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SEPARATION SOLUTIONS

Membrane Applications in Food, Beverage and Biopharm Processing

Bradford Milnes, Koch Separation Solutions

Non-Dairy Membrane Food & Beverage Applications

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- Fruit Juice – Clarification – UF / Concentration – RO
- Citrus Debittering – UF/Adsorbent Resin
- Vinegar – Clarification – UF
- Wine – Clarification and Wine Lees Recovery – MF
- Color Concentration Examples – Juice & Wine
- Gelatin – Protein Concentration – UF & NF
- Dextrose – Sugar Clarification – MF
- Animal Plasma – Purification/Concentration – UF & NF
- Plant (Pulse) Protein – Concentration – MF & UF
- Fermentation & Bio-Pharm – Whole Broth Clarification – MF

Why Use Membranes?

Advanced Membrane Filtration

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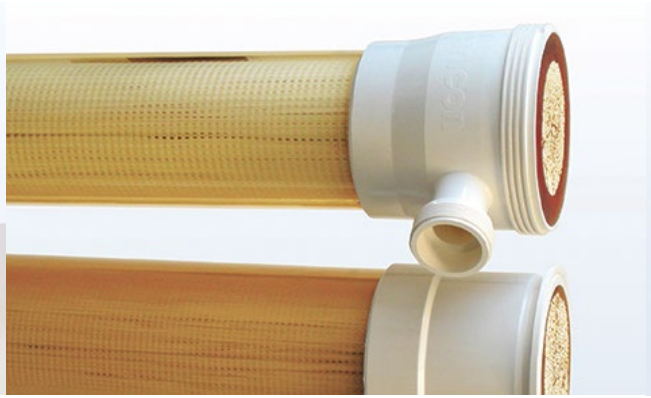

Spiral Wound (UF, MF, NF & RO)

- Compact design, low energy operation
- Sanitary or non-sanitary construction
- High productivity

Tubular (UF & MF)

- High solids tolerance
- Plugging resistant
- Robustly designed

Hollow Fiber (UF & MF)

- High flux and reduced fouling
- Compact design
- Low energy consumption

Ceramic (UF & MF)

- Robust construction
- High temperature operation
- Chemical and solvent compatibility

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Fruit Juice

UF for Clarification of Fruit Juices

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Apple

Pomegranate

Fruit Juices Clarified with Tubular Ultrafiltration

Citrus upgrading is a separate process involving both membranes and an adsorbent resin.

* e. g. Mango, Peach, Guava, Banana

Typical Fruit Juice Clarification Process Using Tubular Membranes

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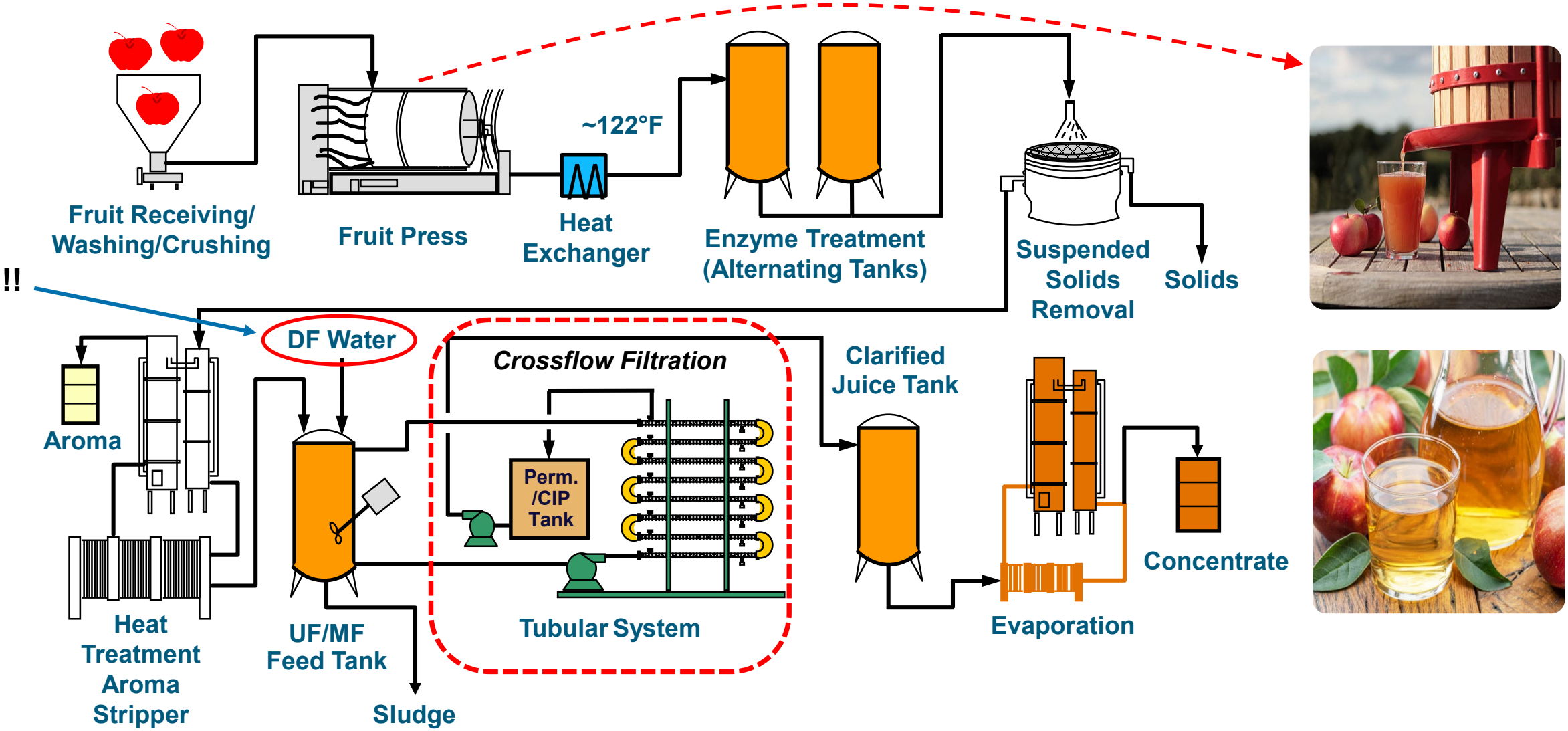

Examples of Feed, Permeate and Retentate Samples for Tubular Ultrafiltration

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Apple

Raw Feed

Permeate

Retentate

Cranberry

Raw Feed

Permeate

Retentate

Tubular Membrane Fruit Juice Clarification System – Topped-Off Batch Operation

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Reverse Osmosis for Juice Permeate Concentration

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- Two-stage reverse osmosis system that concentrates cranberry juice UF permeate from 2°Brix to 20°Brix.
- System operates at 600-650 psi processing the juice at ambient temperature.

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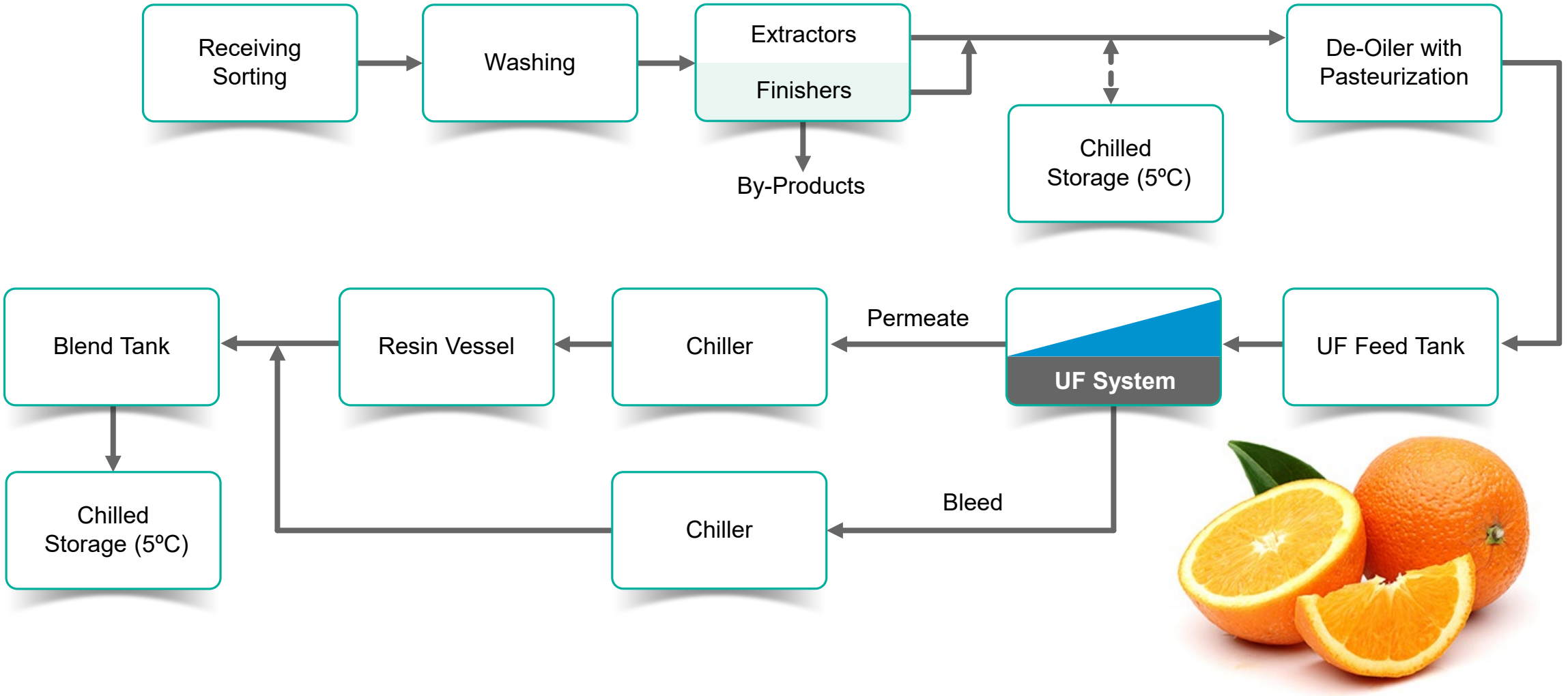
Citrus Juice Debittering

Citrus Juice Debittering Processing Scheme



Hollow Fiber Ultrafiltration & Adsorbent Resin Systems for Citrus Juice Debittering

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Hollow Fiber Reverse Flow Feature for Flux Maintenance

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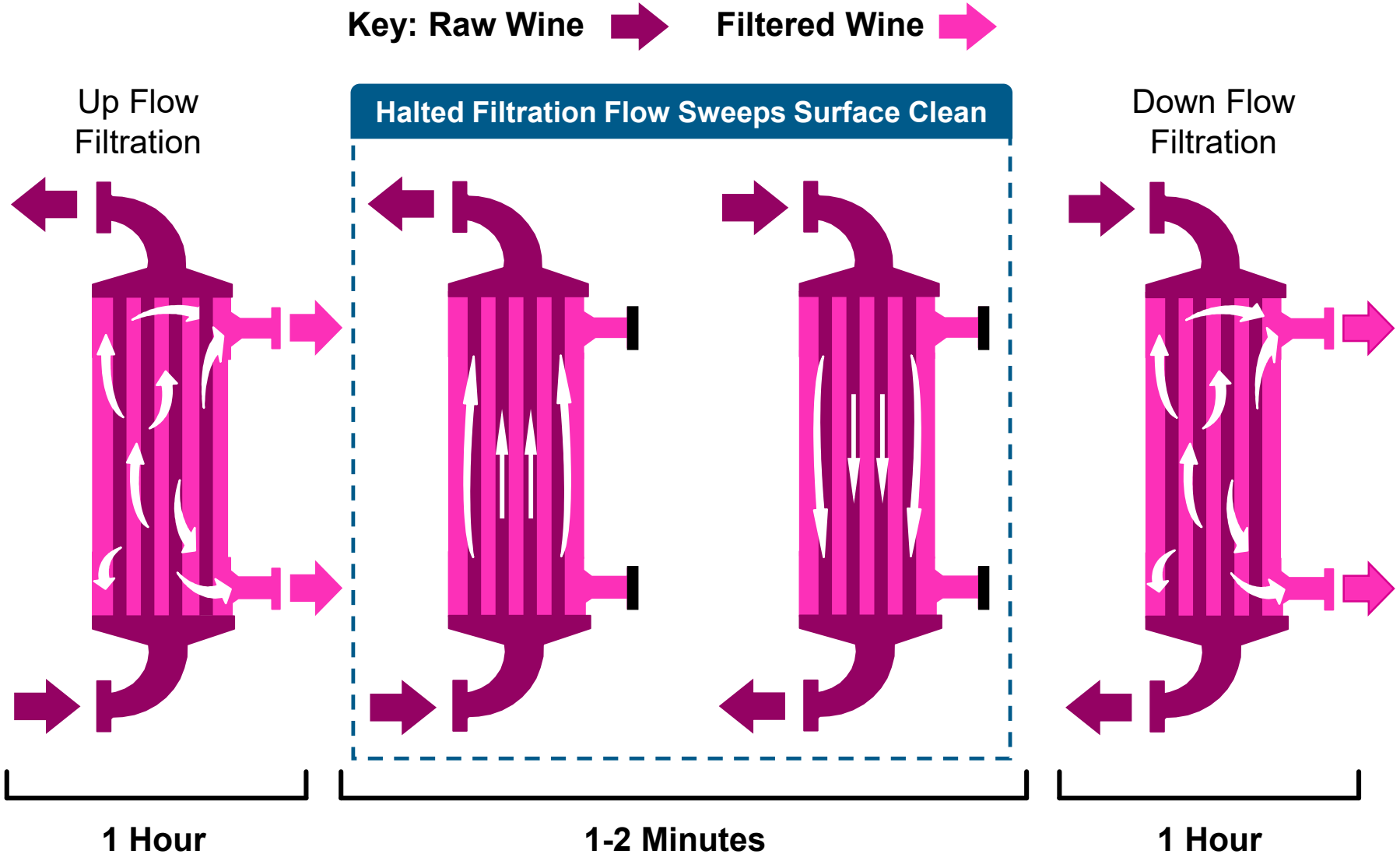

Simplified Navel Orange Juice (Upgrading) Debittering Example

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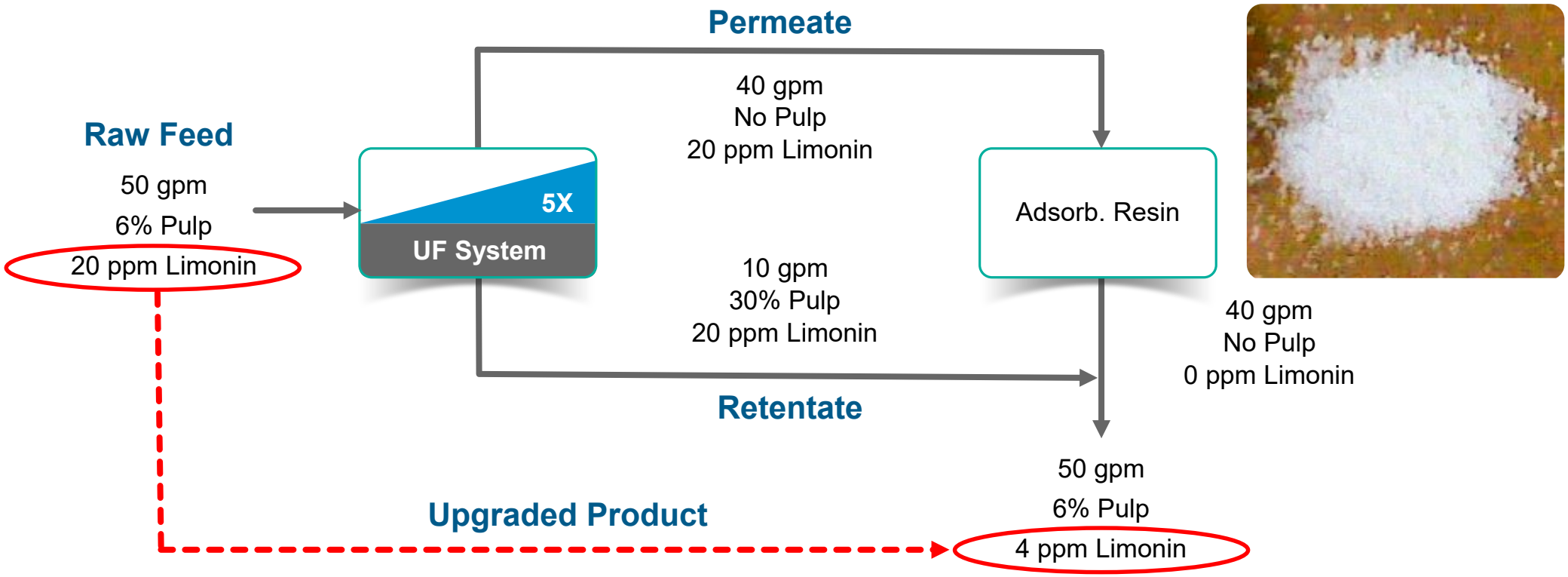
- All streams = 12º Brix Typical
- Limonin detection limit is 5 ppm



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Vinegar

Vinegar Clarification with Hollow Fibers

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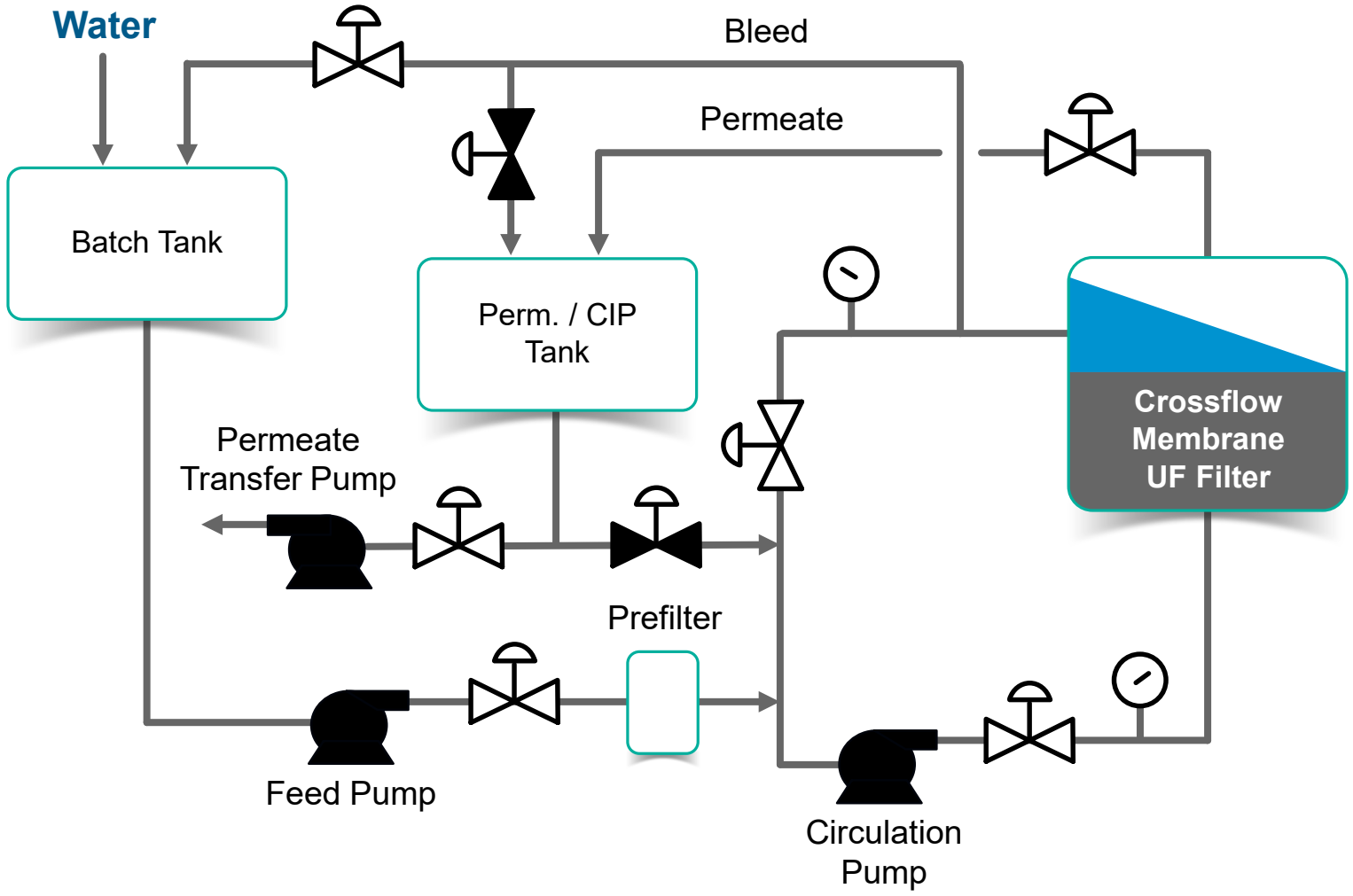
- Hollow Fiber UF cartridges are manufactured with special components to withstand up to 20% (200 grain) acetic acid

Vinegar Clarification – Hollow Fiber System Schematic



- The UF system operates in the batch mode with a pressurized feed & bleed loop but cleans in the 'gravity' feed & bleed mode.
- Feed & bleed allows for installation of a smaller pre-filter which is required for hollow fibers.

Wine Vinegar Clarification Using UF Hollow Fiber Membranes

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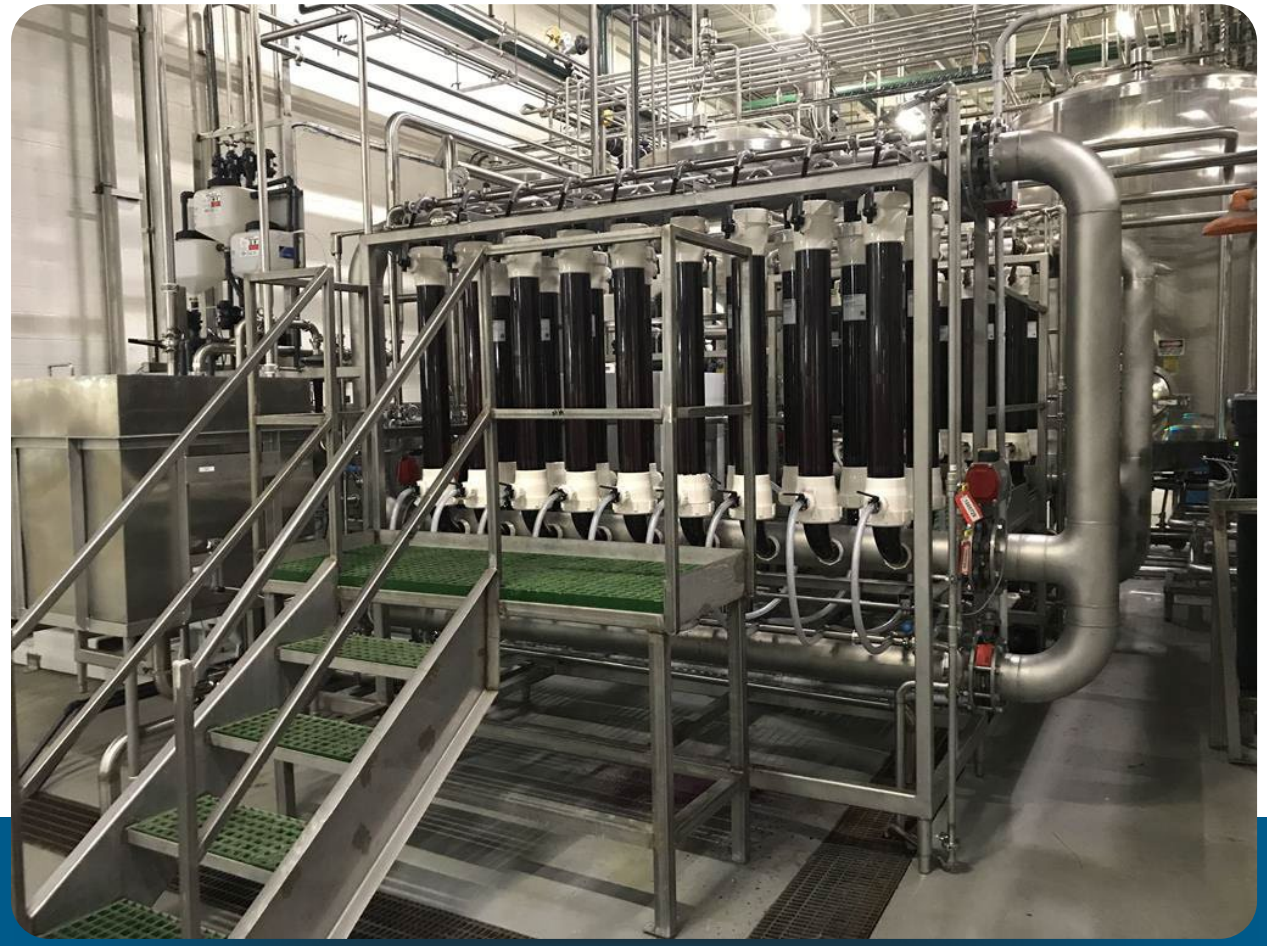

- These systems process white distilled, red wine, cider, malt and rice vinegars. They typically operate at 30/10 psi and room temperature.

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Wine & Wine Lees

Wine Clarification System with Hollow Fiber MF

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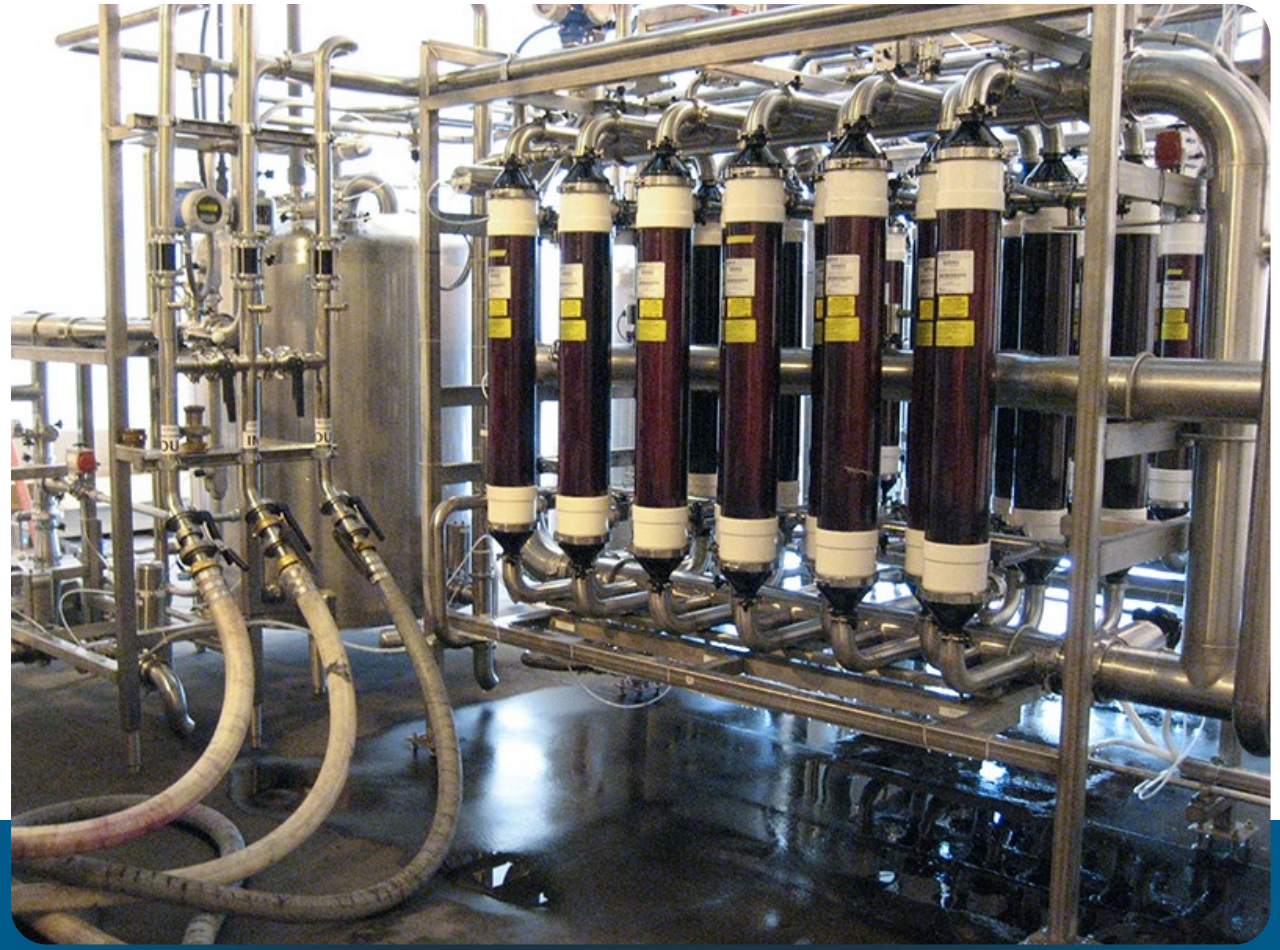
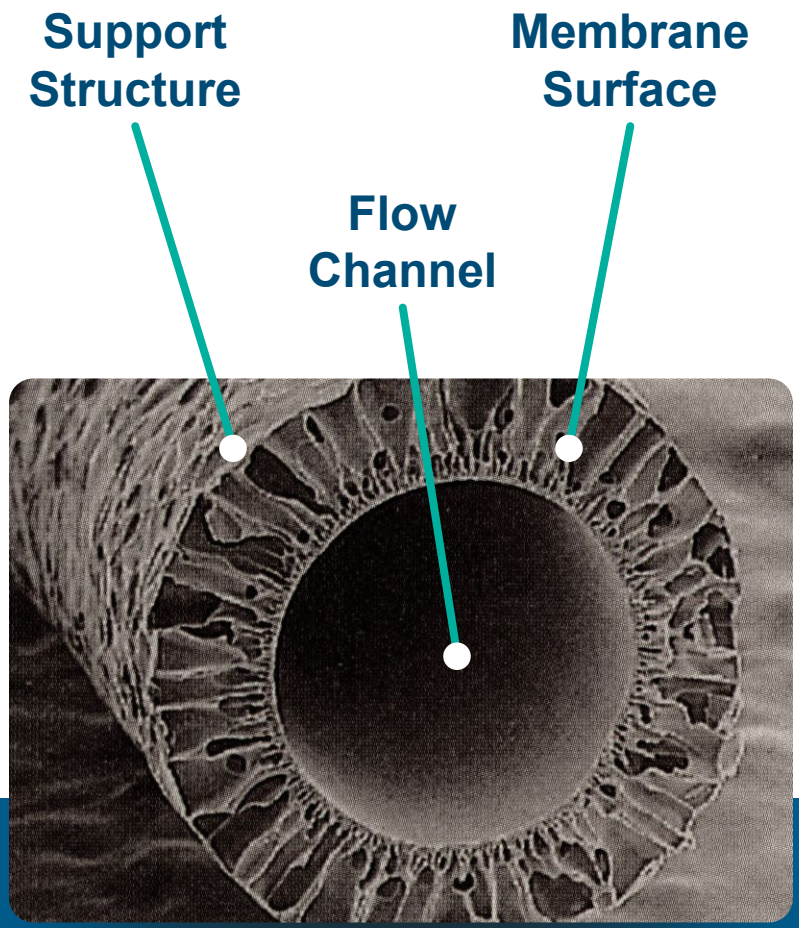
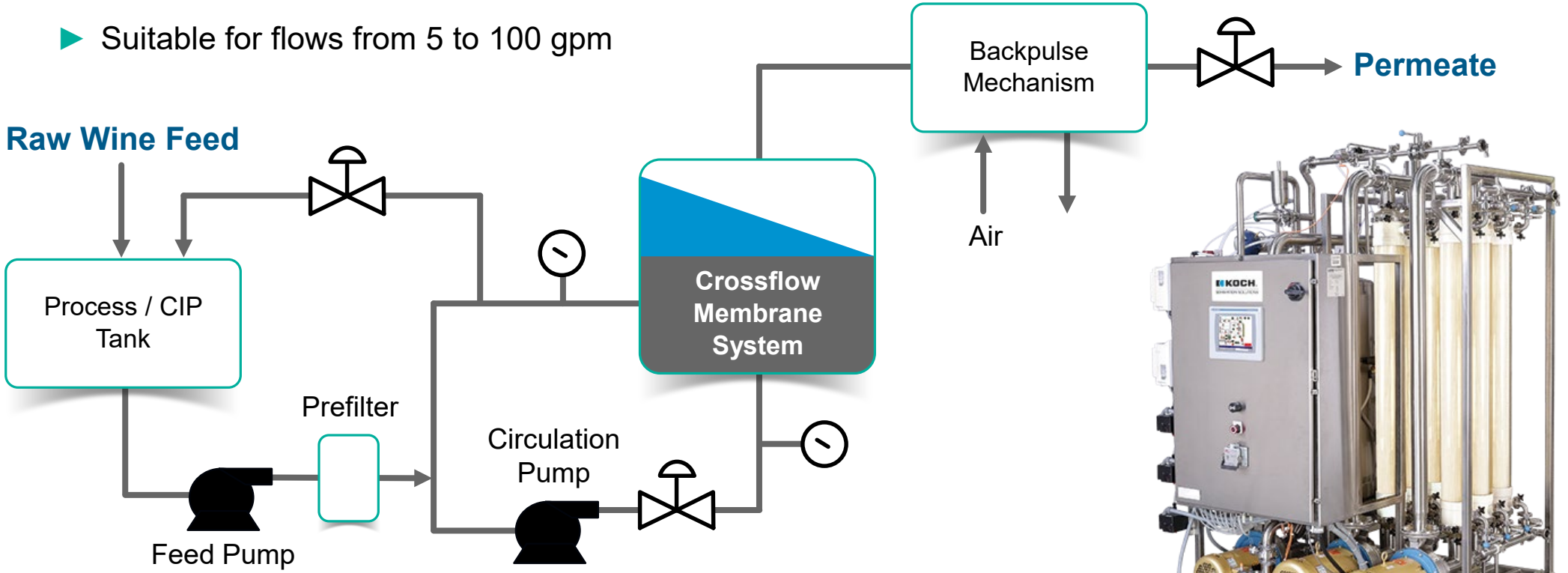




Wine Clarification Flow Schematic

Modified Batch Process

- Suitable for flows from 5 to 100 gpm



Wine Microfiltration System

Utilizing Six-inch Diameter, 60-Inch-Long Hollow Fiber Cartridges

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- 16-Cartridge System – 3,000 ft^2 of Membrane Area

Tubular MF System for Wine Lees Recovery

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- One-inch tubular membranes recovering wine from bentonite lees. The flavor isn't stripped which occurs with rotary vacuum DE filters.

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Color Concentration

Hollow Fiber and Spiral Membrane Systems for Color Concentration

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Grape Juice

Wine

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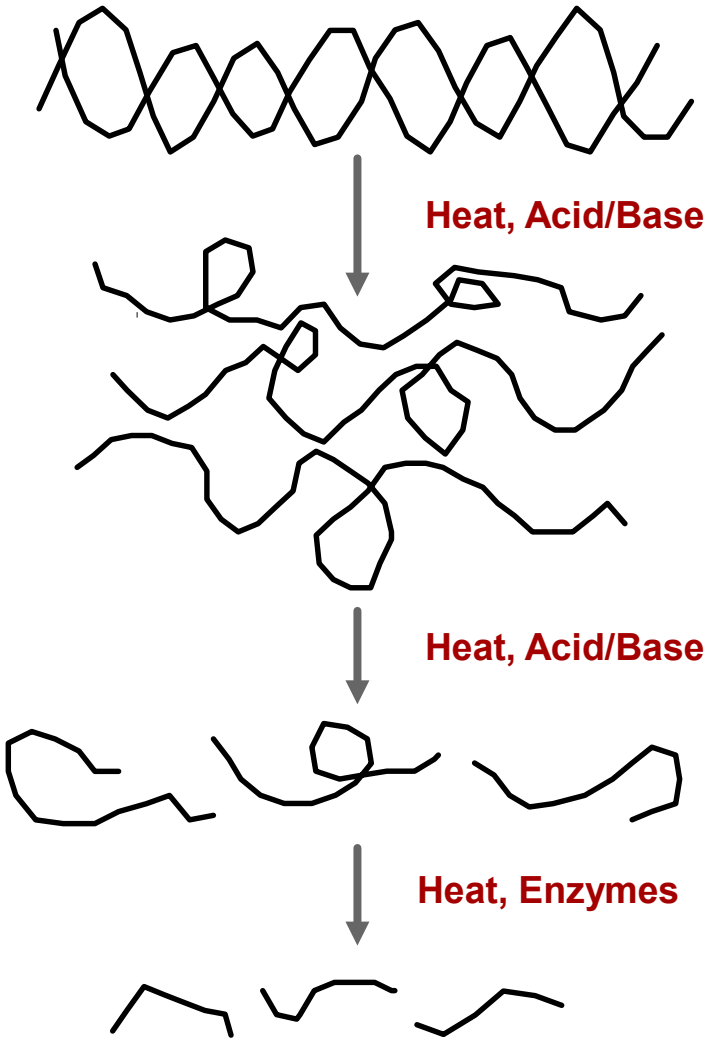
Gelatin

Gelatin Production – Collagen => Gelatin



NATIVE COLLAGEN
Bones, Hides, Skins, Slabs,
Collagenous Material

****

GELATIN
MW=100,000-250,000
95% TKN/TS
High Bloom Properties
Reversible Sol/Gel
High Viscosity
Protecting Colloid

****

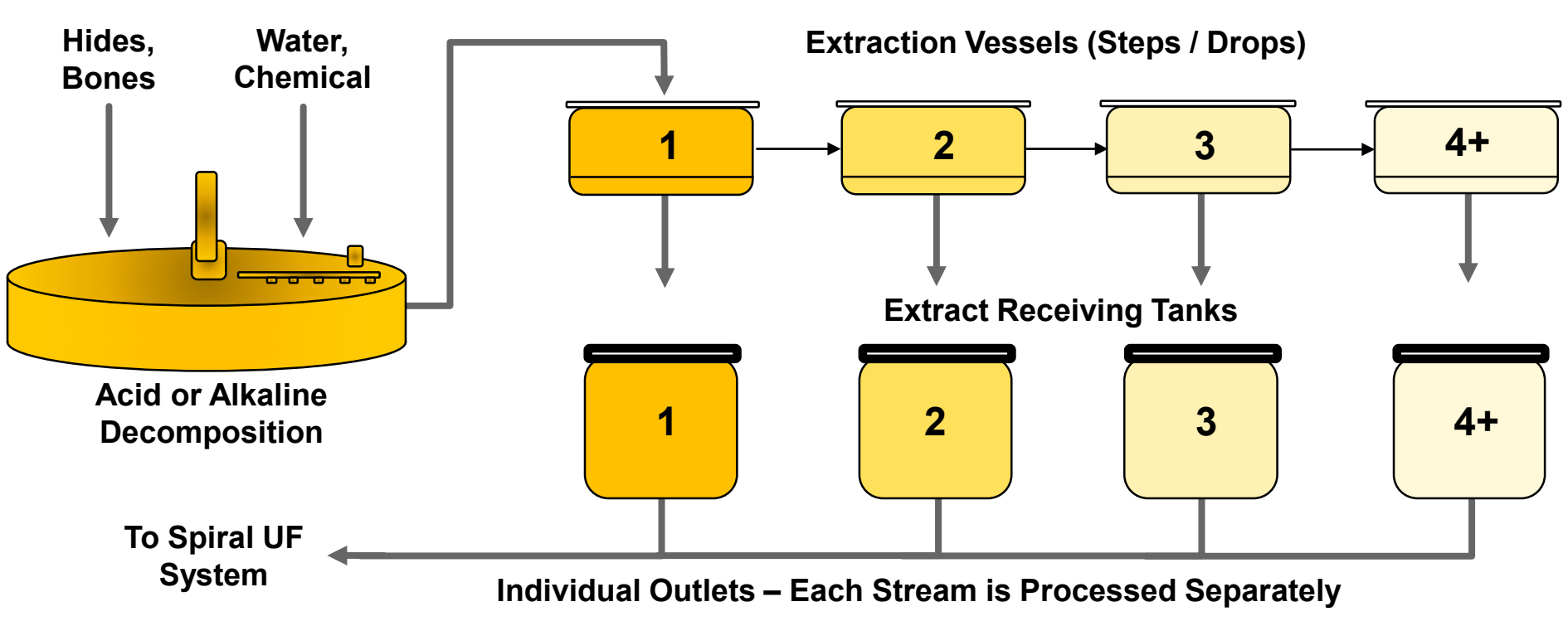
GELATIN
MW: 5,000-100,000
Low Bloom Properties
Low Viscosity

****

PROTEIN HYDROLYSATES
Nutraceuticals MW < 5,000

Details of the Upstream Gelatin Extraction Process

The drops are sequential, and each drop can come down several times per day.
The UF system processes each drop when it is received and is not cleaned between drops.



First Extract 55-65°C
Highest Bloom = 250-325
4.0-6.0% TS

Second Extract 65-75°C
High Bloom = 200-275
3.0-5.0% TS

Third Extract 75-85°C
Medium Bloom = 150-225
2.5-4.0% TS

Fourth Extract 85-95°C
Low Bloom = 75-150
2.0-3.5% TS

Gelatin Concentration

Spiral Membranes - High Temperature Operation

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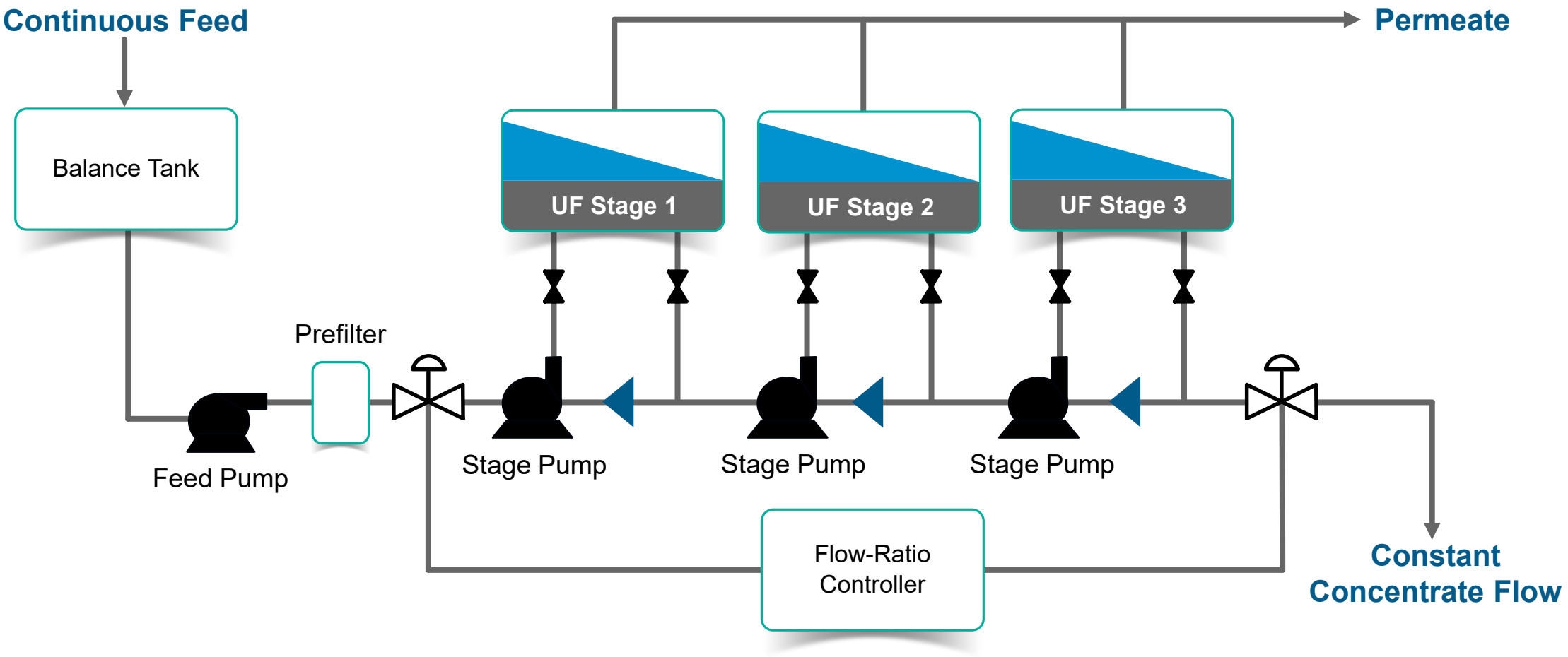
- More recently, fish by-products have also been used for gelatin production.

Raw hides, skins or bones

Continuous Stages-In-Series Operation



Gelatin Concentration – Spiral Membranes

Stages-in-Series – Operating Temperature = 130°F (55°C)

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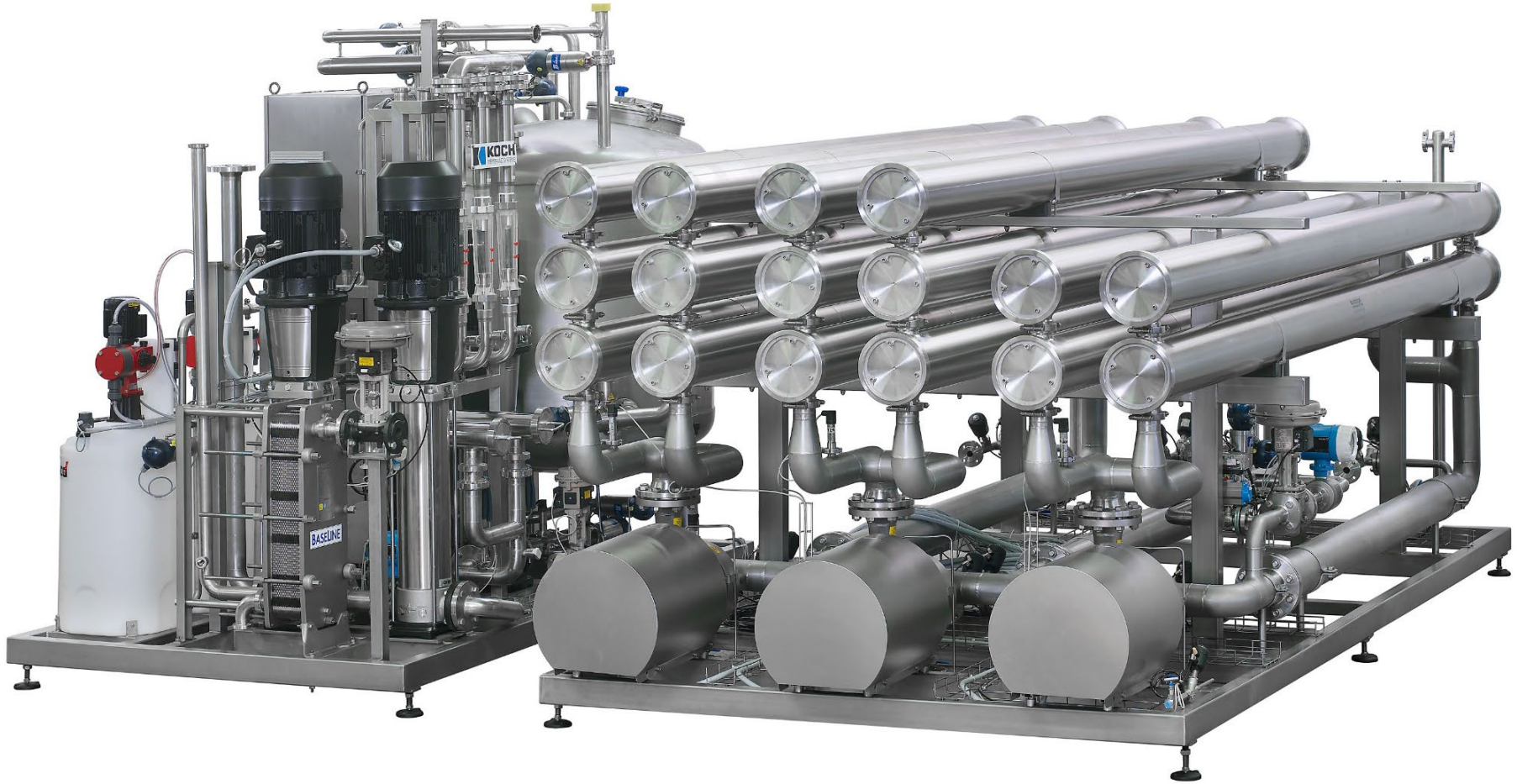
Last stage has larger spacers due to viscosity, and therefore less housings.
Final TS is 18-30% depending on Bloom strength.



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Dextrose

Dextrose Clarification – Conventional DE Process vs. Spiral Microfiltration

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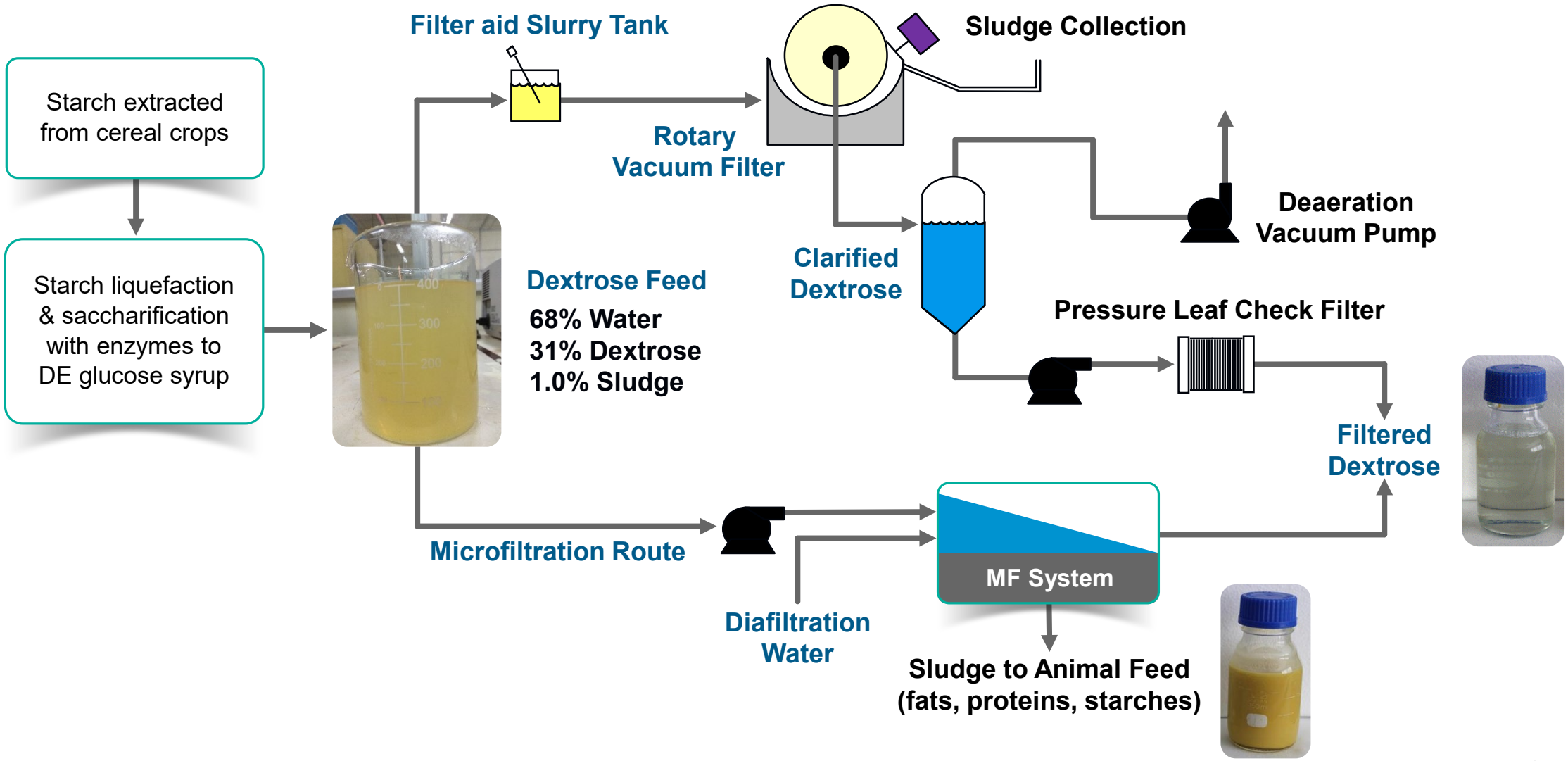

Microfiltration System for Dextrose Clarification from a Corn Wet Milling Process

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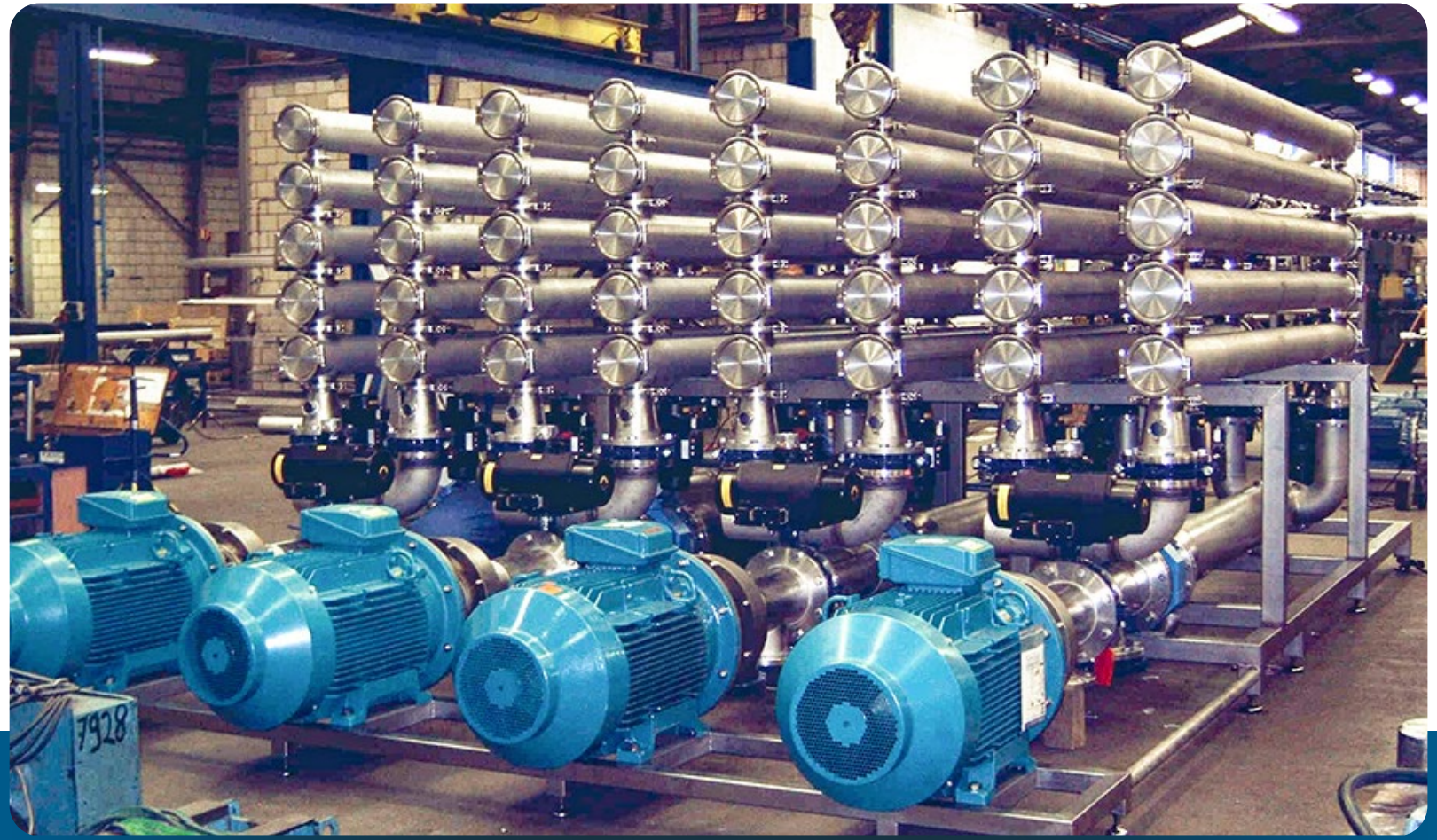
- Three Stages in Series. Feed is 95 DE Dextrose (32% Total Solids), 140°F. Membrane system utilizes 80-mil and 100-mil feed spacers to achieve a recovery rate of 95-98%.

Feed	Permeate	Retentate
31.0% Dextrose	31.0% Dextrose	31.0% Dextrose
1% SS v/v	0% SS v/v	~33% SS v/v

Dextrose Clarification – Spiral MF Membranes

High Temperature Operation (140°F)



- Four Stages in Series
- 10 S3 Hsgs. per Stage
- => Split Stages for CIP
- Note the large recirc lines. This system uses 80-mil & 100-mil spacers.

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Animal Plasma

Animal Plasma Production with UF & NF

Protein-Rich Source Used For Animal Food

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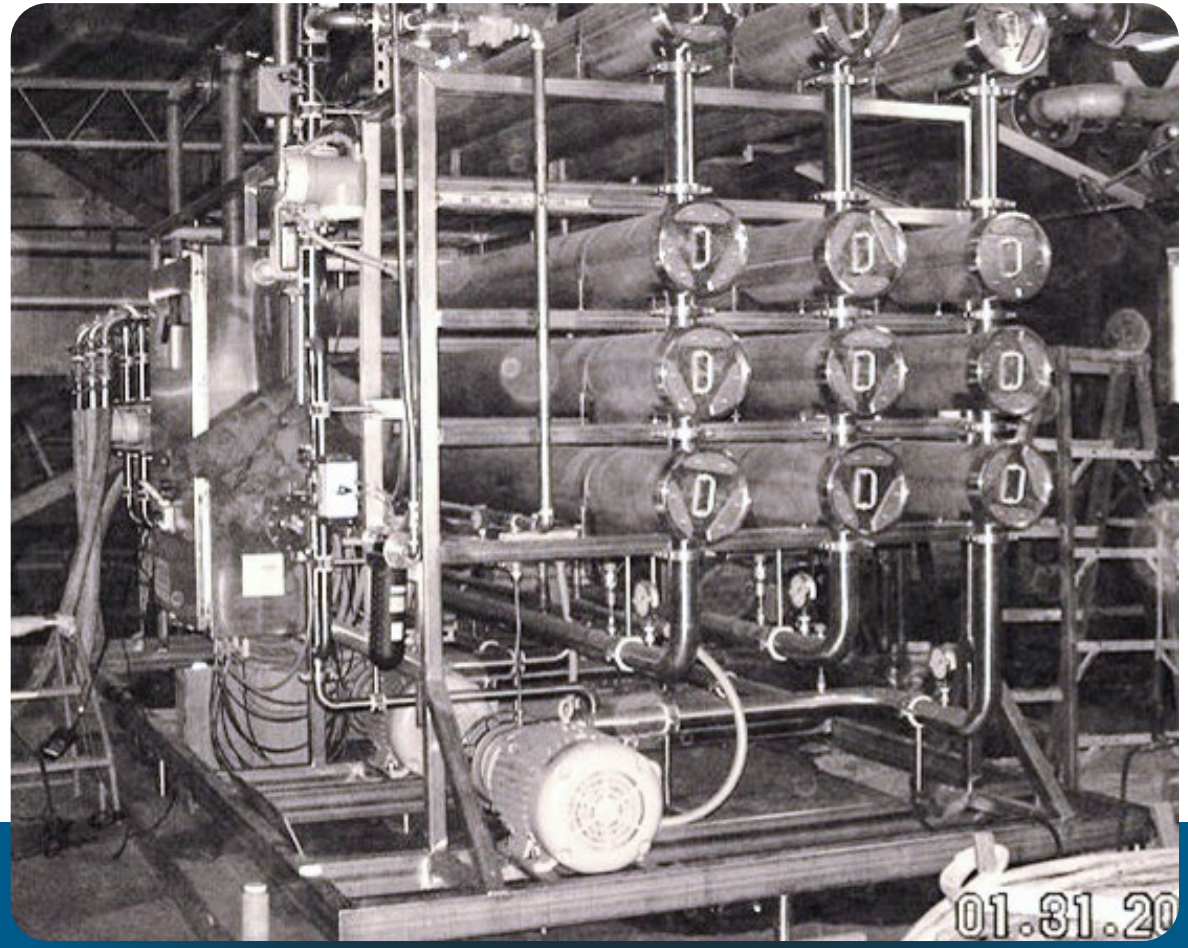

- Three–stage NF system processes plasma from 8-28% TS

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Plant-Based Protein

Plant-Based Protein Applications

MF & UF for Clarification, Concentration and Diafiltration

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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

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Conventional Extractive Process

Plant Source → Extraction → Fiber Removal → Separator → Isoelectric Precipitation → Decanters & Separators → Drying → Plant Protein Product

Extractive Process Using Membranes

Plant Source → Extraction → Fiber Removal → 

UF System → Drying → Plant Protein Product

Plant-Based Protein Separations

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Raw Vegetables (or Pulse Proteins)

Extraction

Fiber Removal

Wastewater Treatment

Diafiltration may be required to enhance yield in the MF step, and to wash out salts that are used in the extraction process in the UF step.

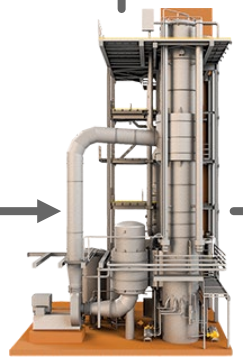
RO for Water Recovery & Reuse

Evaporator Condensate

To Wastewater Treatment

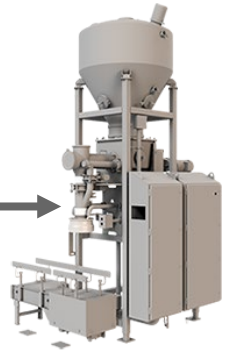
MF for Clarification (Including Diafiltration)

UF for Concentration and Diafiltration



Evaporation

Spray Dryer



Packaging

UF Pulse Protein Concentration system utilizing 8.3-Inch Diameter MF spirals

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Aquaculture - Protein Extracted from Algae

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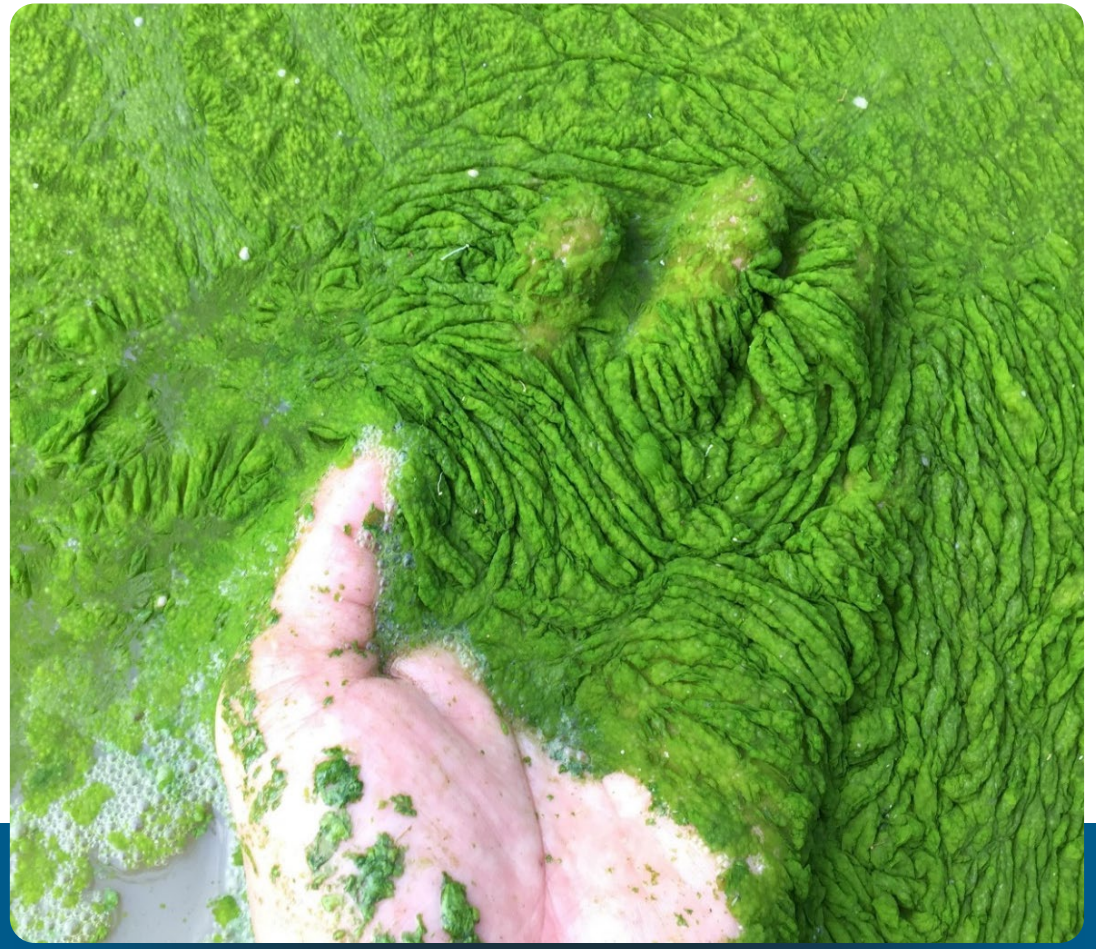

Two-Stage UF Hollow Fiber System

Suitable for Algae Processing With 106-mil Fibers to Handle High Viscosity

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- Eight-inch manifolds are utilized to accommodate the high crossflow requirement of the wide diameter hollow fibers.

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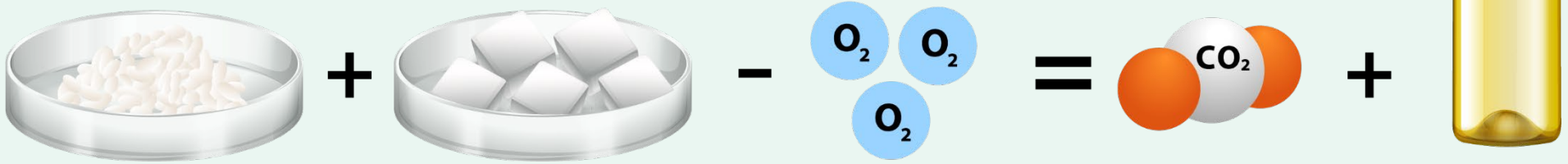
Fermentation & Bio-Pharm

Fermentation Applications Involving Membranes

A chemical reaction of a substance by bacteria, yeast or other organism which typically involves anaerobic production of CO_2.

Sugar + **Yeast** − **Oxygen** = **Carbon Dioxide** + **Alcohol**



Fermentation Applications Involving Membranes

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- 20 8338 S3 spiral housings. Industrial-style spiral MF system for amino acid production utilizing wide gap 80-mil spacers.
- Examples:
  - Wine
  - Vinegar
  - Beer
  - Yeast
  - Food Adjuncts e.g., Soy Sauce
  - Amino Acids
  - Antibiotics
  - Non-Dairy Yogurt

Small Ceramic System for Beer Bottoms Recovery

Recovers 2% Settled Bottoms – Six-Month Payback

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- This system consists of four ceramic modules and utilizes feed and bleed operation with a prefilter

Hollow Fiber System for Pyrogen Reduction During Ultrapure Water Production

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- A 10-cartridge hollow fiber system using 20-mil fibers for high temperature water purification. Cartridges are specially manufactured to withstand sanitation cycles at 90°C (194°F)
- Pyrogens are substances that can produce a fever.
- Pyrogen reduction is a common application for membrane systems. In addition to ‘water for injection’ and related applications for hollow fibers, spiral membranes have been employed for pyrogen reduction in process streams as well, e.g., dextrose for intravenous use.

Large Ceramic MF System

Antibiotic (Erythromycin) Clarification from a Fermentation Process

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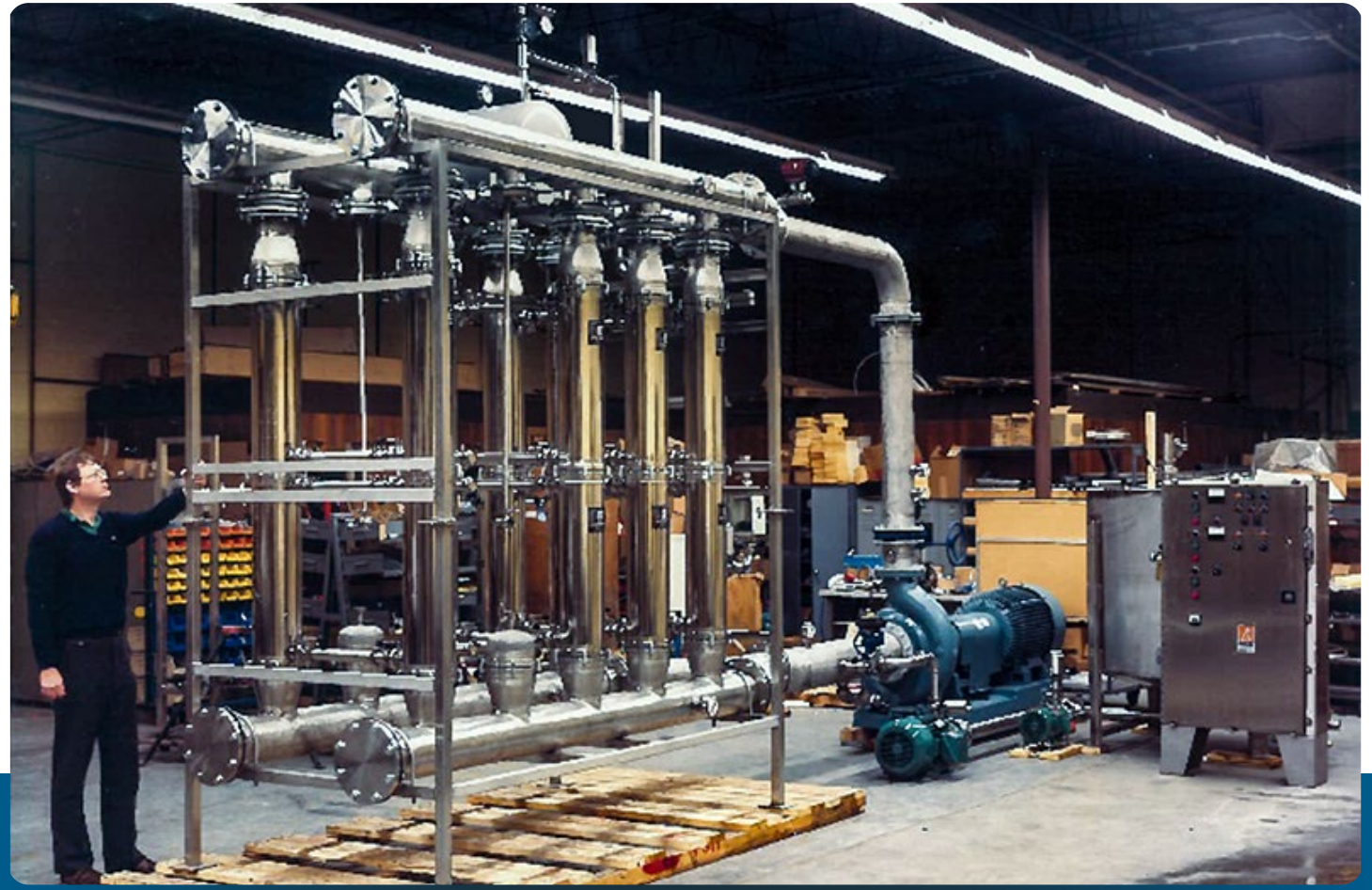

- A 20-housing ceramic system. Ceramic membranes systems offer several advantages such as extremely high temperature capability in both production and CIP and superior chemical tolerance.
- They can also be backpulsed for flux maintenance and cleaning assistance.

Let us start working on your solution…

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Our dedicated team of experienced engineers are ready to assist you.
For any questions please contact:

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