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Technical Services

RAIN

CONTAMINATION

TREATMENT OF LANDFILL LEACHATE BY MEMBRANE FILTRATION

CLEAN WATER

WASTE WATER TREATMENT

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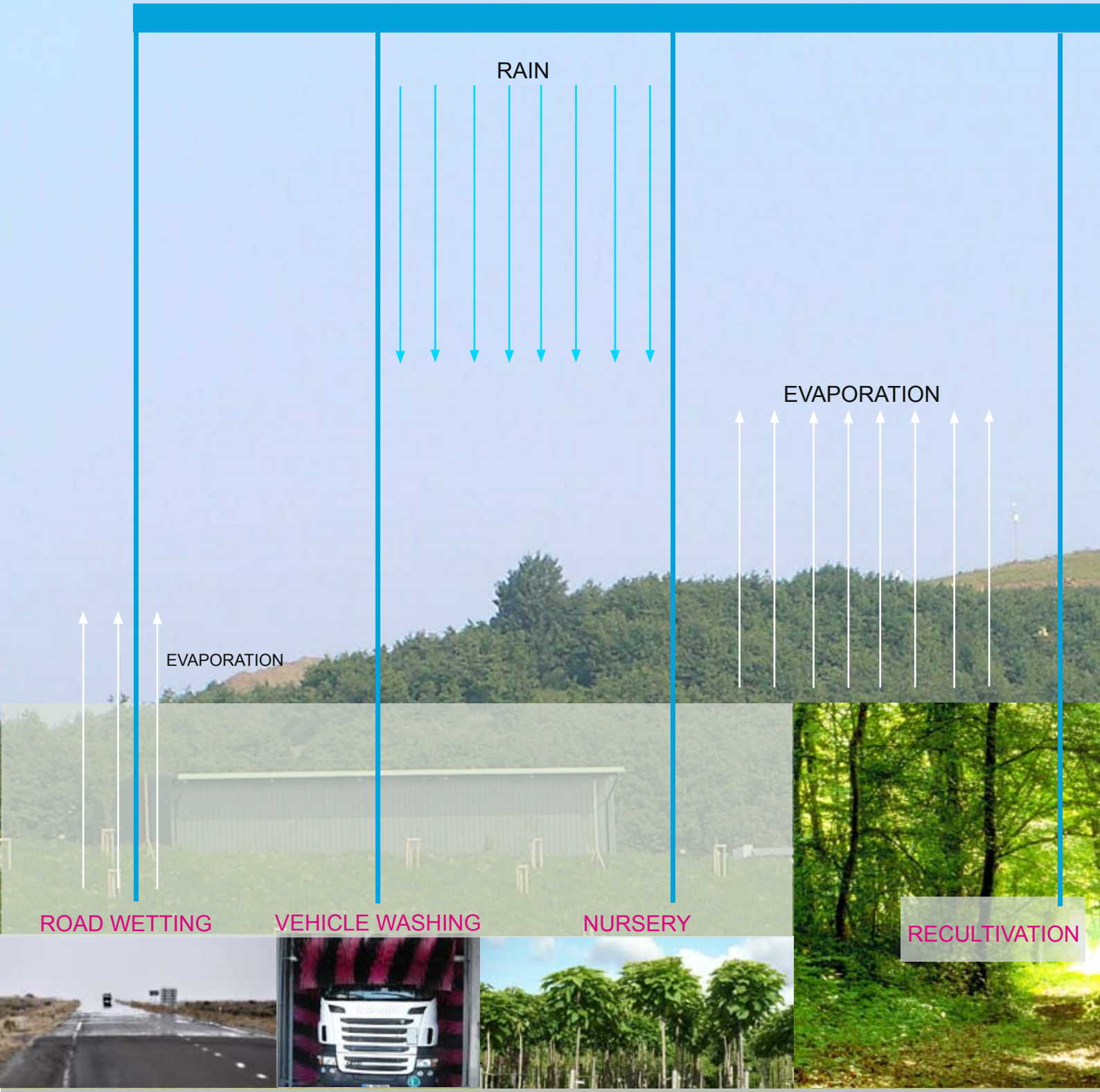
PURIFICATION OF LANDFILL LEACHATE WITH REVERSE OSMOSIS



LANDFILL LEACHATE IS LIQUID POISON

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S AND CONTROLLED INFILTRATION OF LEACHATE RETENTATE

PERMEATE

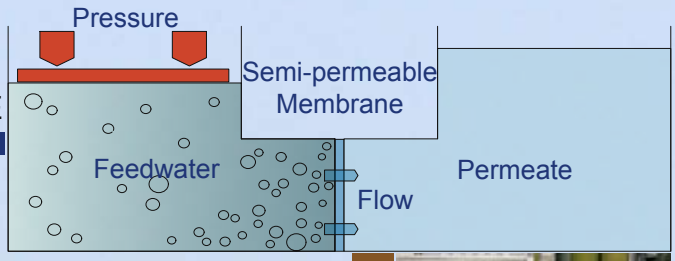
PERMEATE

80%

FLYASH

SLUDGE

REVERSE OSMOSIS



RETENTATE = CONCENTRATE

10%

SOLIDIFICATION OF CONCENTRATE

CONTROLLED INFILTRATION OF CONCENTRATE

LEACHATE BUFFER TANK

How does Reverse Osmosis work?

Pressure is applied to saline water to force the pure water molecules through a semi- permeable membrane. The majority of the dissolved salts, organic material, bacteria and suspendend solids are unable to physically pass through the membrane and are discharged from the system in the rejected brine.
The pure water is then ready for use without further treatment.

LANDFILL AS SOURCE OF LIFE

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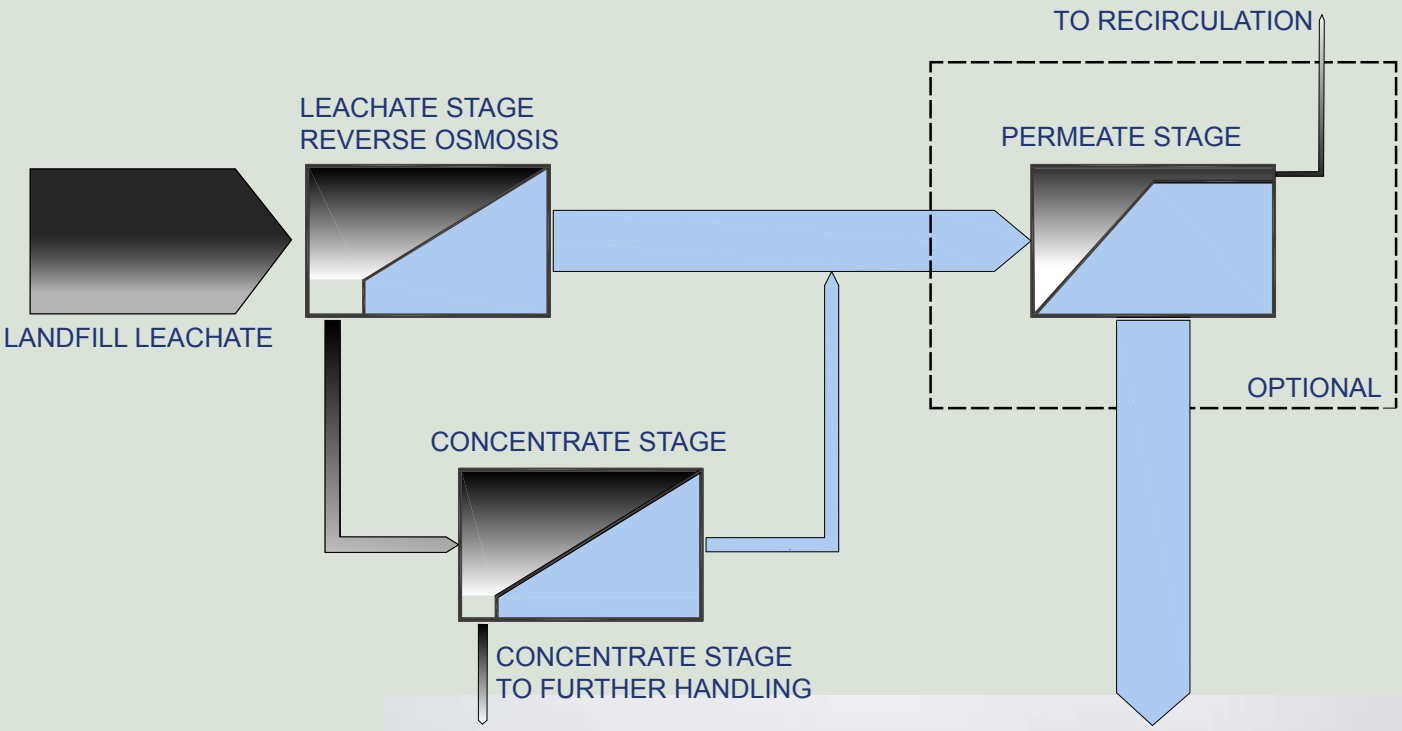
HANDLING OF LEACHATE CONCENTRATE

The purification of landfill leachate with membrane technology helps to avoid further contamination of resources such as groundwater and surface water.
Beside the ecological aspect of minimalizing the burden on the enviroment, the economical feasibility also has to be taken into consideration. In this regard membrane filtration has proven to be a justifiable and economic solution in most cases. This is true even when the overall costs for the purification are compared with alternative approaches for the treatment of landfill leachate.



LANDFILL LEACHATE

CLEAN WATER AFTER RO

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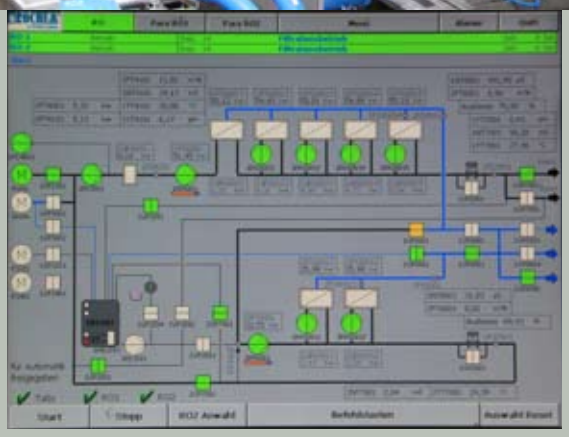

CUSTOMISED PLANTS FOR LEACHATE AT WASTE SITES

Rochem reverse osmosis plants for the treatment of landfill leachate are designed in standarized systems. The plant concepts are based on many years of broad experience in the treatment of leachate.

Various plant concepts can be supplied as the basic units for the treatment of leachate- with completely automated plant control, measuring equipment, prefiltration, cleaning system and high pressure aquipment with all the pipework, fittings and valves ready for operation.

The basic sections are designed as the first stage for the treatment of leachate.

Because of the problems associated with the varying quantities and qualities of leachate, the plants` operating parameters can be adjusted to deal with different flows.

The plant components are of optimum size and well matched to one another, and economical in operation.

The varlous ranges of modules provide substantial plant size flexibility during the planning and design phases. The standardized and modular designs permit accurate investment requirements and thus prevent excessive investment.

When designing the plant for landfills with large leachate yields, it is necsssary to investigate whether it would be advantageous to use a design with two or three reverse osmosis plant sections connected in parallel. This allows part-load operation and the highest possible level of rellable plant availability.

If the quality of the treated water from single stage operation does not meet the requirements, a second RO stage can be fitted downstream without the need for technical alterations. The technical designs in a second RO stage correspond to the existing Rochem Reverse osmosis standard plant range. They are available up to an untreated water capacity of 12.500 l/hour.

ROCHEM ALWAYS OPTIMISE THE TECHNOLOGY

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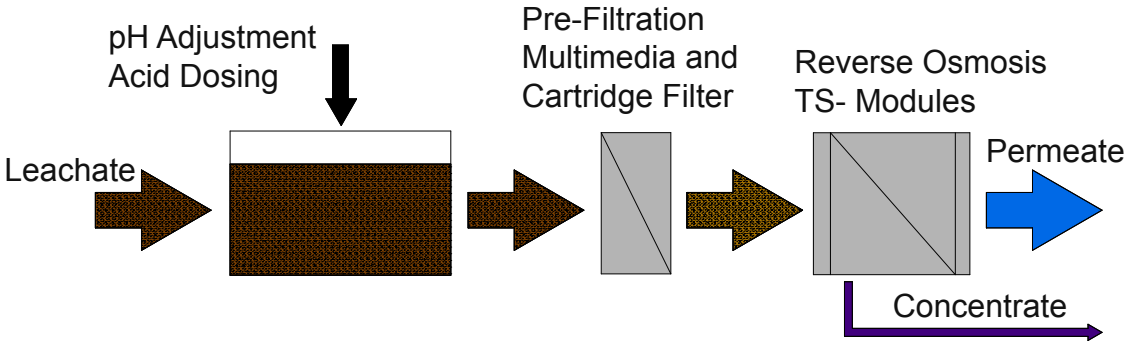
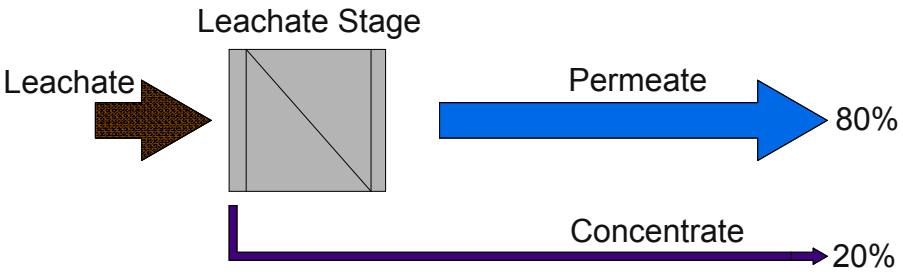
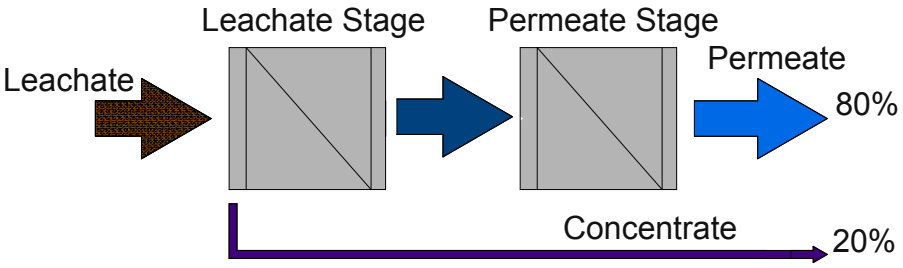
PRINCIPLE OF LEACHATE TREATMENT WITH REVERSE OSMOSIS



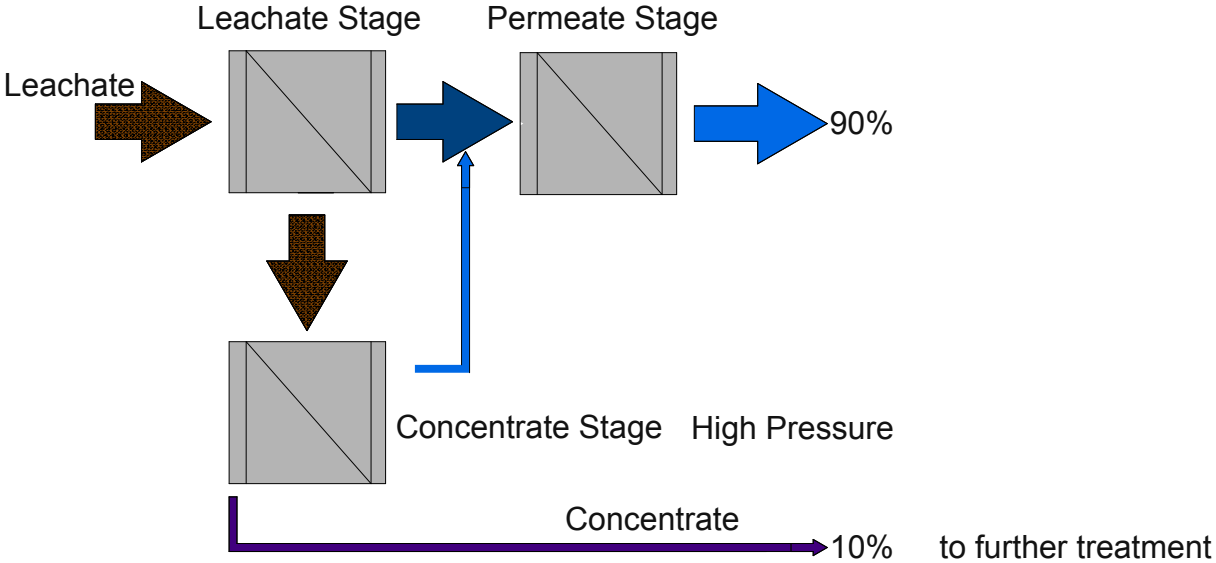
Leachate Stage for High Permeate Quality



Leachate & Permeate Stage for Higher Permeate Quality



Leachate & Concentrate Stage for Reduced Concentrate Quantity



PRINCIPLE OF LEACHATE TREATMENT WITH ROCHEM TECHNOLOGY

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GALICIA SPAIN

SCHÖNBERG, Germany since 1992

SCHÖNBERG, Germany 2013

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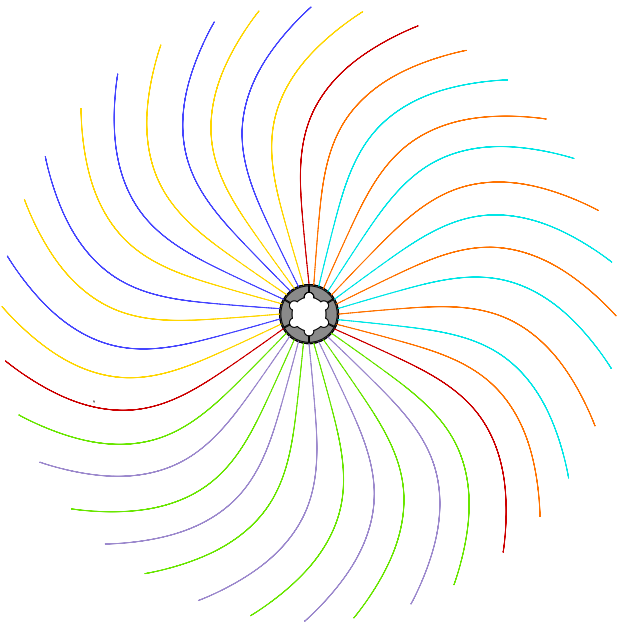
TRIPLE S/ TS MODULE

SELECTIVE SUBSTANCE SEPARATION

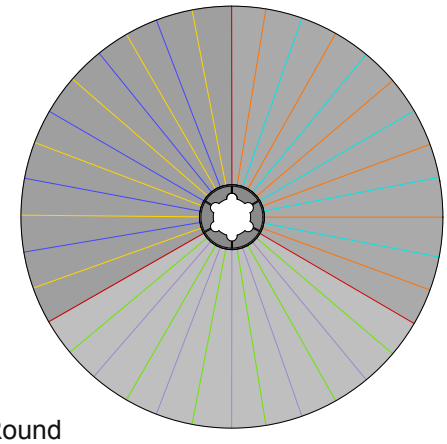
The significant difference to conventional spiral round modules is that Rochem Technical Services combines different feed channels, permeate carriers and membranes in one module element.

THIS IS NEW, developed by Rochem Technical Services

Rochem Technical Services is able to create a module especially for your requirements.



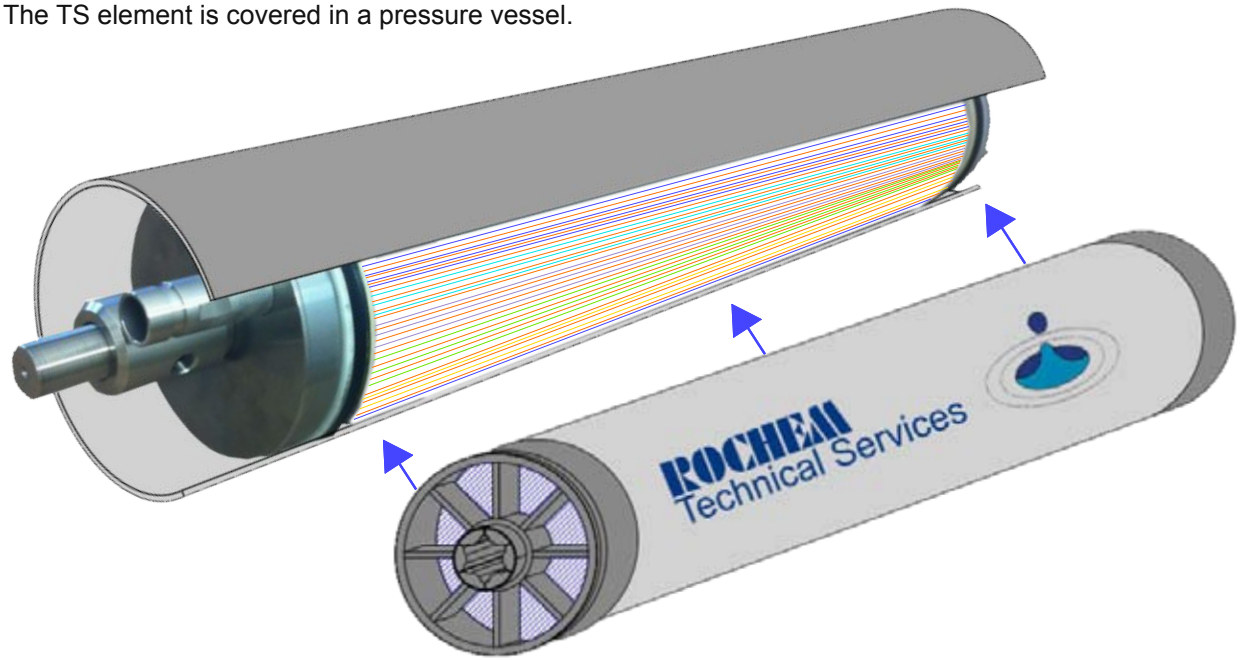
The module element can be split in parts.
Each part includes different feed spacers and membranes;
also the membrane cushion carriers can be different.
R.T.S. Rochem Technical Services has a lot of possibilities to find the ideal composition for your particular objectives.



Spiral Round

MEMBRANE- PERMEATE CARRIER- MEMBRANE / FEED SPACER

The heart of the TS module is the membrane element.This consists of membrane cushions and spacers wrapped in a tube element.The completed membrane element is then pushed on the rod-shaped permeate outlet and collecting device. The membrane element is provided with end flanges on both sides.The end flanges consist of at least one input for the feed medium to be separated and one output for the retentate. The border elements are kept sealed to the tube element. The TS element is covered in a pressure vessel.



ROCHEM TECHNOLOGY

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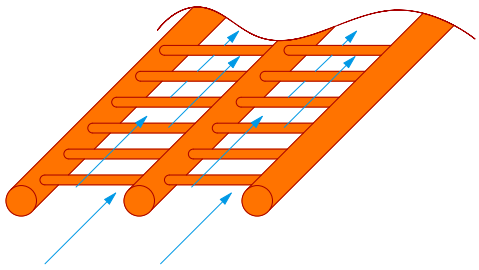
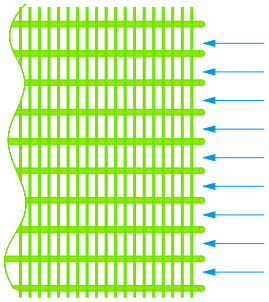
Feed Flow

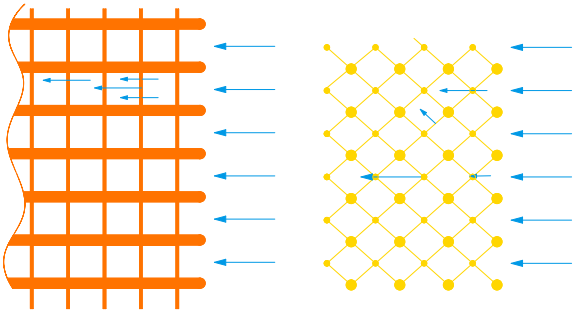
Different types and configurations/ open channel



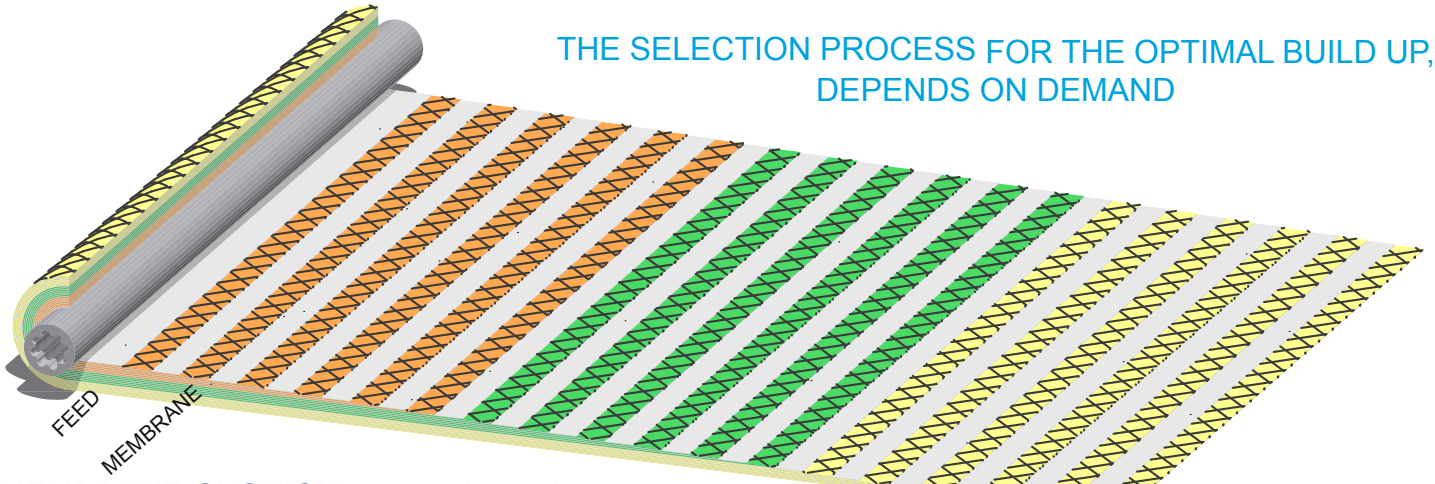
Parallel open channel



Diamond open channel

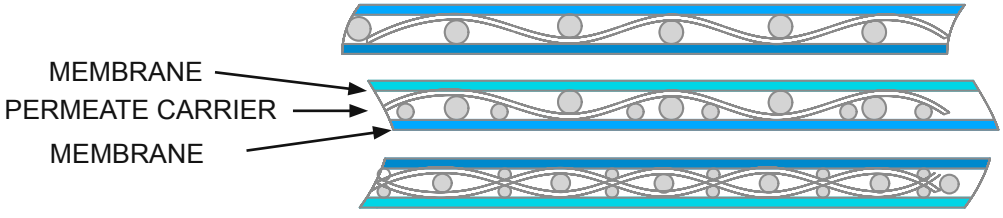


THE SELECTION PROCESS FOR THE OPTIMAL BUILD UP, DEPENDS ON DEMAND



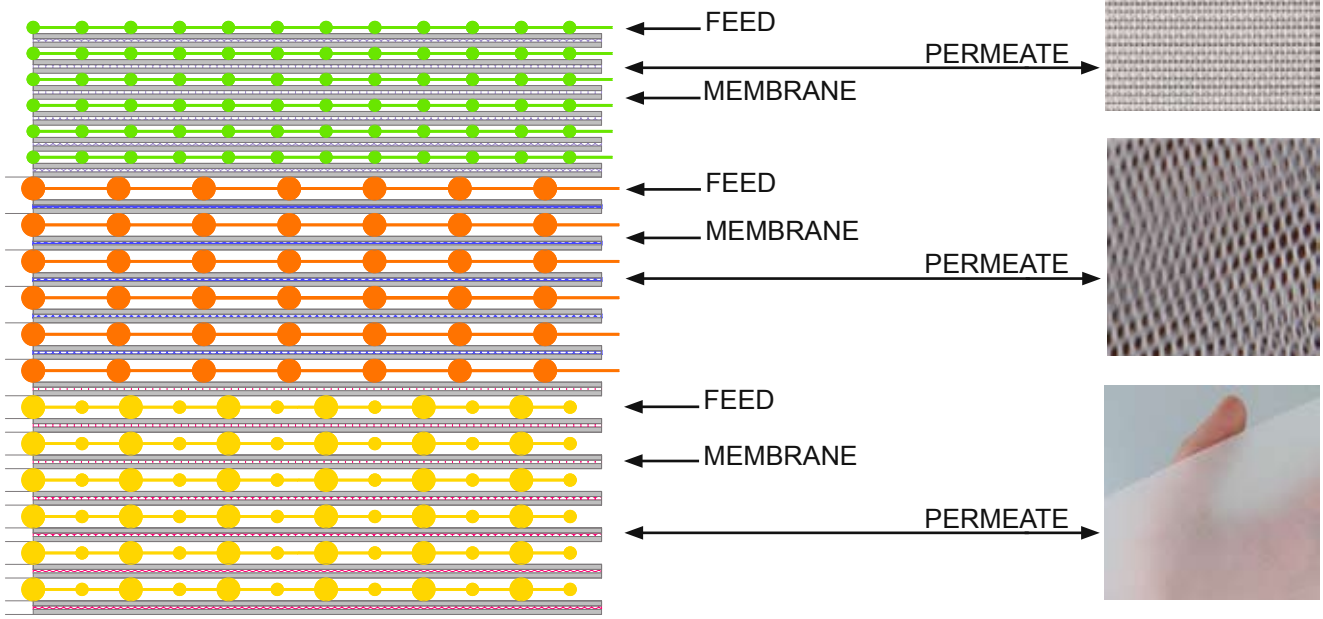
MEMBRANE CUSHION - open channel

For different applications from different materials. The membrane cushion is made up with a sheet known as the permeate carrier. This permeate carrier is sandwiched between two membranes. The outer diameter is sealed by ultrasonic welding of three or more sheets together.



Permeate Carrier

Different Types



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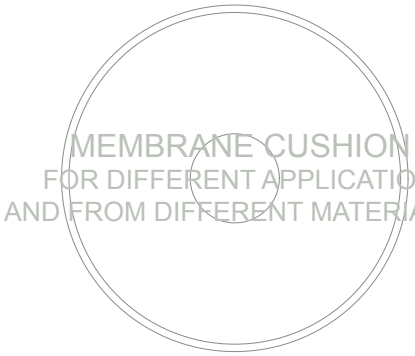
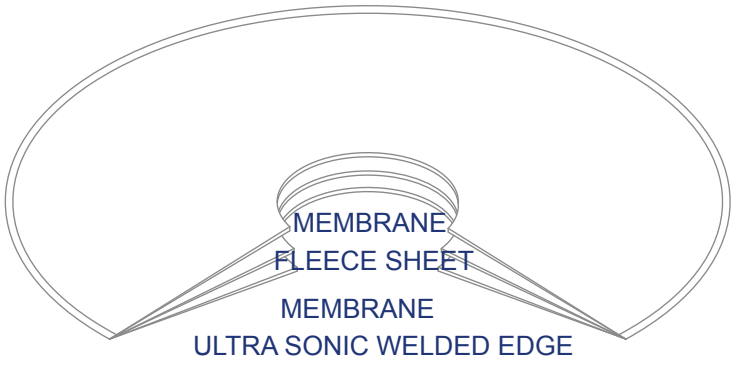
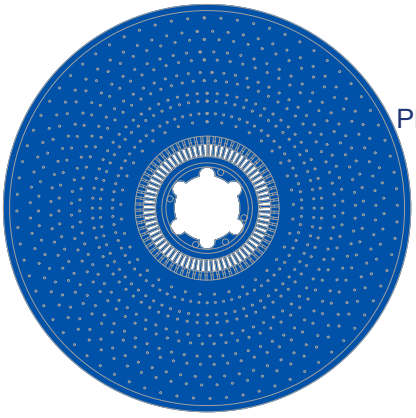
R.T.S. PF/ PLATE AND FRAME MODULE

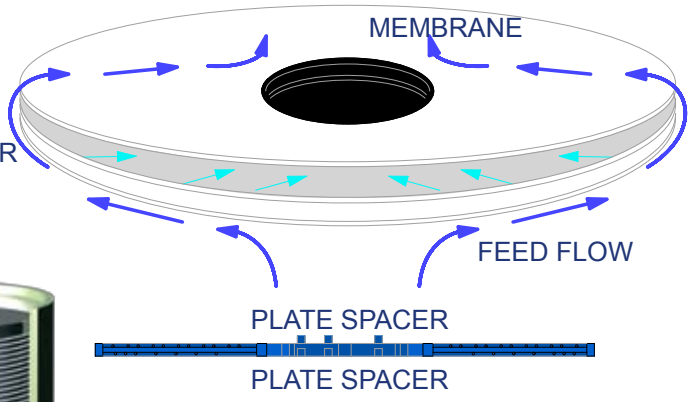
open channel

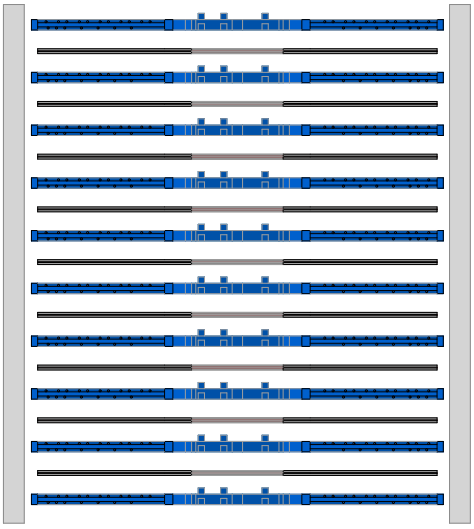




The membrane cushion is made up with a permeate carrier, this permeate carrier is sandwiched between two membrane sheets.The outer diameter is sealed by ultrasonic welding of the three or more permeate carrieres together. The centre hole allows the permeate to flow into the permeate flow channels.







Depending on the type of membrane, the selective separation of certain individual substances or substance mixtures is possible. Important technical applications include the production of drinking water by reverse osmosis and in waste water treatment.
With the help of UF and MF (Ultra/Microfiltration) it is possible to remove particles, colloids and macromolecules, so that waste-water can be disinfected in this way. This is needed if waste-water is discharged into sensitive waters.

PF/ PLATE AND FRAME MODULE

ROCHEM TECHNOLOGY

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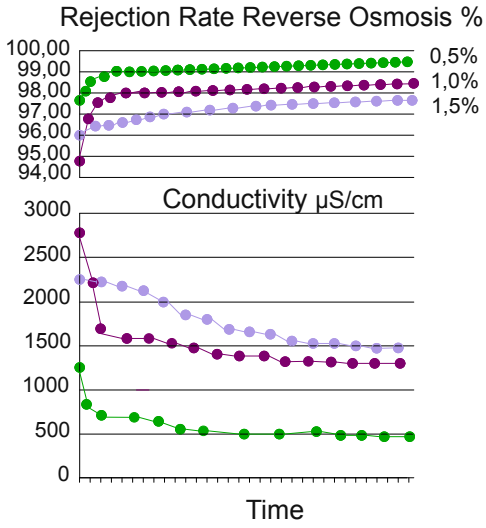
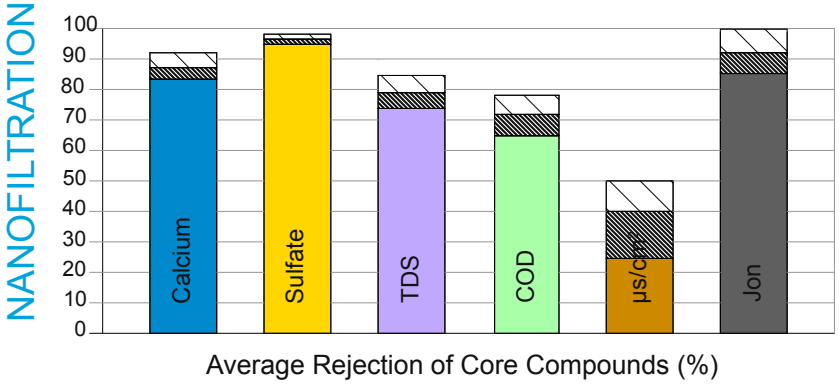
REVERSE OSMOSIS



NANOFILTRATION



Rochem advanced reverse osmosis and nanofiltration processes significantly increase the permeate recovery rate and reduces the volume of concentrate. Depending on the chemistry of the untreated feed water, the volume of concentrate produced can be reduced by at least 50% up to 90% from the volume of a single pass RO treatment, improving waste water management and reducing operating costs.
Reverse osmosis and nanofiltration technology applied to waste water treatment is part of an environmentally friendly and sustainable treatment system.
The R.T.S. reverse osmosis and nanofiltration membranes and the TS -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.

The R.T.S. “TS Triple S Modules“ and the R.T.S. “PF Plate and Frame“ modules are manufactured from the best and most sophisticated materials, for the customer´s application.
The pressure housing is made out of glass fiber up to 90 bar operating pressure and out of stainless steel up to 120 bar (316-316A). End flanges are made out of ABS, Ulfrem or stainless steel.

Membranes:

R.T.S. uses DOW Filmtec /GE-Osmonics/ Hydranautics for
- Micro-Ultrafiltration
- Nanofiltration
- Reverse Osmosis

USE OUR EXPERIENCE

ROCHEM WORKS A LONG TIME EFFECTIVE TOGETHER WITH THE TECHNICAL UNIVERSITY OF BERLIN AND HARBURG

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How does Reverse Osmosis work?

For the production of extremely pure water, PF/ TS Membrane modules apply the reverse osmosis method.
It is a reliable separation method based on a phenomenon frequently encountered in nature, - osmosis - which describes the interaction between a weakly concentrated aqueous solution and a more highly concentrated solution which are separated by a semi-permeable membrane.
The membrane is permeable to water molecules, while salts and other constituents of the water are blocked. The semi-permeable membrane permits diffusion of the water from the lower-concentration side to the higher-concentration side until an equal salt concentration is obtained on both sides (osmotic equilibrium).
For reverse osmosis, pressure is applied to saline water to force the pure water molecules through a semi-permeable membrane. The majority of the dissolved salts, organic material, bacteria and suspended solids are unable to physically pass through the membrane and are discharged from the system in the rejected brine. The pure water is then ready for use without further treatment.

The ROCHEM Plate and Frame PF Module and TS System - A major Advance in Reverse Osmosis Technology.
Rochems plate and frame module technology has created major advances in the field of REVERSE OSMOSIS and its use in the desalination and purification of seawater, brackish water and city water.
The Plate and Frame Module (PF) is a major advance from the plate module technology which was originally developed by the West German Research Centre (GkSS).
The patented PF Membrane-Module is a modern design for desalination and purification of liquids. It operates effectively and economically even at increased turbidity and Silt Density Index levels for reverse osmosis.
The successful development of the PF/ TS module was only made possible by a precise technical approach in developing the total RO system. ROCHEM possesses the rare capability of being both the module manufacturer and the systems manufacturer.
This dual capability, plus direct contact with the end user, is of great advantage to the customer.

Why is the ROCHEM PF/TS Module System the best choice in RO?

Firstly, the patented fluid dynamics and construction of the open channel, unrestricted and fully turbulent feedwater flow systems means that suspended solids carried in the feedwater cannot be trapped or easily settle out inside the membrane module. Most importantly, it also means that the infrequent and highly succesful maintenance cleaning of the membranes can be achieved using a standard inbuilt cleaning system.
Secondly, ROCHEM is committed to the use of only the highest quality of components, materials and methods of design and construction to ensure for the end user 24 hours per day reliability and product water quality.
Advantages of the ROCHEM PF/ TS Module RO System minimises membrane scaling and fouling. While the performance of other types of RO systems can be limited by membrane scaling and fouling, the unique fluid dynamics of the Rochem system have resolved this problem to an easily controllable degree.
Simplified pre-filtration
The open Channel ROCHEM RO PF/ TS module can operate without problems on filtered feedwater with a Silt Density Index (SDI) as high as 15. Other systems specify SDI limits as low as 3.
While simple sand filters and cartridge filters can easily achieve the SDI limits of the Rochem system, the much lower limits required by other membrane systems can only be achieved by more complex filtration and chemical treatments.

ADVATAGES OF ROCHEM SYSTEMS:

Low energy costs
High recovery rates
Long membrane life

The combination of low membrane scaling and fouling, highly stable membranes, and a simple and effective inbuilt cleaning system means that membrane life-expectancy is normally not limited by feedwater pollution in the Rochem sytem. Useful membrane life of 5 years or more has proved to be a realistic figure.

High quality product water/ Latest membrane technology

ROCHEM RO systems use the latest technology, chemically stable, thin film composite (tfc) membrane materials. In addition, the use of membranes in sheet form means that we can select and accurately control the quality of the installed membrane to ensure minimal salt passage to consistently produce high quality permeate.

Fail-safe unattended operation

The only moving part in the system is the pump and all operating functions are automatically controlled and failsafe. No special skills are required to operate the system.

Compact and flexible modular units

The truly modular design and construction of all standard ROCHEM RO units simplifies transportation and installation and enables flexible use of limited floor space.

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The most economical and environmentally friendly way to treat landfill leachate is to reduce it‘s volume by 75 to 80% using reverse osmosis and then return the concentrate to the landfill by controlled reinjection.
If this procedure is not always allowed by local authorities then the treatment process must achieve very high rates of recovery by using a combination of reverse osmosis and nanofiltration by ROCHEM technology.

ROCHEM HAS BEEN MANUFACTURING MEMBRANE SYSTEMS SINCE 1982

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Reverse Osmosis for the purification of landfill leachate.
Due to the ability of modern high-rejection reverse osmosis membranes to retain both organic and inorganic contaminants dissolved in water at rejection rates of 98-99%, reverse osmosis is also useful for purifying liquid waste such as landfill leachate and for helping to solve the growing problem of water pollution.

On the feed- water side of the membrane, the dissolved organic and inorganic contaminants are concentrated in the retentate, where as the pure water is „pressed“ throught the membrane. Consequently with the reverse osmosis membrane a treated water stream - the permeate - is generated, which contains only very low levels of inorganic and organic contaminants.

These meet potable water standards, discharge of this water to the next river or aquifer contributes to maintenance of the natural equilibrium as this leachate was originally mainly clean rain water.
As the reverse osmosis membrane is operating like a well defined barrier, the purification process itself can be controlled continuosly and with a high degree of security by the simple and precise meansurement of the electric conductivity of the permeate.

Furthermore, the membrane process of reverse osmosis offers a high operating stability, as the start- up and shut-down of the respective plants is switch- operated and carried out in a few minutes. Also the stand-by of such systems for short or even long periods of time are easy to handle, as the purification process is activated only by a pressure produced by pumps.

Because of the high rejection rate for each kind of contaminant dissolved in the feed water, a high flexibility against changes of the concentrations of the compounds in landfill leachate is given. Therefore the permeate is always produced at the expected high quality, as this is based on a reproducable high purification efficiency.
The same flexibility can be stated for changes in the volume to be treated. The modular design of reverse osmosis plants allows for a quick increase or decrease of the purification capacity by adding or taking away modules.

However, in addition to requiring highly resistant membranes, the treatment of landfill leachate with reverse osmosis demands the use of open channel module systems that can be cleaned with high efficiency with regard to scaling, fouling and especially biofouling. Therefore tubular modules were the first medium used in the early reverse osmosis systems for the purification of landfill leachate starting in 1984.
An alternative was introduced to this market in 1988. The Rochem disc-tube-module (Plate and Frame- module) has been installed since then with great success.
This is proved by more than 100 plants that are in continuos operation - for many years and under rough working conditions - on landfill sites all over the world.

INTERNAL VIEW

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EXTERNAL VIEW, Vorketzin/ Germany
Container Construction

EXTERNAL VIEW, Schönberg/ Germany Hall Construction

SOLIDIFICATION OF CONCENTRATE

FLY ASH SILO MIXING EQUIPMENT
CONCENTRATE TANK

LEACHATE PROCESSING

Steady improvement of membrane technology has resulted in a high pressure reverse osmosis system based on the PF-module with operating pressures in the range of 120 bar and an adapted process to reduce certain salt fractions by controlled precipitation. High pressure modules are connected to a system of tanks where crystals of, for example, CaSO4 precipitate and are discharged continuously from the bottom of the tanks as sludge. In some instances, depending on the leachate, seeding nuclei may be added to promote crystallisation. With these developments, the limits for the recovery rate in landfill leachate permeate have been overcome and the concentration factor for the organic and inorganic matter dissolved in the landfill leachate was doubled. This means an increase of the permeate recovery from about 80%- related to a concentration factor of 5 to 90% recovery with a concentration factor of 10 for the contaminants retained by the membrane. Thus, the limit for the electric conductivity in the concentrate of a reverse osmosis plant was increased from 50,000 – 60,000 uS/cm (which is the limit of usual reverse osmosis systems) to the range of 100,000 to 120,000 uS/cm.

Due to the high volume reduction related to this increase of pure water recovery, this technology elimates the need for subsequent evaporation steps. After being processed with high pressure osmosis, the concentrate can then be fed directly into a dryer or a solidification device, or burned. Such high pressure reverse osmosis systems are in use at about 30 plants.
The high pressure operation opens new possibilities for the solution of separation problems in chemical engineering. In combination with seeding techniques, it can be used for further improvement of the permeate recovery. For example, the problems associated with the solubility of high concentration of calcium sulfate in one particular leachate are overcome by a controlled crystallisation. The crystals are separated from the concentrate – lowering the scaling potential and thus supporting a further concentration of the retentate – and deposited without problems on the landfill. With this procedure a permeate recovery of up to 95%, equivalent to a concentration factor of 20, can be made possible under certain circumstances. These have to be studied very well in each case to find the limiting factors and to be able to design the right solution.

VORKETZIN NEAR BERLIN; GERMANY 480 m^3 / day, > 90% pure water

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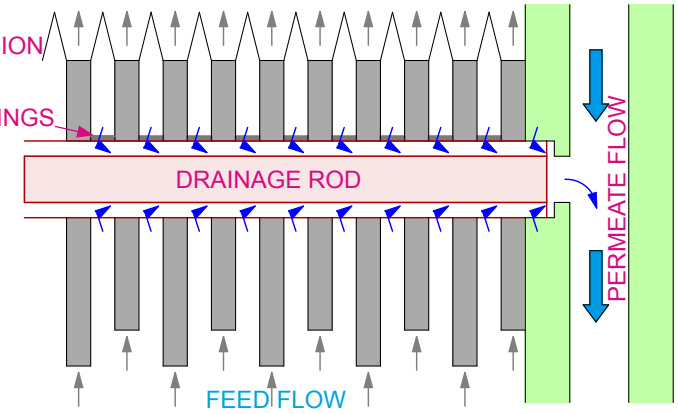
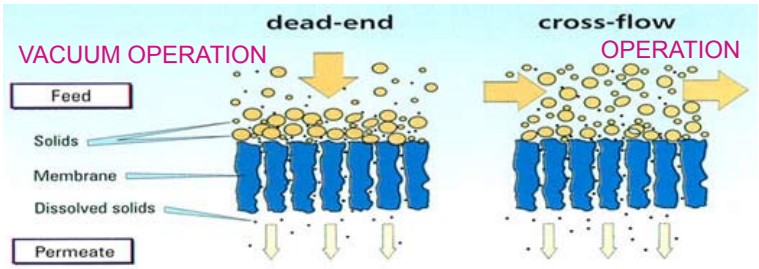
Enlarged Area, Axial Section

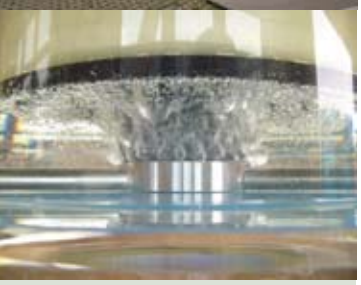




ROCHEM-UF modules (Flat Membrane) have been developed especially for the separation of bacteria, viruses and fine solids from water and wastewater with a high fouling potential. Most importantly modules exhibit low specific energy consumption at high and steady-state fluxes.
Unique is the possibility of an optimal adaptation of the free path feedside (distance between membrane cushions) to the individual case. This feature allows the application in a wide range of solid concentrations. The concept of a membrane cushion stack with completely open feed channels (no spacers or support plates) in combination with the straight-through feed flow combines the advantages of common tube and plate/frame systems. The placement of the modules in combination with a feedside air/water flushing allows membrane cleaning and a stable operation for long periods without use of chemical cleaning agents. In addition the wide spectrum of commercially available flat sheet membranes for ultrafiltration (UF), microfiltration (MF) and nanofiltration (NF) allows the optimal selection of a membrane for each individual application.

Principle of ultrafiltration

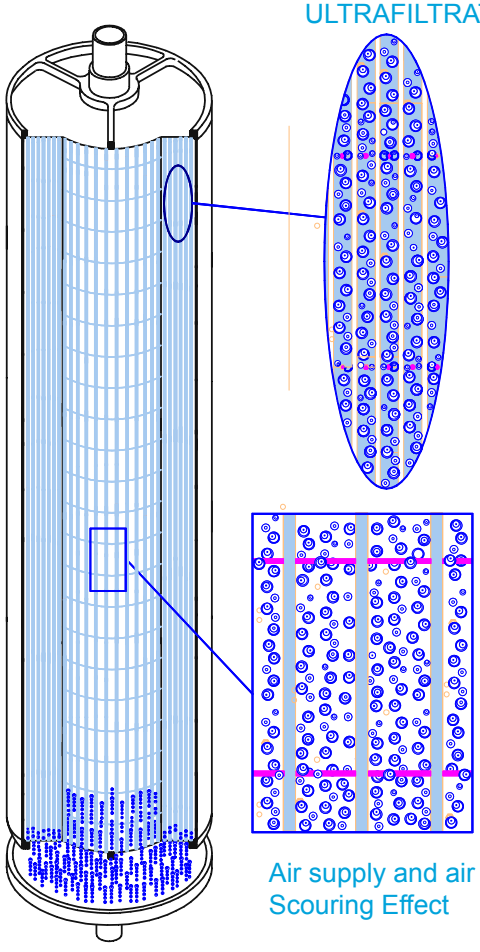
Ultrafiltration and Microfiltration are based on porous membranes. Particles larger than the poresize of the membranes are rejected. In practice even smaller particles are rejected because of the selectivity of the filter cake (gel layer) on the membrane surface. A gel layer cannot be avoided in dead-end operation and is observed in most crossflow applications. Ultrafiltration membranes form an absolute barrier for bacteria and viruses.



MEMBRANE CUSHION:

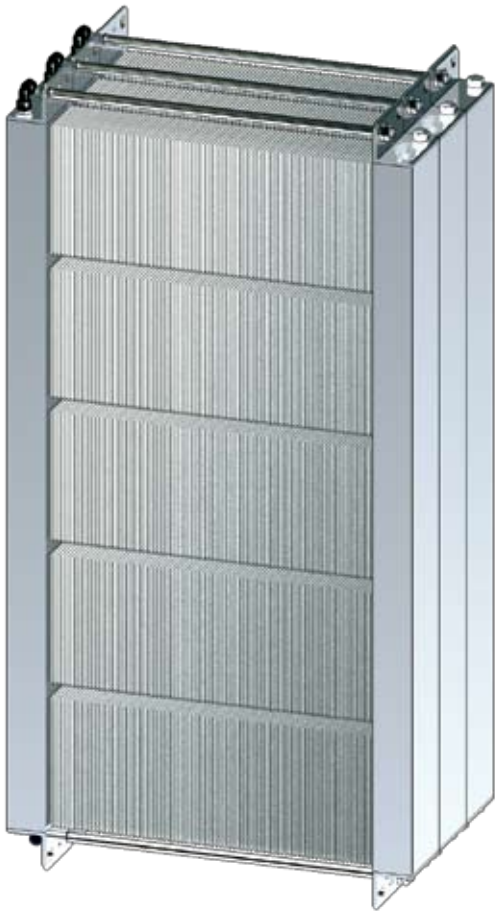
PFDF
PAN
or
CERAMIC

SM MBR- SYSTEM
MICROFILTRATION
ULTRAFILTRATION



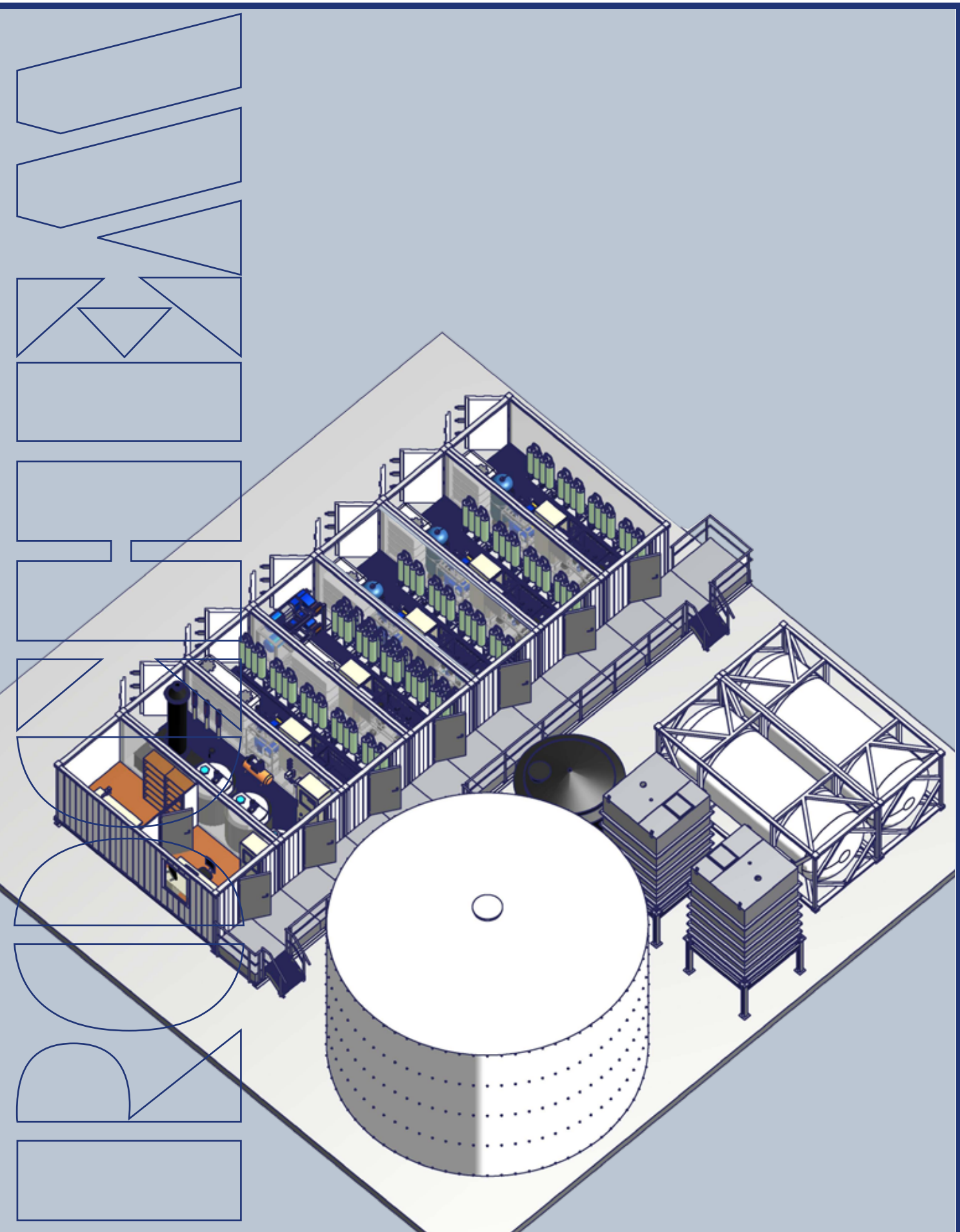
Air supply and air Scouring Effect

SV- MODULE
MICROFILTRATION
ULTRAFILTRATION



MEMBRANE: UF MF CERAMIC

ROCHEM®
Technical Services



USE OUR EXPERIENCE

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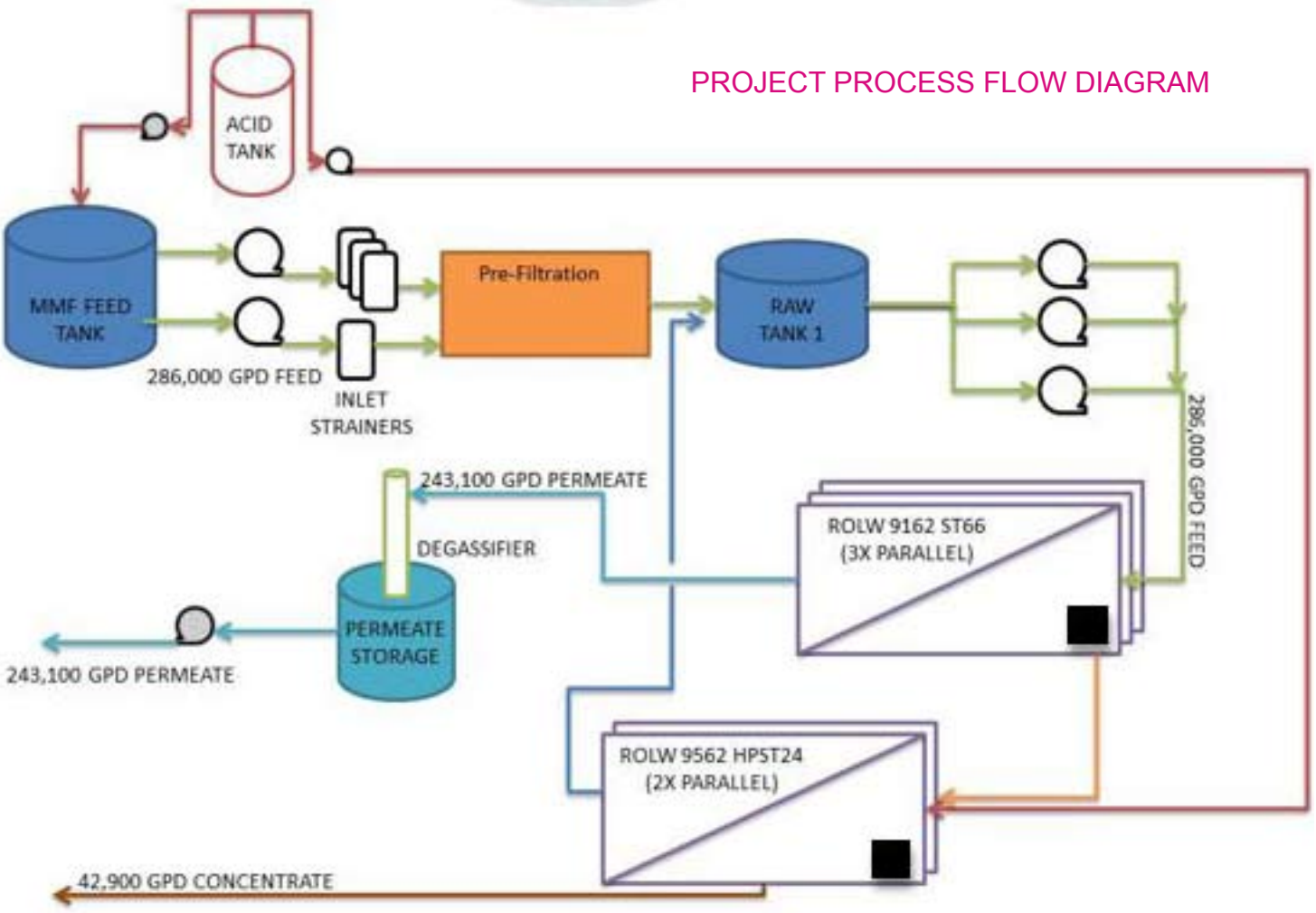
TYPICAL PLANT PERFORMANCE IN LEACHATE PURIFICATION

PARAMETER	LEACHATE	PERMEATE I	PERMEATE II	REJECTION in %
pH-value	7.7	6.8	6.6	-
el.conduct.uS/cm	17,250	382	20	99.9
COD in mgO2/l	1,797	<15	<15	>99.2
ammonium mg/l	366	9.8	0.66	99.9
chloride mg/l	2,830	48.4	1.9	99.9
sodium mg/l	4,180	55.9	2.5	99.9
heavy metalls mg/l	0,25	<0,005	<0,005	>98

PROJECT PROCESS FLOW DIAGRAM



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EXTERNAL VIEW


INTERNAL VIEW


HIGH PRESSURE STAGE

ROCHEM TECHNOLOGY

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- SYSTEM OPERATION
- CUSTOMER FOCUSED
- SPECIAL CHEMICALS
- MODULE MANUFACTURING
- SYSTEM OPERATION
- ASSEMBLY AND COMMISSIONING OF TURNKEY SYSTEMS

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