Overview of Cross-Flow Filtration
Current Technology & Developments
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Agenda

• What is Cross-Flow Filtration?
• Review of Basic Design
• Review of Applications
• Advantages/Disadvantages
• Sizing & Cost
• Opportunities for Juice & Wine Lees
• Tips on Buying
What is Cross-Flow Filtration?

• Also called Tangential Flow Filtration “T.F.F.”

• Definition: Method of clarification where product flow is parallel to the filter surface to minimize clogging, and maximize efficiency
• Dead-end filtration
  • « Cake » clogging

- Wine to be filtered (dissolved components, in suspension, micro-organisms...)
- Filtered wine (dissolved components)

• Cross flow filtration

- RETENTATE: Wine to be filtered (dissolved components, in suspension)
- PERMEATE: Filtered wine (dissolved components)
• Only part of the liquid crosses the membrane on each passage.

• **Retentate** = Coarse components, bigger than the diameter of the pores of the membrane and the raw wine.

• **Filtrate (permeate)** = Filtered wine.
-During the course of the filtration, your retentate is becoming more concentrated with solids.

-At the end of the filtration, you are left with filtered wine, and your retentate with the solids.
• Cross-Flow Filtration:

- Wine to filter tank
- Feed pump
- Circulation pump
- Filtered wine tank
• Cross-Flow Removes Yeast and Bacteria:
Cross-Flow Allows Desireable Components to pass through the Membrane:

- Dissolved salts
- Proteins
- Organic molecules
- Colloids
- Reverse osmosis
- Nanofiltration
- Cross flow filtration
- Ultrafiltration
What Size are the Particles in Wine?

• Grape Solids, Tartrates, Fining Agents
  – 100 to 1,000 microns

• Colloidal or Precipitated Proteins
  - < 0.2 to 5 microns

• Yeast and Bacteria
  – 0.65 to 3 microns
What is a Micron?

• 1 Millionth of a Meter
• 1 Thousandth of a Millimeter
• 39 Millionths of an Inch (0.000039 inch)
Relative Particle Size

- Red Blood Cell 5 μm
- Fine Beach Sand 500μm
- Bacteria Cell 0.65 μm
- Yeast Cell 3 μm
- Mist 100μm
History of Cross-Flow

• Cross-Flow Developed for the Food Industry in the 1940’s- Mainly Water Filtration

• Introduced to Wine Industry in the 1980’s

• Early Cross-Flow did not go well…
Modifications to design allowed a comeback for Cross-Flow

- New Membrane Specifically for Wine
- Back Flush System Improved to Increase Flow Rates
- Design Modification - Prevent Heating
- More Efficient Cleaning
- Fully Automated - Easier to Use
Types of membranes

• Hollow Fiber
• Spiral Wound
• Ceramic
A Unique Membrane
Membrane Specific for Wine

• Inner structure x 10 000

• Outer structure x 5000

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Why a .2 micron membrane?

Permeate : Filtrate (dissolved compounds)
Comportment of Polyphenols

Deformation of the polyphenols through the pores

Re-stabilization in time
Applications

• Filtration of Juice prior to fermentation (pectin free)
• Arrest or prevent alcoholic or ML Fermentation
• Filtration after Fining
• Pre-bottling Wine Preparation
• Taking dirty wine (800 NTU or higher) and end up with wine at 1.0 NTU or lower
Cleaning

- With Back Flush you still need to clean
- Caustic most common
- Non chlorinated-Hydrogen Peroxide
- Enzymes
Advantages of Cross-Flow

- One Pass Filtration
- Minimal Wine Transfer - less oxidation
- Improved Wine Quality (flavor/aroma)
- Minimal Color Loss
Advantages of Cross-Flow

• No Need for Filter Aids – Cost Savings
• No Flavor Issues with DE/sheets
• No Disposal Issues with DE/sheets
• Avoids Health Issues with DE
Advantages of cross-flow

• Time & Labor Savings- 1 x person
• Minimal Wine Losses
• Longer Membrane Life on Cartridges
• Fully Automated
• Can Run Unit Overnight
Disadvantages

- Initial Cost for Equipment
- Slower Flow Rates than DE or sheets
- Module Replacement is Expensive
- Bentonite will Plug Membranes
- Less Control over Filtration
Sizing & Cost

• Smaller Units 150-350 gallons/hour
• Starting cost around $ 25,000
• Difficult to compare Vendors
• Larger Units go up to 15,000 GPH
• Many Filters are Expandable
Status of cross-flow industry

- 800-1,000 Cross Flow Filters in U.S.
- Approximately 13 Vendors
- Mobile Cross Flow Filtration Available
Opportunities for Juice Lees
The process

Cold settling @ 8°C for 12/24 h

Homogenization

Alcoholic fermentation

Enzyme

90 hl + 2 hl

9 hl

Permeate 2 hl (<1 NTU)

Retentate 1 hl (1% of the total volume)

Juice less filtration

For a 20% vol/vol suspended solids initial product

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Juice Lees
The Juice lees filter

D3 Automatic rotary pre-filter

Upper motorized manifold

3 mm ID capillaries modules

Flavy FX1/2/3 filtration unit

Innovation Days Gusmer Enterprises May 2011
Wine Lees...
Opportunities for Wine Lees

- Filters can Tolerate Fining Agents
- Higher Quality of Wine Lees
- Minimal Losses
- No DE
- Less Labor than RDV
Tips on Buying

• Winery References- Great Resource
• Compare against DE/Filter Sheets
• Demo the Worst Case Wine!
• Give Wine Time to Recover
• Make sure Water is Clean
• Check the Fine Print…
Tips on Buying

• Spreadsheet for Cost Justification
• Turbidity Meters - Highly Recommend
• Ask about Servicing!
• Pre-filters (bug catchers) for inlet
• Membranes not Interchangeable

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QUESTIONS?
Thank You!