American Membrane Technology Association

America's Authority in Membrane Treatment

Applications of Membrane Technologies in Food and Beverage

Membrane technology is probably best known for its use in water treatment and many in the public sector link membranes primarily to seawater desalination. In the United States membranes are used to desalinate brackish water, remove color, particulates and hardness from surficial wells and treat surface waters to remove turbidity, bacteria and viruses. There is, however, a large variety of additional applications in the food, dairy and beverage industry using membranes every day.

The most obvious use of membranes is to treat water to a higher quality for bottled water applications. Some manufacturers use membranes to improve the color, taste and salinity of ground water, surface water and even municipal city water. In many instances, the minerals removed from the local source via membrane treatment are blended back in under prescribed recipes to ensure a consistent feel and taste in the finished product no matter where its produced around the globe.

Likewise, treated water is a key ingredient in beverages such as Gatorade where a mixture of sweeteners, minerals and other compounds are added to low Total Dissolved Solids (TDS) water treated by a membrane system to achieve the required taste and nutrition composition and, again, ensure a consistent global taste. Many of the major soft drink companies employ membrane systems for this same reason, treating locally sourced waters to produce a stable, consistent product with good shelf stability, low turbidity and great taste. High levels of calcium and magnesium in source water can precipitate, leading to cloudiness in the finished product during storage. Many of the soft drink bottling facilities use membranes to treat the locally available water to a higher standard before blending in the syrups and carbonation.

"Membranes can be used for fruit processing"

Similarly, beer brewing relies on a consistent water quality to make sure the final taste and quality remain the same day to day. Brewmasters carefully monitor water quality and many large breweries rely on membrane technology for that purpose. Anheuser Busch in Jacksonville, FL has been using membranes to treat well water since the early 1990's.

"Ceramic membrane system for beer processing, photograph courtesy GEA Processing Engineering, Inc."

"Ceramic Microfiltration and Reverse Osmosis system for skim milk processing, photograph courtesy GEA Processing Engineering, Inc."

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In addition to using membranes for high quality process water, some breweries use membrane technology for their wastewater treatment. Brewery wastewaters are typically high in Biochemical Oxygen Demand (BOD), byproducts of sugars, proteins, carbohydrates and yeasts. Some breweries like the Stone Brewing Company in Escondido, CA employ a Membrane Bioreactor (MBR) and Reverse Osmosis (RO) system to reduce the wastewater discharge from the facility and reuse some of the process water.

The dairy industry found that membranes are valuable in a large variety of treatment processes. Ultrafiltration (UF) and Microfiltration (MF) membranes separate compounds based on size and can be used for the removal of bacteria, separation and fractionation of components and more. Milk can be "disinfected" by removing bacteria and viruses using MF and UF and boxed aseptic milk products are now possible using membranes. Milk and whey protein concentrates and isolates are achieved using MF and UF membranes. A distinct advantage of membrane use in these applications is that the treated products are no longer subjected to heat separation, so thermal degradation is completely avoided.

Dairy equipment requires constant cleaning and sanitization. Membrane systems are used here as well to remove suspended and dissolved solids from spent cleaning solutions and recover the reusable acid and caustic.

Cheese processing uses membranes for the treatment of whey to produce various whey protein products. Such membrane processes have turned a discarded by-product into a valuable new revenue stream. Whey and milk concentration is achieved with membranes as is the demineralization of whey for protein recovery. Other common membrane applications in a dairy plant include the use of MF to make skim milk, and the use of Nanofiltration (NF) to separate and concentrate lactose. Enzymes play a major role in food processing and are typically produced through industrial fermentation, where microorganisms, such as yeast and bacteria are used to produce different kinds of enzymes. Microfiltration is widely used to remove the microbial cells from the fermentation broth. The broth can then be treated with Ultrafiltration membranes to harvest, concentrate, and purify the enzymes.

Maple sap collected from trees typically contains about 2% sugar (sucrose) in solution and was traditionally converted into syrup by boiling out the water. Maple farmers embraced RO and NF to concentrate sap up to 17-20 degrees brix prior to boiling.

Recently, new maple sap concentrator units have been introduced, allowing concentrations up to 35 degrees brix and a significant reduction in energy demand related to the final evaporator boiling necessary to develop the full maple flavor. Manufacturers enjoy significant process savings and improved syrup quality.

Membranes are finding their way into the tail end of food processing plants in the form of recovery systems and membrane bioreactor wastewater treatment systems. A facility in Japan installed an MBR system to treat high BOD wastewater from the facility that processed vegetables for peeling, washing and packaging. The quality of the MBR effluent is high enough to feed a downstream RO system and further reduce the TDS. The RO permeate is then reused in the plant as process water and to spray on metal roofs to effectively cool the buildings during summer. MBR systems allow facilities to reduce BOD, Total Suspended Solids (TSS) and nutrient levels below the limits of municipal sewer and environmental discharge and require smaller footprints at costs comparable to those of conventional wastewater treatment.

Facilities processing a variety of fruit and vegetable produce such as potatoes, carrots, apples, onions, lettuce, beets and bananas use membranes for wastewater treatment. These wastewaters are characterized as having

"Wine Processing System, photograph courtesy of KOCH Membrane Systems"

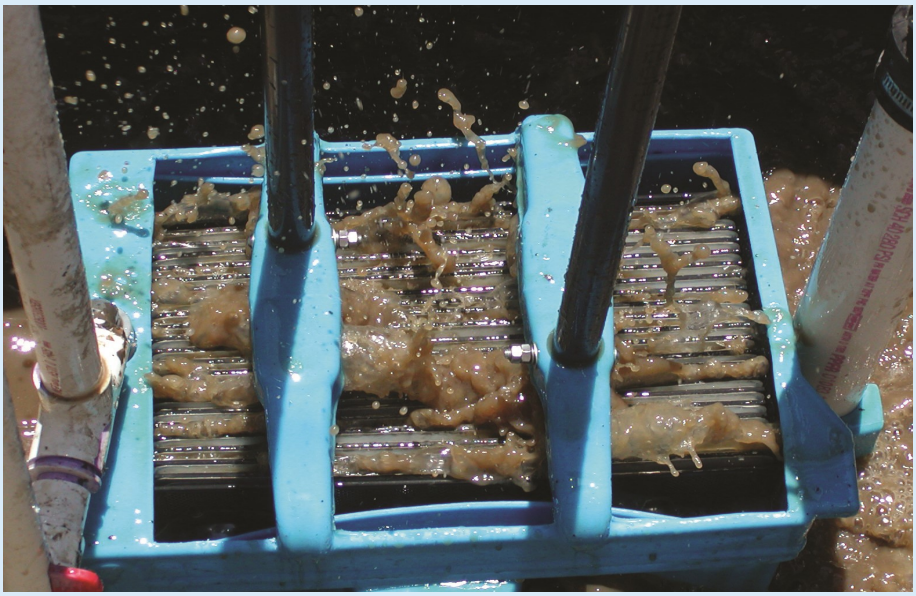
relatively higher amounts of BOD, TSS and nutrients such as nitrogen and phosphorus, when compared to municipal wastewaters.

Significantly increased yields of higher quality juice can be achieved using various membrane technologies. Apple, citrus, cranberry, cherry, grape, pomegranate, carrots and other juices are effectively clarified using UF and MF membranes, resulting in clear juices with a longer shelf life. RO is successfully used to remove water and concentrate juices, reducing transportation costs. Membrane systems typically require less labor and maintenance than conventional treatment methods and can be easily adjusted to accommodate different feed juices.

A combination resin-membrane process can reduce the bitterness of some citrus juices such as orange, grapefruit, tangerine, lemon and lime, enhancing the juice quality, consistency, and yield.

In wine production, membrane filtration is commonly used to remove suspended solids and turbidity to produce clear wine, while allowing the passage of color, ethanol, flavor and aroma components. Tubular membranes have been used for treatment of juice lees, the solids that remain after grape crushing, and wine lees, the insoluble sediments in wine processing, for the recovery of juice and wine that would otherwise be lost. Membranes deliver a higher quality product with less oxidation, no heavy metal residual and reduced waste as compared to conventional diatomaceous earth clarification, in addition to cost savings and lower labor and maintenance requirements. Alcohol adjustment in wine is achieved using membranes and one can reduce the alcohol without affecting the natural flavors in the wine. Other membrane applications for wine and juice include sugar concentration, color |concentration, volatile acidity (VA) reduction and more.

Removing TDS and undesirable heavy metals in the brew water improves the taste and aroma of coffee and minimizes scale in the brewing equipment. Membrane treatment is extremely useful to ensuring a predictable and consistent brew of coffee regardless of the water source.



"Partially-submerged MBR treating a winery waste stream, photograph courtesy of Bio-Microbics"

"Collecting tree sap for syrup production, photo courtesy of the Chippewa Nature Center"

Concentrating juices and milk using membrane treatment reduces transport volumes and subsequent freight costs, requires less energy and results in fewer adverse side reactions. High value food components recovered from dairy processes can be used to fortify other products and food safety and shelf life can all be improved using membranes.

Membranes have been adopted for a variety of reasons including process flexibility, increased yield compared to alternative methods, reduced manpower for system operation, smaller footprints and overall cost saving. Eliminating diatomaceous earth filtration and its related waste and negative impacts on product taste makes membranes an attractive alternative. The comparative ease of cleaning membrane systems is also advantageous.

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Some examples of applications and the membrane process are:

MF – bacteria spore removal from skim milk, whey and WPC

MF and UF – protein fractionation

MF – delipidization of whey

MF – chemical recovery

UF – concentration and fractionation of proteins in milk

UF – brine clarification

NF – demineralization of UF permeate

NF – demineralization of whey

NF – milk electrolytes

RO – water removal from whey and other streams

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

For more information, please contact:

American Membrane Technology Association (AMTA)
2409 SE Dixie Highway
Stuart, Florida 34996
Phone: (772) 463-0820
Fax: (772) 463-0860
Email: admin@amtaorg.com

or visit our website at:
www.amtaorg.com

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