Application Bulletin

Membrane Technology for the Chemicals Industry

Overview

Membranes are widely accepted as an integral part of water recovery and recycling as industries strive to comply with increasingly stringent regulations to reduce or reuse wastewaters. Membranes are being substituted for chemical treatment of wastewaters to reduce chemical, analytical, and labor costs, as well as to produce cleaner and more consistent effluent for discharge or recycle. Typical wastewaters can be treated with ultrafiltrationand reverse osmosis membranes and sent back to the facility as clean water. Membrane systems are often designed to use existing equipment and tanks to minimize implementation costs. Membrane bioreactors are ideal solutions to help reduce plant footprints and operating costs.

For in-process applications, new uses for membrane systems to update, enhance, or replace conventional processes are constantly emerging. The chemical industry demonstrates many examples of how membrane technology is rapidly replacing conventional methods to concentrate and recover materials from process streams. Many chemical processing operations require the removal of water to achieve greater product recovery, reduce spent material disposal costs, and increase plant efficiency. Membranes are an extremely efficient means to accomplish filtration and separation and offer the additional benefits of reduced energy consumption and operating costs over traditional treatment methods. Chemical companies also rely on membrane filtration systems for front-end water treatment to ensure consistent water quality in their processes, as well as to recover and conserve water.

Applications in Specialty Chemicals

Membrane filtration can be used to concentrate spent materials for disposal or recycling. In chemical mechanical polishing (CMP) applications, for example, the spent silica solution used for polishing and contaminant removal can be concentrated using ultrafiltration and reverse osmosis membranes to reduce the volume and costs for disposal. Increased efficiencies can also be gained by capturing valuable raw materials and other products from wash water for reuse; silica can be recovered and reused, as can paints, dyes, inks, catalysts, surfactants, and precious metals. Decontaminated filtrate is also recovered for reuse in these applications.

Membrane filtration is a cost-effective alternative in many operations where evaporation, or dewatering, is involved to concentrate the process stream. In latex, mineral, and other applications, dewatering by membrane systems prior to spray drying significantly decreases drying cost and increases plant efficiency and capacity. Ultrafiltration and reverse osmosis technology can greatly reduce operating costs compared to the traditional method of using an evaporator to recover or remove water, which requires very high energy use.

Diafiltration, a wash process, is another key application for membranes in the chemicals industry. Hollow fiber ultrafiltration membranes can be used to displace materials, such as salts, from retained solids. A good example of this can be seen in the manufacture of inks, dyes, and pigments. Ink processes can have high salt concentrations; the salts are easily separated from the inks using the correctly sized membrane. Tubular membranes, used for high solid streams, can be used to wash out unwanted dissolved contaminants from pigments manufactured for the textile industry to increase final product quality and relative value.

Applications in Industrial Biotechnology

Membrane filtration technology is now being adopted in biofuels production and integrated biorefineries to lower overall energy costs, reduce waste, and increase valuable product recovery. Membrane use is rising in biodiesel processes where membranes facilitate water reuse, particularly in areas where water is scarce. Membranes are also being used to achieve optimum yields in continuous and batch fermentation processes.

A lot of work is going into using membrane filtration to extract fermentable material in the production of second-generation cellulosic bioethanol. For example, ultrafiltration is used for clarifying the process stream after turning it into sugars during the saccharification process.

Some processes use acid/alkali, and nanofiltration can be used to recover and concentrate some of the useful sugars like hemi-cellulose, which also is used in the fermentation process. Nanofiltration

Membrane Filtration Uses in Chemicals	
Application	Membrane Type
Clay; minerals; colloidal silica; latex	Ultrafiltration
Precious metals; heavy metals recovery; catalysts	Ultrafiltration, Reverse osmosis
Inks; dyes; pigments	Ultrafiltration, Nanofiltration
Pulp & paper	Ultrafiltration, Nanofiltration, Reverse osmosis
Surfactants	Ultrafiltration, Nanofiltration
Biopolymers; pharmaceutical intermediates; cosmetics	Microfiltration, Ultrafiltration, Nanofiltration
Paints; coatings	Ultrafiltration, Reverse osmosis

is used for low molecular weight component fractionation and desalting applications, where the process streams may have high concentrations of acids and base chemicals and organic solvents/ water mixture.

An emerging process for the biofermentation cycle involves converting cellulosic materials to sugars and then fermenting them to organic compounds in the form of acids and alcohols. The fermentation process typically produces a low concentration substrate that requires clarification and concentration to be economically viable. Crossflow filtration using spiral wound and hollow fiber membranes is being effectively employed to provide high product recovery and consistent filtrate quality for downstream processing steps.

Chemical processes involving fermentation are also utilizing membranes. Optimum yields are difficult to obtain from fermentation-derived chemicals such as amino acids, organic acids, vitamins, enzymes, and polymers. Microfiltration and ultrafiltration membranes can remove the bulk of the microbial cell mass and proteins to improve the downstream recovery of the valuable product. Nanofiltration can contribute to process efficiency by removing low molecular weight components like color bodies or monovalent salts from the process stream. Reverse osmosis can enable recovery and reuse of water or recover product from certain dilute product streams to improve process yield.

One interesting development application driving the interest in membrane technology is its ability to operate at higher temperatures. Operators seek ways to run continuous fermentation, rather than a batch process. The next few years will see an increase in demonstration plants working on continuous fermentation, and membranes are poised to play a significant role in this important advancement.

Solutions at Work in the Chemical Industry

Koch Membrane Systems (KMS) offers an array of safe, economical solutions to treat waste streams for separation and recovery for reuse and to reduce costs associated with disposal of spent material. KMS engineers are experienced in choosing the optimum membrane arrangement and ancillary equipment to achieve an energy efficient solution based on the solids level of your stream, as well as the lifecycle and system costs for each type of membrane.

With the 40+ years of experience we have, and the well-established and newly-developing selection of membrane types and configurations at our disposal, and with the diligent approach we have used to properly design and apply these systems, we are seeing an acceptance and comfort level with membrane separations that has resulted in routine use of membrane systems throughout the chemical industry.

KMS' ABCOR™ ULTRA-COR™, INDUCOR™, and FEG™ PLUS family of tubular membranes, and the ROMICON™ family of hollow fiber membrane products are ideal for in-process membrane separation applications, including the treatment of streams for concentration and/or recovery from:

- Printing and pigments industry
- Surfactant production
- Electronic production
- Industrial laundering
- Latex production
- Pulp and paper solids reduction and water recycle
- Textile processes
- Chemical Processing Industry (CPI)
- Minerals processing industries

Our ABCOR tubular products can be custom built into a KMS KONSOLIDATOR™ system, specially designed for high final concentration of solids or fibrous material.

KMS' SelRO™ acid/base stable membranes are characterized by an outstanding chemical and thermal stability. Typical applications for these membranes include:

- Decolorization/clarification/demineralization of spent acid and caustic solutions for recycle
- Concentration and demineralization of dyes in acids
- Concentration/desalination/softening of in-process and waste streams
- COD/BOD reduction waste streams such as pulp and paper waste effluents

KMS serves its clients' filtration and separation needs by evaluating client objectives and conducting bench scale testing to determine the best solution to meet these objectives. After review and feasibility assessment, a pilot study is often conducted, lasting from one to two months, from which data is reduced and evaluated thoroughly to establish membrane type and configuration for system design and costs for full commercial operation.

KOCH MEMBRANE SYSTEMS ™

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