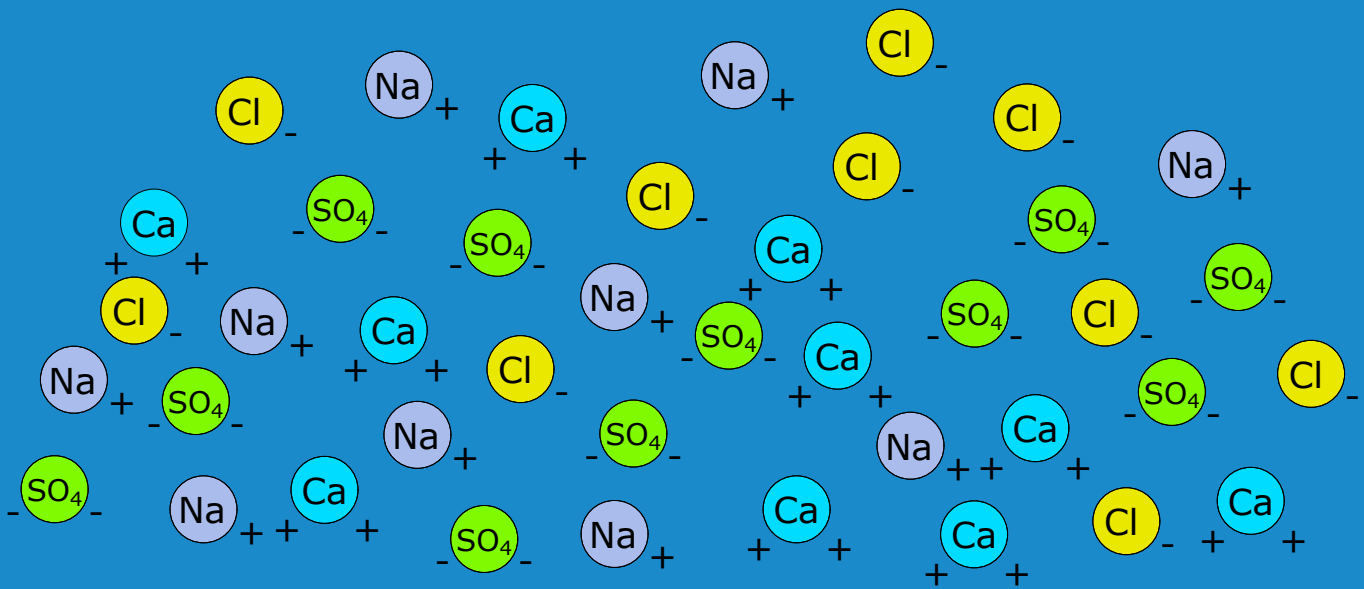




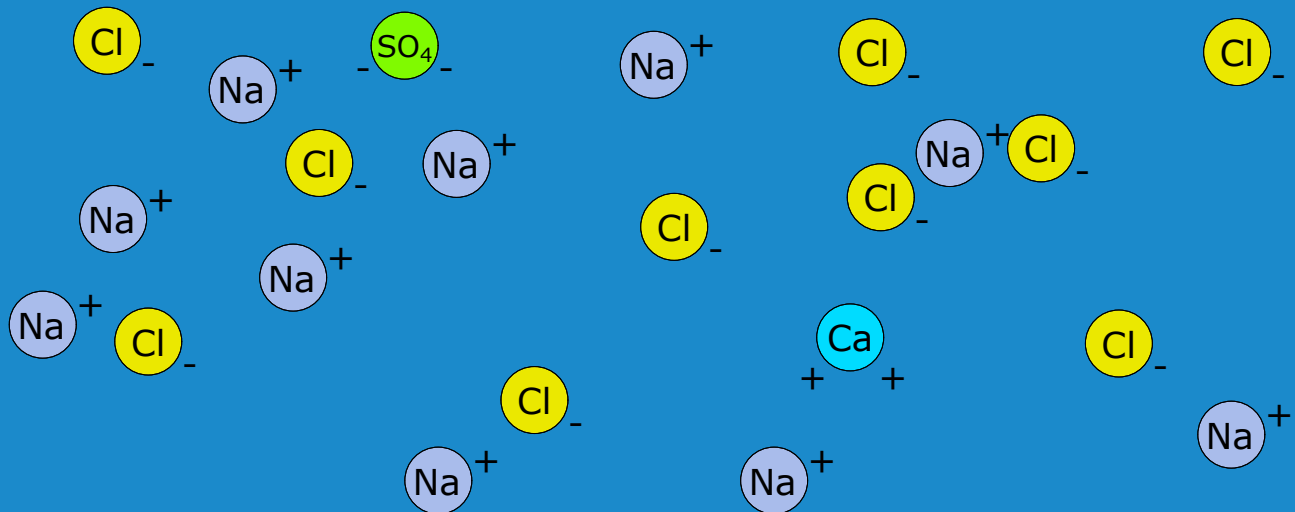
ROCHEM

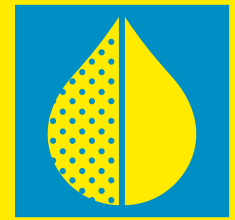
RO- Water Treatment

Nanofiltration



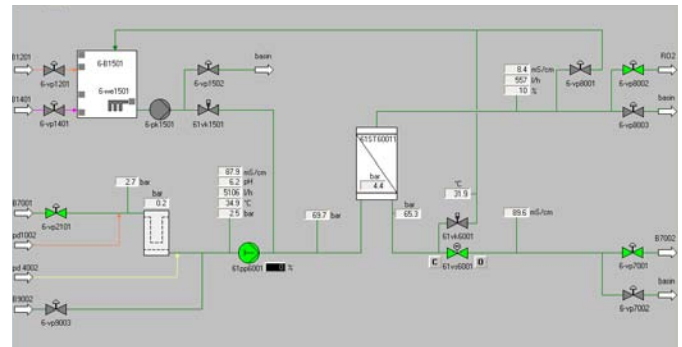
M e m b r a n e



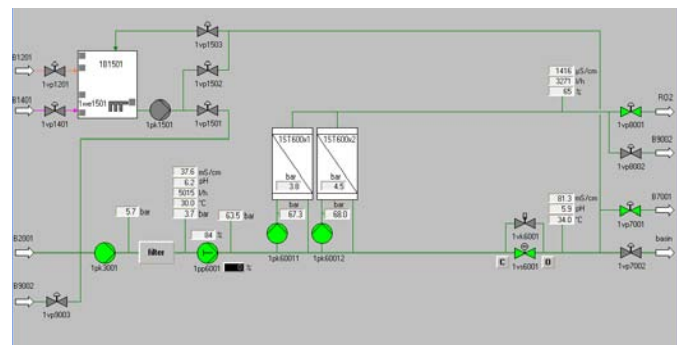


The rejection capabilities of Rochem nanofiltration membranes, especially the targeted removal of compounds which limit recovery, make a wide range of applications feasible. By combining this with seeding and a hydrocyclone the efficiency is even further enhanced for:

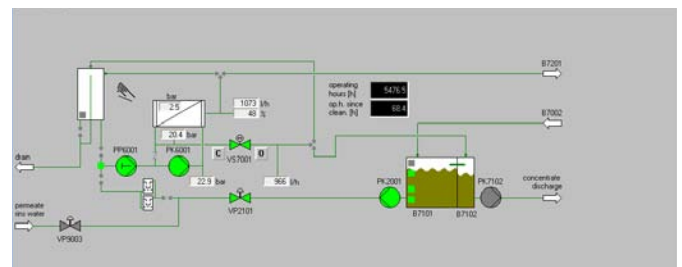
- Minimization of concentrate volume of reverse osmosis systems, especially systems treating landfill leachate.
- Treatment of acid mine drainage (AMD)
- Water softening
- Industrial waste water treatment, including:
 - Acid and caustic recovery
 - Agrochemical
 - Food and beverage
 - Chemical manufacturing
 - Pharmaceutical manufacturing
 - Pulp and paper industry
 - Textile manufacturing
- Municipal water color removal



Visualization Leachate Stage



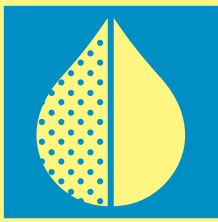
Visualization Concentrate Stage



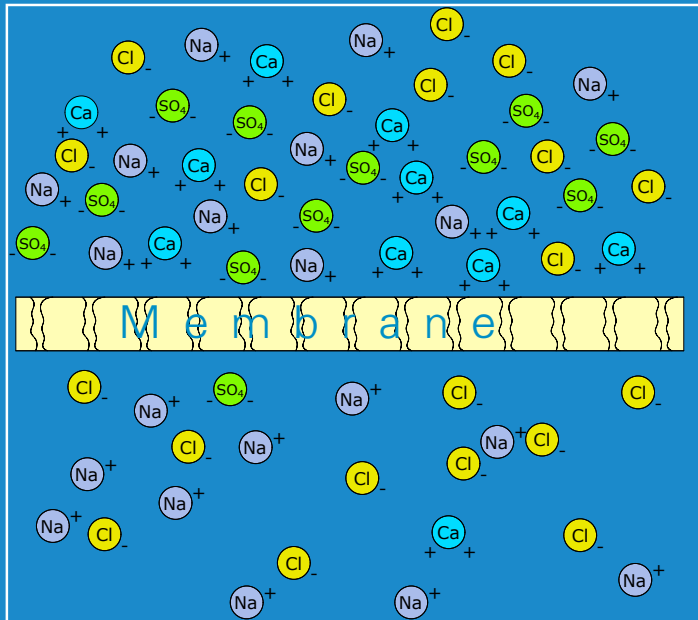
Visualization Nanofiltration



containerized NF Nanofiltration plant on a landfill site in Spain



Nanofiltration



Nanofiltration is a pressure driven separation process. The most important feature of nanofiltration is the significantly different selectivity for monovalent and divalent ions. This selectivity is due to the special structure of the membrane itself. Rochem has taken this selectivity one step further:

While rejection of chlorides is very low (typically 10 to 30% for NaCl), the rejection of sulfates is very high (typically 95 to 98% for CaSO_4 in a binary solution.)

No other nanofiltration membrane achieves this low level of NaCl rejection, while maintaining the highest flux of any thin film composite.

THE MEMBRANES

Rochem thin-film-composite nanofiltration membranes offer high chemical stability over wide pH and temperature ranges. This allows operation in applications with difficult process conditions. The low rejection of monovalent ions, such as sodium and chloride, reduces their impact on the osmotic pressure. Thus, the required operation pressure of the system is reduced. Nanofiltration membranes operate in the pressure range of 10 to 40 bar (150 to 600 psi) compared to reverse osmosis membranes that operate at 60 to 70 bar (850 to 1,000 psi) and up to 120 bar (1,750 psi) in special cases. The lower operating pressure significantly reduces energy consumption and operating costs, minimizing the carbon footprint of the system.

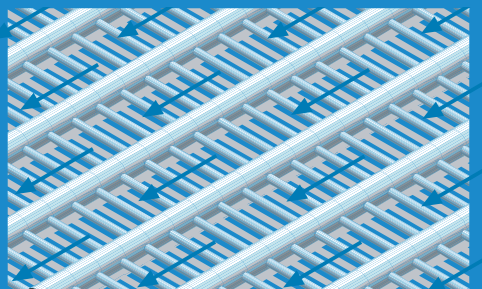
THE ROCHEM SPACER TUBE MODULE

Successful operation of membrane systems in wastewater requires special modules. An "open channel" design allows better control of the formation of boundary layers on the membrane during operation. It also allows for efficient cleaning of the membranes when required.

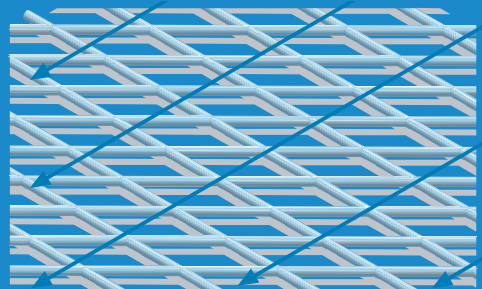
The patented ROCHEM Spacer Tube module has many unique advantages including the "open channel" design. The ST module has been successfully installed for many applications since 2002, including landfill leachate treatment by reverse osmosis.

The same ST module equipped with nanofiltration membranes provides the enhanced capabilities needed for successful sulfate separation in wastewater treatment. This application demands a system strength and chemical stability.

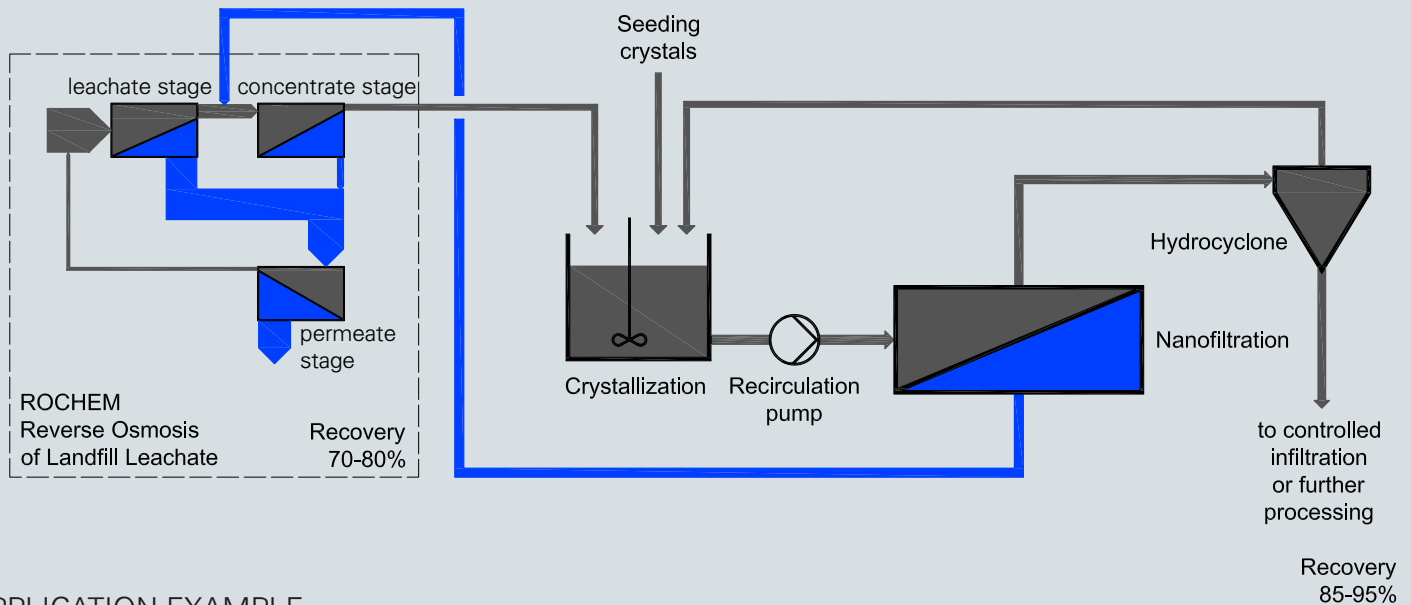
spacer for "open channel" membrane



conventional spacer



Flow diagram for the ROCHEM Nanofiltration combined with crystallization and hydrocyclone



APPLICATION EXAMPLE

The design and construction of the Rochem modules and systems allow for the use of nanofiltration for the purification of wastewater and process water in a wide range of industries. Installed as one step in a hybrid process or as a cascaded operation, Rochem systems can be tailored to meet nearly any treatment requirement.

Applications exist in acid and caustic recovery, agrochemical, food & beverage, chemicals, pharmaceuticals, pulp & paper and textiles.

Cutting-edge applications based on the sulfate removal capability of nanofiltration membranes can be applied to the treatment of acid mine drainage (AMD) and the minimization of concentrate from the treatment of landfill leachate with reverse osmosis.

Volume minimization of concentrate from the purification of landfill leachate with reverse osmosis using nanofiltration

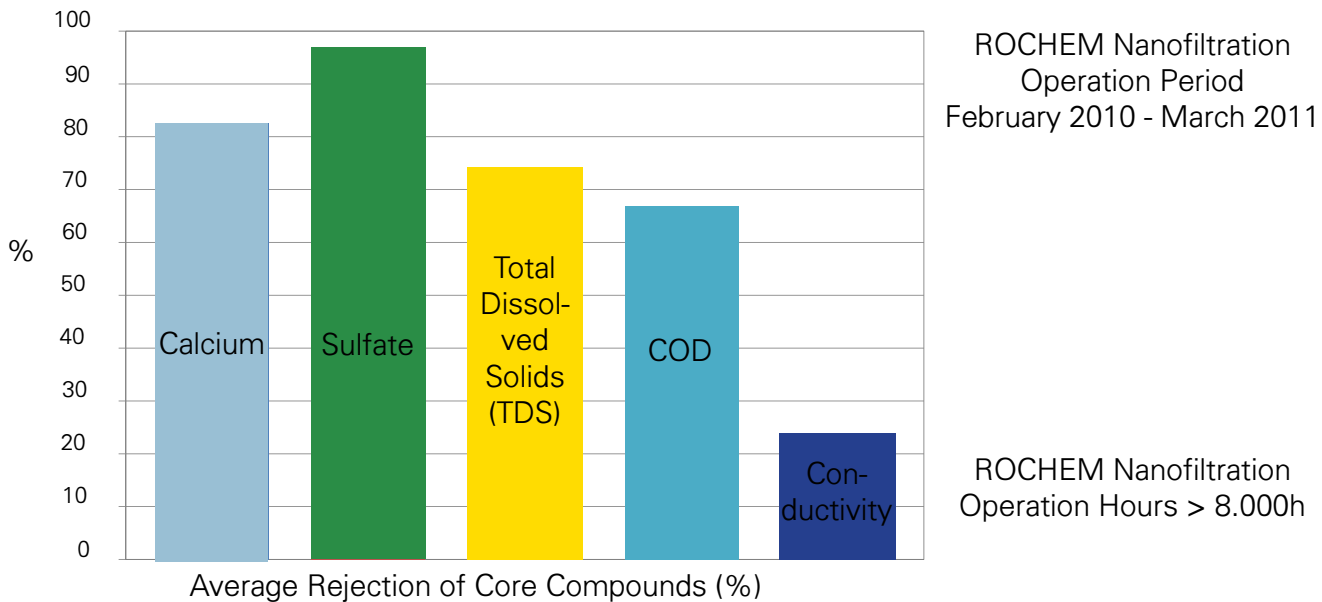
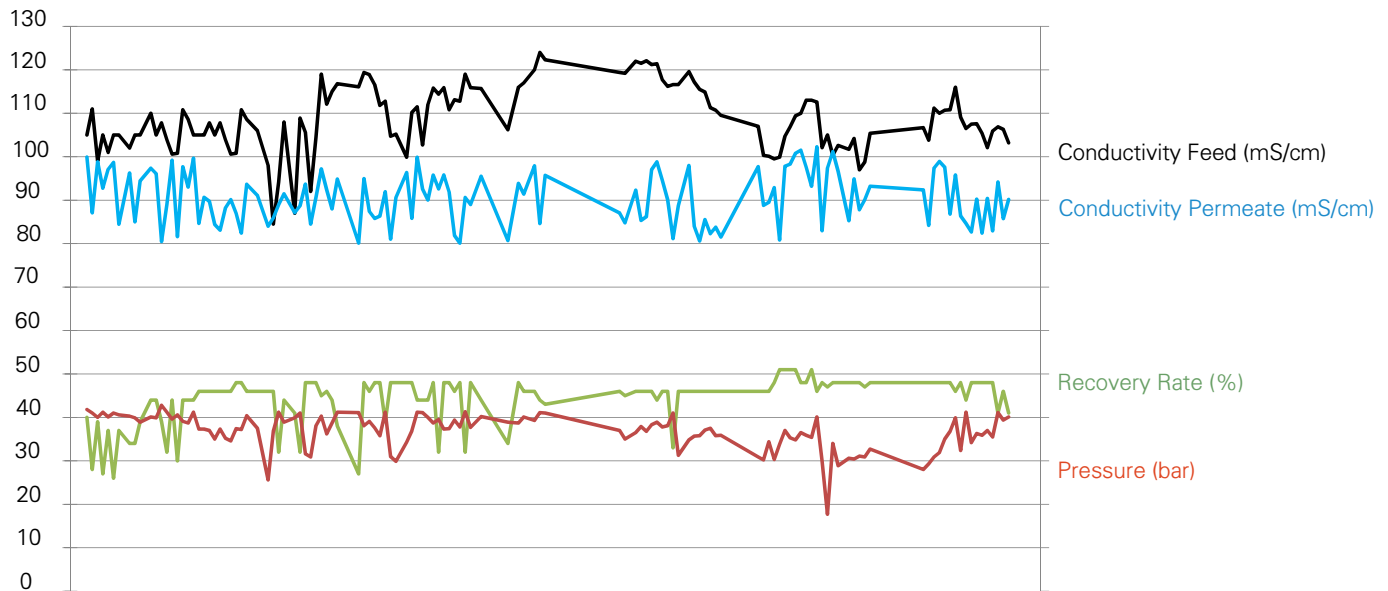
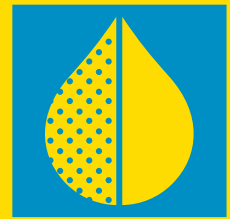
Using nanofiltration, the concentration of the retentate can be increased to the point where crystallization of CaSO_4 does occur downstream of the membrane elements.

In combination with seeding technology and a hydrocyclone this effect can be used to separate selectively the scale forming components from a wastewater stream and allow for further treatment of this water with membrane technology. This minimizes significantly the volume of contaminated wastewater, resulting in a dramatic increase of the total permeate recovery rate.

Together with the precipitated inorganic components, organic components will also be separated in the hydrocyclone from the main stream. The remaining fluid can be used e.g. for controlled infiltration into the landfill body.

CaSO_4 crystals in sludge after hydrocyclone and drying



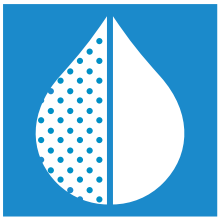


Rochem's advanced nanofiltration process significantly increases the permeate recovery rate and reduces the volume of concentrate. Depending on the chemistry of the untreated leachate, the volume of concentrate produced can be reduced by at least 50% from the volume of a single pass RO treatment, thus improving leachate management and reducing operating costs.

Nanofiltration technology applied to landfill leachate treatment is part of an environmentally friendly and sustainable treatment system.

The chemically stable Rochem nanofiltration membranes and the "open-channel" ST elements provide a process that:

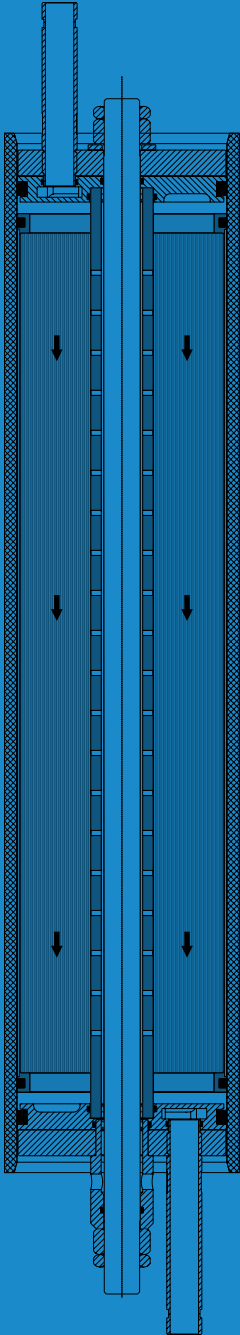
- Is a careful and effective use of assets and resources
- Minimizes the burden on the environment
- Is commercially feasible and affordable.



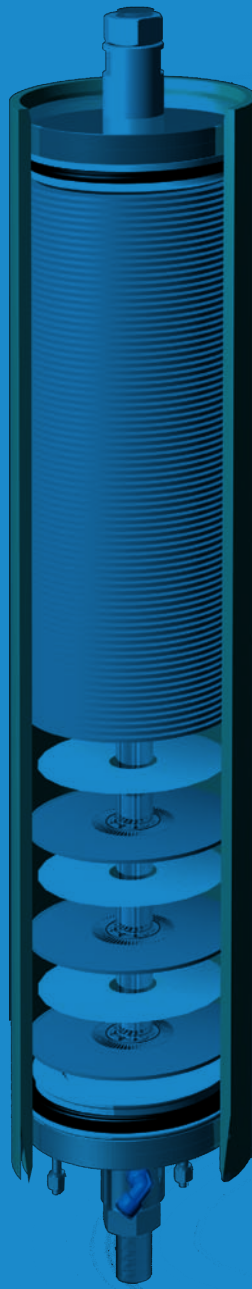
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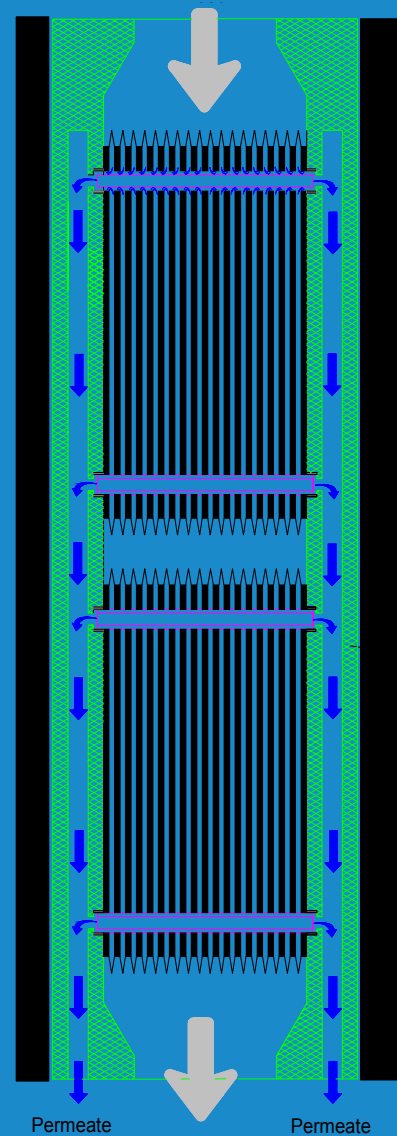
ST- Module
Reverse Osmosis
Nanofiltration



PT- Module
Reverse Osmosis
Nanofiltration



FM- Module
Ultrafiltration
Nanofiltration
Low pressure RO



ROCHEM has been manufacturing
Membrane Systems since 1982.
Use our experience - others do.