Outline

• Solution v. Suspension
• Wine solutes and wine particulates
• Why filtration?
• Types of filtration systems
• Ratings and Pore Size
• Proper use of membranes
Solutions

- **Solutions**: compounds or ions in solution
- Solute cannot be seen
- A solution may be pigmented but it is clear, not turbid
- Homogenous
- **Solute are not removed by filtration**
Suspension

- Often only homogenous with mixing
- If homogenous, they are turbid, or cloudy
- Items in suspension can be seen, if not with the naked eye, then with a microscope
- **Suspended items are removed by filtration**
Solutions and their Solutes

- **Apple Juice**: sugars, malic acid, flavor components
- **Vodka**: ethanol
- **Coffee**: caffeine, phenolic compounds, flavor components, added sugar(?)
Coffee and Wine

- Mostly water
- Made from berries, from which flavors and phenolics are extracted
- Wide variation in quality
- Both are often filtered!
Wine and its solutes

- Ethanol
- Organic acids
- Acetic acid (not too much!)
- K+
- R.S.? Carbon dioxide?
- **Anthocyanins** (reds) and other phenolics
- **Flavors and aromas**
Why we filter
Why not filter?

- Time and expense
- Wine is lost
- Oxidation?
- Downstream? Membrane integrity?
- Flavor? Color? **Not so much!**
- *Brettanomyces* will certainly change the flavor of your wine!
When to filter

- Residual sugar (icewines and the like not included)
- No or partial malo-lactic fermentation
- Wine clarification/lees removal
- *Brettanomyces* or *Pediococcus*
- Filter on the way to the bottle!
Pore size: how low to go

- 0.65μm for any microbe whose name ends with *myces*
- 0.45μm for bacteria, including *Oenococcus*
- 0.22μm?
Plate and Frame System

- Filter pads are disposable and made of cellulose fiber and diatomaceous earth (DE)
- Pads work in parallel to maximize filtration surface area
- Two pore sizes can be used in the same pass (one size on each side)
- Can be back-flushed (in desperation)
- Lees filters are also plate and frame systems but the medium is a re-usable mesh
Filter Sheet Treatment:

- Cool water flush 5 minutes
- Hot water flush 5 minutes
- 10g (I use 15)citric per sheet, re-circulated 15 min.
- Warm water flush 5 minutes
- Cool water flush to cool system
Pressure Leaf System

- Filtration medium is DE (SiO$_2$)
- DE/wine slurry coats metal screen (pressure must be maintained or the DE falls off)
- DE is a respiratory hazard
- Pressure leaf systems are still widely used but new systems are cross flow
Cross-Flow Filtration Systems

- Cross-flow refers to the tangential flow across the filter medium
- Instead of the medium plugging, sediment is continuously removed
- System is also periodically back-flushed with clean wine
- Much larger through-put and much smaller wine losses than other systems
- Medium is reusable
Absolute Security
The “police”

- The membrane does no work!
- Absolute membrane pore size no less than smallest nominal pore size of medium that precedes it
Nominal Ratings, or Pore Size

- Ratings are arbitrary, assigned by the manufacturer
- Rate non-uniform pore construction (some pores are bigger than others)
- Rating based on percent weight removal
- $\beta$ ratio: ratio of what goes to what goes out
  \[ \text{Removal Efficiency} = \left(\frac{\beta - 1}{\beta}\right) \times 100 \]
- Nominal rating is also accompanied by a removal efficiency (90% for example)
Absolute Ratings

- Uniform, or constant media structure
- Constant removal performance
- Nominal filter media will have an absolute rating at a higher particle size
What is Sterile?

- Per FDA definition, sterile filters must remove 10,000,000 cells per square cm.
- Titer Reduction = \# of cells in ÷ \# of cells out
- Medium must be integrity testable
- Effluent has zero recoverable challenge organisms
- 0.65\(\mu\text{m}\) is challenged with *Saccharomyces*
- 0.45\(\mu\text{m}\) is challenged with *Oenococcus*
In More Depth...

- **Torturous Path** of a filter medium reduces probability of a particle passing through.
- Achieved with an increased medium depth or thickness.
- Medium porosity may be a better comparison of filtration systems.
- Even so, using too small a pore size will increase surface loading and clog the filter.
- **Decision making is difficult, but important!**
Important Points

- Compounds in solution, including flavor compounds and anthocyanins, are not removed by filtration.
- Wine flavor affected indirectly by removal of potential spoilage microbes.
- Off flavor from DE/cellulose pads must be removed.
- **Nominal ratings are arbitrary and should be considered along with removal efficiency.**
- Membranes are assigned absolute ratings.
- **Membranes are “the police” and should not do any work.**
- Choose the correct pore size for your application!
Enology & Viticulture Program

Viticulture: Grape Growing
- Site selection
- Vine training and trellising
- Canopy management
- Pest control
- Harvest operations

Enology: the Science of Wine
- Fermentation microbiology
- Wine chemical analysis
- Filtration and Fining

Business of Wine
- Logistics
- Marketing & distribution
• Associate in Applied Science in Enology and Viticulture
• Midwest’s first commercial teaching winery: Lake Michigan Vintners
• Future Facility
Questions?

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