WINE CLARIFICATION
FINING AGENTS: OPTIONS AND USE
Filtrations: Resources for small scale winemaking

Chik Brenneman
WHAT IS FINING?

• DEFINITION: Clarification of wines or juices by additions of insoluble or colloidal particles for the purpose of removing an undesirable physical or chemical characteristic
IS FINING NECESSARY?

• Post fermentation wine contains yeast, bacteria, mineral salts, colloids, grapes material and other amorphous material

• At completion of alcoholic fermentation, wine is a colloidal solution and a colloidal suspension

• Natural sedimentation, centrifugation and filtration do not protect wine against colloidal hazes

FINING AGENTS ARE COMMONLY USED TO CLARIFY & TO AVOID COLLOIDAL HAZES
WHY FINING?

• Particle density (which is close to wine), electrical repulsion forces and diffusion phenomena lead to very slow & insufficient natural sedimentation.

• If you have time, it may settle out.
GOAL OF FINING

• Insure long term stability
  • irrespective of the temperature, light exposure, or storage conditions.

• Fining agents in juice or wine are for:
  • Clarity
  • Color and flavor adjustments
  • Stability modifications
  • Processing aids.
SUCCESSFUL FINING

• Fast and efficient result in minimal losses
• The wine should remain clear with no undesirable effect on aroma, flavor or mouthfeel
• Fining should be conducted on the final wine blend!
MECHANISMS OF FINING

• Fining agents work via surface actions
• The fining agent and its subject may interact via
  • Electrical Interaction
  • Bond (Hydrogen) Formation
  • Absorption
  • Adsorption

• Complex bi-phasic (non-stoichiometric) process that involves flocculation then sedimentation
WHAT IS YOUR GOAL & TIME FRAME?

Clarity
Modification: aroma, flavors, mouthfeel, color
Improved filterability
Stability...

• To treat as far away from the end consumer as possible
CLASSIFICATIONS OF FINING AGENTS

• Fining agents are grouped according to their general nature
  • Proteins
  • Earths
  • Synthetic Polymers
  • Colloids/Polysaccharides
  • Non-Allergenic
PROTEIN BASED FINING AIDS

• Fining agents: Gelatin, Isinglass, Caseins/Milk, Egg whites
  • All animal product based
    • Isinglass, Caseins, Egg allergen concerns
  • Different proteins => different side chains => different reactions
  • Differ in regards to their amino acid composition
  • Overall positive charge
  • pH impact on activity
GELATINS

• Derived from (almost) complete hydrolysis of collagen
• Hydrogen bonding
• pI ~4.7 (formulation depending)

• Use in the winery:
  • Reds, whites and rosés
    • Reduce microbial populations, astringency, moldy aromas; Clarification; unmask hidden positive aromas
  • More efficient at cooler temperatures
  • Flocculation occurs rapidly, but sedimentation slow
    • Filtration (depth) can occur 48-72 hours post add
# PROTEIN BASED OPTIONS

<table>
<thead>
<tr>
<th></th>
<th>GELATIN</th>
<th>ISINGLASS</th>
<th>CASEINS</th>
<th>EGG ALBUMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIGIN</td>
<td>Collagen</td>
<td>Fish- swim bladder (Collagen)</td>
<td>Milk</td>
<td>Egg white</td>
</tr>
<tr>
<td>USE</td>
<td>Reds, whites and rosés</td>
<td>Reds, whites, rosés wines</td>
<td>Reds, whites, rosés</td>
<td>Aged red wines</td>
</tr>
<tr>
<td></td>
<td>Reduce microbial populations, astringency, moldy aromas, juice browning, Clarify and unmask hidden (positive) aromas</td>
<td>Clarity, unmask aromas, aid filtration, soften mouthfeel</td>
<td>Reduces- bitterness, oak characteristics, color (browning/pinking), Cu. Clarification</td>
<td>Polishes and softens</td>
</tr>
<tr>
<td>CONTACT &amp;</td>
<td>7-21 days</td>
<td>10-28 days</td>
<td>2-15 days</td>
<td>5-21 days</td>
</tr>
<tr>
<td>REACTION TIME</td>
<td>Flocculation is rapid, but sedimentation is slow</td>
<td>Flocculation is rapid, but sedimentation is very slow</td>
<td>Flocculation is rapid, but sedimentation is slow</td>
<td>Flocculation is rapid, but sedimentation is slow</td>
</tr>
<tr>
<td>COUNTER-FINE</td>
<td>Often</td>
<td>No</td>
<td>Often</td>
<td>Depends</td>
</tr>
<tr>
<td>LEES VOLUME</td>
<td>Heavy &amp; bulky</td>
<td>Compact, but significant (&gt;2%)</td>
<td>Medium</td>
<td>Compact, can be significant</td>
</tr>
<tr>
<td>DOSAGE</td>
<td>50-1500ppm</td>
<td>15-30ppm</td>
<td>20-100ppm</td>
<td>50-150ppm or 1-3 egg whites (per barrel)</td>
</tr>
<tr>
<td>SPECIFIC NOTES</td>
<td>More respectful in younger wines-Use early. Effect enhanced at lower temps.</td>
<td>Settling not temperature dependent. Can be used late in the process.</td>
<td>When blended with pot. Bicarb enhance solubility. Can float/coagulate on surface.</td>
<td>Must be formulated/prepared with KCl so you don’t end up with turbid wine. Can be foamy.</td>
</tr>
</tbody>
</table>

*Counter fine with bentonite, tannins or silica gel to prevent overfining*
EARTHS

- Bentonite
  - Volcanic Clay (mineral)
    - Classed as a Montmorillonite
  - Complex of hydrated aluminum silicates with exchangeable cationic components
    - Exchangeable cations: Sodium (preferred for general use) and Calcium (sparkling)
    - Rapidly binds with proteins (heat stable and heat unstable), slow to settle

- When rehydrated enormous surface area (300-900m²/g)

- When in solution it acts as a multi-plated negatively charged structure that can exchange cations with positively charged components in juice or wine
CHALLENGES WITH BENTONITE

• Large loss in lees
  • 5-20%
    • If you need to compact lees more try aqueous solution of Silicon Dioxide or Gelatin

• Take care with sparkling wine production
  • Removing all the proteins makes it difficult to establish a quality mousse
    • Large bubble size and poor bubble stability

• Reputed to alter the organoleptic quality of your wine

• Can pick up “cellar” odors, store in a clean dry environment
RECOMMENDED ADDITION RATES

- Bentonite and Juice
  - Only juice components adsorbed (Including amino acids)
  - Juice lees lower monetary value than wine lees
  - Can remove herbaceous aromas and reduce browning
  - Generally need less than if only doing a post fermentation addition
- Follow manufacturers guidelines for preparation and make sure addition is homogenized

- Bentonite addition rates: Juice & Wine

<table>
<thead>
<tr>
<th>Agent</th>
<th>Juice</th>
<th>Wine</th>
<th>Contact Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentonite</td>
<td>0.5-2#/K</td>
<td>1-5#/K (sometimes more)</td>
<td>5-14 days</td>
</tr>
</tbody>
</table>
SYNTHETIC POLYMERS

• Origin
  • Silica gel (Silicon Dioxide)
    • Prevents over-fining (used in conjunction with a protein based fining aid)
    • Aids settling speed, lees compaction and improves filterability
  • Polyvinylpolypyrrolidone (PVPP)
    • Protein like fining agent with selective affinity for low MWt phenolics
      • Adsorbs Catechins and anthocyanins via hydrogen bonding

• Properties
  • Insoluble in water and wine
  • Flocculates

• Uses: Juice or wine
  • Bitterness and color adjustments (pink and brown pigments)

<table>
<thead>
<tr>
<th>AGENT</th>
<th>JUICE (ppm)</th>
<th>WINE (ppm)</th>
<th>CONTACT TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVPP</td>
<td>400-800</td>
<td>150-500</td>
<td>10-21 days</td>
</tr>
</tbody>
</table>
COLLOIDS (POLYSACCHARIDES)

• **Alginate (Sparkolloid)**
  - Polysaccharide on a DE carrier
    • Different formulation due to solubility in alcohol
      • Strong positive charge
      • Helps to settle out finely suspended particles
        • Most effective at <pH3.5
    • Enhances clarity and filtration quickly

• **Gum Arabic**
  - Polysaccharide (Arabinose)
  - Added just prior to bottling
  - Prevents colloidal coagulation (protective colloidal)
COLLOIDS (POLYSACCHARIDES)

- **Mannoproteins**
  - Fresh yeast/ Yeast autolytic fractions
  - Stabilize proteins and tartrates, freshen wine (oxidized),
  - bind metal ions

<table>
<thead>
<tr>
<th>AGENT</th>
<th>WHITE WINE (ppm)</th>
<th>RED WINES (ppm)</th>
<th>CONTACT TIME</th>
<th>LEES VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alginites-Cold mix</td>
<td>125-250</td>
<td>NA</td>
<td>7-14 days</td>
<td>Compact</td>
</tr>
<tr>
<td>Alginites-Hot mix</td>
<td>125-500</td>
<td>125-500</td>
<td>7-14 days</td>
<td>Compact</td>
</tr>
<tr>
<td>Gum Arabics</td>
<td>440-1320</td>
<td>440-1320</td>
<td>No racking</td>
<td>No lees</td>
</tr>
<tr>
<td>Mannoproteins</td>
<td>100-300</td>
<td>100-300</td>
<td>Depends</td>
<td>Depends</td>
</tr>
</tbody>
</table>
NON-ALLERGENIC AGENTS

• 24.250- Listed for current use (domestic wines)
• Microbial based
  • Mannoproteins, yeast based and fungal derivatives (chitin, chitin-glucan)
• Plant based
  • Vegetable (potato)

• 24.249- Experimental
OTHERS

• Carbon, enzymes & copper
  • Carbon
    • Deodorizing and decolorizing carbons available
  • Enzymes
    • B-glucanases & pectinases
  • Copper
    • Sulfide issues
  • Lysozyme
    • LAB’s...
BLENDING AGENTS

• Casein & Bentonite
• Casein & PVPP
• PVPP & Bentonite
• ...

Synergistic effect!
## Fining Agent Comparison

<table>
<thead>
<tr>
<th>Color Reduction</th>
<th>Tannin Reduction</th>
<th>Volume of Lees</th>
<th>Clarity &amp; Stability</th>
<th>Potential to Overfine</th>
<th>Quality Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>Gelatin</td>
<td>Bentonite</td>
<td>Bentonite</td>
<td>Gelatin</td>
<td>Carbon</td>
</tr>
<tr>
<td>Gelatin</td>
<td>Albumen</td>
<td>Gelatin</td>
<td>Carbon</td>
<td>Albumen</td>
<td>Bentonite</td>
</tr>
<tr>
<td>Casein</td>
<td>Isinglass</td>
<td>Casein</td>
<td>Isinglass</td>
<td>Isinglass</td>
<td>Casein</td>
</tr>
<tr>
<td>Albumen</td>
<td>Casein</td>
<td>Albumen</td>
<td>Casein</td>
<td>Casein</td>
<td>Gelatin</td>
</tr>
<tr>
<td>Isinglass</td>
<td>Bentonite</td>
<td>Isinglass</td>
<td>Gelatin</td>
<td></td>
<td>Albumen</td>
</tr>
<tr>
<td>Bentonite</td>
<td>Carbon</td>
<td>Carbon</td>
<td>Albumen</td>
<td></td>
<td>Isinglass</td>
</tr>
</tbody>
</table>

Dependent upon the wine, the agent used, method of preparation and addition, concentration, pH, metal content, temperature, age, and previous treatments.

Wine Analysis & Production. Zoecklein et. al. 1999
CONDITIONS FOR SUCCESSFUL FINING…

• Surface reactions occur between fining agents and molecules they are reacting with.

• Preparation of agent important
  o As directed by manufacturer
  o Generally in water
    o If in wine coagulation will begin prematurely reducing efficacy

• Addition method important
  o Y, T, In-line or manual
    o Must be rapidly homogenized before coagulation begins

• Racking is important
FINING CONSIDERATIONS

• Lack of specificity
• Over-fine
• Oxygen exposure
• Lees volume (loss of wine)
• Stability considerations
• Expense
• Bench trials
BENCH TRIALS

• Essential
  • Simulate cellar conditions

• Determine/observe
  • Flocculation time
  • Settling speed
  • Resultant clarity
  • Volume and quality of Lees
  • Organoleptic effect
BENCH TRIAL SHEETS, CALCULATORS & REGULATIONS

- **TTB WEBSITE**

- **24.246**- materials authorized for the treatment of wine & juice

<table>
<thead>
<tr>
<th>Materials and use</th>
<th>Reference or limitation</th>
<th>TTB notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk products (pasteurized)</td>
<td>The amount used must not exceed 2.0 liters of pasteurized milk products per 7,000 liters (0.2 percent V/V) of wine.</td>
<td></td>
</tr>
<tr>
<td>White, Red, Fruit</td>
<td>To remove off flavors in wine. The amount used must not exceed 10 liters of pasteurized milk products per 1,000 liters (1 percent V/V) of wine.</td>
<td></td>
</tr>
</tbody>
</table>

- **24.250**- wine & juice treating materials administratively

| Chitin-glucan: To clarify and to stabilize wine. | Chitin-glucan must be derived from Aspergillus niger. The amount used must not exceed 500g/L of wine. GRAS Notice No. GRN 003412 | Preliminary conclusion allowing use of chitin-glucan derived from Aspergillus niger 3/22/2016 |
Filtrations

• Physical separation of particles ‘good and bad’ in winemaking
• Principles of filtrations
TYPES OF MICROFILTRATION

• Surface filtration

Depth filtration

- e.g. filter sheet
- e.g. alluvial filter
SURFACE FILTRATION

• Surface filtration
  - Mostly absolute filtration
  - „Coffee filtration“
  - Particles bigger than pores
  - Low dirt holding capacity
**DEPTH FILTRATION**

- Depth filtration
  - Mostly nominal filtration
  - Filtration through 3-dimensional porous body
  - Torturous paths/channels
  - Large dirt holding capacity
  - Economical solution
ABSOLUTE vs. NOMINAL

• Absolute filter
  - +/- defined pore size
  - can be measured
  - „police filter“

Nominal filter
  - relative retention rate
  - indirectly determined
  - particles of variable sizes can be retained

Saccharomyces cerevisiae on 0.65µm PES-membrane

TM-1000_0019
COMPOSITION OF FILTER SHEETS

• Materials

- Cellulose fibers
  - Milled cellulose fibers for 3D structure of filter

- Filter aids
  - Enlarge inner surface
  - Enhance straining effect of filter

- Resin binder
  - Wet strength agent
  - Positive zeta potential binds negative charged particles
NOVOX® PLATE & FRAME FILTER
PLATE & FRAME FILTER

Functional principle

inlet plates

outlet plates

inlet: unfiltered product

outlet: filtered product

filter sheets

inlet side (rough side)

outlet side (fine/branded side)
PLATE & FRAME FILTER

Functional principle – with crossover plate

Inlet: Unfiltered Product

Outlet: Filtered Product

Crossover Plate

Filter Sheets
Plate & Frame Filter

Before closing the filter, wet the pressure section of the filter sheets (from outside)
Plate & Frame Filter

Maintenance of a plate and frame filter

Periodical cleaning of the spindle, use always high quality grease (→ power transmission)

Periodical changes of the gaskets
Plate & Frame Filter

During filtration always vent the filter
Plate & Frame Filter

Checks during filtration / critical figures

1. Max. flow rates

2. Max. differential pressure

3. Permanent flow (no stop and go)
# FibraFix Grades

<table>
<thead>
<tr>
<th>Standard version</th>
<th>High capacity version*</th>
<th>Retention rate (µm)</th>
<th>Supporting sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtrodur 900</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AF 6</td>
<td></td>
<td>35 - 15</td>
<td>Coarse filtration</td>
</tr>
<tr>
<td>AF 9</td>
<td></td>
<td>30 - 10</td>
<td></td>
</tr>
<tr>
<td>AF 15</td>
<td></td>
<td>20 - 8.0</td>
<td>Clarifying filtration</td>
</tr>
<tr>
<td>AF 20</td>
<td>AF 21H</td>
<td>15 - 6.0</td>
<td></td>
</tr>
<tr>
<td>AF 30</td>
<td>AF 31H</td>
<td>12 - 5.0</td>
<td></td>
</tr>
<tr>
<td>AF 40</td>
<td>AF 41H</td>
<td>9.0 - 4.0</td>
<td></td>
</tr>
<tr>
<td>AF 50</td>
<td></td>
<td>6.0 - 3.0</td>
<td>Fine filtration</td>
</tr>
<tr>
<td>AF 70</td>
<td>AF 71H</td>
<td>3.0 - 1.5</td>
<td>Germ reducing filtration</td>
</tr>
<tr>
<td>AF 100</td>
<td>AF 101H</td>
<td>1.5 - 0.6</td>
<td>Sterile filtration</td>
</tr>
<tr>
<td>AF ST 110</td>
<td></td>
<td>0.8 - 0.5</td>
<td></td>
</tr>
<tr>
<td>AF ST 130</td>
<td></td>
<td>0.6 - 0.4</td>
<td></td>
</tr>
<tr>
<td>AF ST 140</td>
<td></td>
<td>0.4 - 0.2</td>
<td></td>
</tr>
<tr>
<td>AF ST 150</td>
<td></td>
<td>0.2 - 0.04</td>
<td></td>
</tr>
</tbody>
</table>

* Provides increased dirt holding capacity for longer service life

Spec Sheets:
# Flow Rates for Wine Filtration

<table>
<thead>
<tr>
<th>Sheet grade</th>
<th>Module grade</th>
<th>Rec. flow rate (gal/ft²/hr)</th>
<th>Max. differential pressure (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF 20, AF 30, AF 31H</td>
<td>AF 23, AF 33</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>AF 40, AF 50</td>
<td>AF 43, AF 53</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>AF 70, AF 100</td>
<td>AF 73, AF 103</td>
<td>12 – 17</td>
<td>22 - 29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sheet grade</th>
<th>Module grade</th>
<th>Rec. flow rate (gal/ft²/hr)</th>
<th>Max. differential pressure (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF 100</td>
<td>AF 103</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>AF ST 110</td>
<td>AF 113</td>
<td>8.6</td>
<td>22</td>
</tr>
<tr>
<td>AF ST 130</td>
<td>AF 133</td>
<td>8.6</td>
<td>17</td>
</tr>
<tr>
<td>AF ST 140</td>
<td>AF 143</td>
<td>7.4</td>
<td>17</td>
</tr>
</tbody>
</table>

**Filter area sheets:**
- 40x40cm sheet → 1.5 ft²
- 60x60cm sheet → 3.5 ft²

**Filter area modules:**
- 12” module → 20 ft²
- 16” module → 40 ft²
# Flow Rates for Wine Filtration

## Prefiltration

<table>
<thead>
<tr>
<th>Sheet grade</th>
<th>Module grade</th>
<th>Rec. flow rate (L/m²hr)</th>
<th>Max. differential pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF 20, AF 30, AF 31H</td>
<td>AF 23, AF 33</td>
<td>700</td>
<td>2.5</td>
</tr>
<tr>
<td>AF 40, AF 50</td>
<td>AF 43, AF 53</td>
<td>700</td>
<td>2.5</td>
</tr>
<tr>
<td>AF 70, AF 100</td>
<td>AF 73, AF 103</td>
<td>500 – 700</td>
<td>1.5 - 2</td>
</tr>
</tbody>
</table>

## Final filtration / Bottling filtration

<table>
<thead>
<tr>
<th>Sheet grade</th>
<th>Module grade</th>
<th>Rec. flow rate (L/m²hr)</th>
<th>Max. differential pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF 100</td>
<td>AF 103</td>
<td>500</td>
<td>1.5</td>
</tr>
<tr>
<td>AF ST 110</td>
<td>AF 113</td>
<td>350</td>
<td>1.5</td>
</tr>
<tr>
<td>AF ST 130</td>
<td>AF 133</td>
<td>350</td>
<td>1.2</td>
</tr>
<tr>
<td>AF ST 140</td>
<td>AF 143</td>
<td>300</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Filter area sheets:
- 40x40cm sheet → 0.14 m²
- 60x60cm sheet → 0.33 m²

Filter area modules:
- 12” module → 1.8 m²
- 16” module → 3.6 m²

**Calculation Example:**

**Actual flow rate** = Rec. flow rate * m² of sheet or module used * number of sheets or modules used

Filtration with AF ST 130 in a 40x40cm filter with 35 sheets:

350 L/m²hr * 0.14 m² * 35 = **1715 L/hr**
Plate & Frame: Functional Principle – with Crossover Plate

Inlet: Unfiltered Product

Outlet: Filtered Product

Plates

Crossover Plate

Filter Sheets
## Grade Choice

**Best Combination Filter Sheet and Membrane Cartridges**

<table>
<thead>
<tr>
<th>Filter Sheet Grade</th>
<th>Membrane Cartridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF ST 130</td>
<td>0.65 µm absolute</td>
</tr>
<tr>
<td>0.6 – 0.4 µm</td>
<td></td>
</tr>
<tr>
<td>AF ST 140</td>
<td>0.45 µm absolute</td>
</tr>
<tr>
<td>0.4 – 0.2 µm</td>
<td></td>
</tr>
</tbody>
</table>
TROUBLESHOOTING

• The filtered product looks good but the process is not profitable due to premature blinding of the filter sheets:
  • Filter was not vented properly
  • Filter sheets inserted the wrong way around
  • Filter sheet grade is too tight
  • No or not the right prefiltration
  • Isolated reasons unrelated to the filter sheets
TROUBLESHOOTING

- The filtered product is cloudy or out of specification:
  - Filtration flow is too fast
  - Filter sheet grade is too coarse
  - Pressure shocks in the filter during filtration
  - Isolated reasons unrelated to the filter sheets