OSMO – optimal utilisation of resources

Selectively operating membrane processes enable recovery and re-use of substances contained in water.

Although conventional processes for the treatment of waste water can remove the waste water load simply and at low cost, it is not generally possible to recover and re-use the substances removed from the waste water. It is a different matter, however, with selectively operating membrane methods such as those used in the Süd-Chemie AG Heufeld plant since 2005. The waste water is cleaned here using state-of-the-art reverse osmosis technology with the result, firstly, that the cleaned water is returned to the production cycle and, secondly, that pure sodium nitrate is recovered for commercial use.

The Nitrea® project

Nitrea® is a combination of membrane technology and concentration, with downstream crystallisation, patent-protected by Süd-Chemie AG. Based on its sustainable combination of processes, the project was supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The construction of the membrane plant was awarded to OSMO Membrane Systems, who had supplied the pilot plant already and guided the pilot processes.

The installation of the high pressure reverse osmosis system at Süd-Chemie was a first for OSMO since a plant with these technical dimensions had never been implemented before.

The pre-treatment and cleaning process stages initially strictly separate all the substances contained in the water which may be undesirable in the re-use of the sodium nitrate. The purpose of reverse osmosis here is to increase the concentration to a maximum since the energy effectiveness of the membrane technology is about an order of magnitude better than that of the evaporator. Against this background, the cost-effective tape-wrapped module technology has been developed further to achieve operating pressures up to 120 bar.

Another function of the plant is to remove the nitrogen loading whilst maintaining strict infeed criteria. Especially with low ion concentrations, conventional membrane technology often reaches its limits because the molecular structure of especially nitrate and ammonium makes these substances very difficult to separate. With the installed technology, however, the generated permeate after the last reverse osmosis stage is of such good quality that it is used as feed medium for the existing VE water plant. The remaining conductivity is less than 50 µS/cm which is clearly below the conductivity of the well water currently used.

Nitrea® is convincing - based both on ecological and economic considerations

Deploying the Nitrea® process also makes sense in terms of business economics, as was demonstrated in a direct comparison with competing treatment processes.

Although the conventional biological treatment of waste water clearly requires lower investments, the lack of the carbon source in the waste water would have resulted in comparatively higher operational costs. A purely thermal treatment could be excluded considering both the investment and operating cost aspects.

Key data for the waste water treatment plant (reverse osmosis plant)

Nitrate concentration - feed	*1 - 100*	*g/l*
Nitrate-nitrogen concentration in the permeate	*< 50*	*mg/l*
Ammonium-nitrogen concentration in the permeate	*< 25*	*mg/l*
Sodium nitrate retention	*> 99,9*	*%*
Nitrate concentration, high pressure reverse osmosis	*> 180*	*g/l*
Working pressures	*40 - 120*	*bar*
The technology can be transferred to other inorganic substance systems		

Reverse osmosis

Reverse osmosis is a pressure-driven osmosis process. Membrane separation processes are physical processes which selectively separate small particles, molecules or ions by means of a membrane. The sizes of the separated particles are in the region of some microns down to one nanometer.

Reverse osmosis is used to separate salts, or ions, from mainly aqueous solutions. Reverse osmosis is used to increase the concentration of solutions or to separate aqueous components.

Semi-permeable membranes are used for this purpose. These have the property of letting through the aqueous component whilst blocking a large portion of most ionic components.

Semi-permeable membranes are solution diffusion membranes. Contrary to the porous membrane used for microfiltration or ultra-filtration, the solution diffusion membrane has no holes. Here, the separation effect is due to the charge carriers in the membrane and resultant attraction or repulsion by the electrical charge. This basically transports the permeating component through the membrane in three steps:

1) Absorption at the membrane

2) Diffusion through the membrane

3) Desorption from the membrane

The charge on the other hand repels (equally) charged ions. This means that polar substances such as water or other polar solvents exhibit a high through-flow, whilst large charged ions are mostly held back.

Depending on the membrane used, the rejection for table salt, for instance, is 97% - 99.5%. The rejection therefore varies with both the membrane used and the medium to be separated. For many mixtures of substances, it is imperative to carry out laboratory tests and possibly even tests in a pilot plant before large scale implementation.