Wine Processing

Wine 3
Introduction to Enology

3/25/2014

Tonight's Lecture

- Announcements
- Wine processing
  - Hoses and fittings
  - Types of pumps used for wine
  - Filtration and clarification
  - Cold stability
  - Heat exchangers and alcohol reduction

Field Trip

- No lab tomorrow - First field trip this weekend
  9:00AM Saturday at Clos Du Bois
- Please be on time
- Clos Du Bois Winery
  910 Lytton Station Rd
  Geyserville, CA 95441

Introduction

Today's lecture covers cellar operations in winemaking that occur between fermentation and bottling not counting oak aging (separate lecture).

We will discuss many forms of winery equipment tonight.

More goes on between harvest and bottling than most people think.

Hoses

- Most wine operations require movement of the wine from one vessel to another, several different types of hoses are available to do this.
- Standard sizes are 1", 1.5", 2", 3" & 4" most North Coast wineries use 1.5" and 2" for wines and juice, red must requires a larger hose, 3 to 6 inches in diameter.
- Good sizes for home winemakers are 1/2" and 3/4"

Remember, a two inch hose carries four times the volume of a one inch hose.
Types of hoses

- **Rubber**, durable, flexible, heavy, opaque, expensive, but still the best if you can afford it, long life makes up for the high cost. ($10 to $22 a foot for 2”)

Types of hoses

- **Plastic**, shorter life span, not as flexible, lightweight, see-through, inexpensive. Often reinforced with nylon or wire. Most types are damaged by hot water over 140°F, ($2 to $5 a foot for 2”). Braided Tygon is good for home winemakers.

Transfer Lines

- Usually stainless steel, never wear out but are expensive. Best used over long distances in a permanent setting. (PVC pipe sometimes used)
- They must always slope about 1/4” per foot and have no low spots so they will always drain dry. ($18 to $30+ a foot for 2” installed)

Fittings

- Fittings are used to attach hoses together and to tanks and equipment. They also include reducers and bushings as well as valves and “Y’s” and “T’s”

Fittings

- They are usually made of stainless steel, but bronze or Nyglass (nylon/fiberglass) are also used because they are less expensive, but are not as durable.
- On larger fittings (4” to 6”) Nyglass or aluminum is most common because of lighter weight and lower cost.

PCT (Pacific Coast Thread)

- **PCT**, Male and female threaded screw fittings. Easy to use but require a strong grip and are not very sanitary. The oldest method so usually found in older wineries. Originally used by fire departments.
**Tri Clamp**

- **Tri Clamp**, Unisex fittings that have a detachable washer, more sanitary because the washer is removed for cleaning every time. Most common fitting used today. (Tri-Clover)

**I-Line**

- **I-Line**, Similar to Tri Clamp but has male and female ends, more durable because the washer is recessed, but they are also more expensive.

**DIN Fittings (Sanitary Pipe)**

- **DIN**, or sanitary pipe fittings are popular in Europe so imported cellar equipment often have them. Very durable, clean and expensive.

DIN, Deutsches Institut für Normung, which means "German Institute for Standardization"

**Cam-lock**

- **Cam-lock**, Usually used on bigger hoses (3" to 6") must lines etc, can be hard to remove uses male & female connectors.

**Valves**

- Valves are used during transfers to control flow. There are two common types:
  - **Ball valves** have low resistance to flow when open because there are no obstructions in the valve but they are difficult to keep clean.
  - **Butterfly valves** have a vane in the middle of the valve that impedes flow slightly but they are more sanitary than ball valves.

**For home winemakers** I like ¼" garden hose fittings or 1" nylon cam-lock. It is alright to use, brass garden hose fittings, but don’t use garden hoses because they are usually not food grade.
Valves

The valve handle is parallel to the direction of flow.

Ball Valve Diagram

Butterfly Valve

Butterfly Valve Diagram

Pumps

- Pumps are used to transfer wine, juice, must & pumice, they differ in ability to:
  - Ability to pump against pressure
  - Ability to handle solids, skins vs. DE (abrasive).
  - Gentleness towards wine.
  - The ability to self-prime

Gravity Transfer

- The gentlest system is no pump at all, using gravity (siphon) or inert gas pressure.

Gravity Transfer

- Prior to the 20th century wineries usually pumped wine by hand, which was hard work, so they were often built on the side of hills to take advantage of gravity. Grapes delivered on top floor, bottling done at the bottom.
Types of Pumps
- There are two major categories of pumps:
  - Centrifugal
  - Positive Displacement

**Centrifugal Pumps**
- Designed to pump a given Gal/Min up to a given "head". If this head is exceeded the pump goes into "slip" and the flow decreases.
- **Head** is the back pressure that the pump is pushing against. It is usually expressed in height (feet or inches) of water.
- If a pump is moving water 100 feet uphill, it has 100 feet of head pressure.

**Head Pressure ~ Resistance**
- If the head is too low, the pump will cavitate, this is where the impeller is moving faster than the liquid that is being pumped.
- This problem can be solved by using a variable speed drive motor and slowing down the pump, or by restricting the outflow via a valve on the discharge. This valve can also be used to control flow.

**Centrifugal Pumps**
- Pump Curve

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Wine Processing
**Centrifugal Pumps**

- **Advantages of Centrifugal Pumps:**
  You can shut off against the pump it goes into slip (this is not always a good idea however) Highest Gal/Min for the cost. Good transfer pump.

- **Disadvantages of Centrifugal Pumps:**
  The seals for the pump are on the suction side, so if they leak the pump may suck in air and aerate the wine.
  The Pump also must be primed. If used for pumpovers the impeller can get clogged with stems. Not good for use with barrels.

**Positive Displacement Pumps**

- There are several different types of P-D pumps, most can handle larger heads, have variable speed capabilities, and they do not have to be primed.
- However, on some types damage will occur if you shut off against the flow. Used for barrels, bottling, transfers and filtration.

**Flexible Impeller**

- **Advantages:** Cheap, gentle if run at low speeds, self-priming, reversible and you can be shut off against them (the pump goes into slip).
- **Disadvantages:** Burns up if it is run dry, and some models are LOUD
- Major manufacturers are Jabsco, Tri-Clover and M&D
**Rotary Positive Displacement Pumps**

- These are one of the best all around pumps for low solids juice and wine. They are fast, quiet, gentle, self-priming and reversible; they are one of the most expensive as well. Most have variable speed drive.

**Progressive capacity (Moineau)**

- Progressive capacity pumps have a helical screw (impeller) carries the wine in pockets through tube with soft rubber lining (stader), gentle, long and bulky, can't be run dry or pump abrasive materials like DE, but good for high solids like red must.

**Piston pumps**

- Used as a high pressure pump for lees filters and must pumps, good for high solids, pulsating output.

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*Wine Processing*
Piston pumps

A duel-piston must pump.

Air Diaphragm Pump

- A type of piston pump, they are gentle, good for high solids (but not skins), pulsating output. Runs on compressed air so there is no danger of electrocution.
- Good for barrels and bottling because if you shut off flow it pressurizes the wine to the set point of the air pressure and stops. Some models are LOUD, Yamada is a good brand.

Air Diaphragm Pump

Single diaphragm pump

Double diaphragm pump

Peristaltic Pumps

- These are large pumps that are very gentle but has a pulsating output. Good for abrasive Materials like D E, no moving seals that can leak.

Pulsating Output

- Air diaphragm, piston, and peristaltic pumps all have pulsating output that can be rough on equipment. This can be moderated with the use of a air chamber on the discharge.

Air Chamber
Clarification and Stability

**Clarification**, operations that achieve clarity (clear/brilliant wine) they include fining (adding a material that removes particles from wine), settling, racking, filtering and centrifuging.

**Stabilization**, operations that remove excess amounts of semi-soluble materials from wine that might become insoluble over time.

Ideally, clarity should be a permanent condition. Operations in stability insure that it is. In tonight's lecture we will go over operations in clarification and cold stability, we will go over more operations in stability in the fining agents lecture.

Filtering

There are many types of filters, they differ in the way they operate and the amount and type of solid particles they remove.

- **Rough** filtration removes larger particles
- **Polish** filtration removes smaller particles
- **Final** filtration insures all particles are removed

The filters will presented in this order as well

Sequence of filtration: **Rough → Polish → Final**

Size of particles removed: **Large → Medium → Small**

What is Diatomaceous Earth?

**D.E.** is a filter aid that is made up of the skeletal remains of diatoms (prehistoric algae). They have intricate structures made of silica, mined from old sea beds.

Lees Filters

The primary (pre-fermentation) lees is the high solids juice (10% to 40% solids) left in the tank after the juice is racked before fermentation.

If the lees juice was fermented without clarification the resulting wine would be very high in H₂S.

Lees filters (as well as other types of filters) use **diatomaceous earth** as a filter aid.
What is Diatomaceous Earth?

- DE imparts no off flavors since it is made of silica (the main ingredient in glass). Silica dust is hazards so you need a respirator when working with DE.
- DE is mined out of the ground and then kilned during processing.

Filter screens

- Can be made of polyester cloth or stainless steel.

DE Filtering

- The filter operates by forcing the juice through a layer of Diatomaceous Earth (DE) held back by a polyester cloth. Since the juice is very dirty, this must be done at high pressures to force the juice through.

Alternatives to DE

- Because of health concerns (to winery workers, not the public) from the crystalline silica in diatomaceous earth some wineries are looking into alternatives such as filter aids made from cellulose or perlite. Vitacel is the trade name of a cellulose based product.

Plate and Frame Lees Filter

- The "cakes" come out dry and are primarily made of DE.
Rotary Drum Lees Filters
- These are another type of lees filter that uses a vacuum to hold a layer of DE on a porous drum, it is very efficient but tends to oxidize the juice.

Pressure Leaf Filters
- Dosing: While the filtration is being done a small amount of DE can be continuously added to the body feed to prevent the pads from clogging.

Pressure Leaf Filters

Filter Press
- Versatile, can be used for rough, polish, or sterile filtrations. It consists of a series of stainless steel or plastic frames that cellulose fiber pads. Also called a plate & frame filter.

Filter Pads
- As wine flows through the pads particles are removed. The type of pad that is used determines the type and size of particles that are removed.
- It is very important not to exceed the pads flow rating.

Filter Press
Membrane Filters

- Membrane filters are used just before bottling as a final filtration. They are an absolute filter all the others we have talked about so far are depth filters.
- The analogy is similar to comparing a screen door to a layer of cotton balls. Since they have a uniform pore size, they can be checked for integrity by seeing how much pressure is required to break the surface tension of the filter.

Membrane Filters

- Filters have about 8 ft² filter area per 10 inch segment.

Crossflow Filtration

- Relatively new to the wine industry they use tangential flow that is perpendicular to the filter media during the filtration.
- As the flow runs across the media it helps to scour the surface and prevent clogging.
- They are expensive but can filter rough to polish in one step and can cost less in the long run saving wine, materials, and labor.

Crossflow Filtration

- Hollow tubes of polyolefin membrane are arraigned in a housing, more housings give the filter greater capacity.
Crossflow Filtration

- Crossflow typically removes particles larger than 0.2 microns.
- Originally got a bad rap when introduced in the 1990s because the process overly heated the wine.
- New units have a reputation for having less of a negative sensory affect than traditional filtration with less wine loss.
- Most units have automated controls so they can run all night.

Thoughts on Using Filters

- There are two schools of thought on filtering. One that it strips the wine of desirable flavor compounds and makes it overly clean and boring.
- The other says it is an essential part of wine making that is necessary for good looking stable wines.

Thoughts on Using Filters

- Advantages: Filtered wine is more brilliant and is much more microbial stable than unfiltered wine.
- Disadvantages: Filtering can affect a wine’s body, and sometimes you do lose some flavor.

Thoughts on Using Filters

- Conclusion: You can make good wines either way: sweet non-ML whites had better be filtered, dry ML complete reds probably can get by without it. Depends on your style of wine making (and marketing plan).

Centrifuges

- Wine centrifuges are devises that clarify a wine by using centripetal force to accelerate the settling out of the wine.
- Popular in the early ‘80s, but fell out of favor because it was thought they over processes wine.
- They work on a continuous process (not a batch process as lab centrifuges do) there are two different designs.
**Decanting Centrifuges**
- These do not get the wine as clean but they handle higher solids. They work particularly well with juice that has just been pressed and must be clarified before fermentation.

**Desluging Centrifuges**
- Work better with a lower concentration of solids and get the wine very clean; can be used for stopping fermentation by removing the yeast.

**Cold Stabilization**
- Cold stabilization removes excess (unstable amounts) of potassium bitartrate (KHTa). KHTa is a product of tartaric acid anion and potassium found in grape juice and wine.
Tartrate crystals

Red wine crystals 20X
White wine crystals 400X

From ETS Labs

Cold Stabilization

- If there is too much KHTa in a wine it will become insoluble especially when chilled, and it will crystallize out of solution.

Tartrate crystals at bottom of wine bottle

Cold Stabilization

- To avoid this, the wine is chilled down (cold stabilized) before bottling and the crystals form inside the tank.
- The wine is chilled down to about 30°F for about 3 weeks

Cold Stability Testing

- To insure the wine is cold stable it should be checked by placing a sample in the refrigerator over night and seeing if any crystals form or by doing a conductivity test.
- There is no perfect test for establishing cold stability.

Seeding

- Seed crystals of KHTa can be added to speed up the reaction.
- This is counterintuitive but adding crystals of KHTa gives the insoluble KHTa in the wine a nucleation point for the crystals to grow and speeds up the process of cold stability considerably.
- Saves a lot of electricity (and money).

Cold Stabilization Tips

- Shutting off bottom jacket on the tank after it has reached temperature increases convection and speeds results.
- In reds, cold stability is not as much of a problem because they age longer and they are not served chilled.
- Best done in the wintertime, more efficient. For home winemakers keep winery doors open on cold nights.
**Tartrate Stabilization by Electrodialysis**

- Electrodialysis, or ED is a recent development to remove excess tartrates (Ta-) and potassium (K+) by passing wine over a membrane with positive and negative charges on either side.
- The ions are passed through the membrane lowering the (Ta-) and (K+) concentration in the wine.
- It has the advantage of being much more energy efficient than cold stabilization.

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**Cold Stability**

- Protective colloids such as yeast mannoproteins added to wine just prior to bottling can be used to prevent potassium bitartrate from crystallizing after bottling.
- Not widely used but this method can save time & energy.
- For a 10,000 gallon tank using seed crystals or ED can save as much as several hundred dollars in energy.

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**Heat Exchangers**

- Sometimes it is necessary to change the temperature of a wine or must rapidly; this is done most efficiently through a heat exchanger.
- They are often used to warm a wine slightly (65ºF) before bottling, also used as must chillers between the crusher and press.

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**Heat Exchangers**

- There are three common types:
  - Tube in Tube
  - Plate & Frame

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**Tube in Tube Heat Exchanger**

- Very efficient, always counter flow
Plate & Frame Heat Exchanger
- Similar to the plate and frame filter
- Efficient and small footprint

Heat Exchangers
- If you do not have a heat exchanger you can warm up a tank by circulating hot water or warmed glycol through the cooling jacket. You can also place a hose over the top of the tank and run hot water over the sides slowly while gently mixing the tank.
- Be very careful when warming a tank this way, if it is not mixed frequently the wine at the top of the tank become very hot!

Dealcoholization
- Lowers alcohol partially or completely
  - Completely for nonalcoholic wines
  - Partially for tax or sensory reasons
- Two methods:
  - Reverse osmosis
  - Spinning cone

Spinning Cone
- Developed in Australia. This allows you to distill out volatile components of wine or juice (such as $\text{SO}_2$ or Alcohol) and a low temperature so the product is not as affected by heat.
- This is done by passing the wine over a series of spinning cones that are located in a column that is kept under a partial vacuum.
- The extra surface area and turbulence produced by the spinning cone combined with lowered pressure allows alcohol and other volatile constituents of wine to pass into inert gas being passed by the spinning cones.
- The process is done in two passes, the first removes aroma compounds, the second removes the alcohol, then the aroma fraction is added back to the base.
Spinning Cone

Only a portion of the wine is treated and then blended back into the main blend.

Reverse Osmosis (RO)

- Osmosis is the travel of water across a membrane from low concentration to high concentration.
- **Reverse Osmosis** the liquid is forced to travel the opposite direction by pressure.

**Reverse Osmosis (RO)**

- This involves cross flow ultra filtration to 10,000 MW (pore size of 0.003 micron) at 1000 PSI on a membrane that allows water and alcohol to flow through as a permate.
- The permate is then distilled to remove the alcohol and then the water is returned.
- The alcohol can also be removed by a second osmosis process instead of a still.

Reverse Osmosis with still

**Reverse Osmosis**

- The Memstar system does not require a still.

Dealcoholization

- In California, these processes are mainly used for lowering the alcohol of a "hot" wine such as one made from over ripe fruit.
- Tasting trial can be done to find the "sweet spot" of the alcohol concentration.
- About 4,000,000 gallons of wine is processed a year here in Sonoma Co. That is enough for 25,000,000 cases worth of wine!
Alcohol “Sweet Spot” Tasting

Dealcoholization

- This can also get the wine below 14% ethanol for a lower tax class. Usually only a small portion of the wine is treated. (Under 14% saves 50¢/Gal Taxes). Dealcoholization costs 10 to 20 ¢/Gal.
- Completely removing the alcohol has very severe sensory and stability considerations.

Next Week

- Remember - no lab & field trip Saturday
- Next week’s lecture: Barrels and Ageing