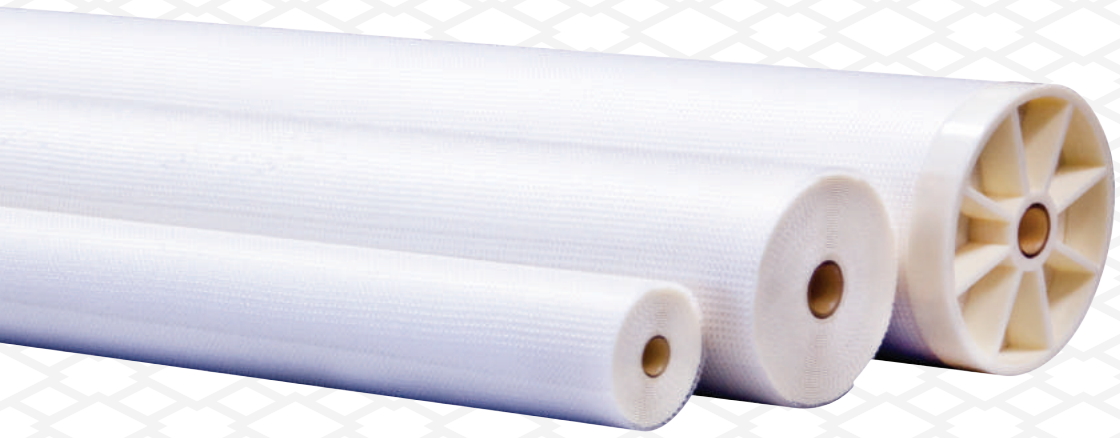
Synder® Filtration

Membranes that Perform.

People who Deliver.

Membrane Filtration
Dairy Industry



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COMPANY PROFILE

OUR PHILOSOPHY

Synder Filtration is an independent US membrane filter and system manufacturer, focused on building long-term customer relationships through our technical expertise, outstanding personal service, and unparalleled responsiveness.

OUR COMPANY

Synder Filtration specializes in manufacturing Nanofiltration, Ultrafiltration, and Microfiltration membranes and systems for specialty process applications. Synder has a unique understanding of the membrane industry, stemming from its history as both a buyer and a supplier of membrane technology. Established in 1989, Synder Inc. originally focused on industrial enzyme technology, and was a pioneer in the application of spiral membranes.

Today, the company serves the Dairy, Biotech, Pharmaceutical, Automotive, and Oil & Gas industries, among others. All sanitary products meet USDA, FDA, Halal, Kosher, and 3-A sanitary standards and Synder is a certified ISO-9001:2008 manufacturing company.

Synder Filtration is a also proud recipient of the President's "E" Award in recognition of manufacturing export growth. Synder has developed an extensive team of international representatives and distributors with a similar dedication to customer service and deep technical knowledge.

OUR COMMITMENT

With our deep understanding of membrane technology, industry-leading delivery times, and a highly responsive staff, we are dedicated to meeting and exceeding your expectations by doing business "the right way", every single day.

We sincerely look forward to working with you.

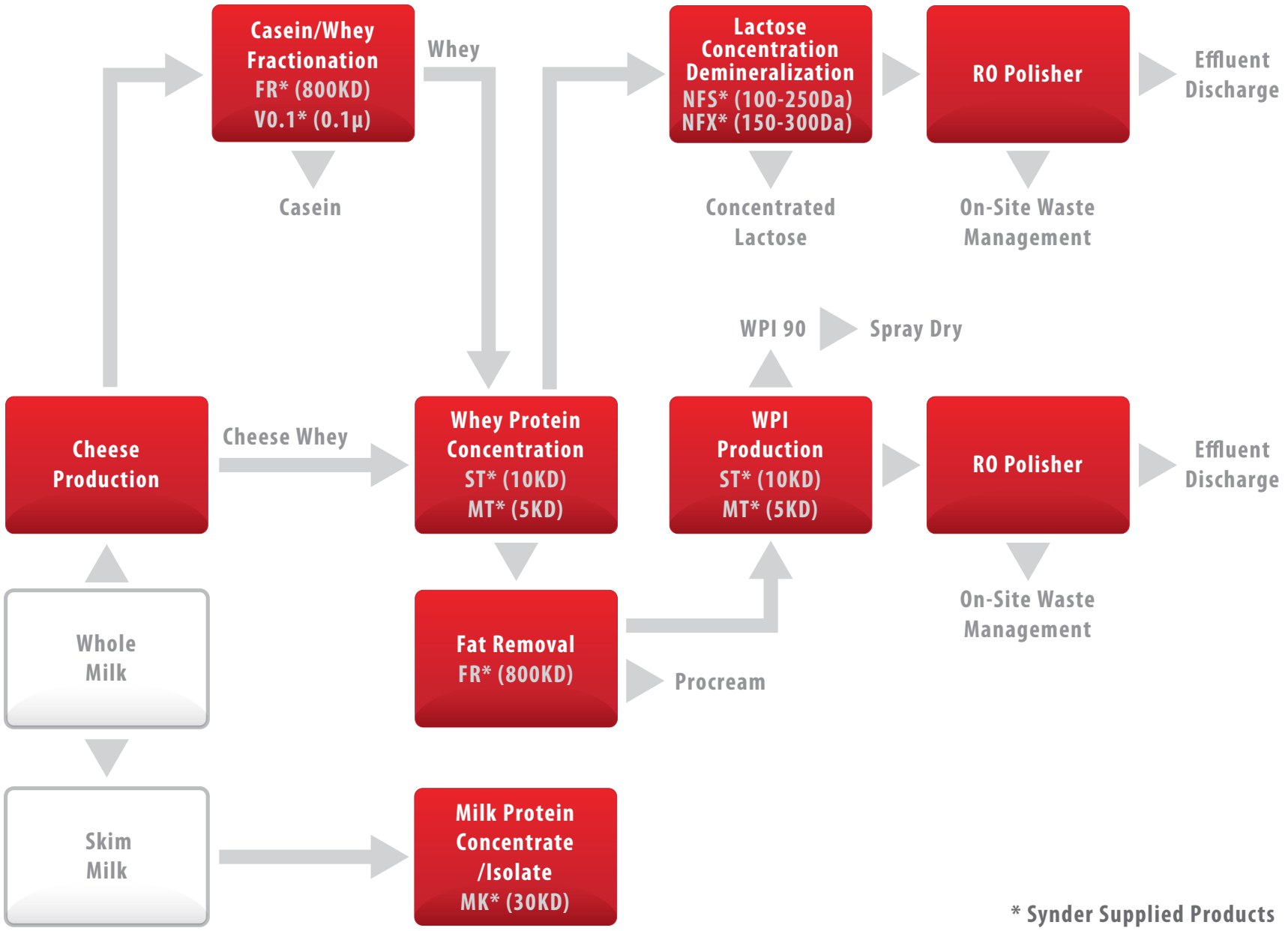
PRODUCT LIST

Synder Filtration offers its complete line of Nanofiltration (NF), Ultrafiltration (UF), and Microfiltration (MF) membranes in a variety of different flat sheet and membrane roll options. With sizes ranging from one square foot to thousands of linear feet, Synder can supply membrane for all scales of testing, research, and production with exceptionally fast lead times.

Membrane	Type	Polymer	Molecular Weight Cut-Off
NFS	NF	TFC	100-250
NFX	NF	TFC	150-300
NFW	NF	TFC	300-500
NFG	NF	TFC	600-800
NDX	NF	TFC	800-1,000
XT	UF*	PES	1,000
VT	UF*	PES	3,000
MT	UF*	PES	5,000
ST	UF*	PES	10,000
SM	UF*	PES	20,000
MK	UF*	PES	30,000
MQ	UF*	PES	50,000
LY	UF*	PES	100,000
LV	UF*	PES	200,000
LX	UF*	PES	300,000
PZ	UF	PAN	30,000
PY	UF	PAN	100,000
PX	UF	PAN	400,000
V3	UF*[1]	PVDF	30,000
V4	UF*[1]	PVDF	70,000
V5	UF*[1]	PVDF	200,000
V6	UF*[1]	PVDF	500,000
V7	UF*[1]	PVDF	800,000
BN	UF*	PVDF	50,000
BY	UF*	PVDF	100,000
BX	UF*	PVDF	250,000
A6	UF*	PVDF	500,000
FR	MF*	PVDF	800,000
V0.1	MF*	PVDF	0.1µ
V0.2	MF*	PVDF	0.2µ

*PHT (High Temperature/High pH) Models Also Available
[1]Not Approved for Use in Food Contact Applications

DAIRY PROCESSING DIAGRAM



* Synder Supplied Products

NANOFILTRATION

Lactose Concentration and Demineralization

Nanofiltration is widely used throughout the dairy industry for lactose concentration and demineralization. By allowing monovalent ions to pass through while partially rejecting multivalent ions, lactose-free milk or whey volume can be further reduced in order to attain savings in transportation costs. The crystallization process can also benefit from the use of nanofiltration beforehand, by reducing the amount of minerals present to product higher-quality lactose from the whey and permeate.

With traditional nanofiltration membranes having typically 98% MgSO4 rejection, Synder's NFS & NFX NF membranes push the boundaries with an astounding >99% MgSO4 rejection. This results in a very high retention of lactose, making it ideal for lactose concentration.

CASE STUDY - NF Lactose Concentration and Demineralization

Overview

The objective of this study was to examine the flux, total organic carbon (TOC) rejection, and calcium rejection performance of Synder's NFX and NFS membranes, with acid whey UF permeate used as the incoming feed stream. These results will determine the potential for NFS to be used in the dairy industry for applications such as lactose concentration and demineralization, with specific focus on calcium removal.

Experimental

Two independent trials were tested with Synder's NFX and NFS membranes in 2540 spiral wound element modules. Acid whey UF permeate generated from Synder's ST 2540 spiral wound elements was used as the incoming feed stream. Elements were tested at 440 psi with a feed flow rate of 2 gpm at 25°C. Permeate flux and calcium rejection was measured from 1x to 3x volumetric concentration factor (VCF).

Table 1: Acid Whey Powder Composition

Description	Specification
Ash	10.5% max
Fat	1.2 max
Moisture	5.0 max
pH	4.5-5.0
Protein (as is)	11% min
Sediment	15.0 mg max
Titratable Acidity	0.30% min

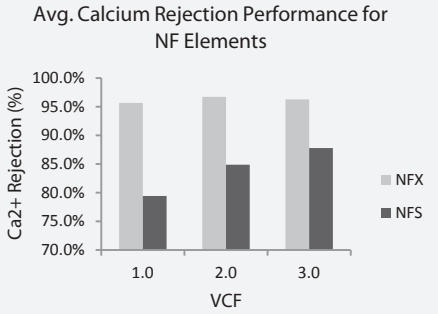


Figure 1: Average calcium rejection performance for Synder's NFX and NFS 2540 elements obtained up to 3x VCF.

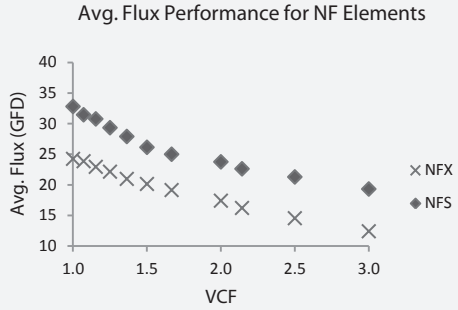


Figure 2: Average flux performance for Synder's NFX and NFS 2540 elements obtained up to 3x VCF.

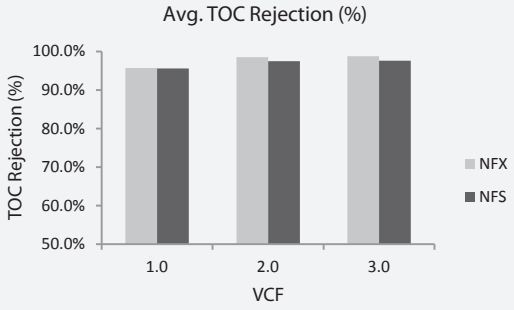


Figure 3: Average TOC rejection performance for Synder's NFX and NFS 2540 elements obtained up to 3x VCF.

Conclusion

The results of this study indicate that Synder's NFS membrane shows superior flux and higher calcium passage compared to NFX, in a feed stream composed of acid whey UF permeate. The considerable difference in calcium rejection performance between the two membrane types shows the benefit for NFS to produce higher-quality lactose.

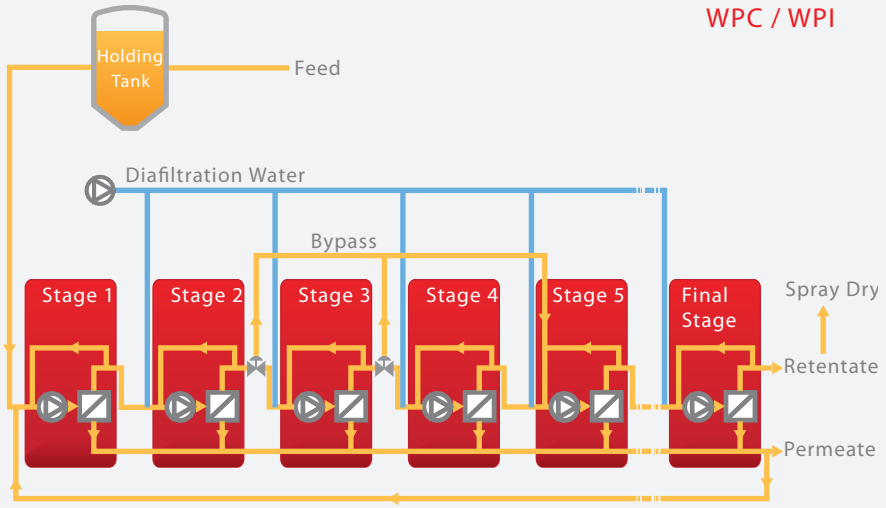
ULTRAFILTRATION

Whey Protein Concentrate/Isolate Production

Synder's polymeric spiral-wound ultrafiltration membranes are standard for the separation of whey protein concentrate and isolate from cheese whey. VT (PES 3), MT (PES 5), and ST (PES 10) ultrafiltration membranes are commonly used in this application to provide an optimal balance of flux, protein separation, and membrane durability.

For WPC, a continuous ultrafiltration system is typically set up stage-by-stage along with diafiltration in later stage to increase the removal efficiency of small non-protein species into the permeate. In the stage-by-stage configuration, the customer typically increases the spacer size of the element to maximize the solid content during the later stage of filtration.

For WPI, microfiltration is necessary step to lower the fat content in whey protein. Ultrafiltration is applied to the defatted protein, along with diafiltration for later stage. The resulting WPI product is typically higher in whey protein and lower in fat and lactose than WPC.

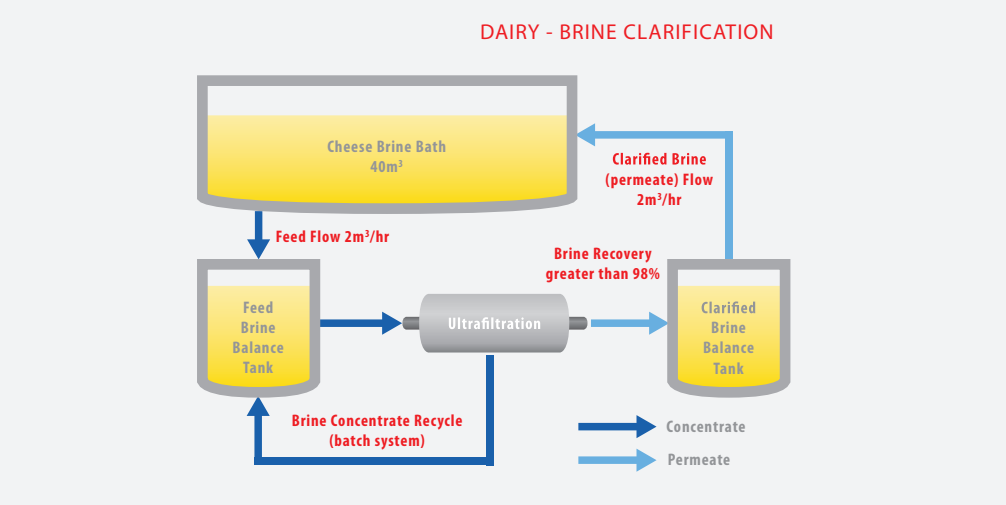


All Sanitary Series membranes conform to 3-A, FDA, and USDA sanitary standards, and are also Kosher & Halal certified. All PES-based Ultrafiltration PHT membranes and sanitary spiral-wound elements are also compliant with USP Class VI standards.

Brine Clarification

Ultrafiltration can be used to clarify brine solutions generated during the curing of cheese, which can help save costs through the reuse of the solution over multiple batches of cheese. Synder's BN (PVDF 50) membrane is able to clarify these solutions well, in addition to provide an ion balance that allows cheese to cure at an optimal rate.

In the production of cheese, salt brining is used to inhibit bacterial growth and add flavor to the cheese itself. Filtration allows for most of the lactose to be removed for ideal curd ripening, and salting draws moisture from the cheese in order to form the rind and prevent the growth of molds. As the need for waste effluent disposal continues to rise, the use of brine clarification through ultrafiltration has becoming increasingly important to minimize costs and reduce environmental footprints.



Milk Protein Concentrate/Isolate Production

Developed in 1999, Synder's MK (PES 30kDa) ultrafiltration membrane was specifically designed for the concentration of milk proteins from skim milk. This membrane is still used today throughout the world for this application stemming from its high performance and stability.

Milk protein concentrates and isolates are extracted from skim milk through the use of membrane filtration technology. Whole milk is divided into skim milk and cream, and the skim milk is then fractionated using ultrafiltration membranes such as Synder's MK PES UF membrane to further concentrate the milk protein. The whey and casein blend offer an assortment of nutritional and functional properties, including high levels of calcium, phosphorous, potassium, and magnesium. Milk protein concentrate can also improve the heat stability and solubility of the product it is incorporated into. The bland flavor profile and light color also make it ideal choice as an additive in products throughout the food and beverage industry, including cheeses, protein bars, yogurts, and baby formula.

ULTRAFILTRATION

PHT Series - High pH & Temperature

Synder also offers a high pH/high temperature "PHT" line of elements available for all ultrafiltration and microfiltration pore sizes. These membranes can be sanitized without the use of chlorine, which can further extend the membrane and equipment life.

CASE STUDY - High Solids Feed Spacer

Overview

Feed spacer geometry can be just as crucial as spacer thickness in high solids applications, such as whey protein concentration. The objective of this study was to examine differences in flux and pressure drop performance between Synder's ST (PES 10kDa) elements with standard 80mil diamond and open channel ribbed spacers in order to identify any potential advantages of switching to an open channel ribbed spacer.

Table 1 : Feed composition and operating parameters

Feed Solution	
Material	Kraft Foods Global, Sweet Whey
Sweet Whey Concentration	20wt%
Synder Membrane	
Elements	ST-5B-2540M (Standard Diamond) ST-5PB-2540M (Ribbed Spacer)
Membrane	10kDa Polyethersulfone
Operating Parameters	
Pressure (PSI)	120
Crossflow Rate (GPM)	4
Temperature (C)	25

Results

Examination of permeate flux trends from three independent trials using a total of 6 elements indicated no significant difference in flux performance between elements containing either of the two spacer types (Figure 1). High protein rejection for all tested elements indicates that the obtained flux values are unlikely to have arisen as a result of a loss of membrane integrity. Despite little difference in flux performance, a more noticeable difference was observed with respect to element pressure differential, where elements containing open channel ribbed spacers showed reduce pressure drop (Table 2). The use of a ribbed spacer showed a reduction in pressure drop of at least 37% across the length of the element (Table 3). The expected pressure drop values for elements with larger diameters were subsequently extrapolated according to open flow channel area and assuming no change in operating conditions (Table 4).

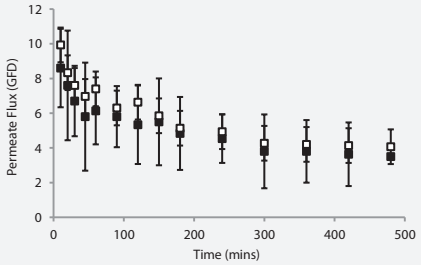


Figure 1. Permeate flux values of ST elements containing diamond net (■) and open channel ribbed spacer s ( ). Error bars represent standard deviation of n=3 samples.

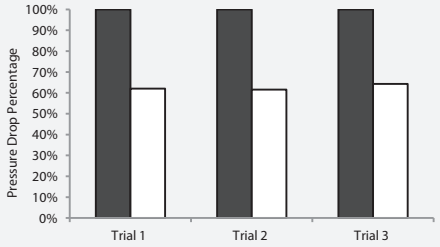


Figure 2 . Pressure drop of ST elements containing diamond net (■) and open channel ribbed spacer s ( ) expressed as a percent of diamond net pressure drop .

Table 2: Average recorded ΔP and protein rejection values for each run.

Element Model	Spacer Type	Protein Rejection (%)		
		Trial 1	Trial 2	Trial 3
ST-5B-2540M	80mil Diamond	99.7	99.5	99.4
ST-5PB-2540M	80mil Ribbed	99.8	99.8	99.4

Table 3. Calculated pressure drop reductions between 2540 elements with diamond and open channel ribbed spacer

Spacer Type	Average ΔP (psi)		
	Trial 1	Trial 2	Trial 3
80mil Diamond	2.9	2.6	1.4
80mil Ribbed	1.8	1.6	0.9
Pressure Drop Reduction	37.9%	38.5%	35.7%
Average Pressure Drop Reduction		37%	

Conclusion

The data obtained in this study indicates that the use of open channel ribbed spacers may offer distinct advantages over standard diamond spacers in high solid applications such as whey protein concentration. Despite no observable differences in flux performance when challenged with 20% total solids in the form of sweet whey, there was a significant difference between the two configurations with respect to pressure drop, where ribbed spacers showed a calculated pressure drop reduction of 37% compared to diamond net. This allows pumps to deliver the same crossflow rate at lower speeds, resulting in reduced operating costs.

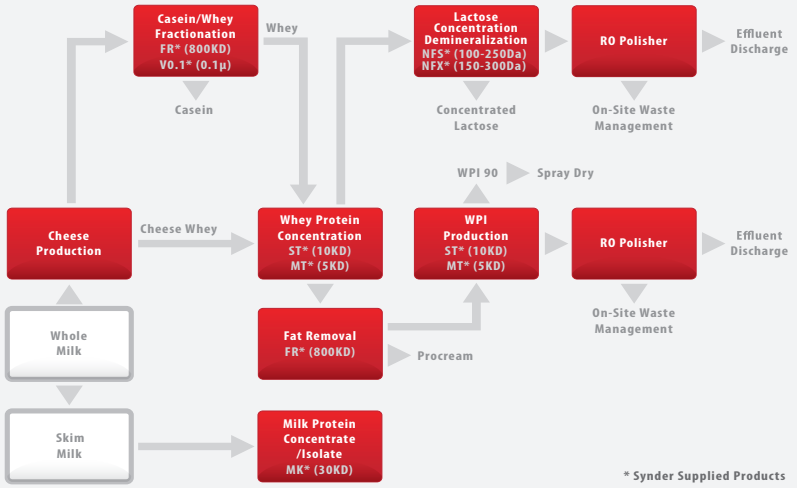
MICROFILTRATION

Protein Fractionation/Separation

Whey and casein protein separation are important processes used in the dairy industry. Synder's FR (PVDF800) and V0.1 MF membranes provide an economically feasible solution for the separation of these valuable proteins.

The use of microfiltration technology for protein fractionation and separation into whey and casein proteins is widely used throughout the dairy industry. The large pores in the microfiltration membrane allow the whey and casein to be easily separated before the use of ultrafiltration for further concentration and purification. This technique of protein standardization allows for more control over the quality of protein by-products and optimized product ratios.

PROTEIN FRACTIONATION/SEPARATION



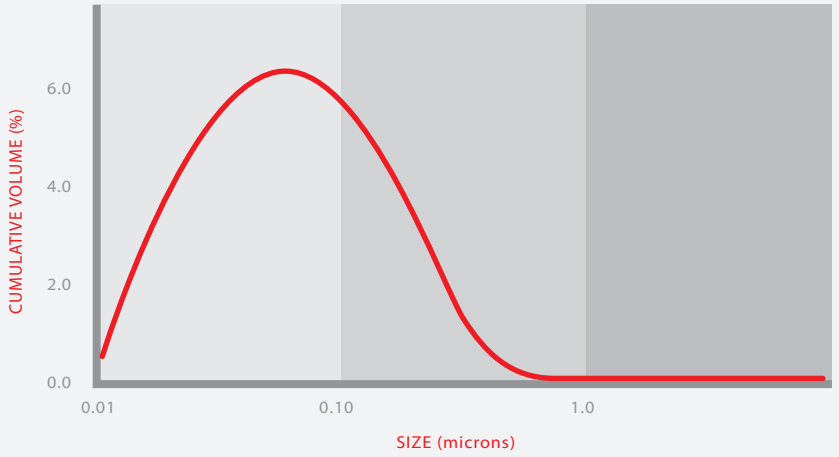
All Sanitary Series membranes conform to 3-A, FDA, and USDA sanitary standards, and are also Kosher & Halal certified.

Fat/Microbial Removal

Synder's FR (PVDF 800), V0.1 & V0.2 MF membranes can be used as the final fat and microbial removal stage in the production of milk in order to produce high quality WPC and WPIs. Our UF systems are able to operate at lower pressures and are typically less expensive to build and operate compared to ceramic membrane systems.

With the largest pore size range, microfiltration is commonly used to extend the shelf-life of milk and produce high-quality milk products. It is especially applicable for use of bacteria and spore removal when treatment options involving high temperature conditions are not suitable. This process can be used as a pretreatment step to pasteurization to ensure that all vegetative spores are completely removed from the milk.

FAT / MICROBIAL REMOVAL



PHT Series - High pH & Temperature

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See Sanitary Catalog for more details.

CASE STUDY - MF for Casein Concentration in Skim Milk

Overview

The objective of this study was to determine the casein concentration capacity of Synder's FR microfiltration (MF) membrane in the production of micellar casein concentrate (MCC) from skim milk. In a comparison to traditionally-produced milk-derived whey protein concentrate (MD-WPC), the use of MF for the production of higher purity casein products is beneficial for a variety of downstream applications.

Experimental

All testing was performed at the Wisconsin Center for Dairy Research (WCDR) using Synder FR 8038 elements with 46mil feed spacers, where two elements were operated in parallel. The feed solution was comprised of pasteurized skim milk (Table 1). Elements were tested at 15 psi and at an operating temperature of 34°C. Diafiltration was used continuously throughout the duration of testing and utilized a UF permeate from the same process. Retentate samples were subsequently spray-dried and analyzed for total solids, true protein, and casein concentration, which were then compared to that of MD-WPC powder derived from traditional methods without the use of diafiltration.

Table 1: Composition of skim milk used in this study

Description	Specification
Total Solids	8.9%
True Protein	3.1%
Casein	2.5%

Table 2: Comparison of casein concentration of total protein in spray-dried powders

Sample	Casein in Total Protein (dry basis, %)
MCC	93.7
MD-WPC	4.1

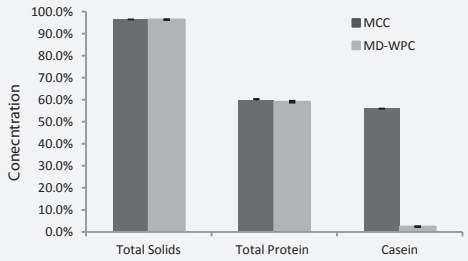

Figure 1: Total solids, total protein, and casein concentrations in MCC and MD-WPC powder.

Conclusion

The results of this study indicate that the combined use of MF and diafiltration in the processing of skim milk allows for the modification of casein ratios compared to traditional MD-WPC products. The ability to product casein-rich products, such as MCC, is useful for a wide variety of food and beverage applications. The use UF permeate for diafiltration not only lessens the water consumption associated with typical diafiltration processes but can also contribute to the stability of caseins in the during fractionation[1].

[1] Crowley SV, Molitor M, Etzel MR, Kalscheuer R, Lu Y, Kelly AL, O'Mahony JA, and Lucey JA (2015) Optimising the production of beta-casein and co-products during membrane fractionation. Poster presented at NIZO Dairy Conference, 30 Sept - 2 Oct: Papendal, The Netherlands

CASE STUDY - MF for Fat Removal

Overview

The objective of this study was to examine the flux and fat removal capabilities of Synder's FR (PVDF 800kDa) Microfiltration membrane.

Experimental

Synder's FR 2540 spiral wound element module with a 46mil feed spacer was tested in a feed stream of homogenized whole milk. The element was tested at 15 psi with a feed flow rate of 8 gpm at 30-35°C. Permeate flux and fat concentration were tested, with the fat analysis performed by Eurofins DQCI (Mounds View, MN). Table 1 shows the permeate flux measurements, while Table 2 shows the fat concentration in the feed and permeate samples.

Table 1: Permeate Flux Measurements

Sample	Flux (GFD)
Permeate Flux	61

Table 2: Fat Concentration Measurements

Sample	Fat Concentration (%)
Feed	3.09
Permeate	<0.01

Conclusion

The FR membrane was able to easily remove fat from the whole milk feed solution, with fat rejection measuring above 99.5%. Permeate flux was also adequate, at 61 GFD. This data, along with WCDR's study on FR for casein concentration in skim milk makes the FR membrane highly suitable for these types of applications within the dairy industry.

If you have questions about our products, need help finding the right custom membrane solution for your application, or would like to place an order, please email us at sales@synderfiltration.com or call us at (707) 451-6060.

SYNDER GLOBAL SERVICE MAP

Synder® Filtration

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People who Deliver.

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