Membrane Filtration

Microfiltration of Dairy Products
Cross-flow microfiltration technology is rapidly gaining prominence in the processing of dairy ingredients. Microfiltration, along with other membrane filtration processes like ultrafiltration, reverse osmosis and nanofiltration, is making it possible to produce products with very unique properties and functionalities.

The practical dairy applications of microfiltration are often limited by severe fouling of the membrane, which results in flux decline and changing of the retention characteristics. Microfiltration is a pressure driven process where the Trans Membrane Pressures (TMP) are in the order of 1 to 2 bar which is very critical to the performance of the processes. This makes the plant design and control of operating parameters very important.

In addition, advances in membranes, both organic and inorganic types, have made these processes technically possible and economically viable. While the following are only a few examples of potential separation processes, several new applications are being developed.

**Bacteria and Spores Reduction in Fluid Dairy Products**

Demand for products with low bacteria and spore counts is increasing. Examples of these are Extended Shelf Life (ESL) milk, pretreatment of cheese milk to prevent gas formation during the cheese aging process, production of skim milk and whole milk powders with very low bacteria and spore counts, and better microbiological quality of Whey Protein Concentrates.

Plants equipped with special ceramic membranes can give at least a Log 4 (99.99%) reduction in bacteria and spores depending on the loading in the feed.

**Reduction of Fat in Whey Protein Concentrates (WPC)**

The limitation of fat removal from whey by mechanical separation results in high fat content in WPC. This high fat level limits the maximum protein content in the final WPC powder, usually 80-84% depending on the feed quality. Whey Protein Isolates (WPI) require reduction of fat content in the final product to < 0.5%.

This can be accomplished by reducing the fat content further than using mechanical separation only by microfiltration with either ceramic or spiral wound membranes. The choice depends on a variety of parameters such as capital cost, operating cost, and others.

**Fractionation of Casein and Whey Proteins in Skim Milk**

Separation of casein from whey proteins in skim milk and its concentration gives an opportunity to fortify cheese milk without increasing the whey protein content. This has a positive influence on increasing the capacity of cheese making equipment without affecting the quality of cheese. As an added benefit, whey proteins produced by such a process have some unique functional properties since they have not come in contact with cheese starter, rennet or cheese additives.

Advances in ceramic microfiltration membranes make this process feasible. The process can be also accomplished to a lesser degree by spiral wound membranes.
Several recent developments in the membrane construction technology have been a key to the advances in microfiltration processes. Ceramic and spiral wound microfiltration membranes each find their unique place in these processes. For every application, the different membranes need to be evaluated carefully to assess the advantages and disadvantages of each.

**Spiral Wound Organic Membranes**

Ultrafiltration, nanofiltration and reverse osmosis spiral wound organic membranes have been the workhorse of separation processes in the dairy industry.

Recent advances in membrane materials and element construction, coupled with plant design techniques, have made possible their use for microfiltration processes. Compared to inorganic membranes, they have their place in a number of microfiltration applications.

GEA Filtration can evaluate both inorganic and organic membranes for your application.

**Ceramic Membranes**

Microfiltration processing for most of the applications in the dairy industry is very sensitive to the Trans Membrane Pressure (TMP). Deviation of the TMP from a narrow optimum range can cause an adverse effect on the retention coefficients and often cause irreversible fouling.

**Conventional microfiltration** techniques have a disadvantage due to the hydrodynamic pressure drop from the inlet to the outlet of the flow channel caused by the recirculating flow. As illustrated in the accompanying diagram, this causes a decline in the TMP along the flow length resulting in:

- Decline in permeate flux along the length of the flow channel.
- Formation and migration of the gel layer from the inlet of the flow channel.

This heterogeneity reduces the quality of separation, shortens running time and therefore can reduce the attractiveness of the application.

**Uniform Trans-Membrane Process Pressure (UTP)** has been developed by hydrodynamically creating a pressure gradient on the permeate side of the membrane to match the feed side. This results in a constant TMP along the length of the flow channel. The control system to maintain these parameters is very critical to the process.
Recently TAMI Industries of France has introduced a new solution—ISOFLUX®. This membrane has been designed by varying the active layer thickness along the length to compensate for the pressure gradient. This technique makes the process much simpler by eliminating the need for additional permeate side components. Control of such a process is also quite simple making the operation very stable. ISOFLUX® membranes are available in 0.14, 0.2, 0.45, 0.8 and 1.4 micron pore size. While standard layer gradients are available, the possibility of varying the gradient to match the process exists.

In addition, ISOFLUX® membranes utilize non-circular cross section flow channels to be able to increase the membrane area per element and housing. This dramatically reduces the plant physical size and its holdup volume.

Several inplant trials have resulted in higher fluxes, better retention and longer running time obtained by ISOFLUX® membranes compared to other techniques.

GEA Filtration has a worldwide exclusive arrangement to use ISOFLUX® membrane for dairy applications. ISOFLUX is a registered trade mark of TAMI Industries.

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A Reliable Partner

GEA Filtration is part of GEA, an international process engineering leader in the life sciences industry with more than 150 companies operating worldwide. As a team member with other technology leaders within the group, GEA Filtration is uniquely positioned to provide both customized membrane filtration plants as well as complete process lines specifically tailored to each customer’s specific needs and requirements.

Global Experience, Local Presence

GEA Filtration specializes in cross-flow membrane filtration technologies, namely Reverse Osmosis (RO), Nanofiltration (NF), Ultrafiltration (UF) and Microfiltration (MF). We also offer a wide range of system configurations and membrane types to provide you with the best possible solution for each application.

GEA Filtration has extensive experience in the following industries:
- Dairy
- Food including Sugar, Starch and Sweetener
- Beverage
- Pharmaceutical / Biotechnology
- Environmental / Chemical

Multi-disciplined teams at dedicated GEA Filtration centers in USA and Denmark can provide the following value-added services:
- Pilot trials and application development
- System scale-up
- Project engineering
- Process integration
- Controls and automation
- System fabrication
- System installation and start-up
- Service and plant audits
- Replacement membrane inventory.

GEA Filtration also has a wide selection of pilot plants in all membrane types available for on-site trials at customer’s location, from bench top models to continuous, semi-automated pilot plants designed for large flow scale-up capability.

For more details on the specifications for each of these pilot units, consult our website at www.geafiltration.com.

Pilot Plants
For more information on all the products and services provided by GEA Filtration, access our website www.geafiltration.com.