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When purity is key.

Optimization of Whey and Whey Derivatives Demineralisation Process

Whey Technology and Utilisation Conference June 12th 2013

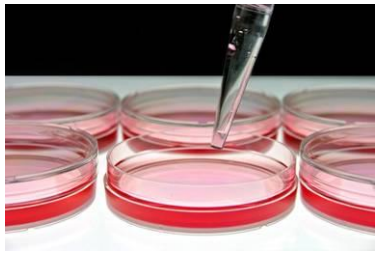
Why Novasep?

Novasep designs and develops processes and purification technologies, and also provides industrial systems with guaranteed performance for the purification and production of :

- **Food ingredients**
- **Functional Ingredients**
- **Bio-Industries**
- **Biopharma**

Our Markets

Biopharma



Recombinant Proteins
Vaccines
mAbs - ADC
Blood Fractionation
Biomass Extracts
Cell Therapy

Food Ingredients

Sugar
Starch
Milk ingredients
Demin Whey
Lactose

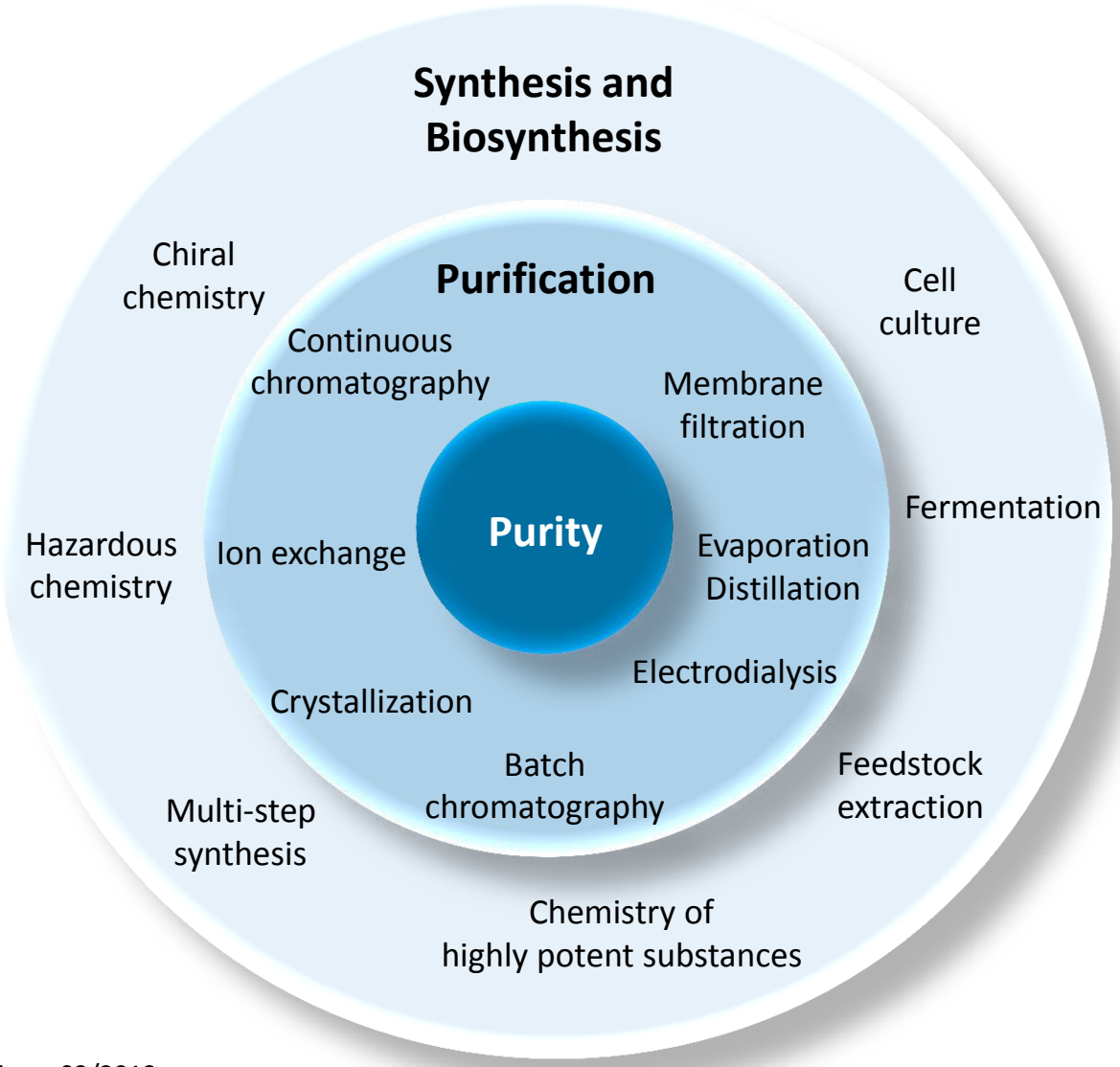
Functional Ingredients

Polyphenols
Anthocyanes
FOS
Sweeteners
Omega 3
Stevia

Bio-Industries

White Biotechnology
Organic Acids
Aminoacids
Antibiotics
Vitamins
Bio-based Chemicals

Combined Technologies

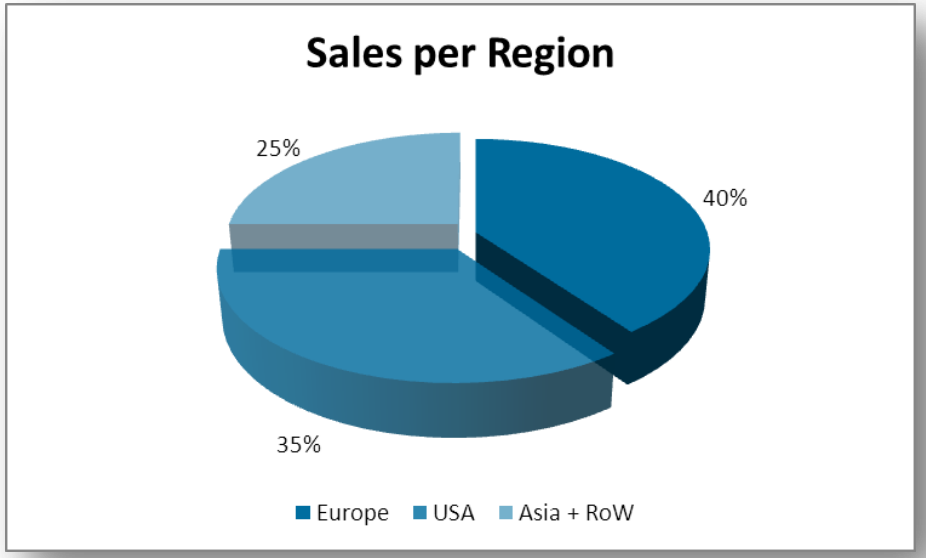


Novasep Today

300 M€ turnover

1200 people, 200 in R&D

13 sites



Over **650 customers** served worldwide

Over **100 R&D projects** per year

Over **100 different active molecules** produced per year

Over **2,000 purification systems** installed worldwide

A Global Presence


Freeport

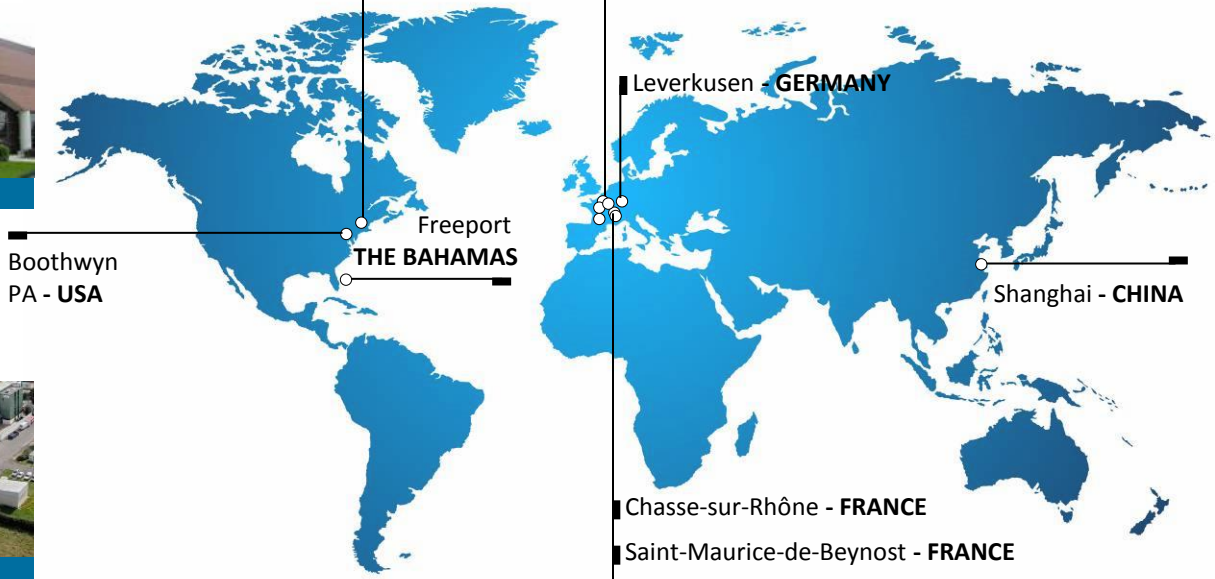

Shrewsbury


Seneffe


Pompey

Boothwyn


Leverkusen




Shanghai


Le Mans


Mourenx


Chasse-sur-Rhône


S.-M.-de-Beynost

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Dairy Ingredients
Purification of Minor Components

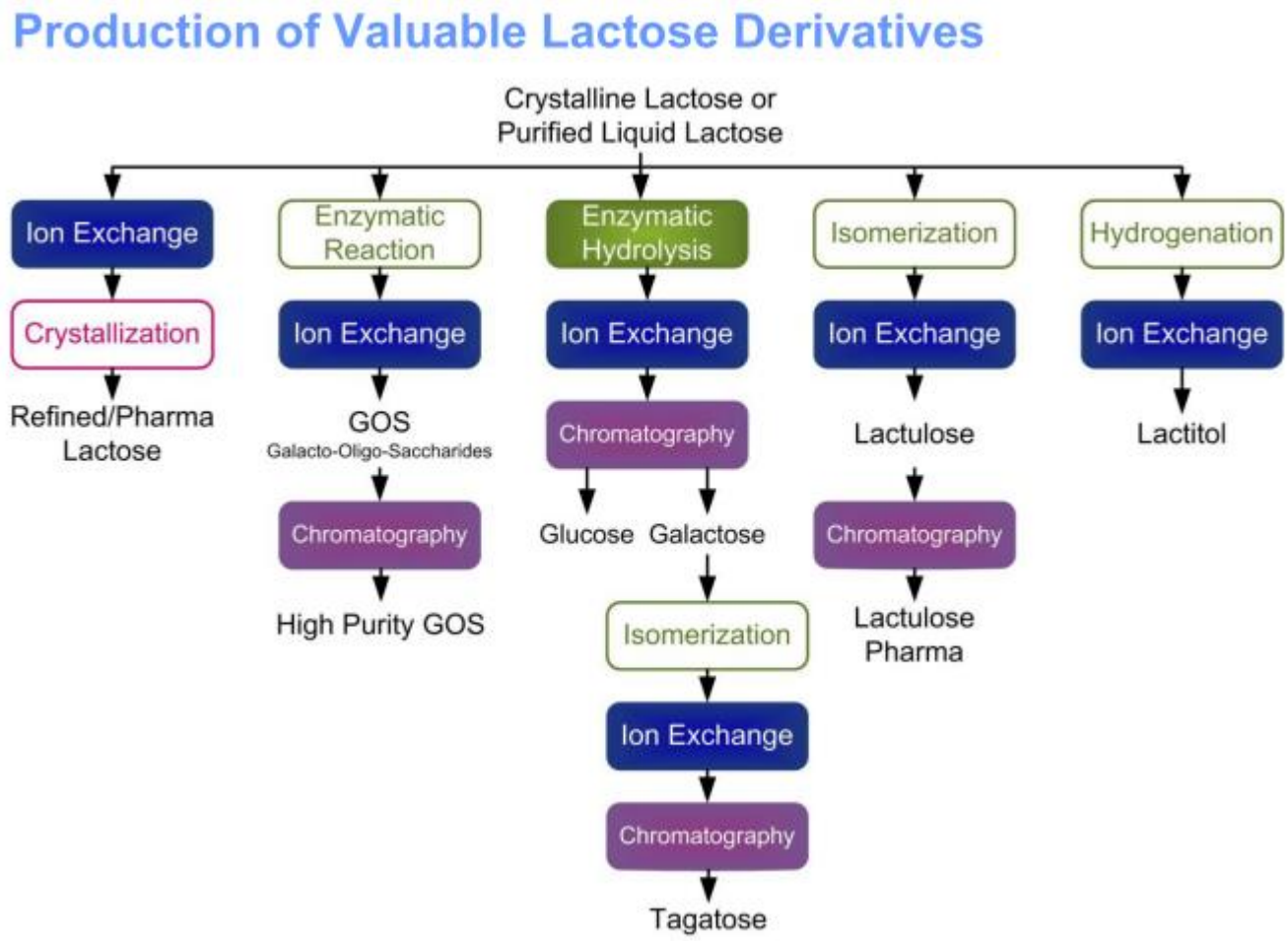
Applications of Novasep Purification Technologies for the Production of Various Dairy Ingredients

		MF	UF	NF	IEX	DK	SSMB	LPLC	RO	ED
Milk Products	Liquid Cheese	X	X							
	Milk Debacterization	X								
	Milk / Whey Protein Separation	X	X							
Regular Products	Premium Edible Lactose Quality			X	X	X			X	
	Pharma Lactose Quality			X	X	X	X		X	
	High Yield Lactose Production			X	X	X	X		X	
	Liquid Lactose Syrup			X	X	X	X		X	X
	WPC		X							
	WPI		X		X		X			
	Demineralized Whey 30		X	X					X	
	Demineralized Whey 50/70			X					X	X
	Demineralized Whey 90			X	X				X	X
Lactose Derivatives	Lactitol				X					
	Tagatose			X	X	X	X		X	
	Lactulose				X		X			
	GOS				X		X			
Specialty Products	β-Lactoglobuline		X		X			X		
	α-Lactalbumine		X		X			X		
	Lactoperoxidase		X	X	X			X		
	Lactoferrin		X	X	X			X		

What products Can be obtained from Whey

- Whey powder
- **Demineralised whey D30/D50/D70/D90**
- WPC 35
- WPC80 and WPI
- Whey permeate
- Lactose and derivatives
- Native and denatured whey proteins
- Fractions with enriched proteins
- Bioactive peptides
- Oligosaccharides
- etc

Lactose Production
Increased Yield and Quality



Demineralised Whey Products

Applications

- D30 – D70 Food Ingredients

- D70/D90 Infant Formula

Demineralised Whey D90 Producers

- Nestlé
- Danone
- Friesland Foods Domo
- Euroserum
- Lactalis

Demin Whey D90 Growing Demand Asia

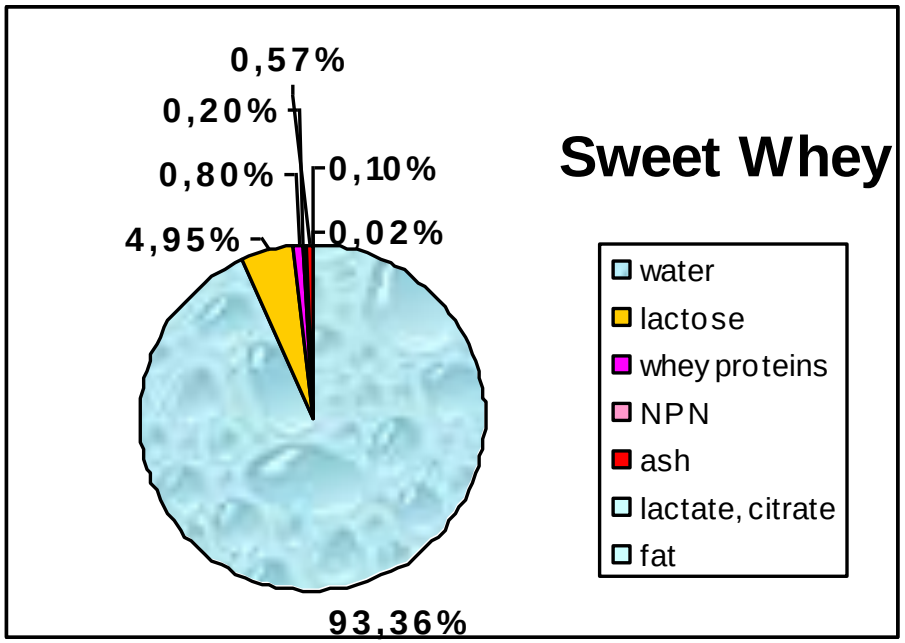
Infant Growing Demand Asia/China BBC April 2013

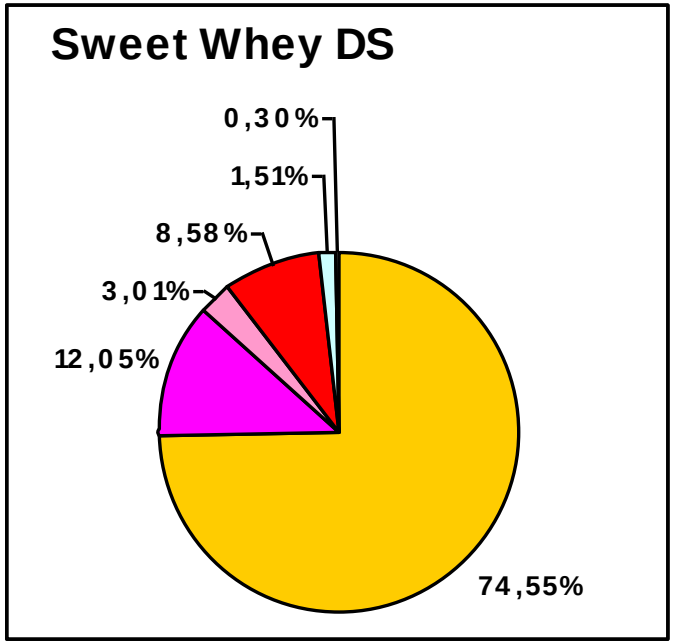
“Baby milk rationed in UK over China export fear”
Demand for foreign-made baby milk in China is strong after contaminated baby formula killed six infants in 2008”.
Retailers in the UK are rationing sales of powdered baby milk because of a surge in demand in China.
Danone, the manufacturer of Aptamil and Cow and Gate baby milk powder, said most supermarkets were introducing a restriction of two cans per customer. It said the limit was to prevent some individuals from bulk-buying baby milk for "unofficial exports". Retailers were also capping sales of Nestle's baby milk powder.

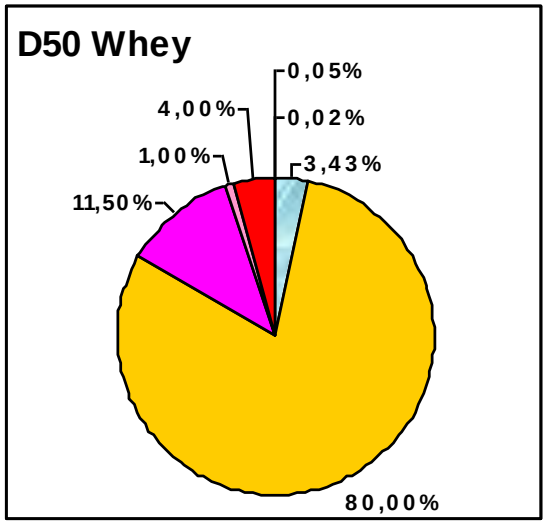
Demin Whey Producers UK and Ire Opportunity

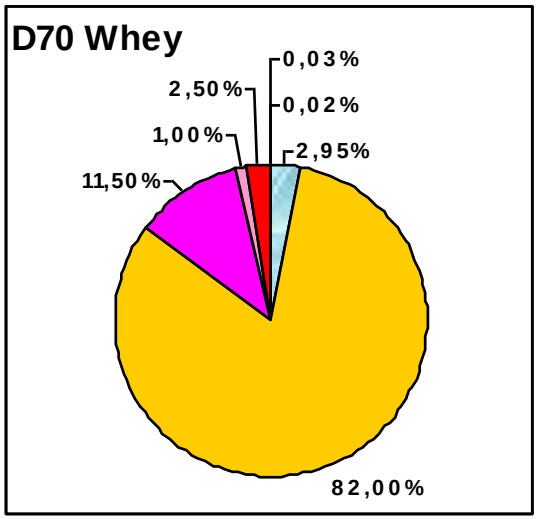
Europe Milk Quota System will be abolished in 2015.

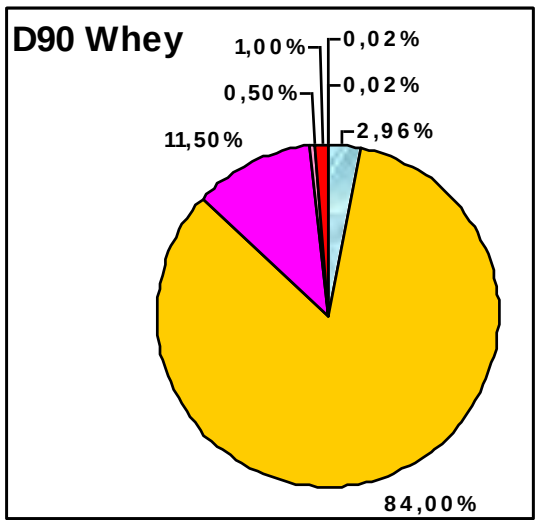
Typical Sweet vs. Demineralized Whey composition





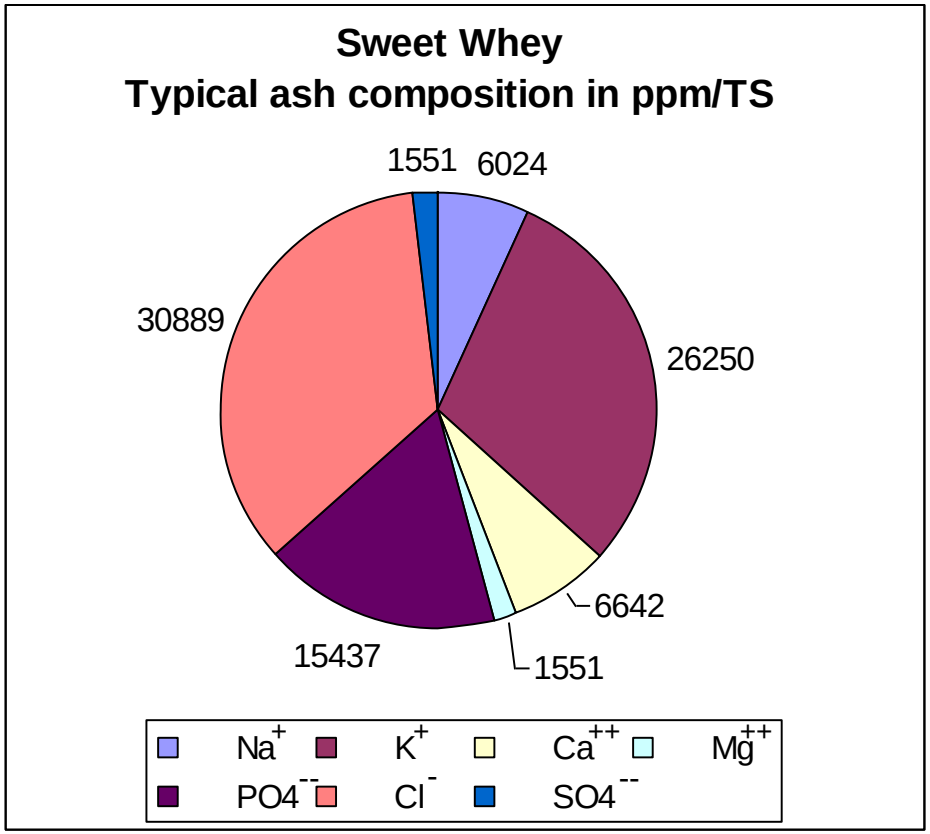






Sweet Whey
mineral composition

Combination of monovalent and divalent Ions



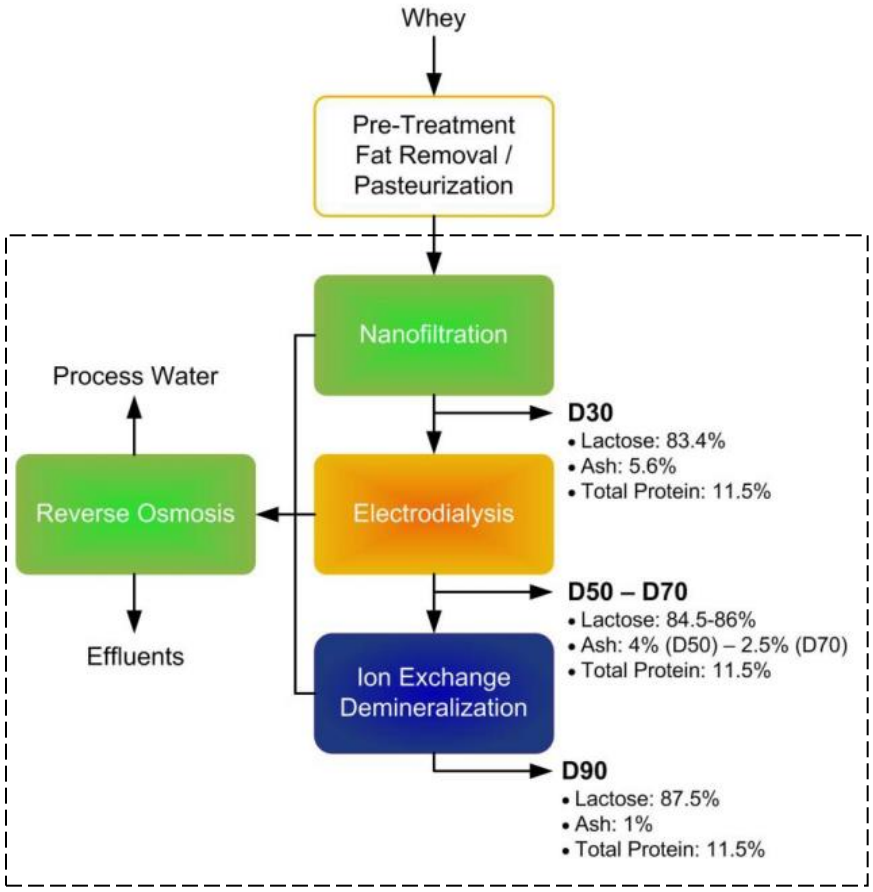
Whey demineralization technologies

Novasep separation technologies used industrially for whey demineralization:

- Cross-Flow Nanofiltration
- Electrodialysis
- Ion-Exchange

Dairy Industry
Demineralization of Whey or Permeate

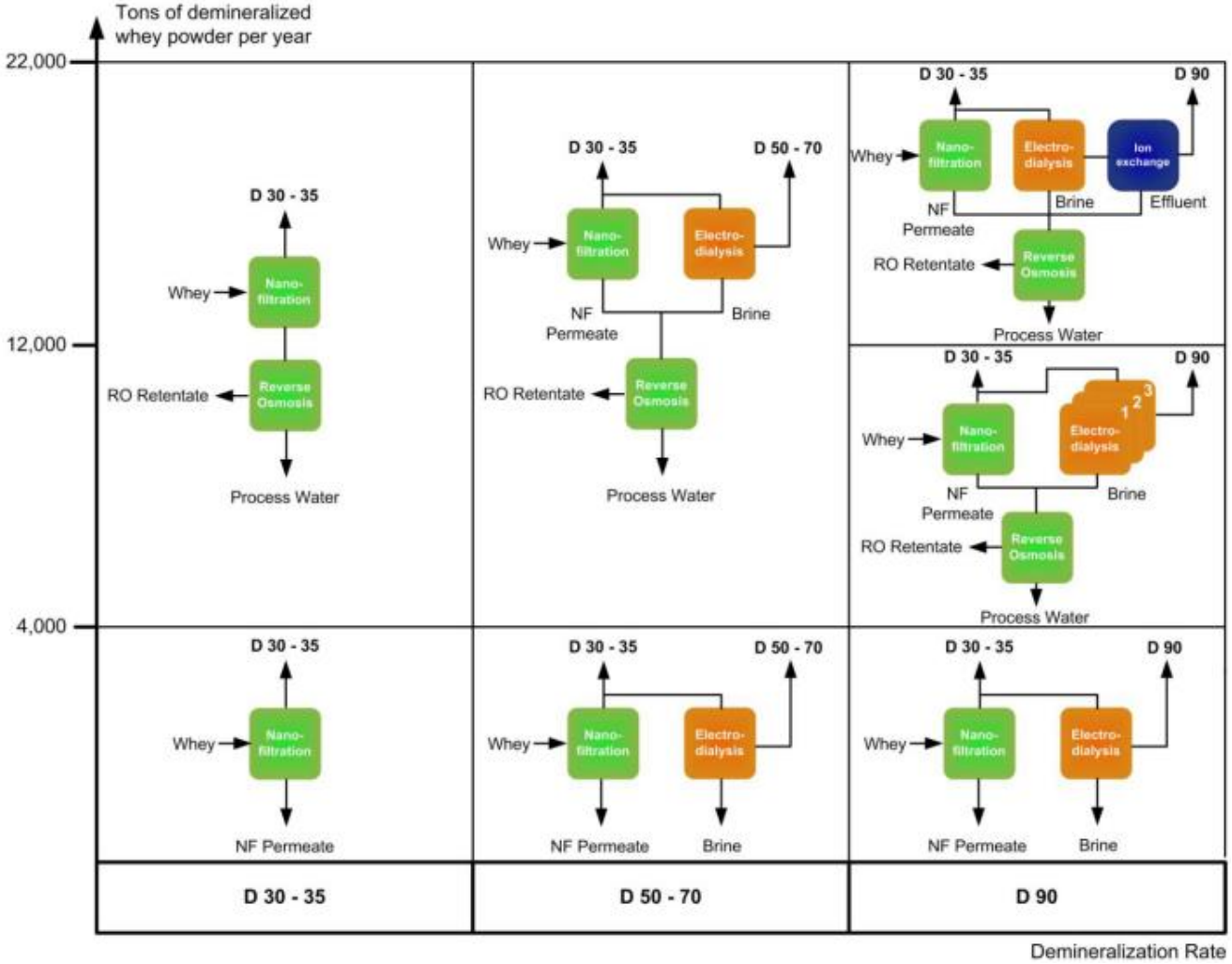
An optimized demineralization process provided by Novasep



- Combination of NF+ED+IEX:
  - Highest Flexibility
  - Modular System
  - Lowest Costs
- A Question of Costs:
  - CAPEX + OPEX for NF
  - CAPEX + OPEX for ED
  - CAPEX + OPEX for IEX

Demin Whey / Permeate
Combine the Best of NF + ED + IEX

Optimized set-up of Novasep/Mega lines with 1xEDR-6/250



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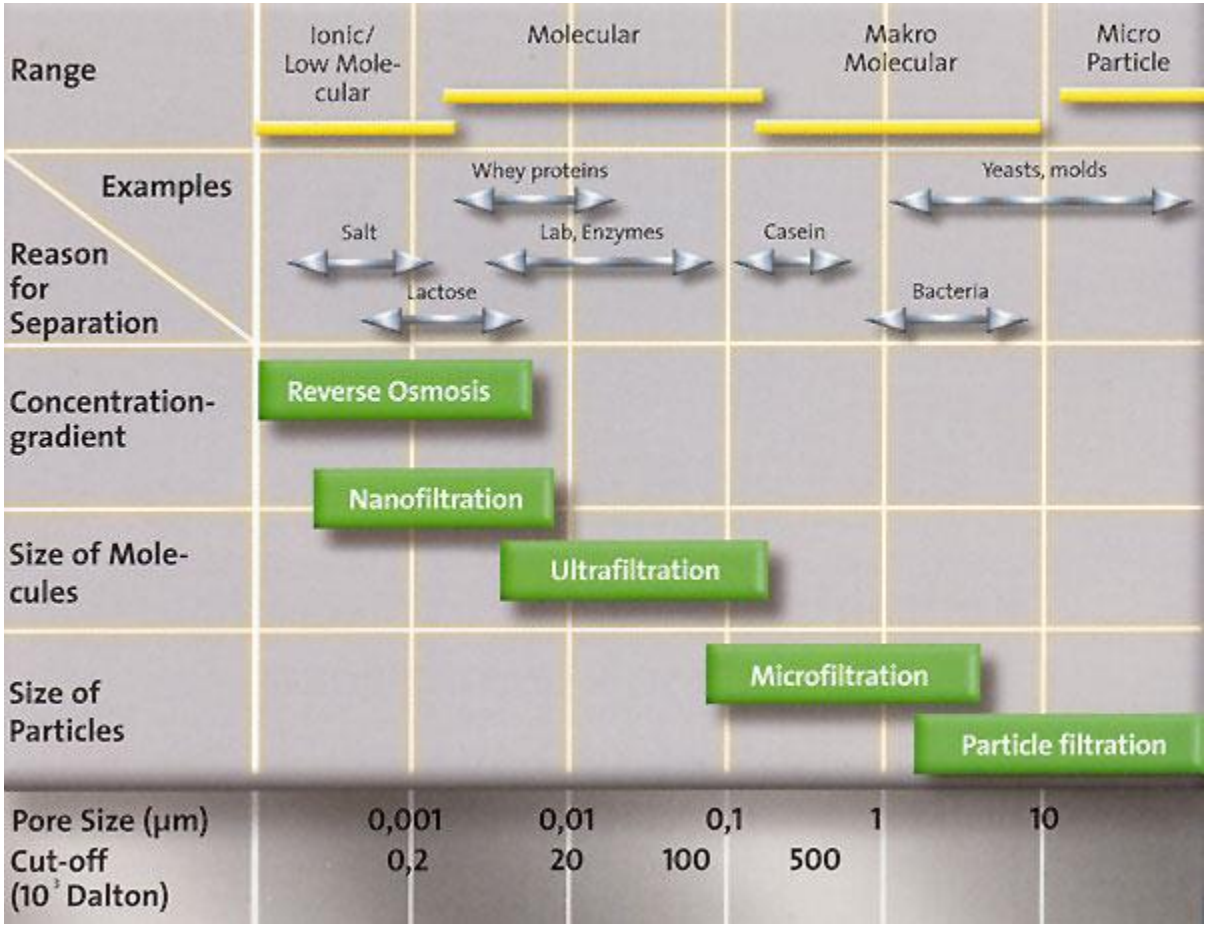
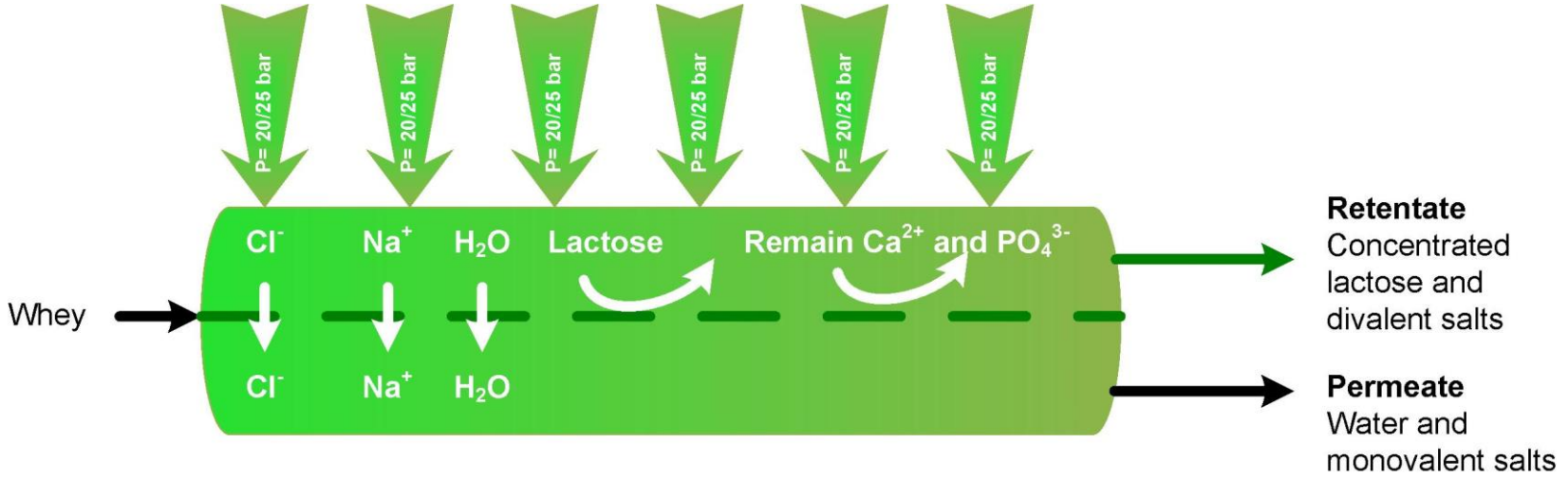
Membrane Technologies for Whey particles of different



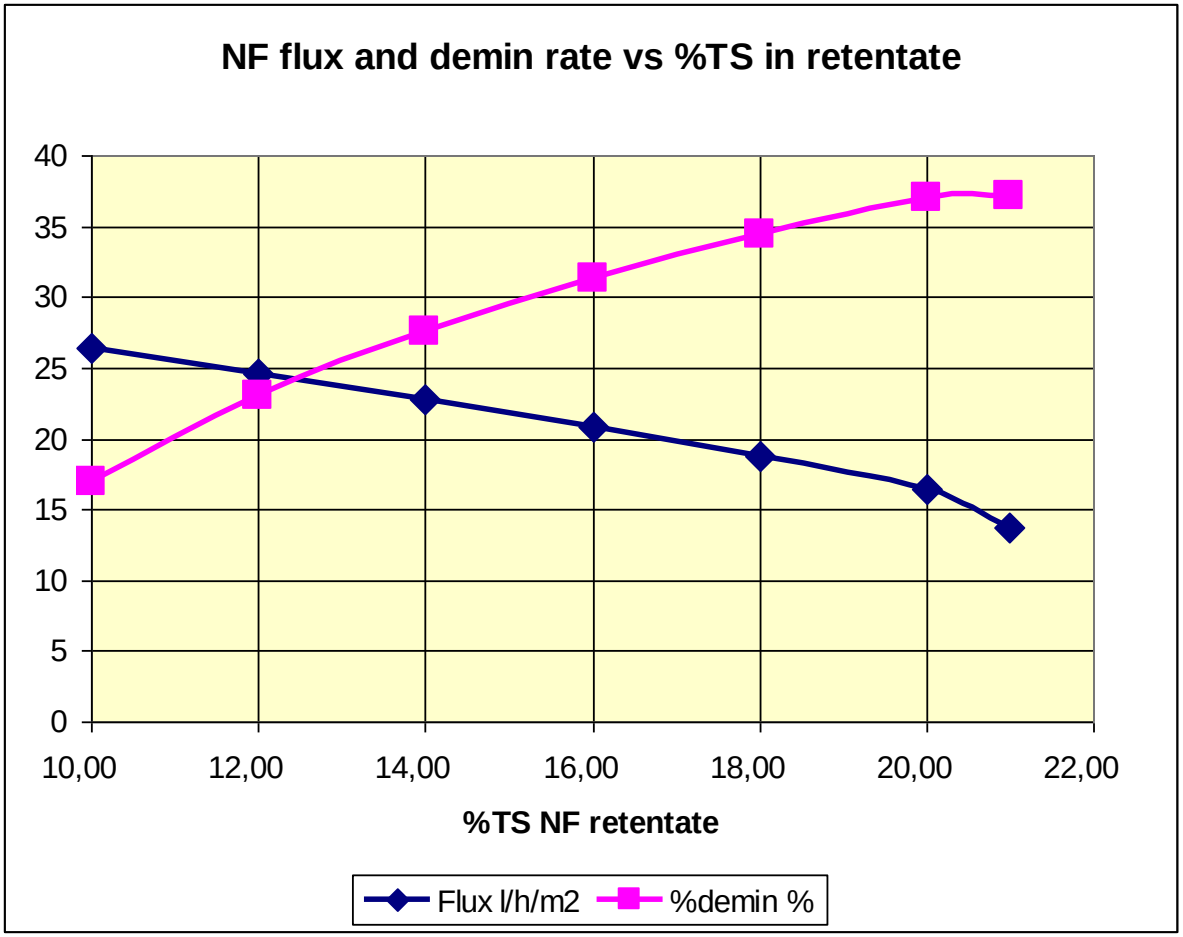
Whey demineralization technologies

Cross-Flow Nanofiltration

- **Continuous Process 21 Hrs + CIP**
- **Removal of 30% of the minerals in NF permeate, mostly monovalent minerals**
- **Ideally suited for initial concentration (water removal) of liquid whey from 6 to 18-22%TS**

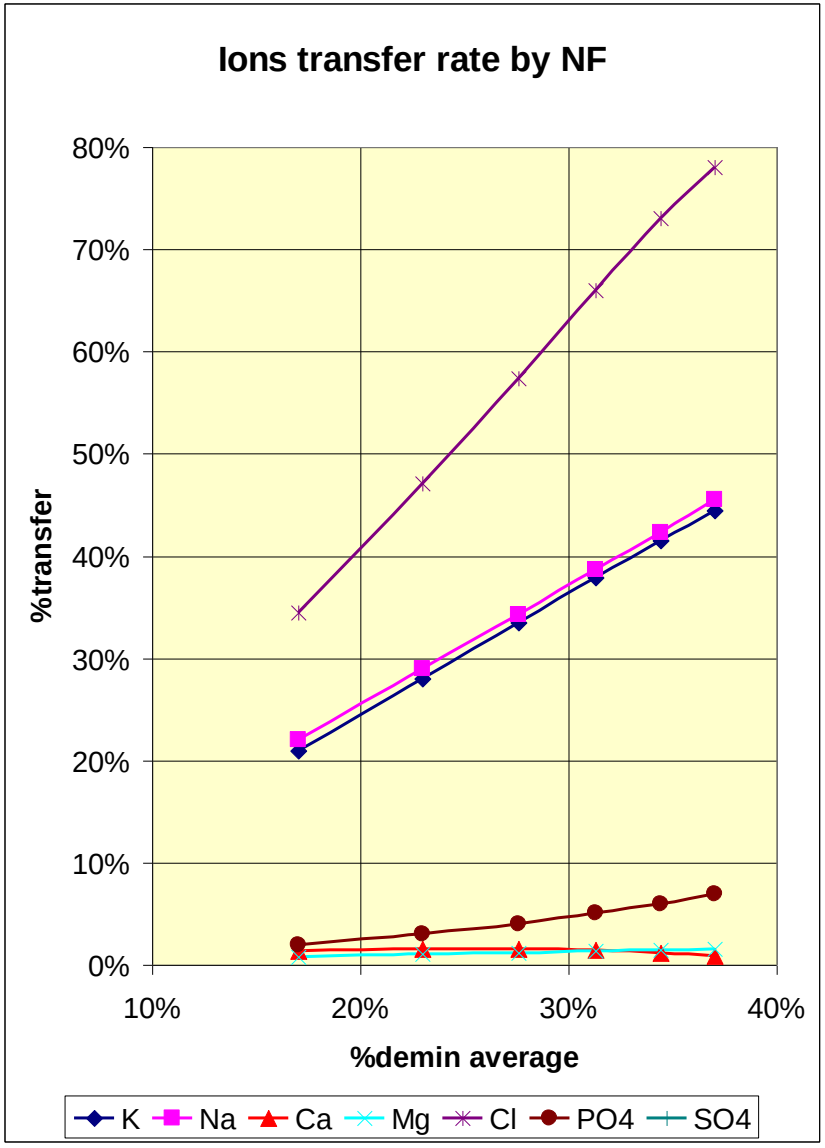


Demineralization by Cross-Flow Nanofiltration



- **Whey feed to NF 6%TS**
- **Flux declining quickly when NF retentate reaching 21-22%TS**
- **Demineralization rate limited to 30-35%**

Demineralization by Cross-Flow Nanofiltration



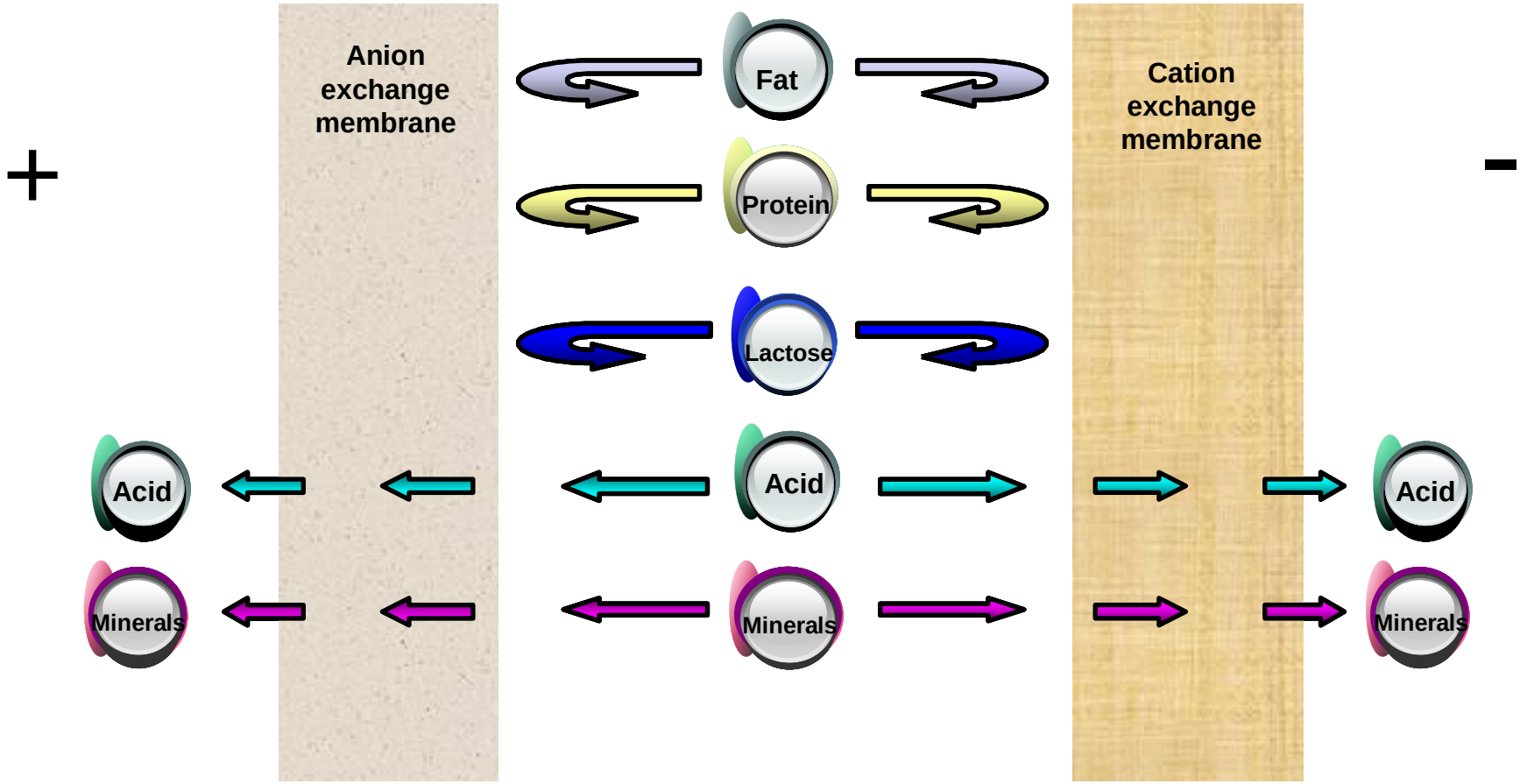
- **NF is a monovalent demineralization process, because most ions transferred to NF permeate are monovalent : Cl, K, Na**
- **NF retentate is enriched into divalent ions : Ca, Mg, PO4, SO4**

Demineralization by Cross-Flow Nanofiltration

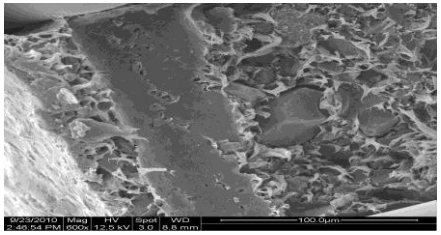
- **Most effective demineralization process, only consuming electricity, NF membranes replacement, and small quantities of CIP water and chemicals**
- **Capital cost is effective, as the NF can be designed from small to large capacities, by varying the number of stages on a single NF skid.**
- **Loss of whey proteins into NF permeate is nearly 0**
- **Loss of lactose into NF permeate limited to about 1%**

- **Nanofiltration can only demineralize 25-35%**
- **Mostly a monovalent demineralization process**

Whey Demineralization by Electrodialysis Principle



Homogeneous Vs Hetrogeneous membranes



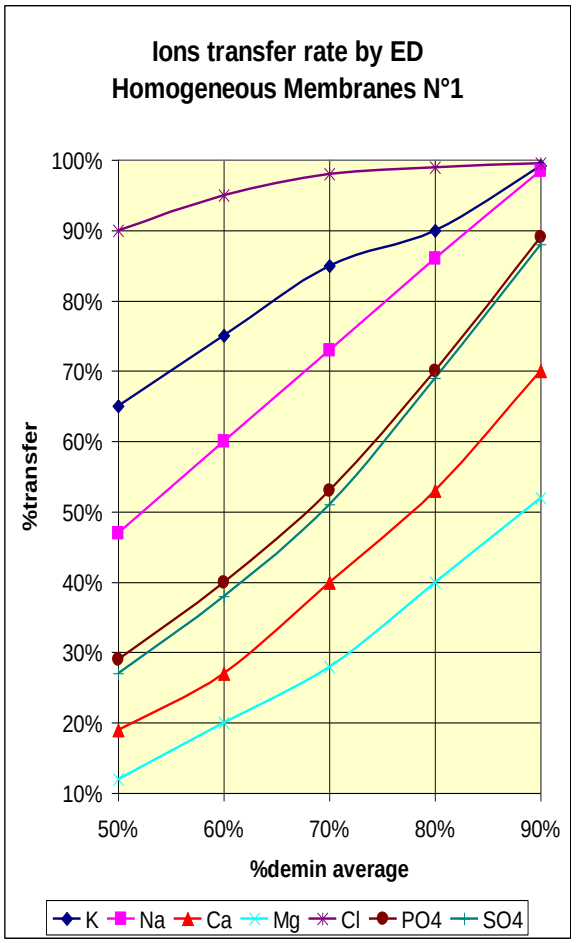
Mega Membrane material
Heterogeneous

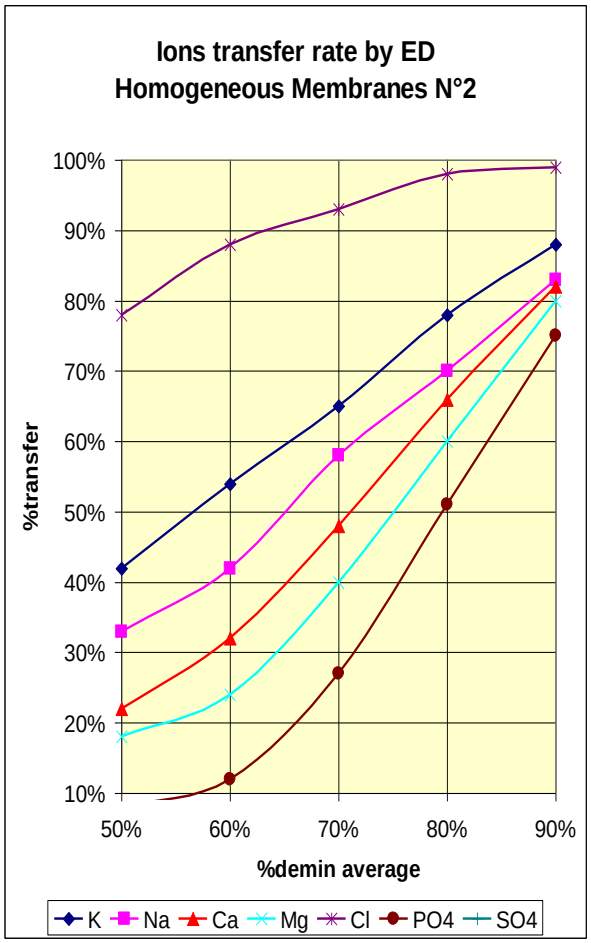
Mega ED membranes are ion-exchange heterogeneous membranes have tangible benefits compared with traditional and homogeneous membranes

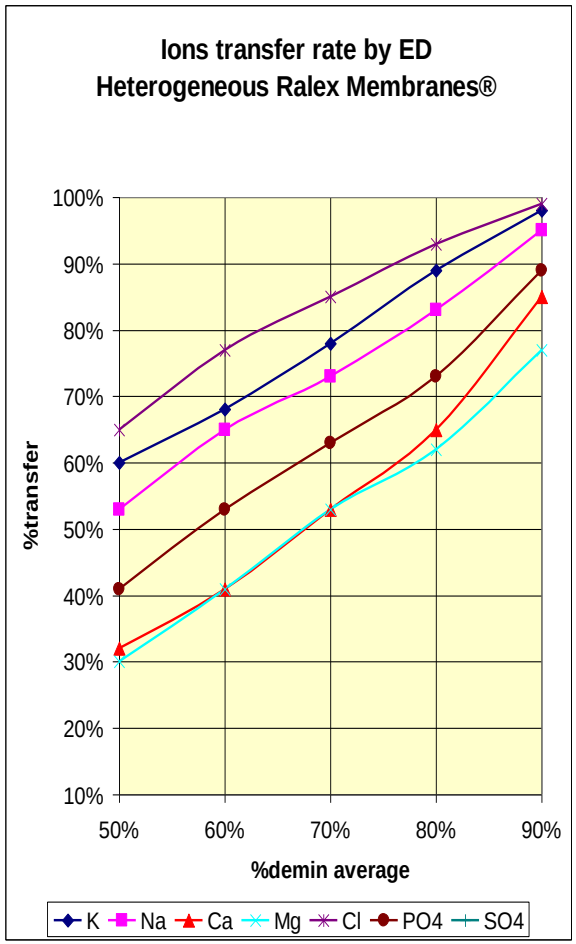
- Heterogeneous membranes, polymer mixed with milled ion exchange resin for membrane conductivity
- Open structure with large channels for small monovalent and large diavalent ions,
- More uniform ions transfer rates compared to homogeneous membranes

Demineralisation by Electrodialysis

• Homogeneous ED membranes N° 1 and 2 traditionally used for whey demineralization have good transfer of monovalent ions, but poor transfer of divalent ions - Heterogeneous membranes manufactured by MEGA have more uniform ions transfer rates



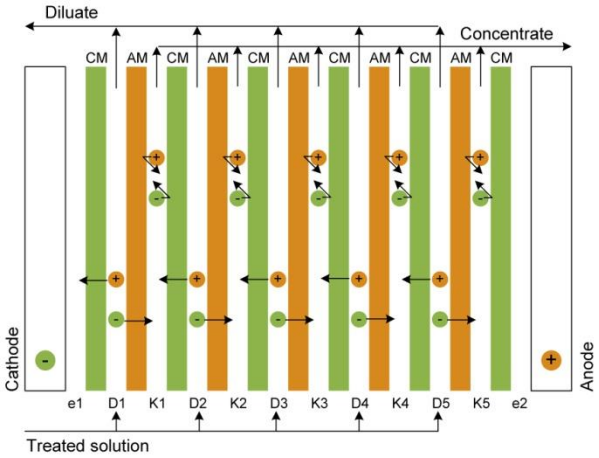


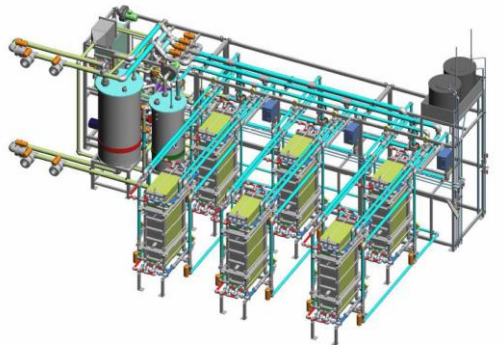


Whey demineralization technologies

Electrodialysis

- Works best on pre-concentrated whey concentrated
- Flexible demineralization rate D50, D70, D90
- Chemical minimal usage, limited to ED membranes cleaning
- Electrodialysis process running at 15C to ensure microbiological stability of whey

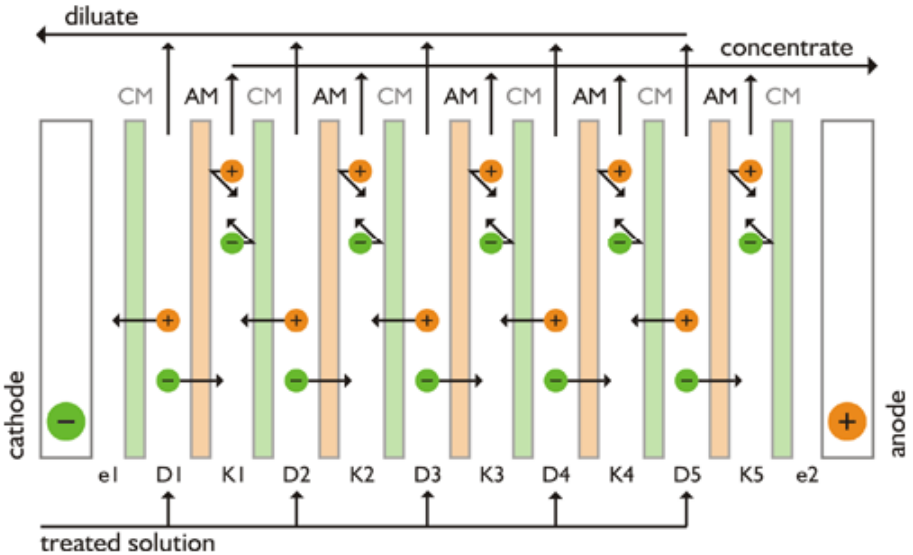




Whey demineralization technologies

Electrodialysis

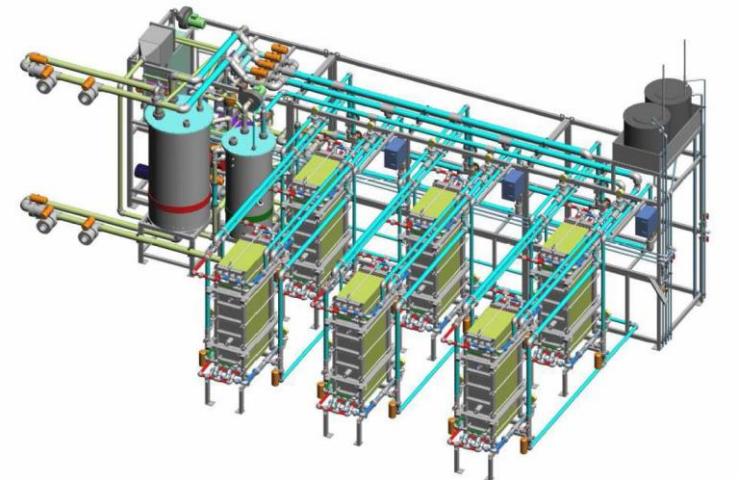
- Removal of mostly monovalent, and some divalent ions by transfer from whey solution into brine solution
- Nearly no effect on whey concentration
- More efficient at high conductivity, pre-concentrated whey 20-22%TS is optimum



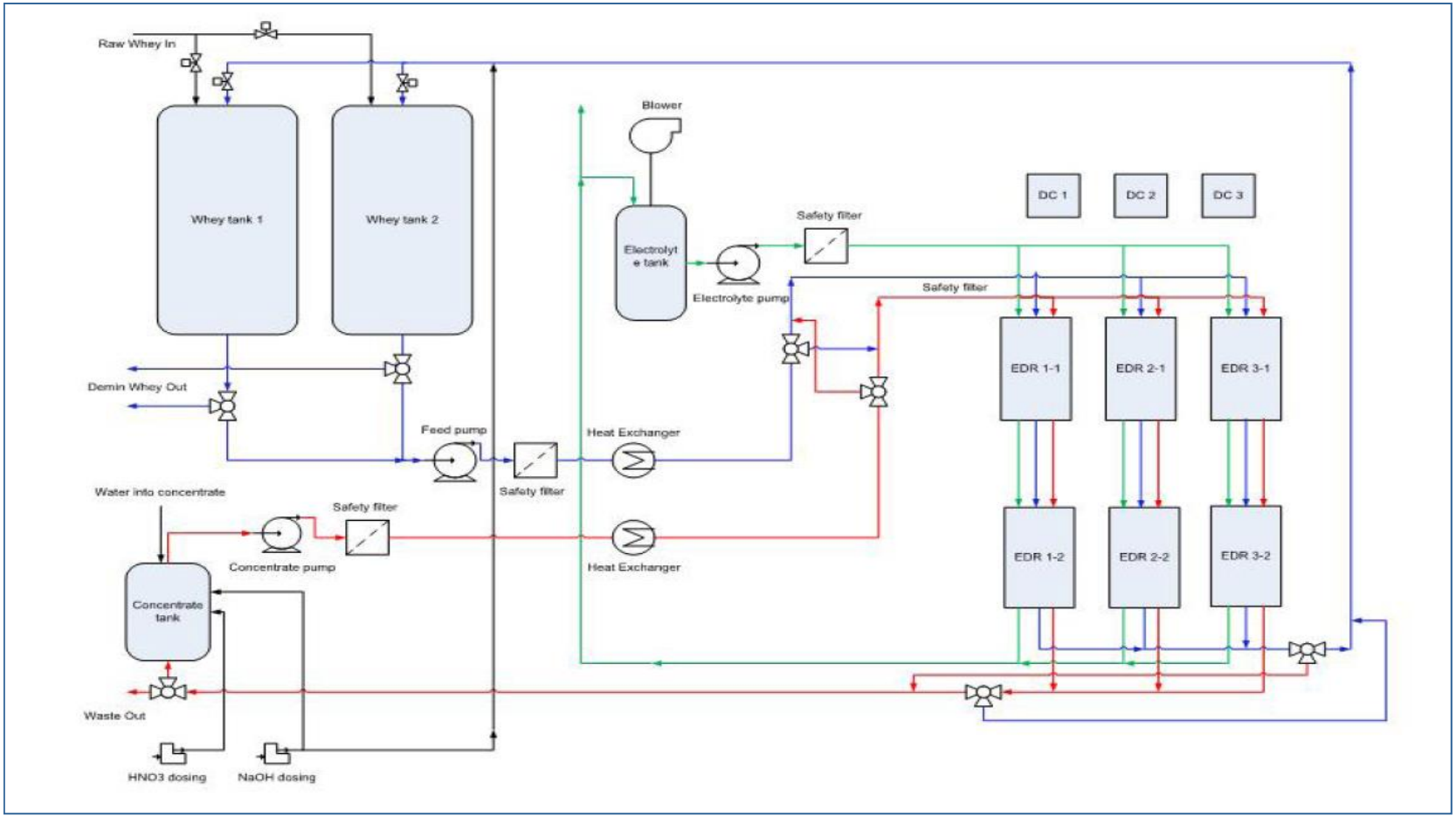
Whey demineralization technologies

Electrodialysis

- Batch Process - working cycle time of ED unit: up to 20 hours per day, CIP cycle time: only 4 hours
- 4 years membrane lifetime warranty and post-warranty services
- Easy Maintenance – Over Head removal of membrane stacks



Demineralisation by Electrodialysis



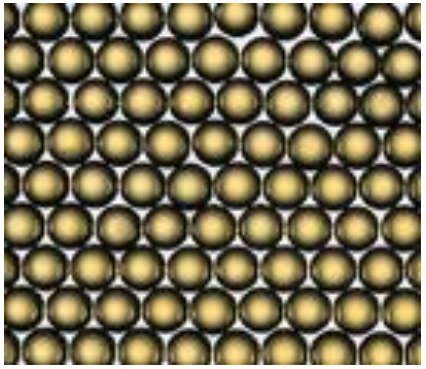
Demineralisation by Electrodialysis

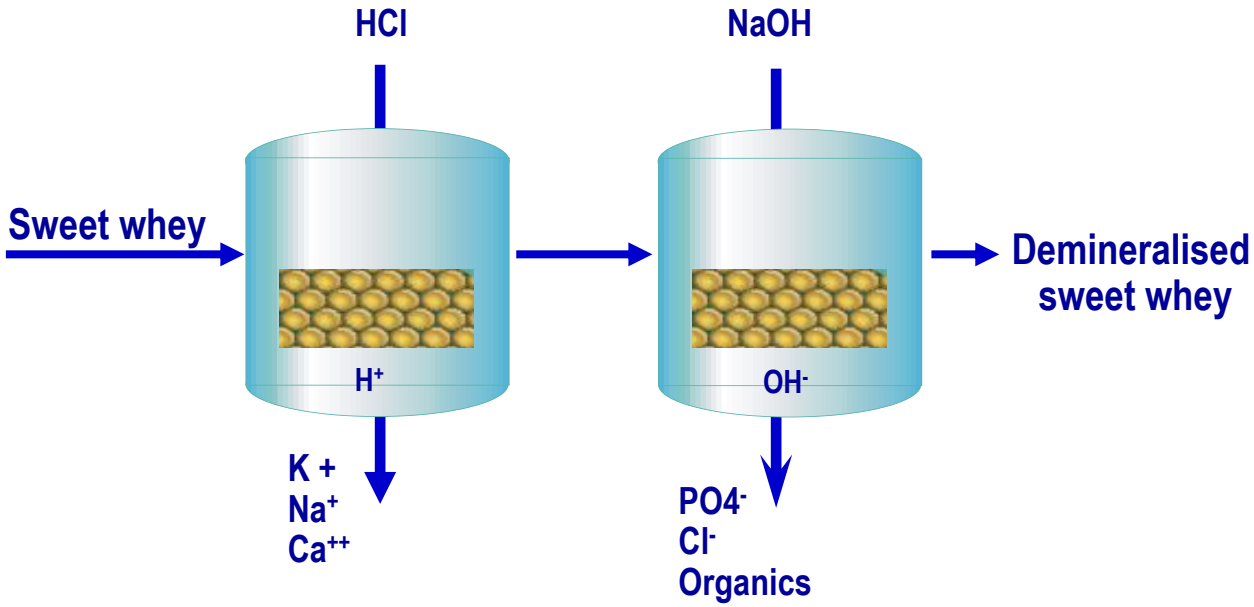
- **Electrodialysis provides intermediate to higher levels of demineralization, only consuming electricity, membranes replacement and small quantities of CIP water and chemicals**
- **Capital cost is effective, if a small number of ED skids is used at full demin capacity**
- **Loss of whey proteins into Brine Concentrate is in the range 1-2%**
- **Loss of lactose into Brine Concentrate limited to about 2%**

- **Production of brine concentrate saturated with minerals**

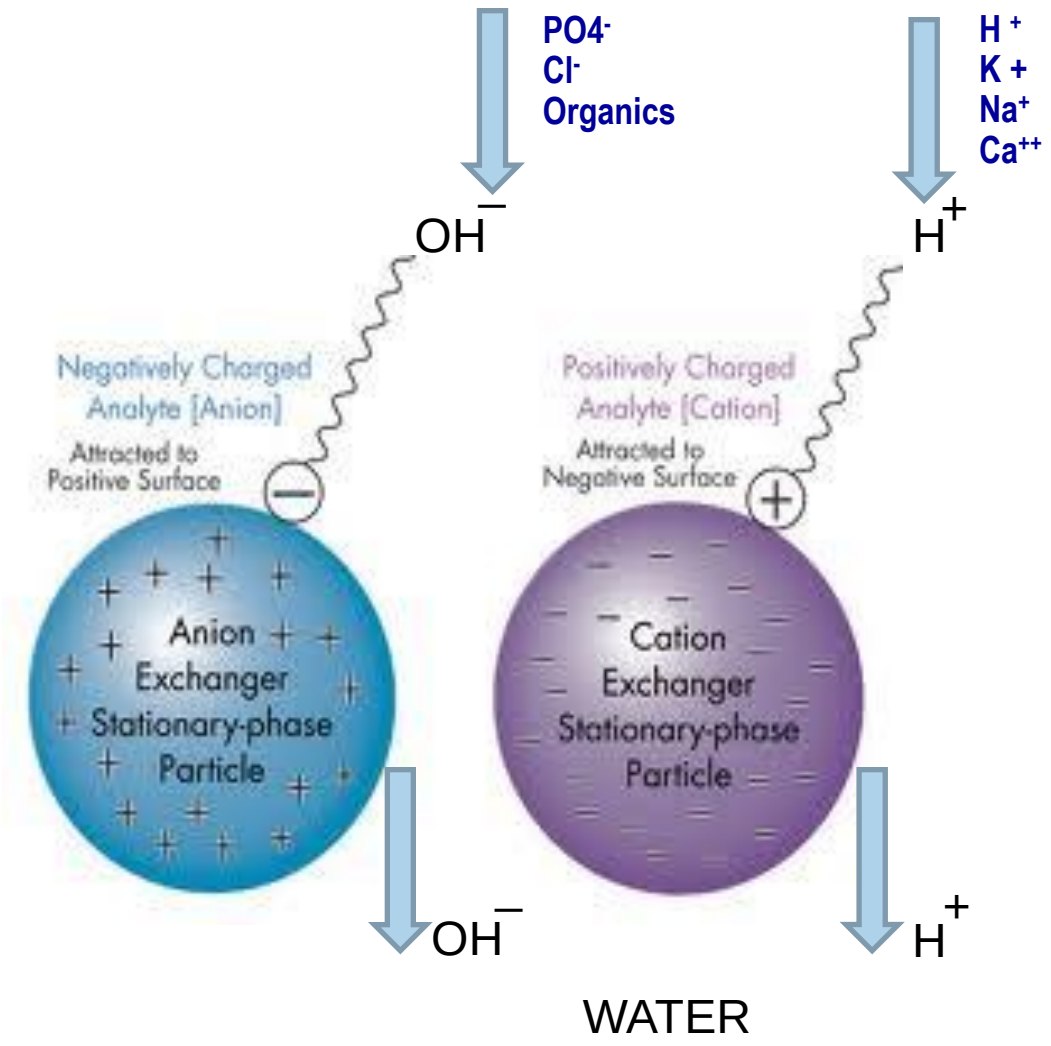
Demineralisation by Ion Exchange

- **Applicable to all type of whey: dilute, concentrated, pre-demineralized**
- **Most efficient removal of divalent ions**
- **Ideal for high demineralization rates and compliance with specific D90 ionic profiles**

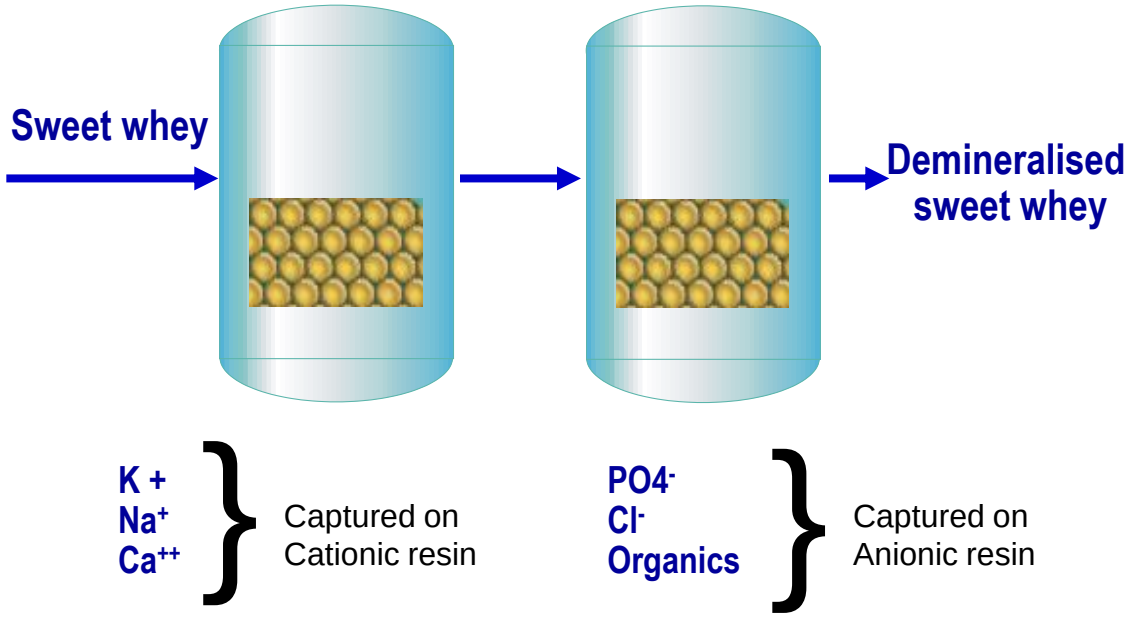




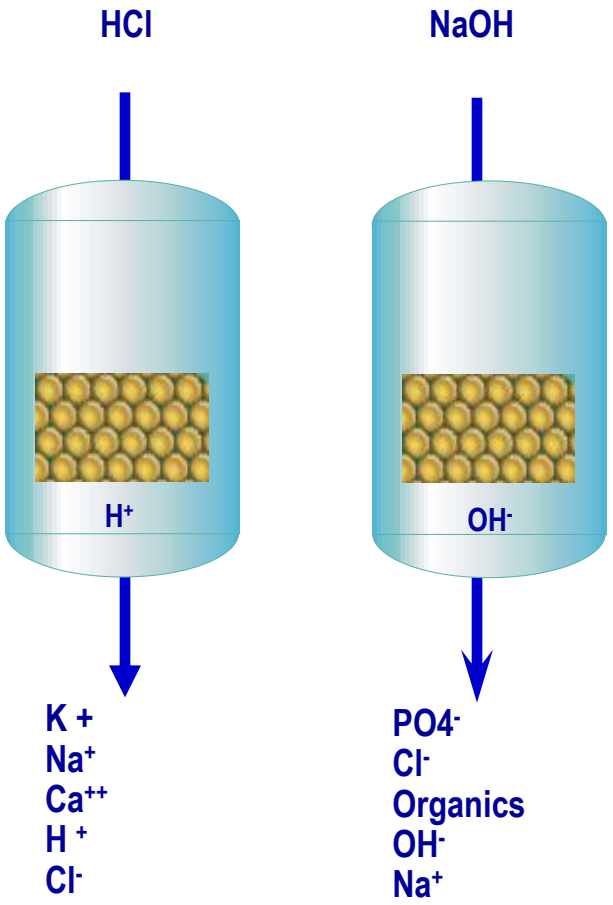
Ion Exchange Principle



Ion Exchange Resin Process



Ion Exchange Resin Regeneration



Demineralization by Ion-Exchange

- Ion-Exchange mainly used for the production of D90 demin whey,
- Can be used as a polisher, after NF, or NF + ED
- Capital cost is effective
- Loss of whey proteins vary usually around 5%
- Loss of lactose limited to about 1% during sweet-on/off operations
- Simple batch operation, fully automatic

- Resins regen consumes Acid & Base chemicals and generates effluents

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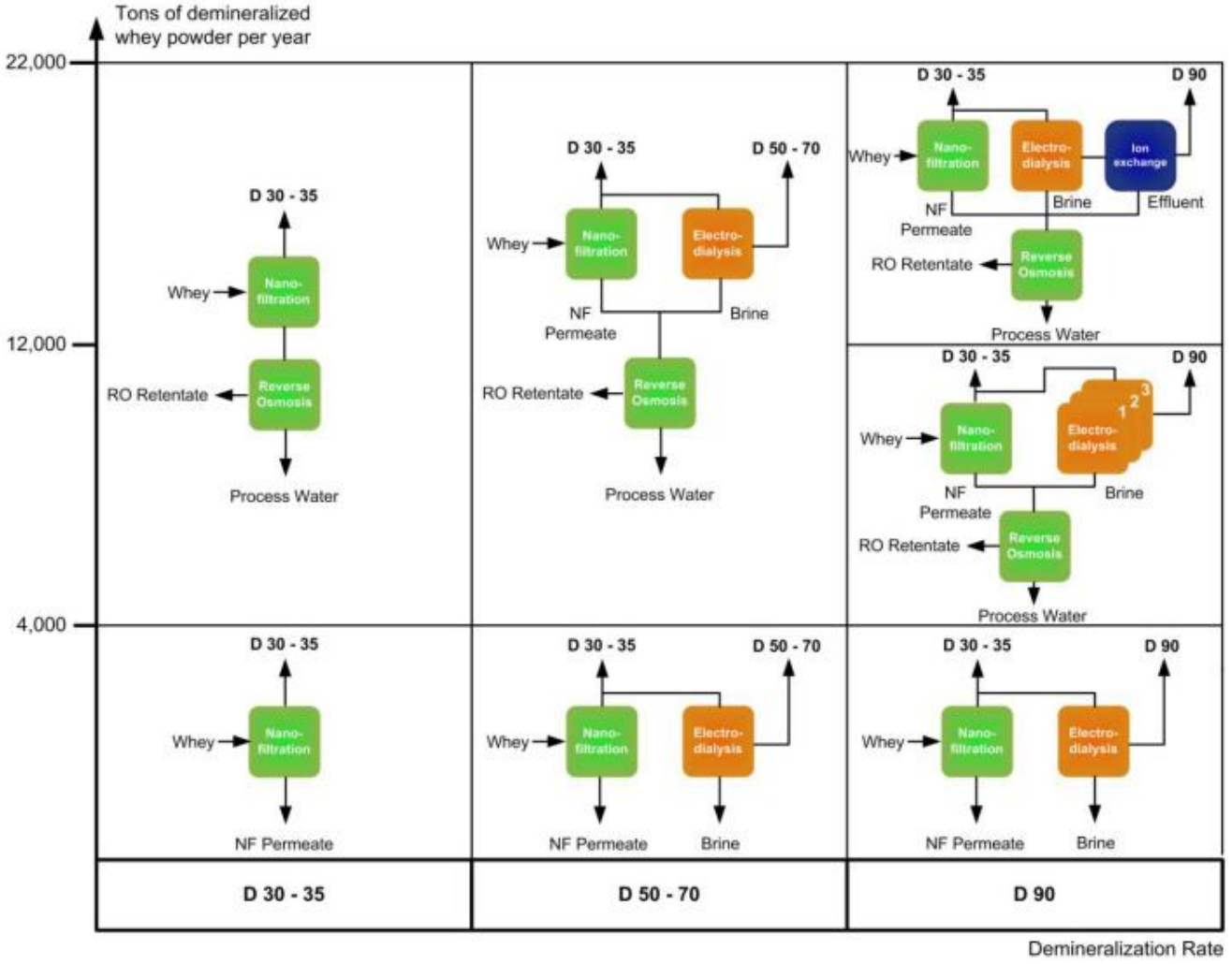
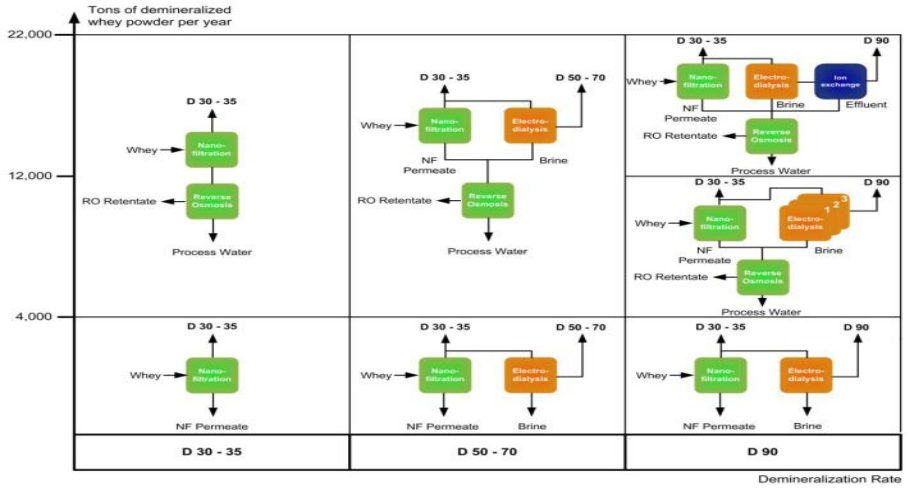
Optimized whey demineralization process solutions



Whey Demineralization Novasep/Mega conclusion

Dairy Map Strategy



- **Optimum CAPEX/OPEX combination.**
- Design and implementation of processes adjusted to any targeted capacity for various markets (D30, D50, D70, D90)
- Multi-step processes requiring higher capital investment, but provide significant reductions in operating cost and chemicals/effluents for larger production capacities
- Conception of flexible processes allowing future capacity increase depending on market demand

Thank You for Your Attention!

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