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Membrane processes for efficient water use

Secure water supply even during drought

When water is scarce, less groundwater from deep wells is available to the industry. However, other sources can be tapped using membrane processes.

In a global perspective, water consumption has more than doubled since the 1960s. About one third of the world's population is already directly affected by severe to extremely severe water stress. In Europe, the southern regions have been particularly affected.

Little snowfall in winter, very low rainfall over long periods of time and persistently high temperatures have led to an extreme drought in this summer 2022. In addition to a record number of forest fires, an ever-increasing water shortage is the result. Due to the warming climate, these phenomena are a long-term trend likely to get worse.

Impact of water scarcity on operational safety

The effects are already being felt today. Falling water levels in reservoirs and wells lead to restrictions on withdrawal rights. In this context, manufacturing industries are increasingly competing for water with the extraction for drinking water or water used for irrigation of agricultural land where usually the latter two are prioritized.

In order to make the most efficient use of the increasingly scarce resource water, alternative sources and recycling technologies will be necessary in the future. Membrane technology is an essential part for this since it can be adapted very well to different water qualities. If high-quality well water is scarce or no longer available, efficient membrane processes can provide process water from alternative sources. In the following, two examples show how well water can be replaced with the help of membrane processes and how a reliable water supply can be ensured all year round. OSMO Membrane Systems, a company of the GAW GROUP and a close partner to GAW technologies when it comes to water treatment, developed the concepts and delivered the turnkey plants.

Solution approach for recycling wastewater

The recovery of biologically treated wastewater can contribute to a reliable year-round water supply in many cases and reduce the amount of fresh water used in the process.

In a first step the wastewater effluent is filtered using ultrafiltration (UF) membrane technology which removes particles and biomass. Due to the small pore size of 0.01 µm, bacteria and viruses are retained very efficiently, keeping biological activity at a minimum.

The UF membranes are operated in an out-in process with a continuous slow cross-flow. This ensures a significantly higher solids tolerance which is particularly important in wastewater and guarantees a very robust process.

Regular and fully automatically backwashes are carried out to keep the UF membranes clean. Sodium hypochlorite is dosed several times to support the backwashing and prevent biological growth. Unlike in other UF systems no further chemicals such as coagulants are required to operate the UF system ensuring an environmentally friendly and low cost operation.

Wastewater effluent often shows high COD and salinity, which requires further treatment of the UF filtrate. Specially designed reverse osmosis (RO) systems significantly reduce organics as well as salinity. To prevent precipitation of mineral compounds in the RO process (so-called scaling) specially adapted high-performance antiscalants are used, ensuring reliable plant operation under difficult conditions.

The high quality permeate water produced by reverse osmosis can be re-used at many points in the manufacturing process. Piloting on site using a container plant is an option, which will optimize the process, ensuring reliable operation and minimizing investment cost.

Process water from wastewater in a paper mill

A large paper mill in northern Germany produces high-quality wood-free paper. The sustainable use of water as a resource is of particular importance for the company. The strategic goals specify a 30% reduction in wastewater volume and a 40% reduction in COD load for all paper and pulp producing mills in the Group for the year 2030 compared to 2008.

The original wastewater treatment of the paper mill comprised mechanical cleaning with screens and save-alls, two Moving Bed Bio Reactors (MBBR) and an aeration tank with surface aerator. In the secondary clarifiers, the biomass is separated from the clarified water by sedimentation. Cloth filters further remove suspended solids before the clear water is discharged into the Emsden River.

Since mid-2018, up to 150 m³/h of the effluent are fed to the wastewater recycling plant to produce process water. In a first step, the effluent is treated by an ultrafiltration unit. The UF filtrate is further treated by a reverse osmosis system, which desalinates and decolorizes the water. The RO permeate meets the high demands required for the production of bright white fine paper and replaces part of the well water to protect the groundwater body. It is noteworthy that the quality of the RO permeate is higher than the well water mainly used for the paper making process.

The concentrate produced at the ultrafiltration stage is returned to the wastewater plant. reducing the COD load of the wastewater. The RO concentrate is discharged to the Ems River together with the effluent of the wastewater treatment plant.

Apart from saving well water thus reducing dependency on public concessions, a considerable amount of heat energy of the warm wastewater can be fed back into the process. This corresponds to a recirculation of about 1.67 MW of thermal power annually.

With the wastewater recycling plant, the paper mill could reduce the production-specific wastewater volume from 2.7 m³/t (paper) to around 2.0 m³/t (paper) and fresh water consumption from 3.8 m³/t (paper) to 3.1 m³/t (paper). This saves 650,000 m³ of well water per year.

The installed plant technology clearly demonstrates the possibility of using water from wastewater resources, which can be applied in other industries as well.

Process water from river water in a chemical park

The operator of a chemical park in southern Germany was unable to continue to obtain the full volume of groundwater from deep wells that had been used for decades due to regulatory changes imposed by the authorities. Until then, fully demineralized water could be ensured by using an ion exchange system only. As an alternative, a process was developed by OSMO that uses river water as feed water to produce demineralized water.

By means of an ultrafiltration plant, the river water is purified from particles and colloidal constituents and an excellent filtrate with a turbidity < 0.1 NTU and an SDI < 3 is produced for further desalination steps. A reverse osmosis (RO) plant serves as the main desalination stage followed by the already existing ion exchange system. The RO plant removes about 95% of the dissolved solids. Hardness components and nitrate, process-critical silica compounds are removed. In addition, dissolved organic substances are retained which are not desired in the process water and which would lead to problems in the following ion exchanger. The RO permeate is heated and fed to the existing ion exchange plant, which is the final desalination step. Using RO as an additional desalination step before the ion exchanger saves 95% of the regeneration chemicals sodium hydroxide solution and hydrochloric acid compared to a conventional ion exchange only process, reducing operational costs significantly considering current chemical prices.

Conclusion

Water scarcity is a growing problem. The extraction of well water is increasingly limited. River water and wastewater are potential raw water sources to replace well water.

Treating river water or wastewater applying membrane technology has proven to be a sustainable and reliable choice of process.

Savings of starch, coating colour & pigments for paper and board mills

A strong example of how to achieve additional impressive resource savings -besides water- in the production of paper and board are the GAW systems for processing starch. Especially when native starch is used – the enzymatic starch processing. By combining two modes of operation in a very special way, it creates a customized starch size at the end of the modification process. This size includes the requested viscosity and molar mass distribution for the respective application - regardless of the starch type, starch temperature and solids content. Expensive raw material losses are no longer an issue, as the dwell time in the system can be set as required and is kept constant at all times, i.e. also during a stop or start of the system. Therefore, it is possible to run with almost no wastewater. A mobile rental unit is available for industrial trial runs directly at the mills.

Another patented innovation is the Coating Colour Recovery System. This process for recovering coating colours does not only require 70% less energy than grinding fresh pigment. It also significantly reduces the amount of wastewater because the separated sewage water is completely returned to the process.

The Austrian family company GAW technologies has been a strong brand in the paper industry for more than 70 years. As a part of the GAW Group, it is a dispensable and reliable technology partner in the treatment of chemicals, starch, coatings, wastewater and process water as well as automation and digitization. More than 150 employees generate annual sales of around 35 million euros. Each year around 10% of the operating performance is spent on R&D, mainly focusing on the reduction of the use of water, energy and raw materials in the customer's production process. www.gaw.at

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