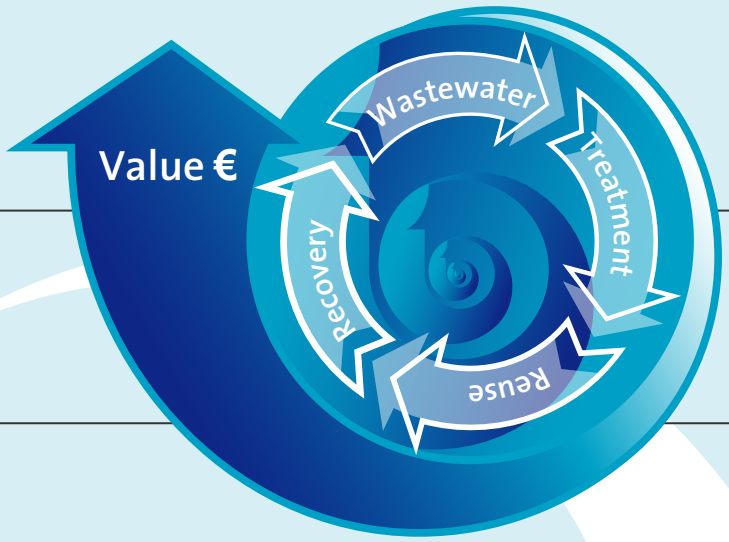

bluetec
PROCESS WATER TECHNOLOGIES

BLUE-tec bv

COMPANY

BLUE-tec is a company providing process water treatment technologies. It is situated in Wageningen, the Netherlands where are its own office spaces, process and construction hall.



VISION

BLUE-tec's vision is to create an abundant supply of water while at the same time recovering valuable materials, by optimizing and applying new membrane technologies.

MISSION

Our mission is to deliver affordable solutions, by means of novel membrane technology, for the concentration and separation of liquid feed streams such as wastewater, food producing liquids, chemicals, etc.

TECHNOLOGIES

BLUE-tec's focus lies in developing and improving the application of membrane technology. BLUE-tec works on pressure driven membrane processes and membrane contact processes. The focus for development is currently the Forward Osmosis (FO) technology. We work with FO coupled to Reverse Osmosis (RO) or Membrane Distillation (MD). We've performed tests with different feed streams, some of which are municipal and industrial wastewater, product streams from the food industry and produced water from the oil and gas industry and currently we are investigating the possibilities of manure/digestate concentration.

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Markets

INDUSTRIAL WASTEWATER

Several industrial wastewater types can be treated by BLUE-tec technologies, like FO, Osmotic-MBR, etc. Examples are:

- Oil & gas industry
- Land fill leachate
- Heavy polluted industrial streams, including Zero Liquid Discharge (ZLD)

DOMESTIC WASTEWATER

Domestic wastewater is a resource for biogas and nutrients. Through concentration of domestic wastewater by FO clean water is produced next to a concentrate. From the concentrate biogas and nutrients can be recovered and micro pollutants can be removed.

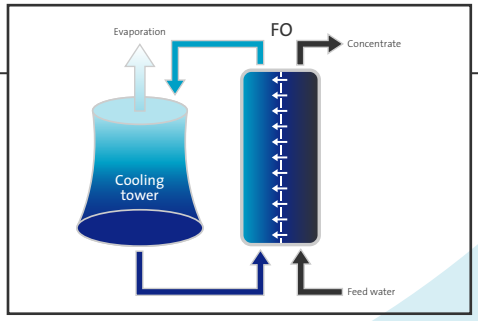
AGRICULTARE INDUSTRY

BLUE-tec offers solutions for the treatment of manure and digestate in the agro-industry. By the use of smart membrane filtration nutrients will be concentrated and recovered.

PRODUCTION LINE

BLUE-tec has a lot of experience in applying membrane filtration processes especially in the food and beverage industry. Examples for the use of FO to concentrate production streams are, fruit juice, whey, concentration of specific compounds, etc.

COOLING TOWERS



A unique combination is the use of Forward Osmosis with cooling towers. In this way savings are achieved by: less make up water, less chemical usage, less blow down and the possibility to concentrate wastewater or a product.

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How we work

ONE STOP SHOP

FEASIBILITY STUDIES

BENCH SCALE & PILOT RESEARCH

ENGINEERING

TURN KEY DELIVERY

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BLUE-tec Testing Facilities

MEMBRANE TESTING FACILITY

BLUE-tec's membrane testing facility is designed for upscaling investigations and feasibility studies. The heart of the testing facility, a flexible platform for Forward Osmosis (FO) modules, allows to test different modules, sizes, and types of membranes.

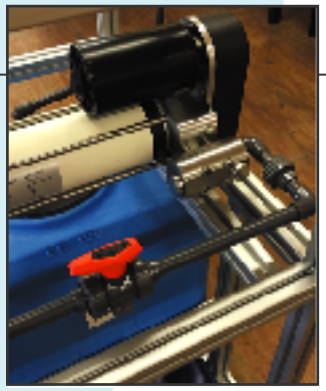
We have designed Reverse Osmosis (RO) and Membrane Distillation (MD) systems as draw recovery technologies. Both are suitable for independant use and at the same time able to work with our FO setup.

A typical test setup includes hollow fibre or flat sheet membranes of up to 7m^2 and a suitable draw recovery system.

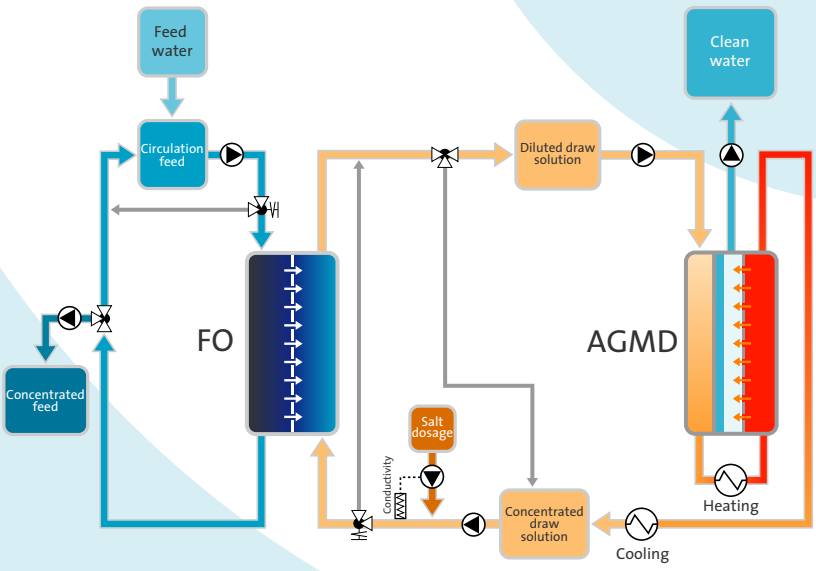
WHAT WE PROVIDE

- Testing of FO systems
- RO or MD technologies as draw recovery
- Testing of stand alone RO or MD systems
- Test unit for membrane contactors
- Photometer laboratory analyses (inhouse) of parameters such as COD, Ammonium, Phosphate

YOUR PROFIT



- Feasability study with real water from your facility. Data of the whole process line, beginning with your water and ending with a concentrated stream and clean water stream.
- Data on membrane flows, COD rejection, membrane fouling, draw recovery performance, and salt leakage (RSF).



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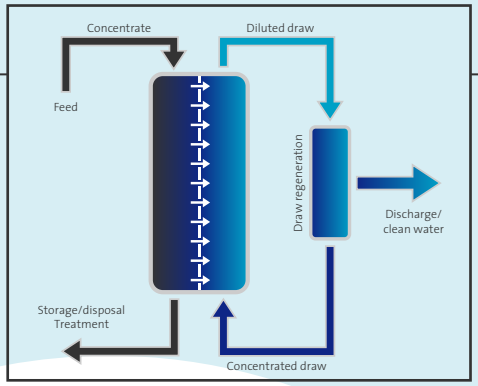
Technologies

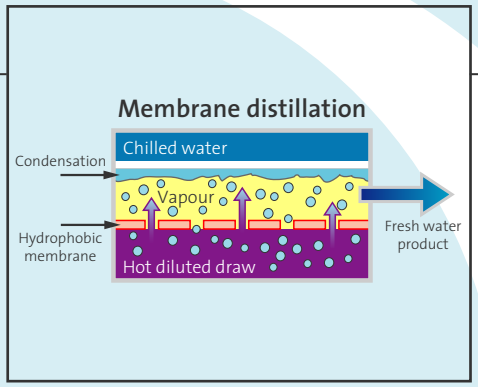
FORWARD OSMOSIS

Forward Osmosis (FO) is based on the principle that water permeates from a liquid with low osmotic pressure to a liquid with high osmotic pressure, seperated by a semi permeable membrane.This mechanism takes place in all living cells.
This process doesn't require any energy or pressure. FO is a low fouling separation process. FO membranes rejects organics, minerals and other solids, similar to RO, but do not have the typical fouling problems.



MEMBRANE DESTILLATION

In membrane distillation (MD) water permeates though a hydrophobic membrane by difference in vapor pressure, which is obtained by temperature difference. The difference in vapor pressure allows water as a gas to pass the membrane pores while liquid water molecules are rejected by the hydrophobic membranes.

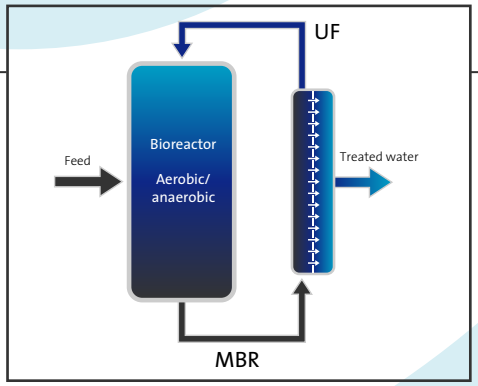


PRESSURE DRIVEN MEMBRANE PROCESSES

Microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO) are pressure driven processes. By applying pressure the water flows through the membrane and components with a certain size are retained.

MEMBRANE BIOREACTORS

In membrane bioreactors (MBR) membrane filtration is combined with a biological process for the membrane filtration a pressure driven membrane such as UF, but also FO, the Osmotic Membrane Bioreactor (O-MBR) can be used. The biological process can be either aerobic or anaerobic. Advantage of the O-MBR is the low fouling tendency of the FO membrane and the excellent treated water quality after the RO-process ready for reuse.



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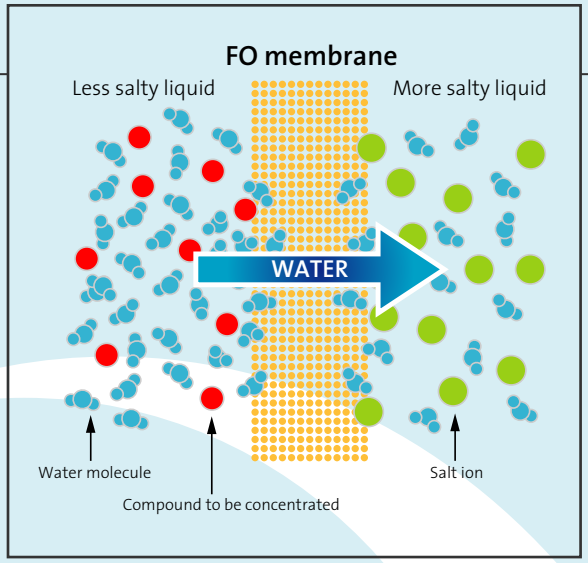
Forward Osmosis

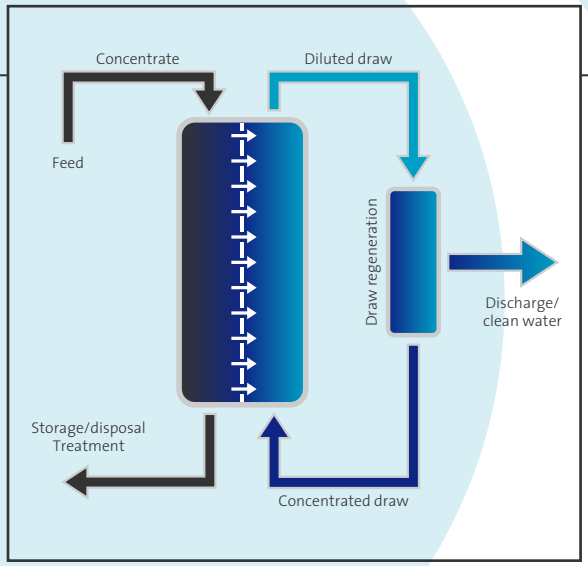
PRINCIPLE

Forward Osmosis (FO) is based on the principle that water permeates from a liquid with low osmotic pressure to a liquid with high osmotic pressure, seperated by a semi permeable membrane. This process happens spontaneously without any energy or pressure. FO is a low fouling separation process. FO membranes rejects organics, minerals and other solids, similar to RO, but doesn't have the typical fouling problems.



PROCESS

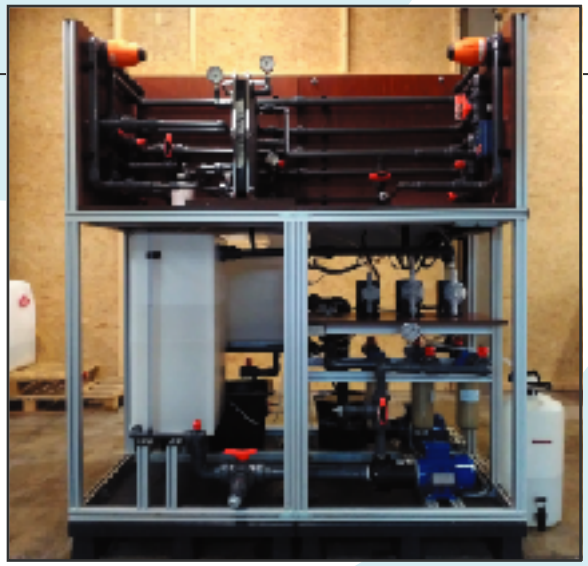
The high osmotic solution which draws the water from the feed is called draw solution. As a result the draw solution is diluted so it's necessary to recover it. This can be done by different technologies such as RO or MD. The outcome of this process is a concentrated draw and clean water.



APPLICATIONS

FO can be used in many processes, such as:

- Concentration in the food and beverage industry
- Concentration of high fouling wastewater (oil & gas, landfill leachate, chemical wastewater)
- Zero Liquid Discharge (ZLD)
- Direct concentration of wastewater with recovery of water, biogas and nutrients
- Cooling towers
- Osmotic-MBR



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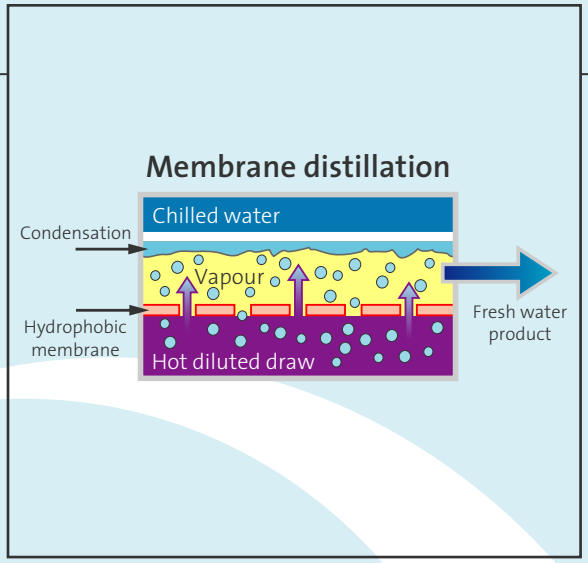
Membrane Distillation

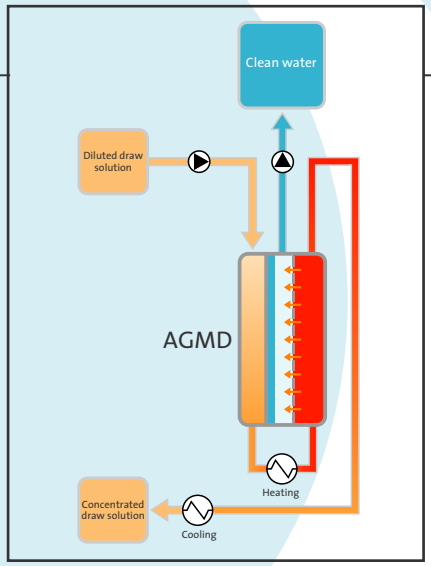
PRINCIPLE

In membrane distillation water is transferred though a hydrophobic membrane by difference in vapor pressure. The driving force of this process is a temperature difference. The difference in vapour pressure allows water in gas form to pass the membrane pores while water molecules are rejected by the hydrophobic membranes.



PROCESS

There are several configurations of MD. BLUE-tec uses mostly AirGapMD (AGMD) for a high energy recovery. MD can run on low grade (waste) heat of 80 C, and therefore very suitable for industrial applications, or off-grid applications where waste heat from Combined Heat and Power (CHP) units can be used.



APPLICATIONS

In a FO-MD setup MD is used for draw solution recovery. In the FO-MD combination high concentration factors can be achieved or feed solutions with an already high osmotic pressure can be treated. Salt concentrations above 180 g/l can be reached.

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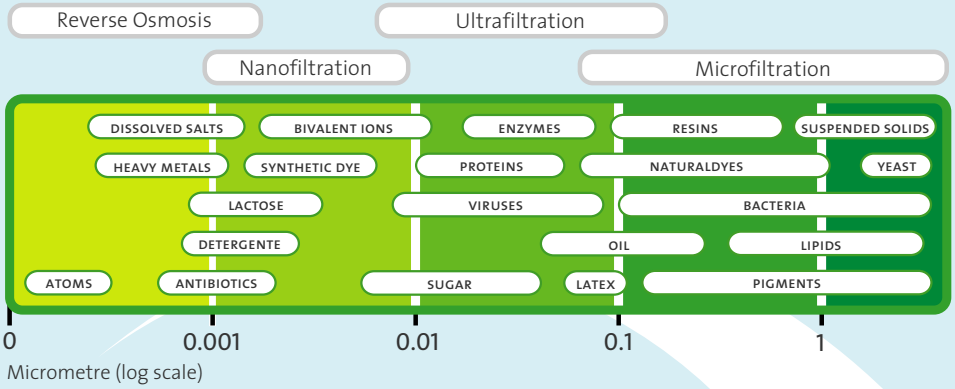
Pressure Driven Membrane Processes

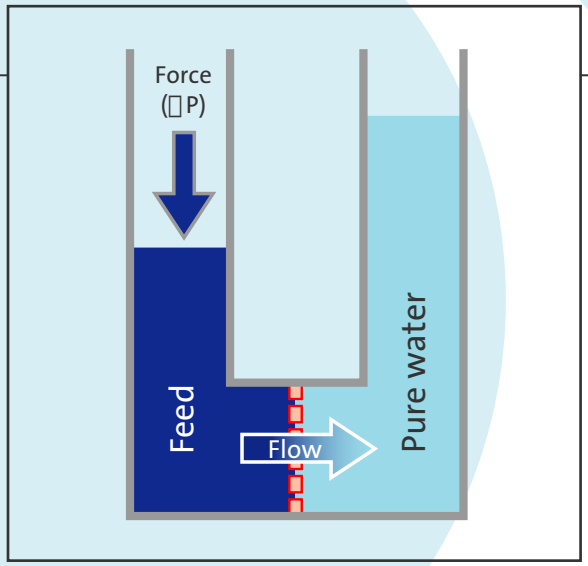
PRINCIPLE

Microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO) are pressure driven processes. By applying pressure the water flows through the membrane and components with a certain size are retained. The figure shows the size of components rejecting each type of membrane.



PROCESS

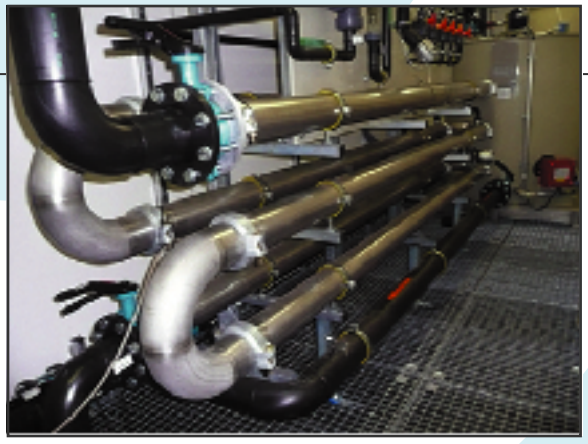
The pressures applied in the pressure driven membrane processes vary from 0,2 till 60 bar. In Reverse Osmosis the applied pressure has to be higher than the osmotic pressure of the feed solution in order to separate the water from this solution.



APPLICATIONS

Pressure driven membrane processes are used in many applications to remove dissolved or undissolved particles. Some examples are:

- Membrane bioreactors
- Effluent polishing
- Reverse Osmosis (RO) in combination with Forward Osmosis (FO)



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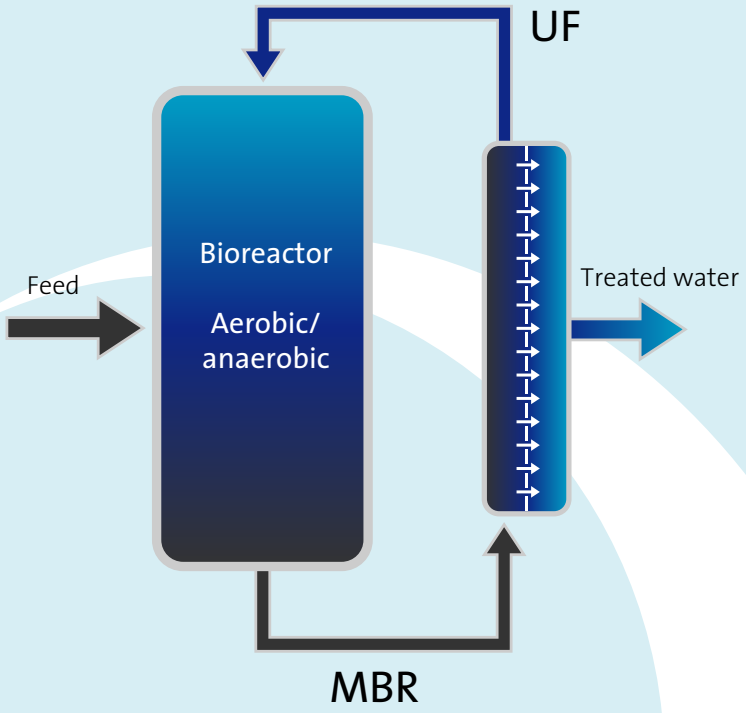
Membrane Bioreactors

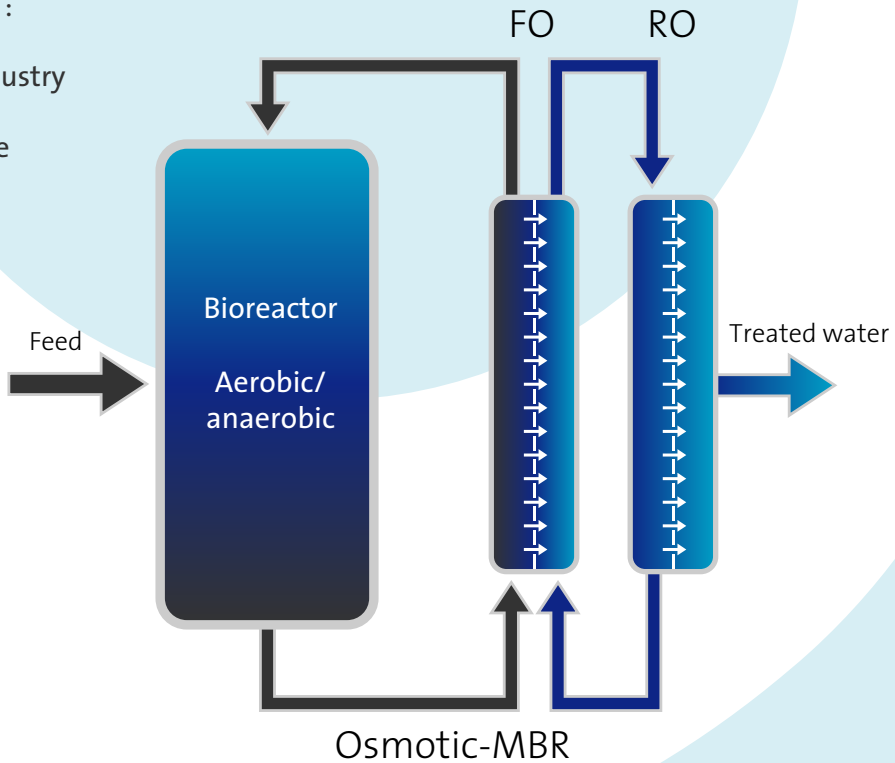
MEMBRANE BIOREACTOR (MBR)

Advantages of MBR processes are:
- Small foot print due to high biomass concentrations
- Excellent treated water quality
- Low sludge production



OSMOTIC-MEMBRANE BIOREACTOR

(O)MBR's can be applied for the treatment of :
- Industrial wastewater
- Wastewater from the waste processing industry
- Domestic wastewater
- Wastewater on board of ships and off shore locations (without RO)



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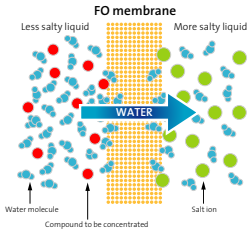
Early Adapter Project: Forward Osmosis

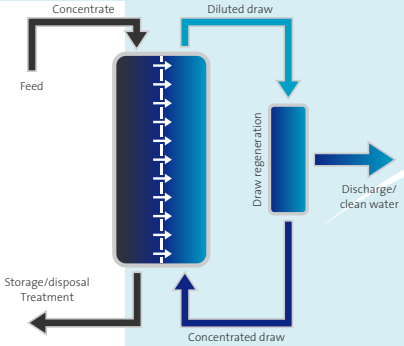
Concentration of liquids and recovery of clean water and/or raw materials

PROJECT DESCRIPTION

The project is focused on developing the commercial use of forward osmosis to concentrate highly fouling streams. Forward osmosis differs from traditional membrane filtration technology in its resistance to fouling and it doesn't use any mechanical pressure or heat for the separation. This opens concentration possibilities where classical technologies fail, such as reverse osmosis or evaporation.



Forward osmosis principle

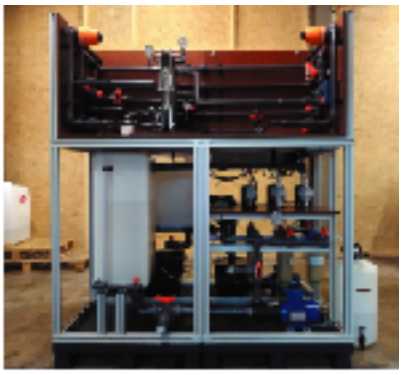


Forward osmosis with draw solution recovery

FO-RO AND FO-MD PILOT PLANT

BLUE-tec has constructed a pilot plant testing the feasibility of forward osmosis for these different applications, after which the results will be evaluated for use in scale-up calculations.

The pilot plant has a 1 to 7 m^2 FO membrane. For the recovery of the draw solution reverse osmosis (osmotic pressure till 60 bar) and membrane distillation (osmotic pressure till 200 bar) are used.



FO-MD pilot unit

RESULTS

The pilot tests confirm the low sensitivity for fouling of the FO membranes. By simple osmotic backwash without chemical cleaning the original flux of the membrane could be restored easily.

Tests are performed with different feed solutions having different concentration factors and for the draw solution recovery either RO or MD are used.

BACKGROUNDS FORWARD OSMOSIS

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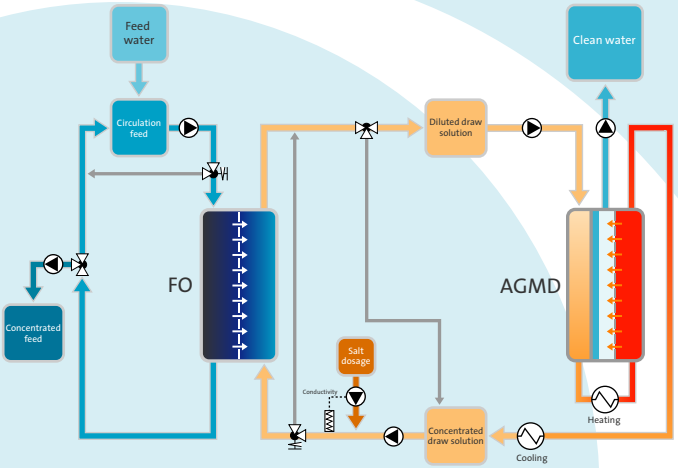
The high osmotic solution is called draw solution. During the FO process the draw solution gets diluted by the extracted water from the feed. Further treatment is needed in order to recover the draw solution. In this project Reverse Osmosis and Membrane Distillation are applied for this.

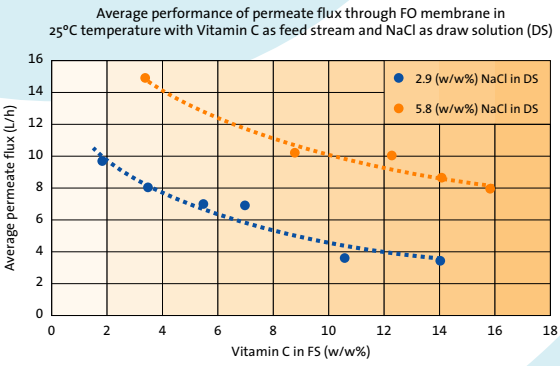


Forward Osmosis with Air Gap Membrane Distillation flow diagram

PILOT TEST

Four different types of industrial feed streams are tested for up concentration using FO:

- The concentration of Vitamin C for DSM.
- The concentration of whey for FrieslandCampina.
- The concentration of food industry wastewater, whereby opportunities to reuse the purified water and to extract biogas from the concentrate will be explored for Marfo.
- The concentration of the produced water released during oil extraction for Shell and Gaz de France.



Membrane flux in relation to the feed concentration at different draw solution concentrations

DSM | FRIESLANDCAMPINA | MARFO | SHELL | GAZ DE FRANCE | ISPT | NL GUTS | RIJKSDIENST VOOR ONDERNEMEND NEDERLAND

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