
Membrane
TECHNOLOGY FORUM®
BROUGHT TO YOU BY
Dairy
FOODS
ADPI
AMERICAN
Dairy Products
INSTITUTE

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

Bacteria Removal/Microbial Reduction from Milk

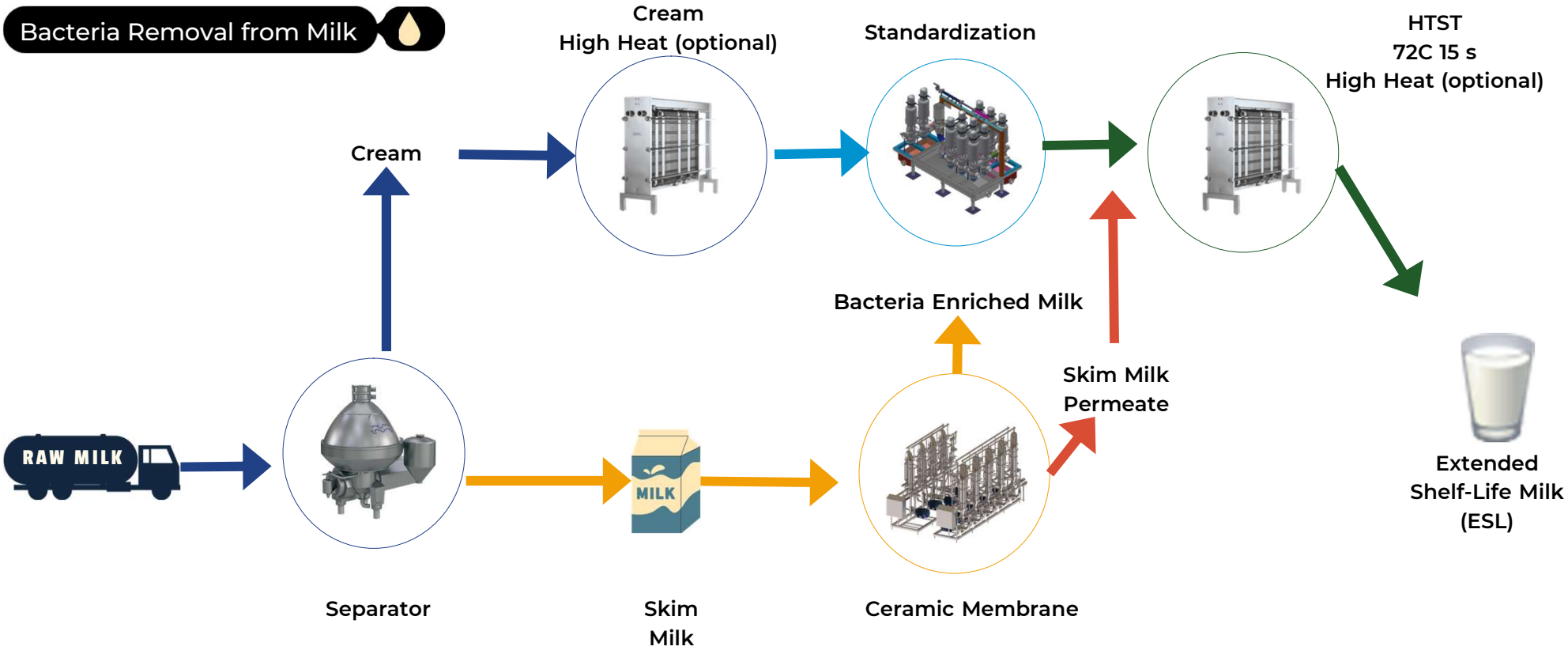
- Regular milk has an expiration over 20,000 CFU/ml. Typically ~ 2-3 weeks depending on milk storage temperature

- The benefit of Extended Shelf Life (ESL) milk is the shelf life can be extended to 4-8 weeks. And if high heat step is added the shelf life can be extended for several months (6-8)

Extended Shelf Life Milk

Membrane Technology Forum® — Brought to you by Dairy Foods & ADPI American Dairy Products Institute

Bacteria Removal from Milk



Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

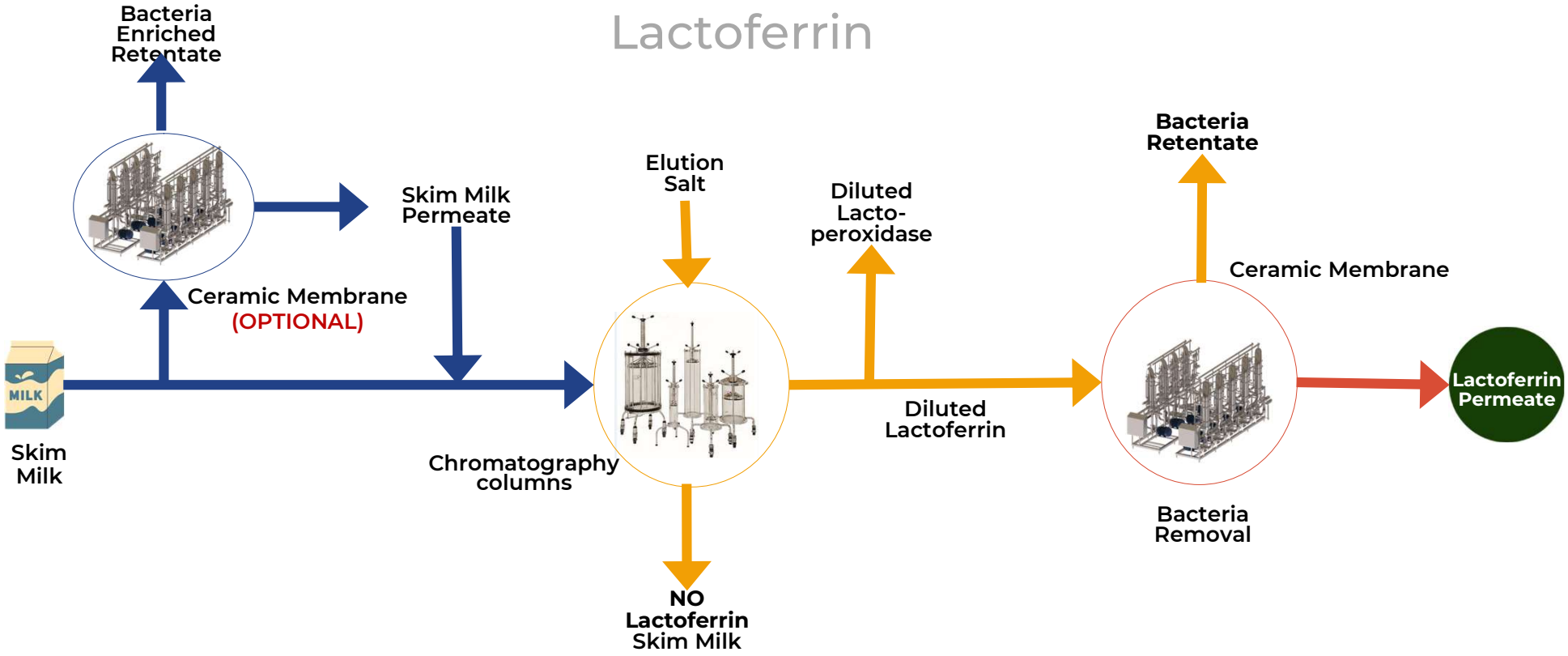
PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

Bacteria Reduction in Whey Ingredient



Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

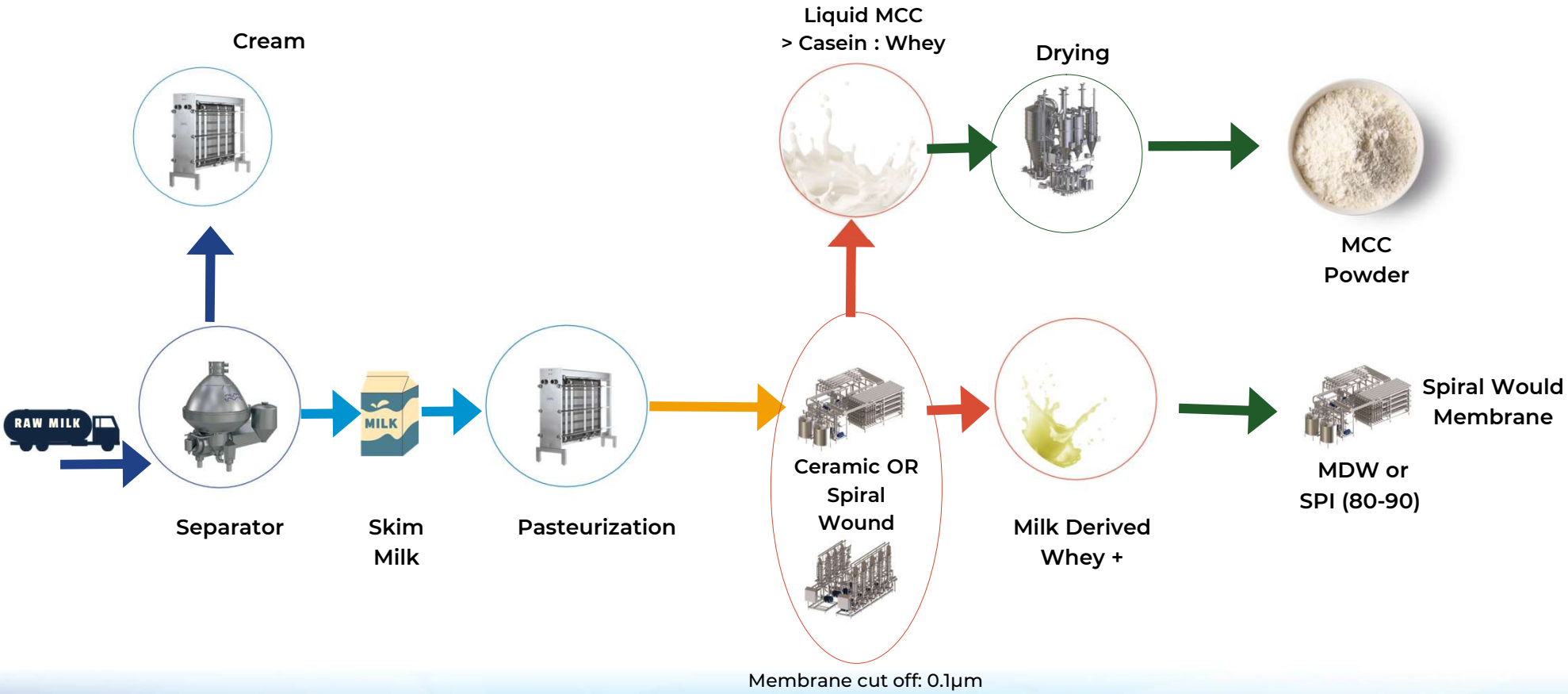
Micellar Casein & Serum Protein

- Micellar Casein Concentrate (MCC) is a protein ingredient rich in Casein%. While milk contains 80:20 Casein to whey ratio. The MCC can offer opportunities to increase Casein to Whey ratio as high as 95:5. Same time produce Milk derived whey (MDW).

- MCC an excellent source of amino acids and calcium.
  Ingredient can be used in retort beverages

- Serum protein or MDW is obtained in the permeate stream of the MF process. MDW is known for clean flavor and value compared to cheese derived whey protein

Micellar Casein Concentrate - Process



Ceramic vs. Spiral

Comparison Case Study

Pasteurized Skim Milk
35 gpm
9.2% TS

MCC - Retentate
10gpm

DF%
75%

Ceramic MF

Temp 120F

MDW (native whey) Permeate
50 gpm

6-stage operation
0.1 micron
Channel Diameter – 3.8 mm
Element Diameter – 37 mm

Pasteurized Skim Milk
35 gpm
9.2% TS

MCC - Retentate
10gpm

DF%
120%

Spiral MF

Temp 60F

MDW (native whey) Permeate
70 gpm

6-stage operation
0.1 micron
Diameter – 8” inch
Length – 38” inches
Mil Spacer – 30/45

Ceramic vs Spiral - Difference in Process

- Why does ceramic have lower DF% water ?

  Pore size, Hydrophilic, higher velocity

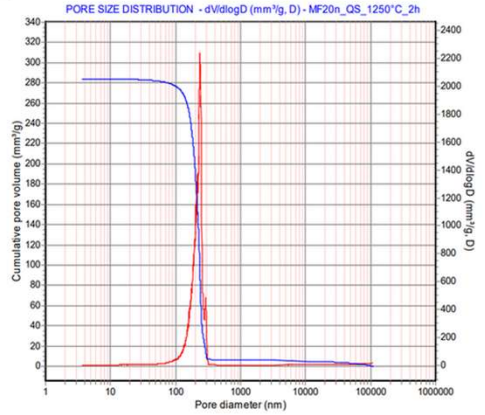
- Why is ceramic system operated at higher temperature?

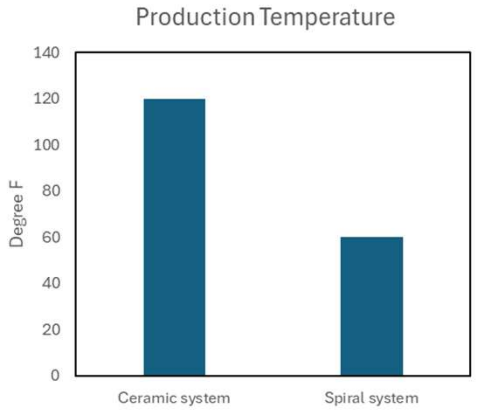
  120F on ceramic vs 60F on spiral

- What is the frequency of cleaning on these systems?

  Ceramic – (8 hours production + 4 hours CIP) x 2 times

  Spiral – 20 hours production + 4 hours CIP





Basis for Operating Expenditures

OPEX Comparison

PARAMETERS	CERAMIC	SPIRAL
Water Usage	15,000 Gallons	23,000 Gallons
Steam	4200 lbs	1800 lbs
Membrane	5 years life	1 year life
Pump Power	650 HP (incl all pumps)	350 HP (incl all pumps)
Hold Up Volume	750 gallons	1200 gallons
Chemical	Higher strength caustic / acid by 4-5x concentration	Lower strength caustic & acid

Ceramic vs. Spiral

Comparison Case Study

Factoring in the UF & RO

Pasteurized Skim Milk 9.2% TS

DF% 75%

MCC - Retentate 10gpm

Ceramic MF

Temp 120F

MDW (native whey) Permeate 50 gpm

DF%

WPI

Spiral UF WPC/WPI

Lactose 18-20% TS

Permeate RO

Water Permeate

Pasteurized Skim Milk 9.2% TS

DF% 120%

MCC - Retentate 10gpm

Spiral MF

Temp 60F

MDW (native whey) Permeate 70 gpm

DF%

WPI

Spiral UF WPC/WPI

Lactose 18-20% TS

Permeate RO

Water Permeate

All Three Systems

OPEX

PARAMETERS	MCC (FROM CERAMIC)	MCC (FROM SPIRAL)
MF Total Annual	$585,596	$343,830

PARAMETERS	NATIVE WPI UF (FROM CERAMIC)	NATIVE WPI UF (FROM SPIRAL)
UF Total Annual	$262,383	$247,447

PARAMETERS	PERMEATE RO (FROM CERAMIC)	PERMEATE RO (FROM SPIRAL)
RO Total Annual	$132,400	$160,932

General Comparison on Topics

General Comparison

Topics	CERAMIC	SPIRAL
Leak Detection	Difficult	Easier
Repair Possibility	No	Yes
Manpower for replace	More	Less
Membrane Life	Higher	Lower
Back pulse	Yes	No
Chemical-Temperature Resistance	High	Low
Viscosity	High	Low

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

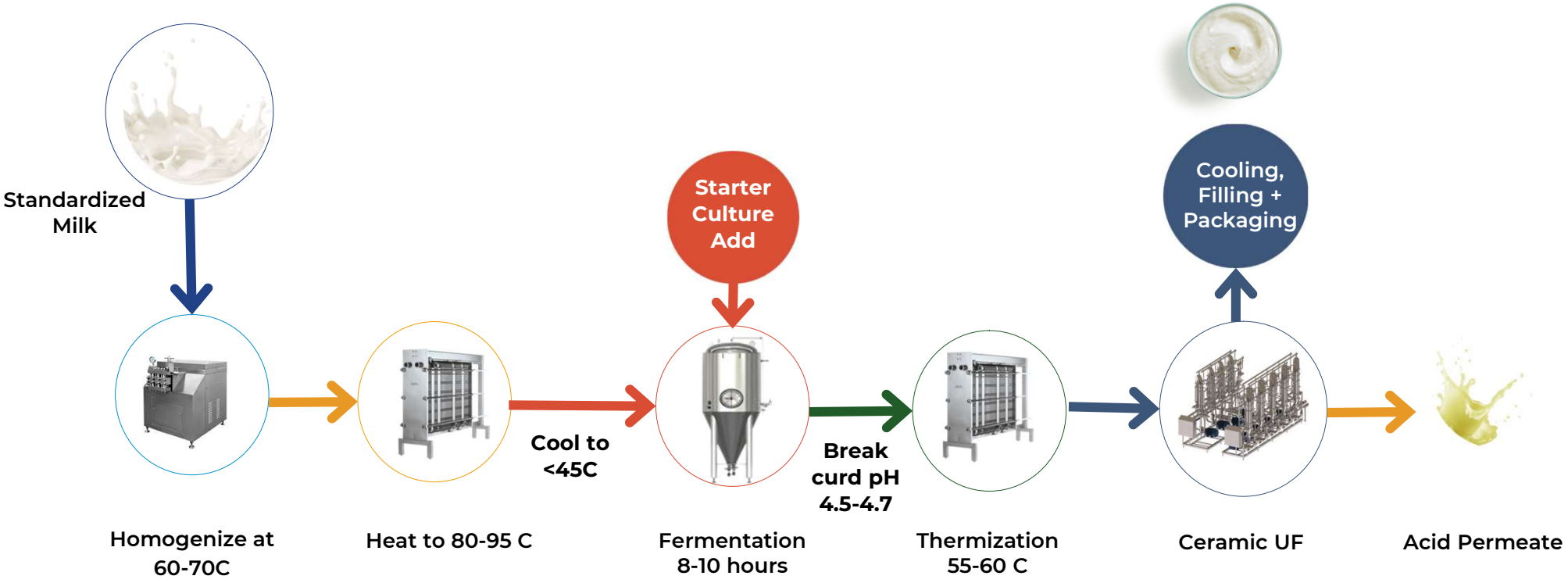
saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF-LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

Yogurt Introduction

- Greek yogurt is fast growing product line in fermented products market.
- Superfood category due to high protein% & optional fat %
- Has rich-texture, flavor, taste, mouth feel
- Now we can use filtration to raise the protein without loosing functional , nutritional and improved customer satisfaction

Greek Yogurt - Brief schematics



Advantages of filtration in Yogurt Process

- Increased yield on filtration process compared to mechanical separator
- Efficient separation of acid whey and easy disposal
- Multiple options to produce different Protein: Fat ratio on the same filtration system
- Efficient processing compared to traditional fermentation and yogurt production techniques

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

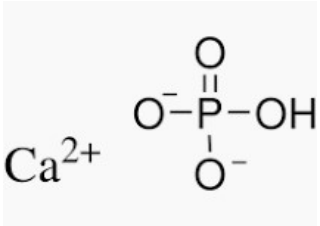
Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

Decalcification Process (CaPO4)

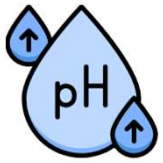
- Calcium in a mineral predominantly found in milk & whey
- Calcium Phosphate can be precipitated from dairy permeate at higher ppm concentration predominantly using alkaline pH (6.7-7.0) and higher temperature
- Heat and alkaline pH alters the calcium to go from serum phase to colloidal crystalline phase
- Clarifiers, dryers have been used for extraction purposes



Decalcification Process – Extraction of Calcium Phosphate

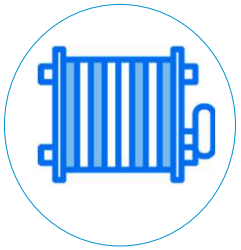
SILO/TANK
PERMEATE

Heat to 75-85 C
HOLD TIME



MAINTAIN CAUSTIC
pH 6.8-7

COOL 60-65 C



NANOFILTRATION
FOR LACTOSE

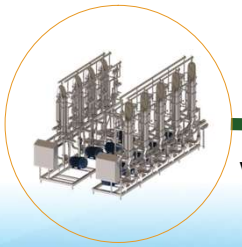
NOZZLE
CLARIFIER

NOZZLE
CLARIFIER

WASHING

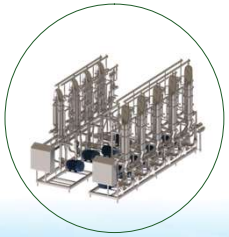
FILTRATION
(OPTIONAL)

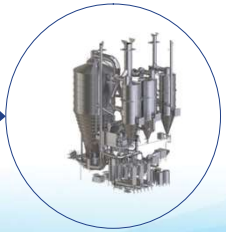
Ceramic UF



WASHING

Ceramic UF





DRYER

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

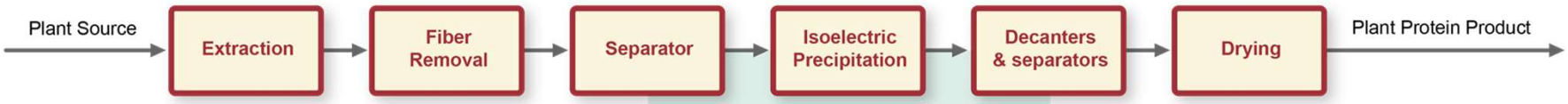
Plant-Based Protein Applications – MF & UF for Clarification, Concentration and Diafiltration

Primary Source is Pulses. Examples of pulses are:

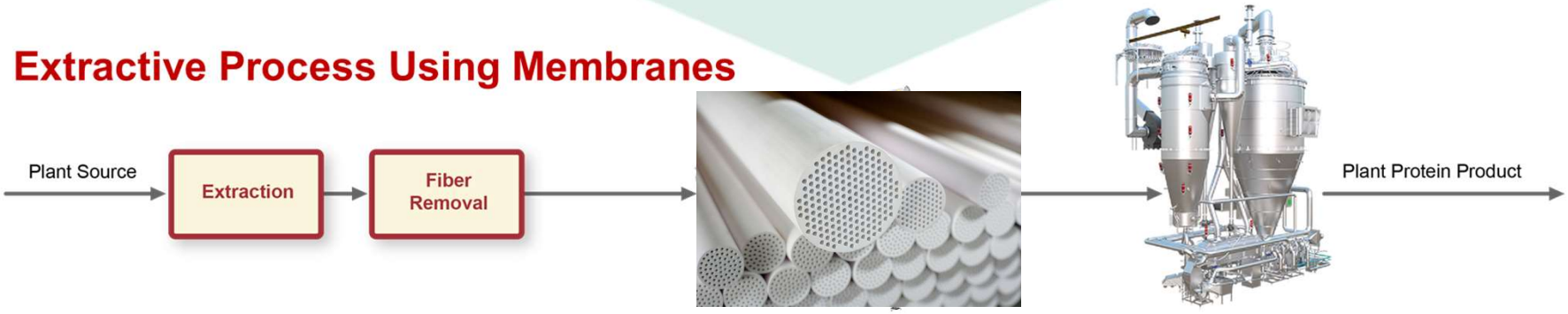
- Black & Green Lentils
- Split Peas
- Navy Beans
- Chickpeas
- Black Beans
- Kidney Beans
- Mung Beans

Plant-Based Protein Production

Conventional Extractive Process



Extractive Process Using Membranes



Ceramic or Spiral

Drying

A single membrane system eliminates the need for the isoelectric precipitation step, as well as replacing an array of multiple decanters and separators

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES

Wine Lees

- Lees are the sediments of dead yeast and suspended particulates left behind after wine fermentation (For beer its beer bottoms)
- Traditional techniques involve diatomaceous earth (DE) or vacuum press filters
- Crossflow filtration offers advantage on quality, hygiene, clarity, and minimal oxygen transfer compared to DE
- 0.2 micron filter, 3-8 mm channel diameter
- White Wines typically flux higher compared to Red Wines

Unique Applications & Opportunities for Ceramic Membrane Filtration [Dairy + Non-Dairy Foods]

PRESENTED BY SAAGAR VIJAYARAGAVAN, PH.D
DIRECTOR OF PROCESS ENGINEERING, DAIRY MARKET
Kovalus Separation Solutions

Ph - 715-323-4592

saagar.vijayaragavan@kss-sep.com

1. EXTENDED SHELF LIFE MILK
2. BACTERIAL REDUCTION - WHEY + LACTOFERRIN
3. CERAMICS VS SPIRALS IN MCC PROCESS
4. YOGURT
5. DECALCIFICATION PROCESS
6. PLANT PROTEINS & FERMENTATION
7. WINE LEES