverse osmosis. We take in seawater, a highly concentrated solution, and force it through the membrane by adding pressure. On the other side, we obtain salt-free water, while back on the first side the remaining water still holds the salt the membrane prevented from passing through.

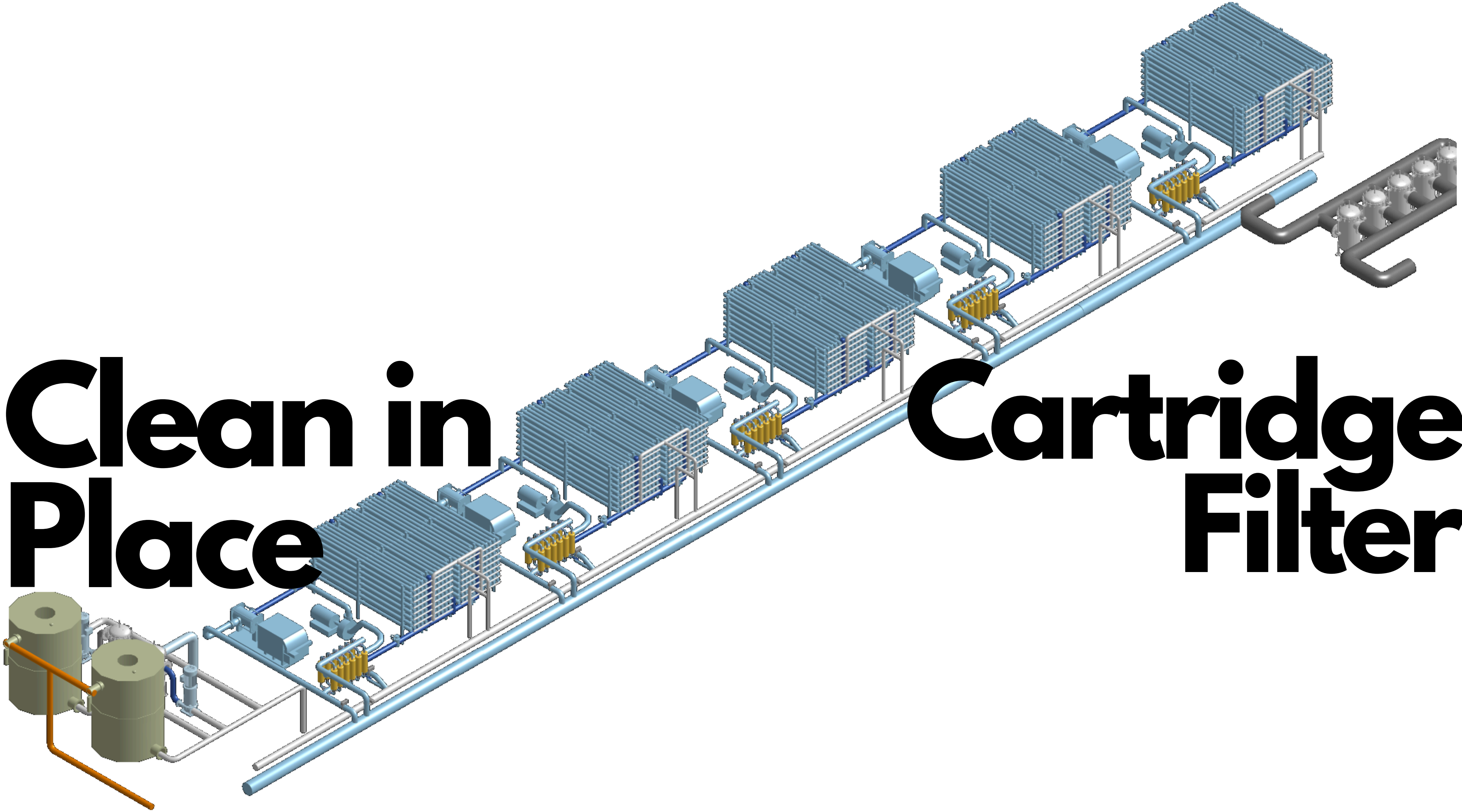
Reverse osmosis process

In reverse osmosis desalination, water is taken from the sea and receives a first treatment to eliminate impurities, oil, seaweed, rubbish, and so on. Once free of organic substances, the saltwater can be subjected to reverse osmosis. After the filtering, we have two streams: one brine and the other freshwater. The brine solution is diluted before being returned to the sea, avoiding high concentrations of salt which could harm the ecosystem. The freshwater passes through a remineralization and chlorination process, after which it is stored in tanks and then sent to the distribution network for consumption.
Reverse osmosis is not only the most advanced desalination system in the world today, it is the most efficient and beneficial for the planet: it generates up to four-and-a half-times fewer greenhouse gas emissions than all other technologies, it doesn't harm the marine environment, and it's able to recover a large part of the energy used in the process.



Clean in Place

Cartridge Filter



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Membrane CIP (Clean in Place): A Complete Guide

Analysts expect the global market for reverse osmosis membranes to be worth $5 billion by 2026. Operating a membrane system can be a challenging task. Ensuring proper operation is critical to maintain the quality of the end product.

As part of the operation and maintenance of any membrane system, membrane cleaning is crucial. Having a successful CIP can help lower operating pressures, improve quality, and extend membrane life.

It can optimize membrane performance and extend membrane life. Learn more about membrane CIP and how you can optimize your membrane system performance.

What Is Membrane CIP?

Clean-in-place (CIP) is a procedure to clean the interior of membranes of the reverse osmosis (RO) system. Membrane CIP lets you conduct cleaning without disassembling the water treatment system.

CIP cleans and rinses using a cleaning solution. It removes foulants that accumulate on the membrane surface during standard operations.

When to Conduct an RO/NF CIP Cleaning Procedure

It is recommended to follow the membrane manufacturer's guidelines for cleaning frequency. Membranes can suffer damage if cleaning does not happen at the recommended cleaning intervals based on system performance.

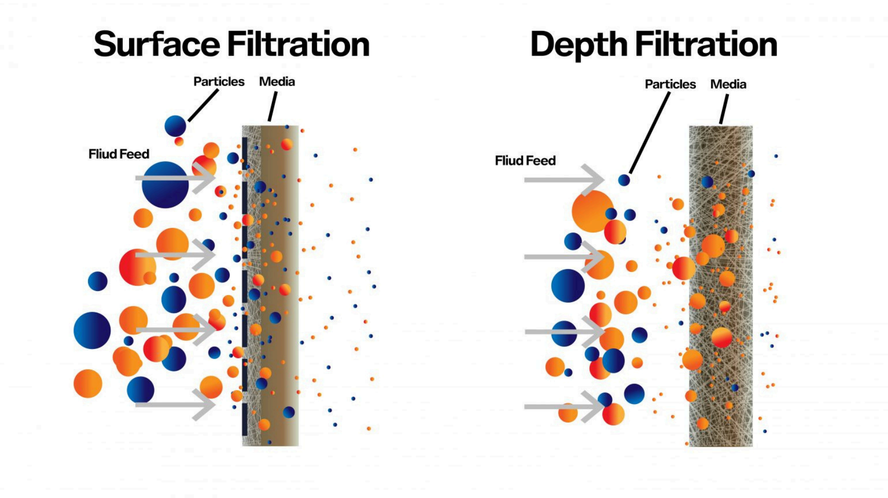
The use of data normalization can help determine when to clean. Most manufacturers recommend cleaning when:

- Normalized permeate flow decreases by 10%
- Normalized pressure differential increases by 15%
- Normalized salt rejection decreases by 10%

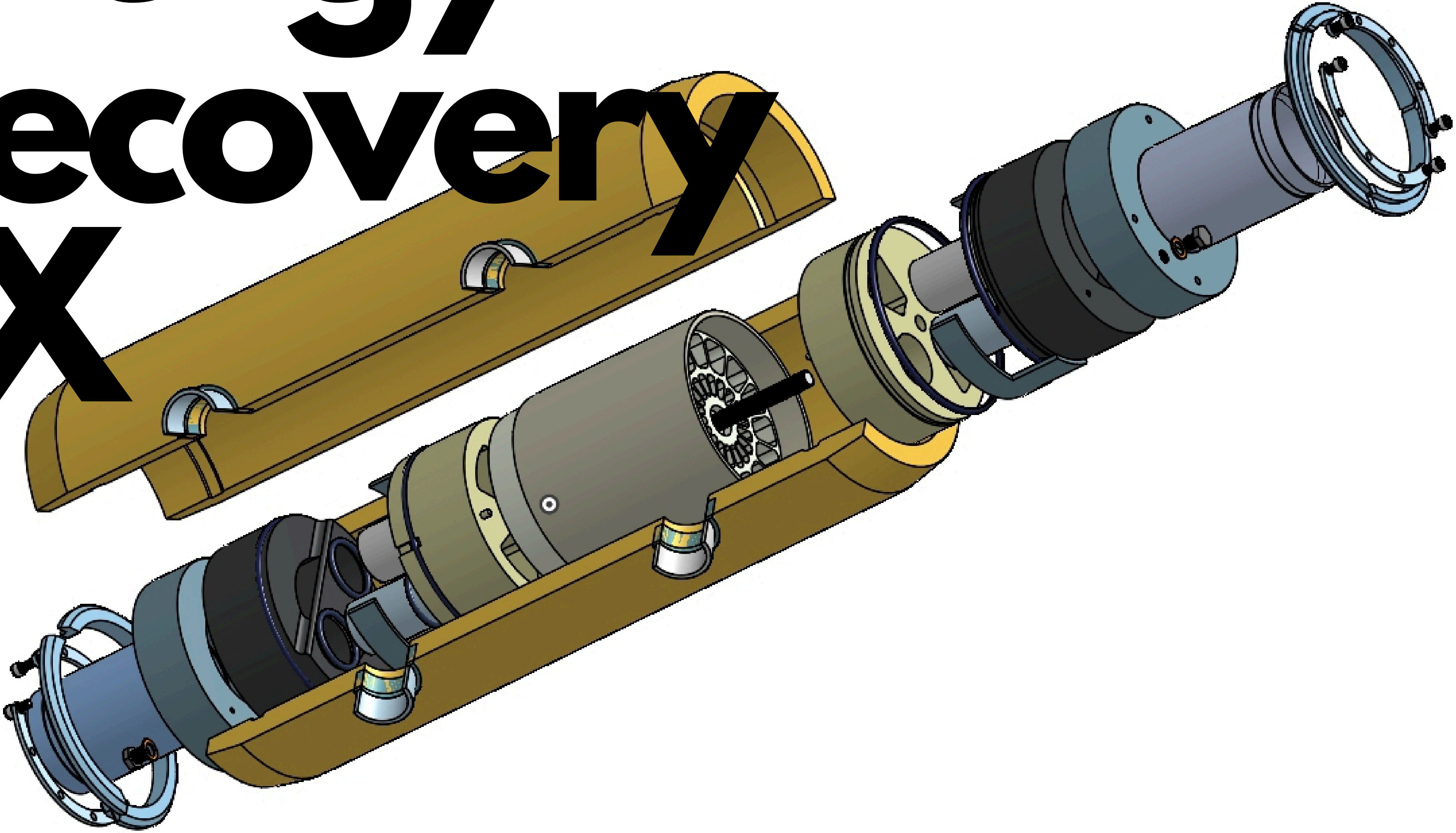
Using normalized data is important. Operating conditions constantly change. Normalized data lets you compare the RO membrane performance against a standard that eliminates factors that naturally affect membrane operations like temperature and salinity.

What Is A Cartridge Filter And How Does It Work?

A cartridge filter is a piece of tubular filtration equipment that can be used across various industries for an array of filtration requirements. A cartridge is encased within a housing or a casing and used to remove unwanted particles, pollutants, and chemicals from liquids. The cartridge is exposed to water, liquid or solvent that needs filtration, as it flows inside the housing and passes through the filter element. Cartridge filters can also remove submicron particulates.



Energy Recovery PX



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PX® Pressure Exchanger®
Best-in-class Energy Recovery in Desalination and Wastewater Treatment

Energy Recovery's award-winning PX® Pressure Exchanger® (PX) family of products provides unmatched energy recovery for seawater reverse osmosis (SWRO) desalination systems. Large and small desalination projects around the world rely on this range of PXs to achieve optimal operations and maximum energy savings. Designed with only one moving part using highly engineered alumina ceramic, the PX stands up to the harshest of environments resulting in an unmatched life-cycle cost advantage

* Historically energy consumption and costs made SWRO uneconomical. With the PX Pressure Exchanger, up to 60% of that wasted energy can be recycled, driving substantial savings and emission reductions. In addition, the size and/or number of high pressure pumps can be decreased.
Superior Precision and Durability:
The PX cartridges have only one moving part and are made with high-purity aluminum oxide ceramic. They're corrosion-proof and three times more abrasion-resistant than steel. All that adds up to unmatched durability.
We design and manufacture ceramic PX components in-house at our California headquarters. This allows us to control the precision and quality of our core components down to the micrometer level, ensuring every PX device performs with maximum efficiency, durability, and reliability.

Flexibly-sized
PX S devices are designed to meet the needs of small- to medium-sized plants.

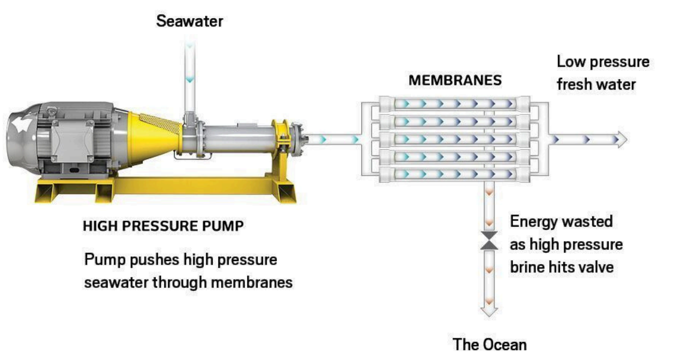
Modular Design
PX S devices can be installed in parallel according to specific plant needs.

Efficiency
Designed for maximum efficiency, the PX consumes no electrical power, enabling SWRO facilities to reduce their energy consumption by as much as 60%.

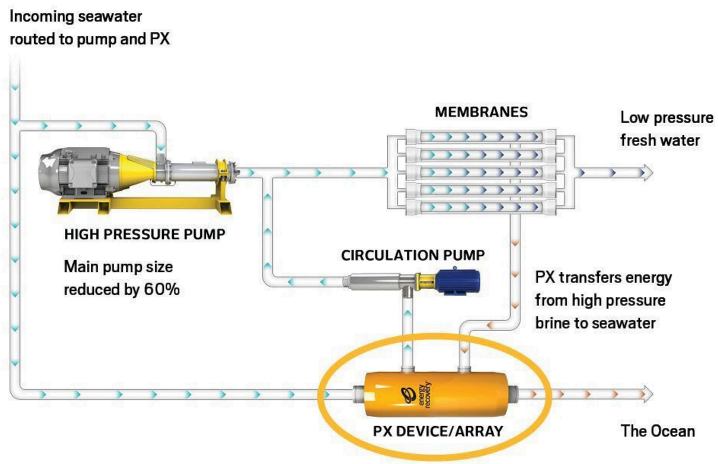
Performance
With no scheduled maintenance and proven performance for the long run, our PXs offer unbeatably low life-cycle costs.

Flexibility
Our range of PX capacities provides flexibility to optimize train size to specific project requirements, making the PX the ideal solution for new installations and retrofits alike.

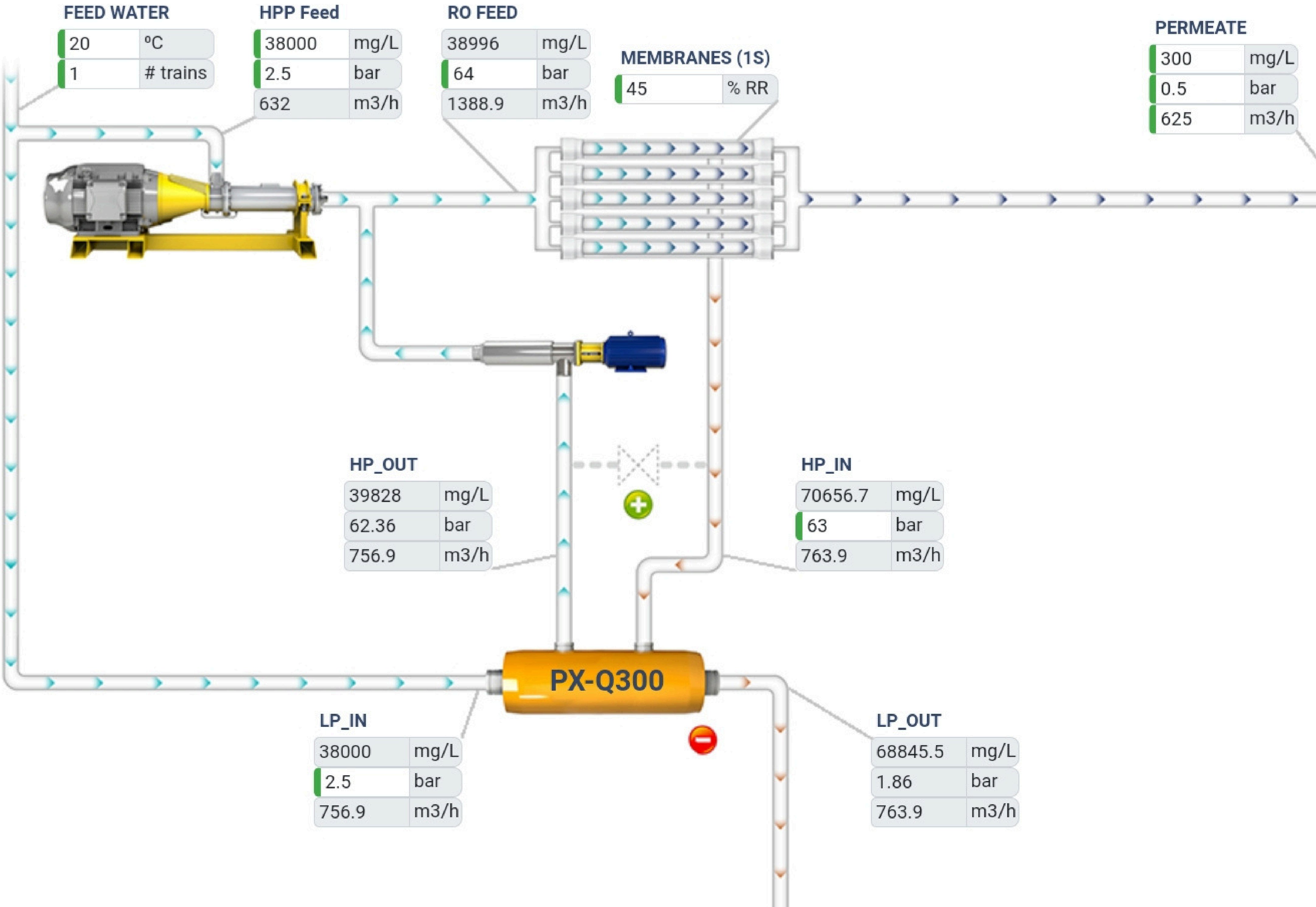
SWRO without Energy Recovery Devices (ERDs)



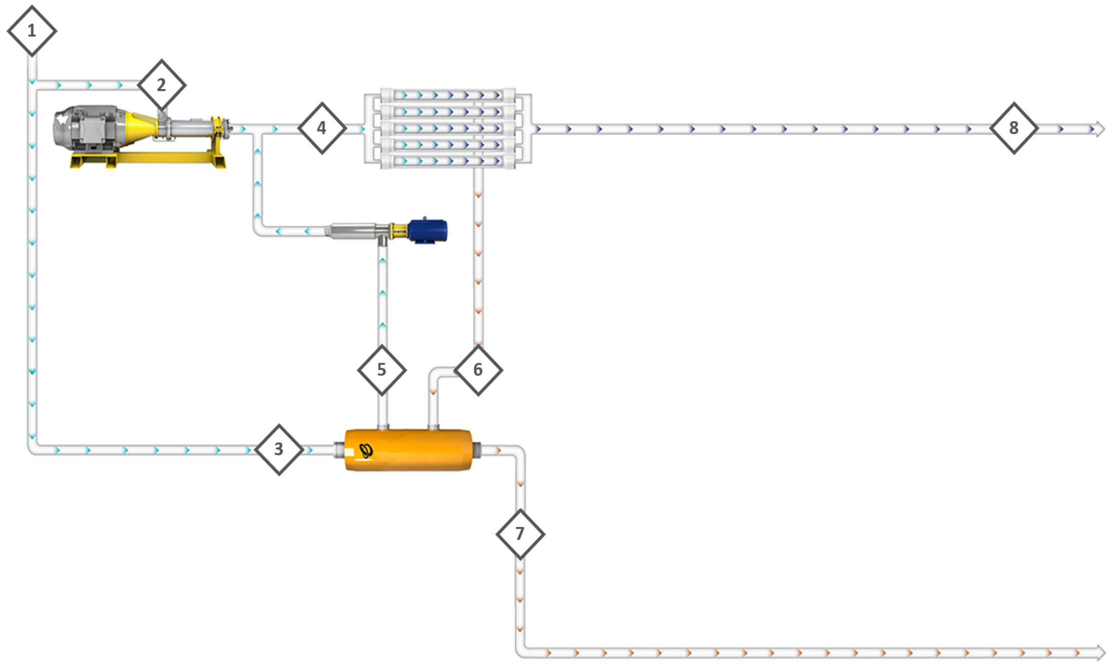
SWRO with the PX Pressure Exchanger



Example:
Seawater Flowrate: 100 m3/h
Applied Pressure: 75 bar
R.O. Recovery: 40%
Permeate Flowrate: 40 m3/h
Power required without energy recovery devices: 300 kW
Specific Energy: 300/40 = 7.5 kWh/m3
Power required with Energy Recovery Turbine: 177 kW
Specific Energy: 177/40 = 4.4 kWh/m3
Power required with Pressure Exchanger: 140 kW
Specific Energy: 140/40 = 3.5 kWh/m3
Device Type
Energy savings
Costs
Energy recovery turbine (ERT)
30-40%
+
Pressure exchanger (PX)
50-60%
++


FEED WATER
20 ºC
1 # trains
HPP Feed
38000 mg/L
2.5 bar
632 m3/h
RO FEED
38996 mg/L
64 bar
1388.9 m3/h
MEMBRANES (1S)
45 % RR
PERMEATE
300 mg/L
0.5 bar
625 m3/h
HP_OUT
39828 mg/L
62.36 bar
756.9 m3/h
HP_IN
70656.7 mg/L
63 bar
763.9 m3/h
PX-Q300
LP_IN
38000 mg/L
2.5 bar
756.9 m3/h
LP_OUT
68845.5 mg/L
1.86 bar
763.9 m3/h

Project Name : T 60.000 m3
Project Location : alger
Company Name : Hhireche
Projection By : Hassan
Date : 11/23/2023
Case Name : Case 1



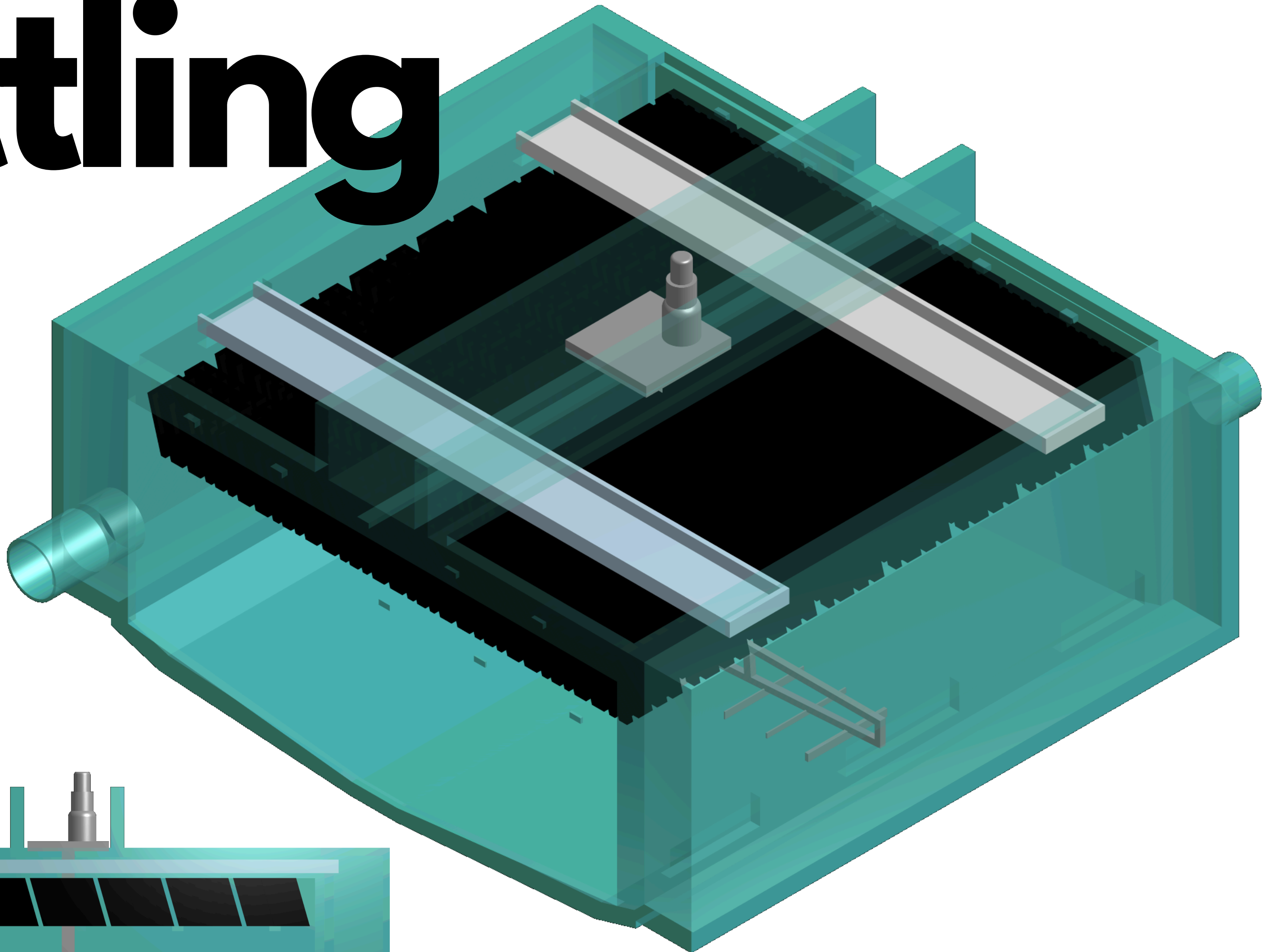
Line No.	1	2	3	4	5	6	7	8
Stream	RAW FEED	HPP FEED	LP_IN	RO FEED	HP_OUT	HP_IN	LP_OUT	PERMEATE
TDS, mg/L	38000	38000	38000	38996	39828	70656.7	68845.5	300
Press, bar	-	2.50	2.50	64.00	62.36	63.00	1.86	0.50
Flow, m3/h	1388.9	632	756.9	1388.9	756.9	763.9	763.9	625

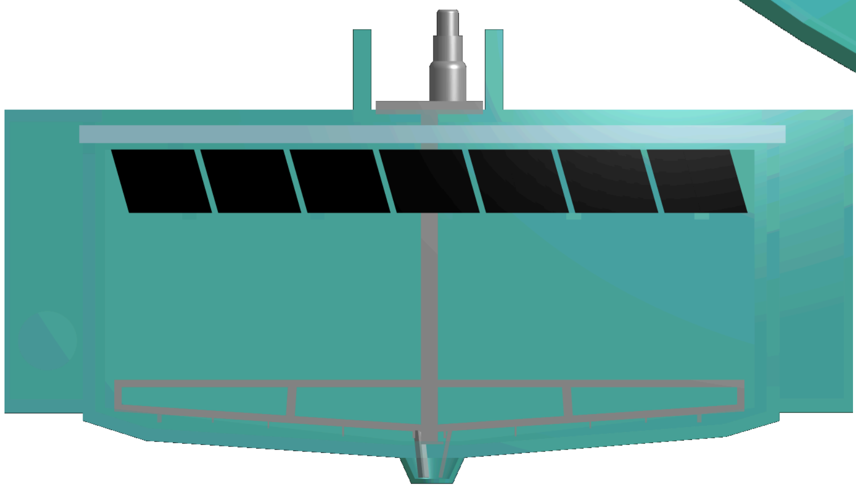
PX Technology Performance			
PX unitary flow	54.56 m3/h	HP DP	0.64 bar
Salinity Increase at membranes	2.62 %	LP DP	0.64 bar
Volumetric mixing VM	5.6%	RO Specific Energy **	8.97 kWh/kgal
Lubrication flow (LF) per PX array	7.01 m3/h	Brine Recovery Efficiency	98.08 %
LF as % of concentrate flow	0.92 %	Overall PX Efficiency	97.2 %

Feed Temperature: 20 ºC	# of Trains: 1	PX Model: PX-Q300	Total # of PX: 14

PUMP	ERI Model	PUMP Efficiency	MOTOR Efficiency	VFD Efficiency	POWER (KW)	PX POWER SAVINGS (KW)	CO2 SAVINGS (TONS/YEAR)	POWER COST SAVINGS (USD/YEAR) *
HPP	N/A	81.8	94.8	97.0	1,436.4	1567.9	8099	$ 13,734,687
Circ Pump	N/A	84.3	94.1	97.0	44.8			

settling





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Purpose Of Sedimentation

Sedimentation is a unit operation to settle out the suspended particles and flocs in water. Sedimentation water treatment is achieved by lowering the velocity of the water below the suspension velocity to settle out suspended particles by gravity. The process is also known as settling or clarification.

Most water treatment plants include sedimentation in their treatment processes. However, sedimentation may not be necessary in low turbidity water of less than 20 NTU. In this case, coagulation and flocculation are used to produce pinpoint (very small) flocs which are removed from the water in the filters.

The sedimentation generally follows coagulation and flocculation and precedes water treatment filtration. This type of sedimentation commonly known as clarification requires pretreatment with chemical addition (in the coagulation/ flocculation process) and removes the resulting floc from the water. Clarification in the treatment process should remove 90% of the suspended particles from the water, including bacteria and reduce the load on the filters.

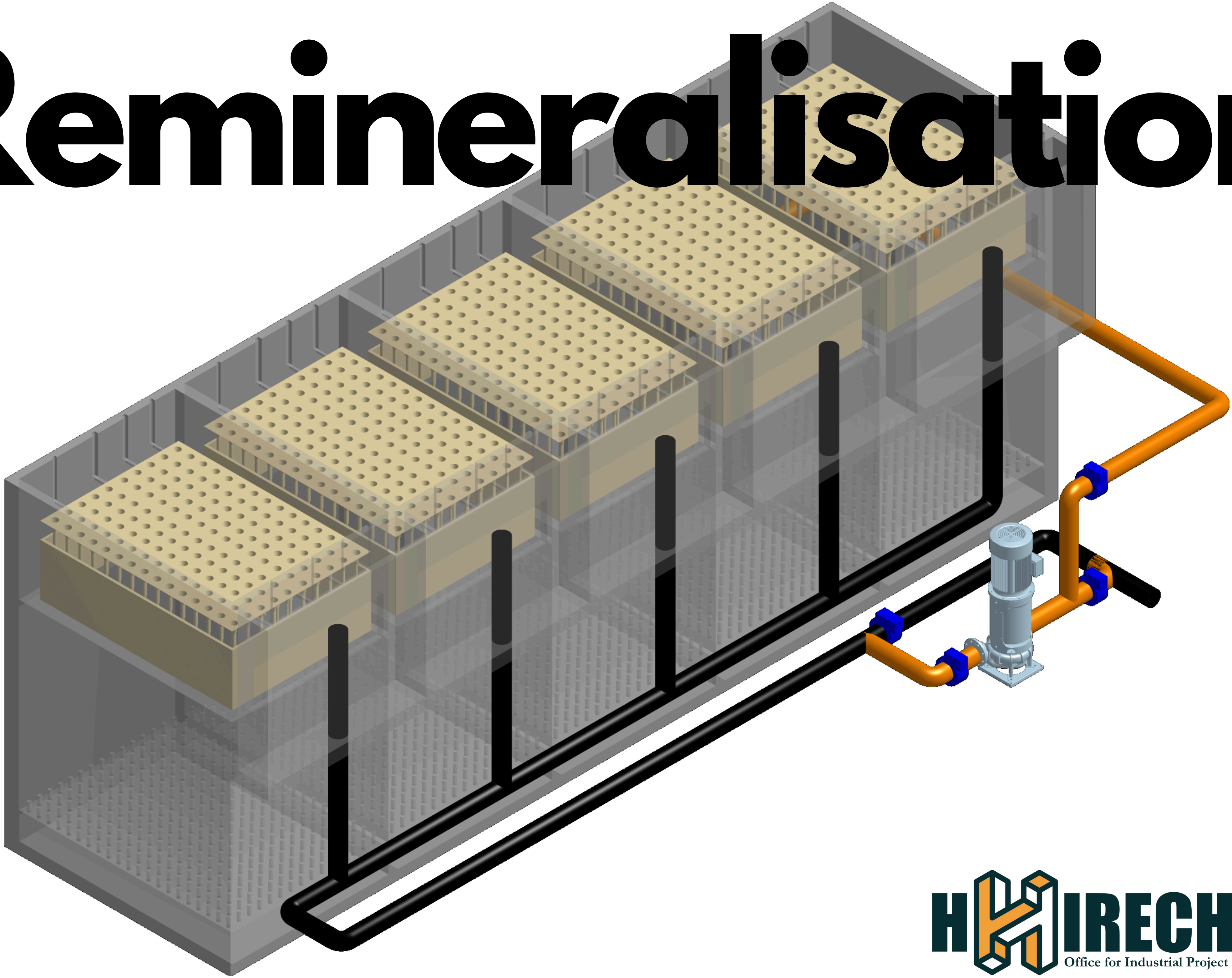
Sedimentation can also occur as part of the pretreatment process, where it is known as pre sedimentation which can also be called as plain sedimentation because the process depends merely on gravity without addition of chemical coagulants. Without coagulation and flocculation, plain sedimentation can remove only coarse suspended matter (such as sand, grit etc.) which will settle rapidly out of the water. This type of sedimentation typically takes place in a reservoir, grit basin, or sand trap at the beginning of the treatment process. So plain sedimentation will reduce the load on the rapid mix basin, flocculation basin and sedimentation chamber, as well as reducing the volume of coagulant chemicals required to treat the water. In addition, plain sedimentation basins are useful because raw water entering the plant from a plain sedimentation tank is usually more uniform in quality than water entering the plant without such a holding basin. Impounding storage reservoirs are generally serving as plain sedimentation tanks

Types Of Sedimentation

In general, there are four types of sedimentation.

- Type I Sedimentation, known as discrete settling, describes the sedimentation of low concentrations of particles that settles as individual entities. Example of Type I settling in water treatment plants is the settling of silt, grit etc., from river water before applying to the slow sand filters.
- Type II sedimentation, known as flocculant settling, describes sedimentation of larger concentrations of solids that agglomerate as they settle. Sedimentation of coagulated surface waters prior to rapid sand filters is an example of flocculant settling. This type of settling is known as the clarification.
- Type III sedimentation, known as hindered settling or zone settling, describes sedimentation of a suspension with solids concentration sufficiently high to cause the particles to settle as a mass. An example of the hindered settling is the upper portion of the sludge blanket in sludge thickeners.
- Type IV sedimentation, known as compression settling, describes sedimentation of suspension with solids concentration so high that the particles are in contact with one another and further sedimentation can occur only by compression of the mass. The lower portion of a sludge thickener is an example of compression settling.

Remineralisation



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neutralisation and/or remineralisation

neutralisation using the chemical method
In most cases this is carried out as an injection of lime, sodium hydroxide or sodium carbonate; please refer to the section neutralisation – remineralisation for details of the reactions involved. Complex systems may require several injections at various stages of the treatment. In plants that have total clarification, with settling tanks (or flotation units) and filters, lime is mainly used and injected at a minimum of two points :

- for flocculation pH adjustment (NB in this case, due to the Ca^{2+} ions, flocculation will be better than when NaOH or Na_2CO_3 are used); at this stage, lime slurry may be suitable;
- for final pH adjustment to the pHs value; one then needs to use a saturator that delivers clear lime water while screening out lime impurities ; sodium hydroxide can be used as an alternative at this point.

Aggressive CO_2 can also be neutralised by filtration through a $CaCO_3$ based granular neutralising product, according to the same reaction and implementing the same technology as for remineralisation using this process.
remineralisation using CO_2 + lime
The following reaction applies :

Using this equation, one can calculate that, **in order to increase mineralisation (M-alk. and CaH) by 1°F**, 8.8 mg · L^{-1} of CO_2 and 7.4 mg · L^{-1} of **pure** hydrated lime (or 5.6 mg · L^{-1} of pure quicklime) have to be injected into the water.
CO_2
Industrially, CO_2 is supplied in cylinders under a very high pressure and more generally in cooled “low pressure” containers.
In some industrial type installations, CO_2 can be obtained by burning gas (submerged burners); however, the impurities generated by incomplete combustion and/or the original fuel, means that it cannot be used for drinking water production.
When used in sea water processing, CO_2 obtained by distilling sea water can be recycled and used to remineralise water intended for human consumption (e.g. Alba/Barhein, 43,000 $m^3 \cdot d^{-1}$, see figure 43).
lime
Depending on its origin, the purity of lime can vary from 80 to 95%; obviously, this factor has to be taken into account when calculating not only the amounts to be used but also the way in which the product is to be used.
As an illustration, with a 90% “pure” product, if one wants to increase water hardness by 8°F, then 59.2 mg · L^{-1} of pure lime or approximately 65.8 mg · L^{-1} of commercial lime will have to be added and this will cause the water to be contaminated by 6.6 mg ·L^{-1} of suspended solids when the latter are not screened out in a saturator (see further on).
utilisation
There are many applicable cases, depending on the quality of the raw water and of the reagents used :

- with **distilled water** that only requires added salts, CO_2 can be injected and the lime water saturated using in-line mixers, by adjusting the **pH** to the **pH**s, or even slightly above the latter

remineralisation using CO2 + limestone

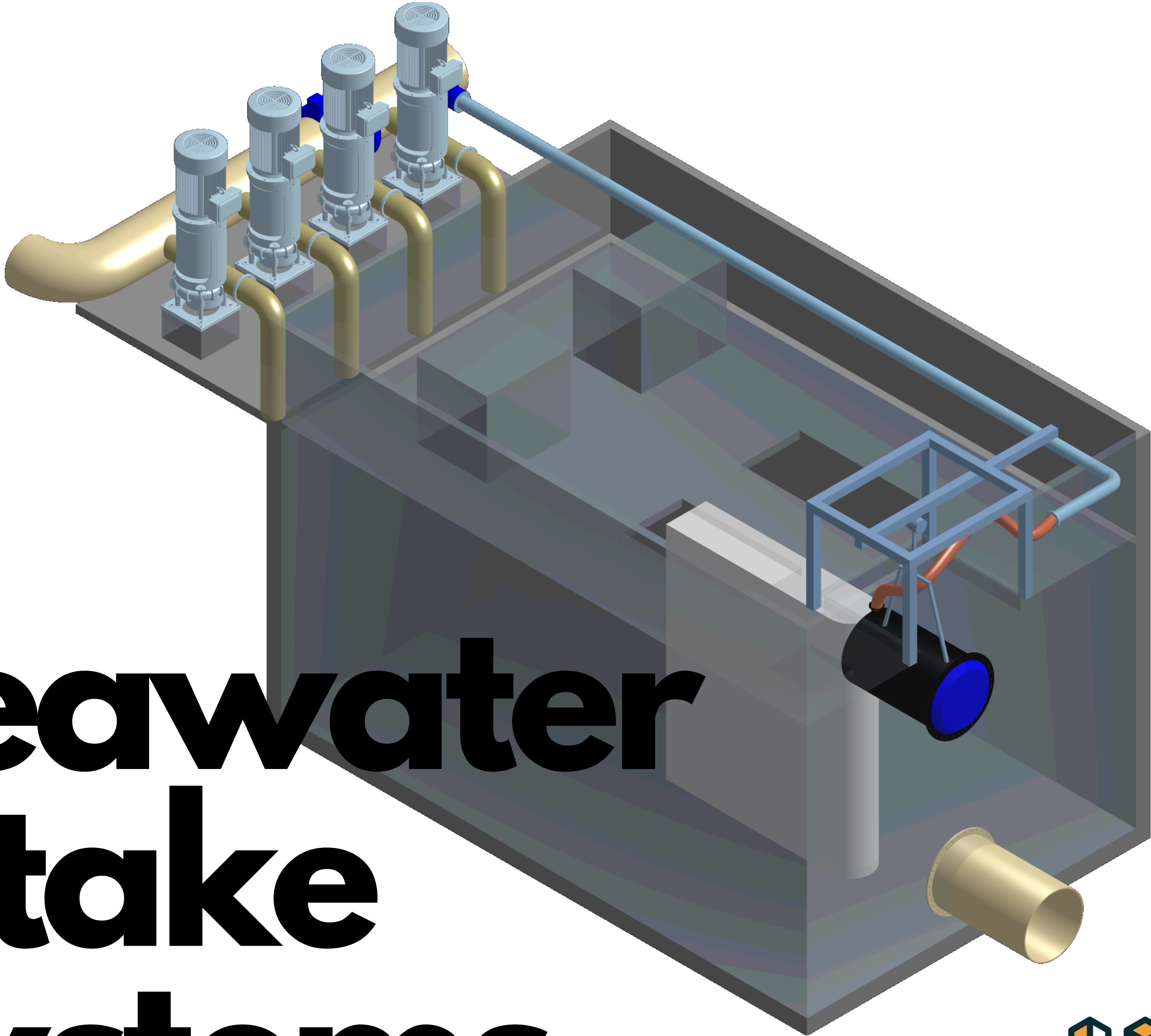
reaction
The following theoretical reaction applies :

In order to increase TAC and TCa by 1°F, theoretically, therefore, one needs to use 4.4 mg · L−1 of CO_2 and 10 mg · L−1 of $CaCO_3$.
reagents
The calcium carbonate routinely used in France is a special form with an interesting reactivity associated with its physical state: lithotamine (or maërl) is sold under different brand names including "Neutralite", "Neutralg", "Timalite"... It consists of coral type fossil algae debris (Lithothamniumcalcareum) and major deposits of this material can be found off the Brittany coast.
Other forms of more or less finely crushed limestone can be used. However, the following contact times will need to be adjusted accordingly.
The chemical composition of lithotamine does not vary much: it has a predominating proportion of calcium carbonate, 5% to 10% of magnesium carbonate and a few impurities.
Therefore, the following neutralisation reactions will apply :

Depending on the $CaCO_3$/$MgCO_3$ ratio and on the % purity of the commercial product, marine limestone consumption can vary from 2.2 to 2.4 kg per kg of CO_2 neutralised.
More or less calcinated magnesium oxide based products have occasionally been proposed ($CaCO_3$, CaO, MgO mixture). These products are more reactive and, therefore, require shorter contact times; however, the presence of available bases can lead to a pH > pHs and produce a highly scaling water, especially during prolonged shutdown periods or when the throughput falls below the normal throughput level. In such cases, an accurate check has to be undertaken.
contact
Powdered calcium carbonate can be used by injecting a suspension in water containing CO_2 that requires neutralising; however, this method only applies to surface water that requires clarification and the use of a settling tank.
In these cases, a sludge blanket clarifier is particularly appropriate because it concentrates the suspension and allows for more prolonged contact times (30-45 minutes); furthermore, carbonate impurities help to "ballast" the floc, enhancing its settling properties.
More generally, "marine limestone" is supplied in granules that are put in contact in gravity or pressure "reactor-filters" where the water to be treated flows through the filter medium. The efficiency of this type of system depends on :

- the reactivity of the product used (porosity, density);
- particle size;
- temperature;
- the raw water's initial M-alk.;
- contact time.

Seawater Intake Systems



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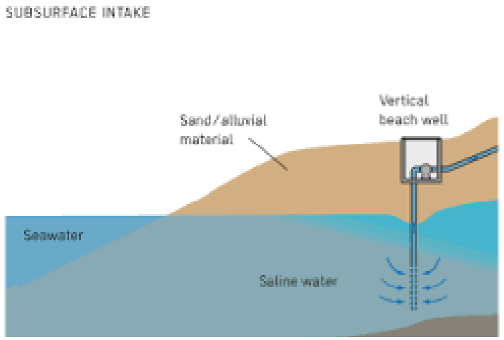
Desalination Plant Intakes

INTRODUCTION

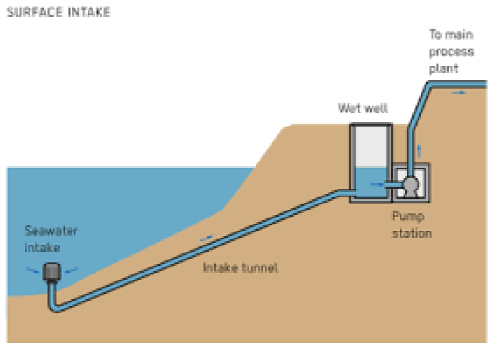
Seawater intakes are an integral part of every seawater desalination plant. The purpose of this white paper is to provide an overview of potential impingement and entrainment (I&E) impacts associated with the operation of open ocean intakes for seawater desalination plants and to discuss alternative solutions for efficient and cost effective I&E reduction. For information on alternative intakes for seawater desalination plants, refer to the WateReuse Association's white paper titled "Overview of Desalination Plant Intake Alternatives."



WHAT IS IMPINGEMENT AND ENTRAINMENT?

As with any other natural surface water source currently used for fresh water supply around the globe, seawater contains aquatic organisms (algae, plankton, fish, bacteria, etc.). Impingement occurs when organisms sufficiently large to avoid going through the screens are trapped against them by the force of the flowing source water – i.e., algae, plankton and bacteria are not exposed to impingement. On the other hand entrainment occurs when marine organisms enter the desalination plant intake, are drawn into the intake system, and pass through to the treatment facilities.

Impingement typically involves adult aquatic organisms (fish, crabs, etc.) that are large enough to actually be retained by the intake screens, while entrainment mainly affects aquatic species small enough to pass through the particular size and shape of intake screen mesh. Impingement and entrainment of aquatic organisms are not unique to open intakes of seawater desalination plants only. Conventional open freshwater intakes from surface water sources (i.e., rivers, lakes, estuaries) may also cause measurable impingement and entrainment.



A third term, "entrapment," is then used when describing impacts associated with offshore intake structures connected to an on-shore intake screen and pump station via long conveyance pipeline or tunnel. Organisms that enter the offshore intake and cannot swim back out of it are often referred to as entrapped1

. Such marine organisms could either be impinged on the intake screens
or entrained if they pass through the screens and enter the downstream facilities of the desalination plant.

PUMPS

DÜCHTING PUMPEN

TORISHIMA

SULZER

(RO) MEMBRANES

LG Chem

TORAY

VONTRON

INSTRUMENTATION

VEGA

KROHNE

Endress+Hauser

ELECTRIC

Schneider Electric

SIEMENS TIA Portal

WEG

PIPELINE

MAGHREB PIPE Industries

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