

# MEMBRANE FILTRATION SYSTEMS FOR DAIRY PROCESSING APPLICATIONS

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# What is Membrane Filtration?

- Membrane filtration is a process that has become increasingly important in many industries, including food and beverage, pharmaceutical and biotechnology sectors.
- It involves the use of a semi-permeable membrane to separate small particles and molecules from larger ones.
- In dairy applications, this process is used to remove bacteria, protein, fat, minerals, lactose and other contents from milk and other dairy products.



# History Of Membrane Filtration In Dairy Industry

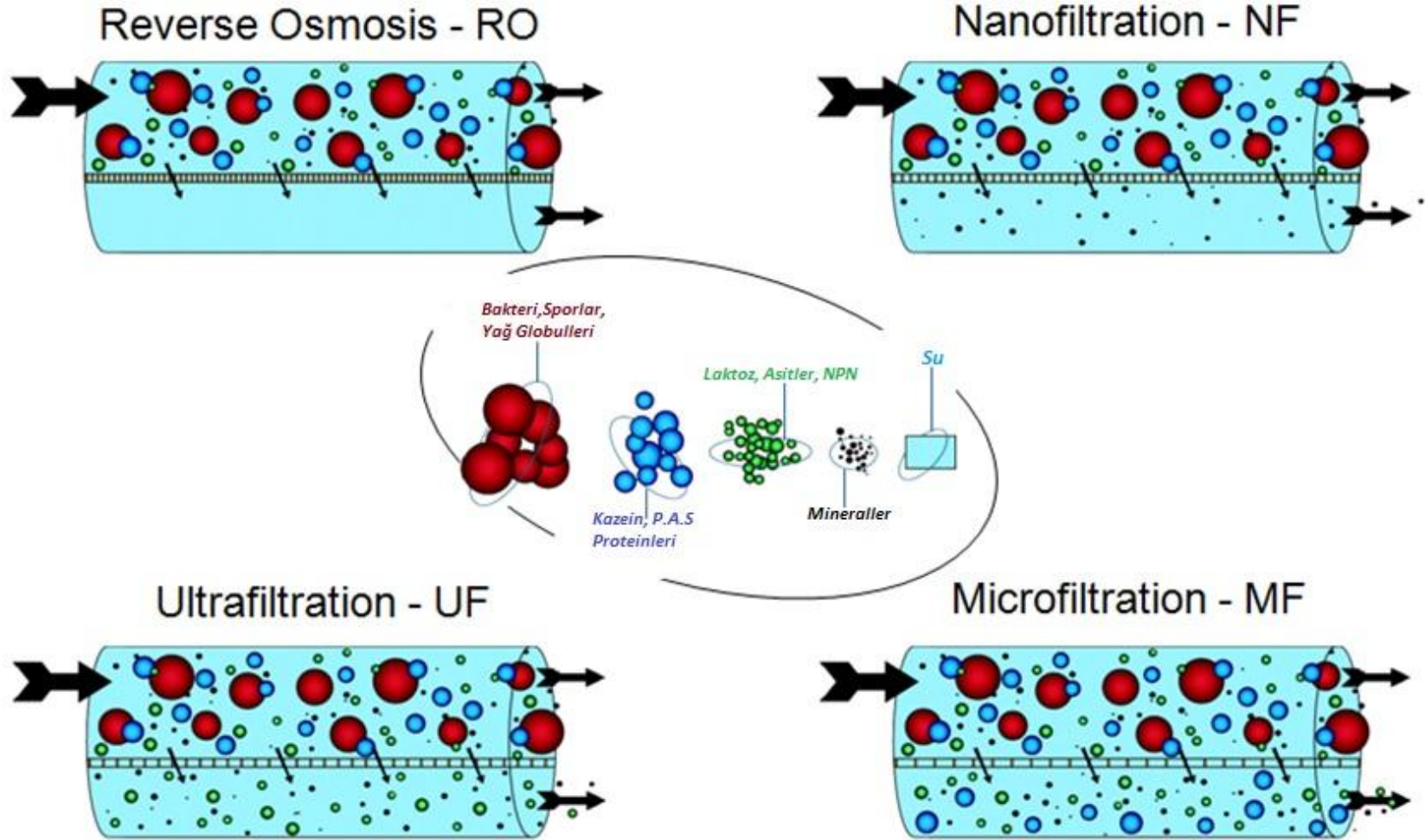
**60's / UF:** One of the first applications of membrane filtration in the dairy sector was in the 1960's when Ultrafiltration membranes were used to concentrate milk.

**70's / RO:** Reverse osmosis membranes were introduced in the dairy industry, enabling the separation of water from milk. This technology was highly efficient and allowed for the production of concentrated milk with a higher protein content.

**80's / MF:** We saw the introduction of Microfiltration membranes to the dairy industry. These membranes has larger pores than Ultrafiltration membranes, which allowed them to separate bacteria and other contaminants from milk.

**90's / NF:** Introduction of Nanofiltration membranes in the 1990's. These membranes used to separate smaller molecules such as minerals, ions and amino acids, which allowed manufacturers to create speciality dairy products such as whey protein isolates, demineralized whey and lactose free milk.

# Membrane Filtration Applications



# Membrane Types

The main types of commercial membrane elements are:

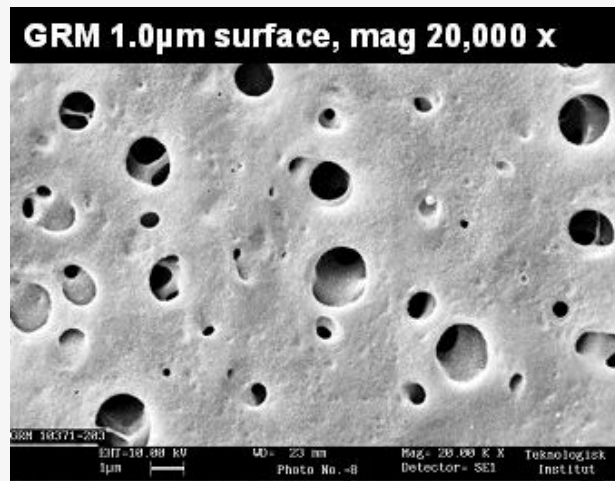
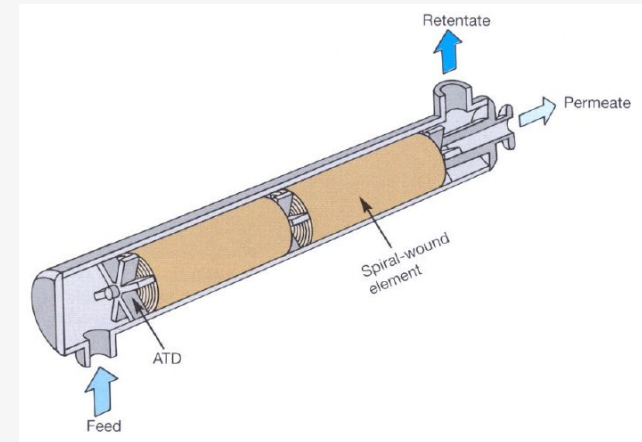
- Spiral wound
- Plate & Frame
- Ceramic
- Tubular
- Hollow fiber





# What is membrane filtration?

- Membrane filtration is one of a wide range of separation process, where the key parameter is size.



# Milk Contents:

## Avarage Milk Contents:

True Protein (%) :	3,04
NPN (%) :	0,16
Fat (%) :	3,60
Lactose (%) :	4,70
Ash (%) :	0,75
Total Solid (%) :	12,25

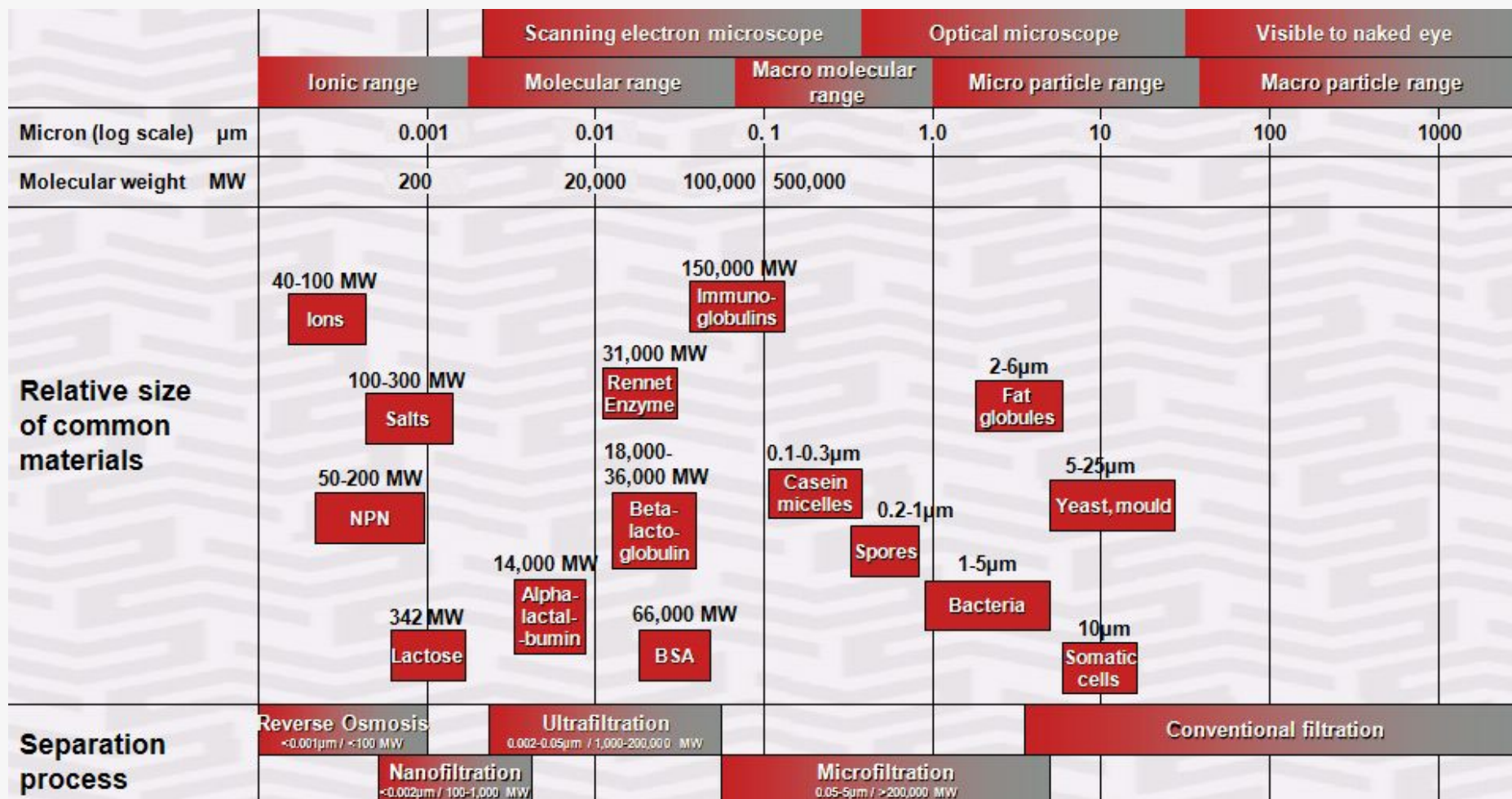


## Avarage Whey Contents:

True Protein (%) :	0,60
NPN (%) :	0,20
Fat (%) :	0,05
Lactose (%) :	4,50
Ash (%) :	0,50
Total Solid (%) :	5,85



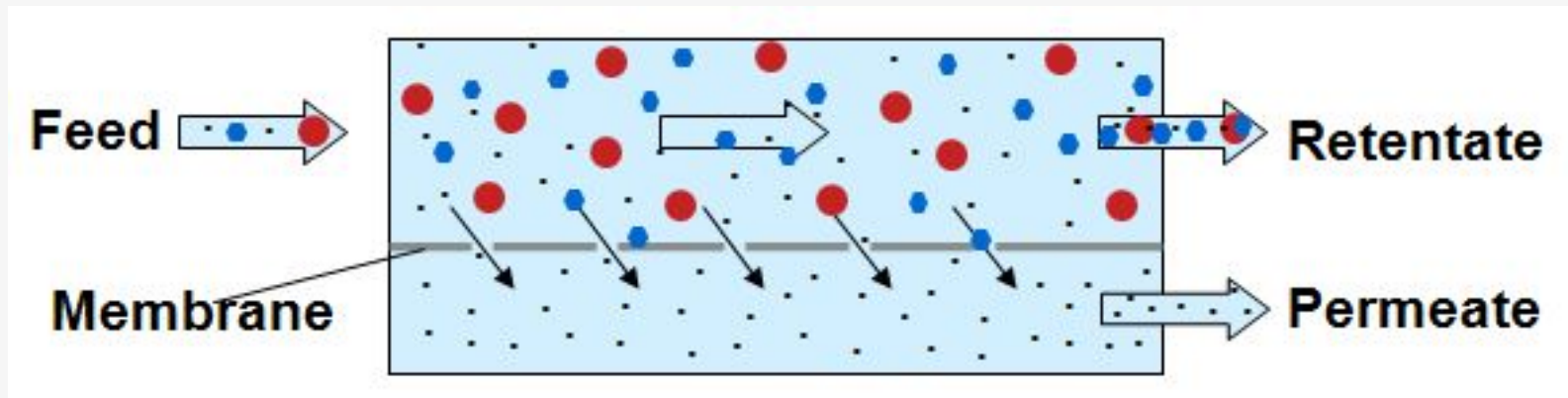
# Relative Size Of Common Materials





## How membrane filtration works?

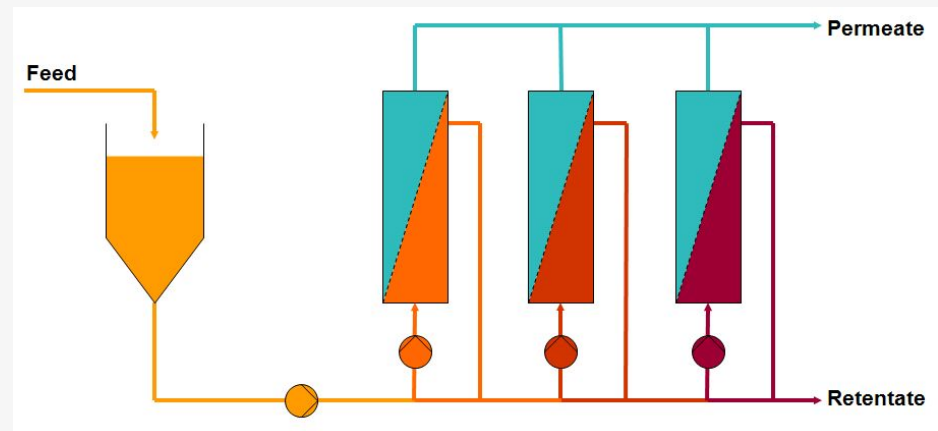
- In the basic terms membrane filtration is the passing of a single feed stream through a membrane system.
- The membrane is a physical barrier that is permeable for only some of the components in the feed stream, which is thereby separated into two individual streams called the retentate and the permeate.



## Terms and Expressions

- Retentate:** The fraction of the feed product, which is rejected by the membrane. Also called concentrate.
- Permeate:** The fraction of the feed product, which passes through the membrane. Also called filtrate.
- Concentration factor:** The volume of feed product needed to produce 1 kg retentate.

**Feed:** 10,000 l/h  
**CF:** 4  
**Retentate:** 2.500 l/h  
**Permeate:** 7.500 l/h



## Whey

- Pre-concentration
- Concentration
- Demineralisation
- WPC, WPI

## Milk

- Pre-concentration
- Concentration
- Protein standardisation
- Casein standardisation
- MPC, MPI
- Feta, UF cheeses
- Quark, cream cheese types

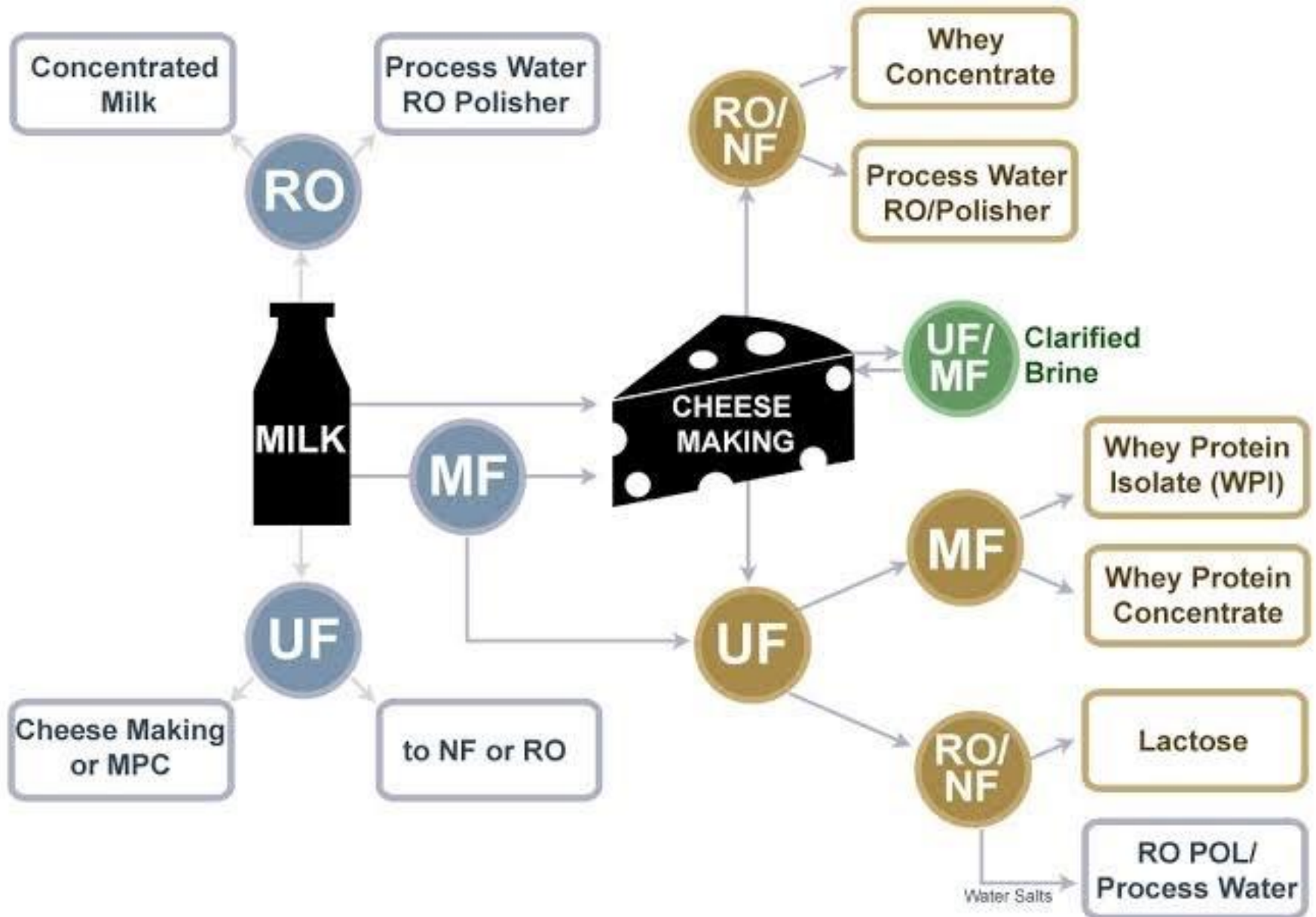
## Permeate

- Pre-concentration (UF permeate)
- Concentration (UF permeate)
- Demineralisation (UF permeate)
- Polishing (RO, NF permeate)

## Other

- Water and product recovery
- Milk Recovery
- Cheese brine purification
- Condensate polishing

# Membrane Filtration Possibilities





## Milk Filtration Possibilities

Microfiltration	Ultrafiltration	RO or NF of milk
<ul style="list-style-type: none"> <li>• Bacteria removal</li> <li>• Fat separation for MPI 90+ %</li> <li>• Protein fractionation</li> <li>• Casein concentration</li> </ul>	<ul style="list-style-type: none"> <li>• Protein std.</li> <li>• MPC 50</li> <li>• MPC 65</li> <li>• MPC 70</li> <li>• MPC 80 (diafiltration 30-75 %)</li> <li>• MPC 85 (diafilt. 100+ %)</li> <li>• MPI 90+</li> </ul>	<ul style="list-style-type: none"> <li>• RO concentration up to 18-22 % TS (21 bar)</li> <li>• Or up 30-32 % TS (35 bar)</li> <li>• NF concentration up to 20-24 % SNF with some desalination</li> </ul>

## Whey Filtration Possibilities

Microfiltration	Ultrafiltration	RO or NF of whey	RO or NF of permeate
<ul style="list-style-type: none"> <li>• Bacteria removal</li> <li>• Fat separation for WPI 90+ %</li> <li>• Protein fractionation</li> </ul>	<ul style="list-style-type: none"> <li>• WPC 35 (8-10 % TS)</li> <li>• WPC 50-75 (15-25 % TS)</li> <li>• WPC 80-84 (diafiltration 25-30 % TS)</li> <li>• WPI 90+ (diafiltration 25-30 % TS)</li> </ul>	<ul style="list-style-type: none"> <li>• RO concentration up to 18-20 % TS</li> <li>• NF concentration up to 20-26 % TS desalination approx. 35 %</li> </ul>	<ul style="list-style-type: none"> <li>• RO concentration up to 18-20 % TS</li> <li>• NF concentration up to 20-26 % TS desalination approx. 35 %.</li> </ul>
Sweet or acid whey	Sweet or acid whey	Sweet or acid whey	Sweet or acid whey

# SPIRAL WOUND ULTRAFILTRATION PLANT

## UF applications (Dairy I):

Ultrafiltration for concentration of milk or whey is widely used in the dairy industry. UF concentration is used as a concentration step in the process of making different whey or milk powder products.

### Milk

- Protein standardisation (cheese milk, milk powder, market milk)
- Yoghurt
- UF cheeses (Feta, Domiati, Queso Fresco, Queso Blanco, etc.)

### •Sweet and acid whey

- WPC 35 – WPC 80, WPI
- Special products, yoghurt, desserts
- Concentrate for Ricotta
- MF permeate
- WPC
- Special products, yoghurt, desserts
- MF concentrate
- Concentration of casein (increase of TS)



# SPIRAL WOUND ULTRAFILTRATION PLANT



## UF applications (Dairy II):

### Cultured milk concentration

- Quark, Topfen, Pâte fraîche, Baker's cheese, Tvorog
- Strained Yoghurt, Skyr

### Cultured cream cheese

- Cream cheese, Double cream cheese, Labne, Mascarpone, Strained Yoghurt

### Buttermilk / Churn water

- Concentrate for food ingredients, powder
- Acid buttermilk
- Quark and other fresh cheeses

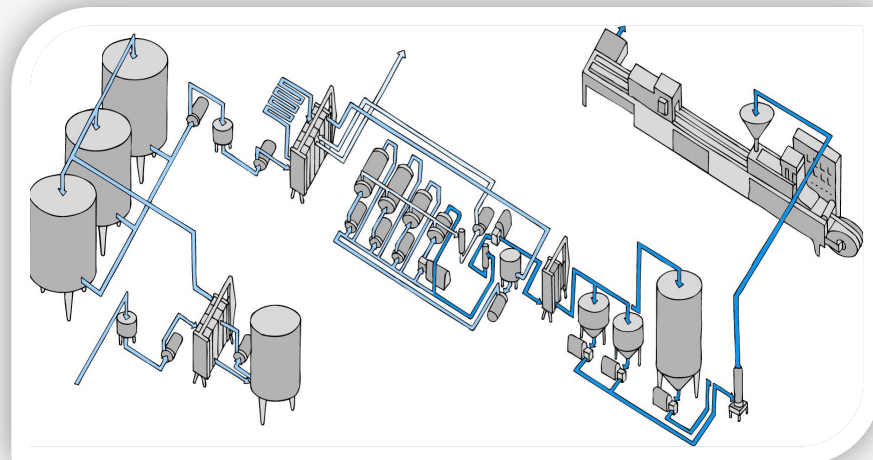
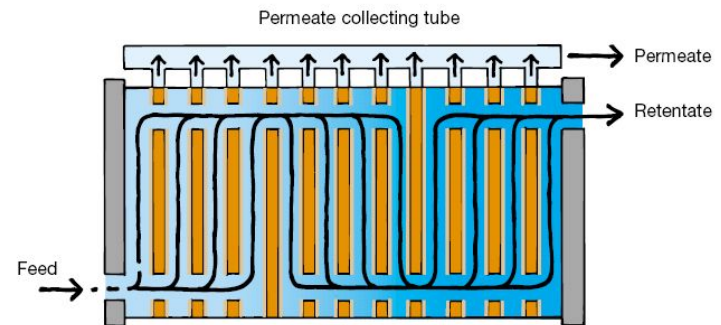
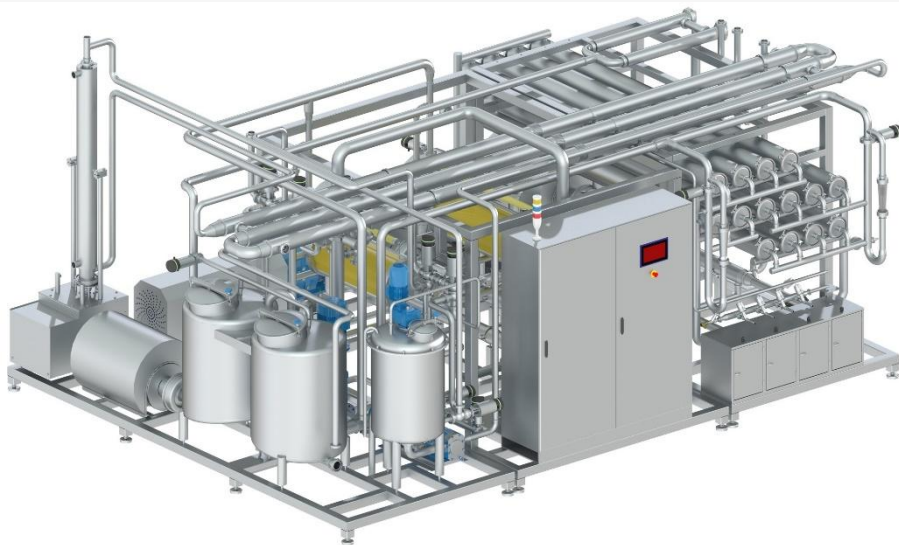




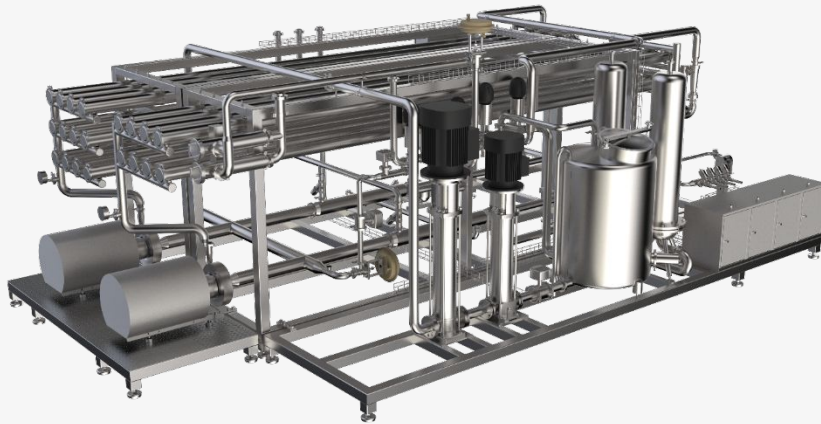
# ULTRAFILTRATION PLATE AND FRAME PLANT

## UF for Fermented Cheese Concentration (Dairy III):

Labneh, Cream Cheese, Double Cream Cheese, Quark, Mascarpone, Strained Yoghurt, Stirred Yoghurt etc...



# REVERSE OSMOSIS PLANT



## RO Applications (Dairy I):

Reverse Osmosis filtration is based on a very dense membrane that rejects virtually all substances except water. This is possible due to a very high system pressure.

RO is used for concentration of liquids to higher solids levels, depending on application.

### Milk

- Pre-concentration (alternative or additional to evaporation) Concentration in order to reduce transportation costs
- Yoghurt

### •Whey (Sweet & Acid)

- Pre-concentration (alternative or additional to evaporation)
- Concentration in order to reduce transportation costs
- Pre-concentration for WPC
- Concentrate for Ricotta / Whey cheese
- Concentration for animal feed



### •MF permeate

- Pre-concentration for production of WPC

# REVERSE OSMOSIS PLANT

## RO Applications (Dairy II):

### •UF Permeate

- Pre-concentration for production of lactose or alcohol
- Concentration in order to reduce transportation costs
- Concentration for animal feed

### •Sweet buttermilk

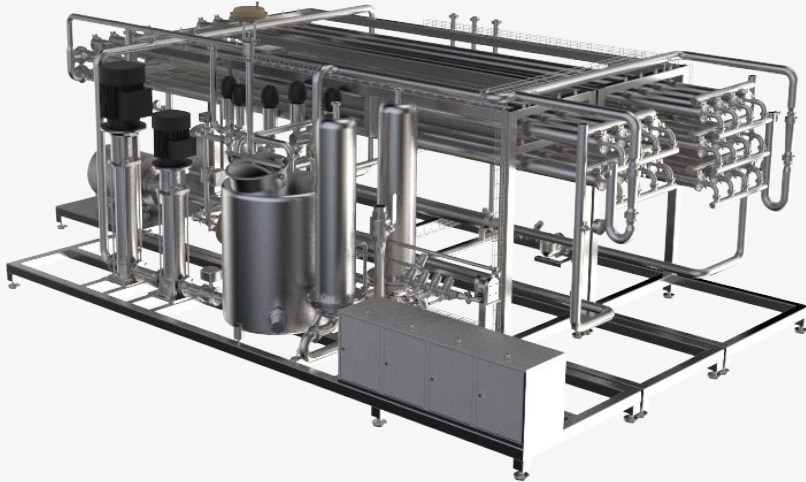
- Concentration (alternative or additional to evaporation)
- Concentrate for food ingredients, – Skimmed or Whole Milk Powder

### •White water recovery

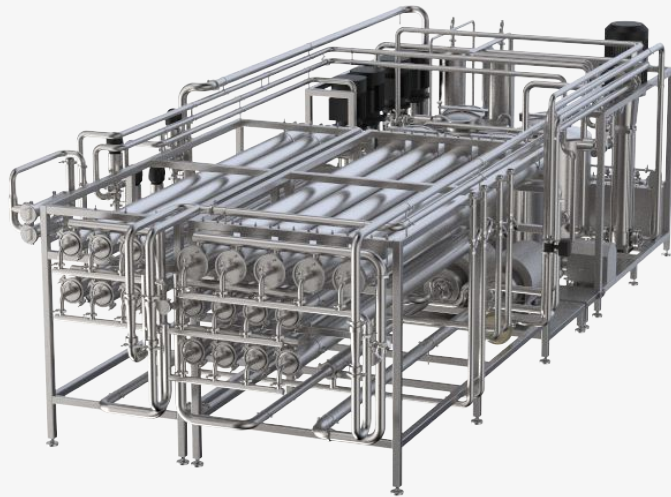
- Concentration of product residues in flush water from tanks, pipelines etc.

### •White water recovery

- Evaporator condensate, RO permeate, NF permeate
- Reduce Water footprint for sustainable environment



# NANOFILTRATION PLANT



## NF applications (Dairy):

Nanofiltration is a RO process in which a more open membrane allows small monovalent ions such as sodium and chloride to pass. This means that NF combines concentration (like RO) and partial demineralisation.

### Whey

- Partly demineralised Whey (baby food, special WPC products)
- Pre-treatment for ion exchange and electro dialysis
- Demineralisation of salt whey (Cheddar)
- Increase of RO concentrate total solid TS%

### •UF permeate

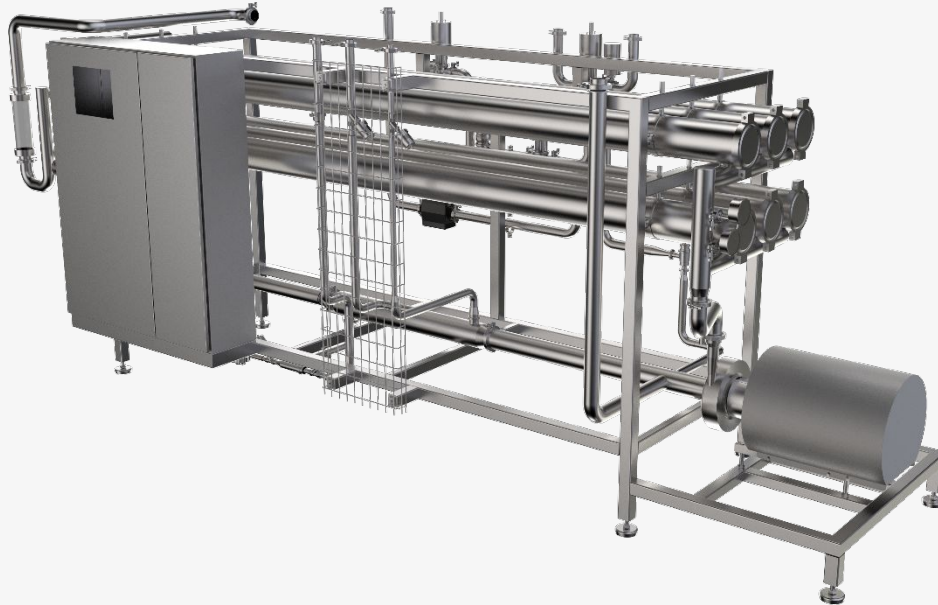
- Partly demineralised permeate for fermentation, lactose powder, 90% LAC/TS powder
- TS increase of RO concentrate



### •Milk



# MICROFILTRATION PLANT



Microfiltration capability for separation of microorganisms from raw milk is presented in Figure 2.

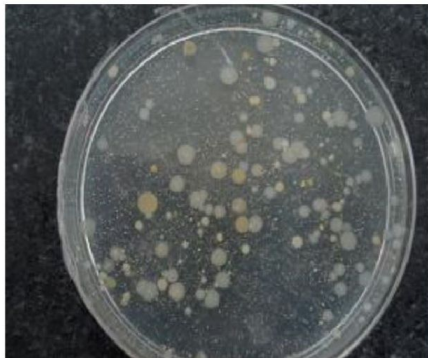
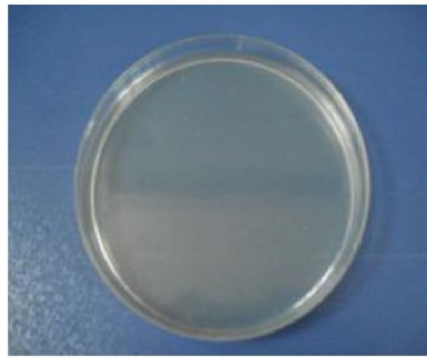


Figure 2. (a) medium from raw skim milk



(b) medium from microfiltered milk

## MF applications :

### Milk

- Bacteria Removal for ESL milk or cheese
- Bacteria, Spores and Fat Globules
- De fatting of milk for MPC & MPI production
- Protein fractionation (Casein standardization)

### Whey

- Removal of bacteria from whey for WPC or WPI production
- de-fatting of whey for high-protein WPC

### Cheese Brine

- Removal of bacteria, spores, yeast, mould, and other impurities



**Thank You For Listening!**