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Second edition.

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Traditional Flavor Real Economics

TAGS - YOU'RE ALL IT

MARK STUPICH

Exploring new paths to crafting quality wines

The lives of winemakers center around producing the best possible wines from the raw materials (grapes) with which they are provided. At times, these grapes are of superior quality and contain the potential for producing magnificent wines. At other times, this potential is not the case. Winemakers must then explore additional methods to produce a wine of consistent flavor and aroma, using a minimum of physical and economic resources.

This book discusses tools and techniques available to winemakers to help them produce the best possible wines. We present the latest ideas concerning chemical reactions important to the color, flavor and body of wines.

Two of the most effective tools for making excellent wines are the influence of toasted oak and the effective use of oxygen. Traditionally, the influence of oak on wine occurred through the use of toasted oak barrels and tanks as storage containers. Centuries of experimentation and refinement have optimized the preparation, seasoning and toasting regimes required to provide well-integrated flavors and textures. Recent advances in wine storage and aging have prompted the use of traditional toasted oak in stainless steel tanks.

Mixing innovation with tradition, winemakers working with StaVin have pioneered the use of Oak Integration Systems in the production of wines. Tank Fans, Segments and Beans are serving as viable barrel alternatives. They allow the winemaker to dictate the quality, amount, timing and type of toasted oak that will integrate with the wine. In addition, these products can relieve winemakers of the labor and sanitation issues associated with barrels. Although Oak Integration Systems provide flavor and texture comparable to barrels, aging in stainless steel tanks has until recently limited oxygen-induced maturation. However, the advent of micro-oxygenation now allows these wines to match the integration, complexity and maturation of barrel-aged wines. This combination of techniques also allows winemakers a degree of control in production not previously possible.

Winemakers are engaged in the constant endeavor of creating better wines. The purpose of this book is to introduce techniques in fermentation and aging for the production of clean wines free of defects, to increase control and to decrease costs for wineries. Today's innovative use of toasted oak and micro-oxygenation techniques present powerful tools for evoking the winemaker's personal style and crafting a high quality wine.

This book does not presume to have all the answers. Rather, our intention is that it be a catalyst to promote discussion amongst us. Then we will all continue to learn from each other.

Benefits of using toasted oak and oxygenation

Coffee

Extraction of nostalgic aromas

Toasting breaks down the molecular structure of oak, pyrolyzing the lignins, hemicellulose and cellulose. Properly seasoned and slow toasted, the byproducts are delightful nuances that react synergistically with wine resulting in nostalgic flavors and aromas. Whereas oak that is underseasoned, toasted too rapidly and/or at too high of a temperature, results in antagonistic compounds that deleteriously affect the wine.

Vanilla

Synergistic flavors and aromas

Positive and nostalgic aromas include: vanilla, roasted coffee, toffee, caramel, toasted nuts, crème brulée, black licorice, cinnamon, cloves, nutmeg, graham crackers, brown sugar, caramelized butter, chocolate, bacon and campfires.

Antagonistic flavors and aromas

Negative aromas include: raw green oak, pencil shavings, creosote, burnt rubber, dill and the smell of a burnt-down house.

Reduced sulfide and vegetal characteristics

When oak and macro-aeration are used during fermentation, minimized sulfide production and decreased vegetal characteristics are observed. Micro-oxygenation administered at high levels prior to the completion of malolactic fermentation can be utilized to help overly green and tannic wines. Once malolactic fermentation is complete, micro-oxygenation in a tank with high quality oak can further diminish these problems and assist in the proper maturation of the wine.

Establishment of desirable mouthfeel and structure

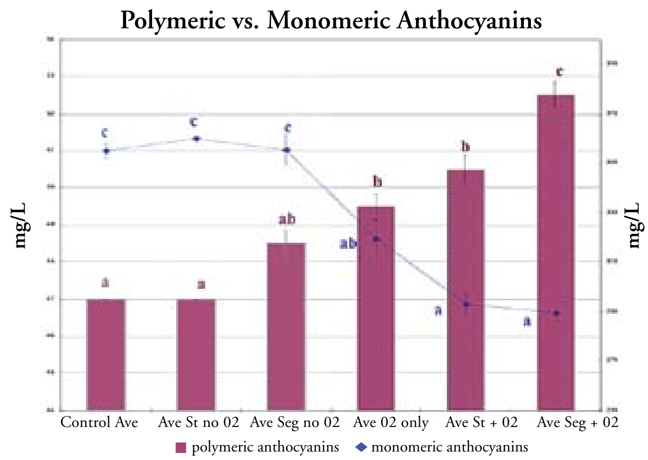
High quality oak contributes compounds to the wine that enhance a desirable mouthfeel and structure in wines by balancing acidity, alcohol and fruit intensity. Oxygen catalyzes reactions in the wine that help to soften and integrate these compounds.

Enhance wine color

Reactions of toasted oak compounds, oxygen and anthocyanins produce stabilized pigments, intensifying and enhancing wine color.

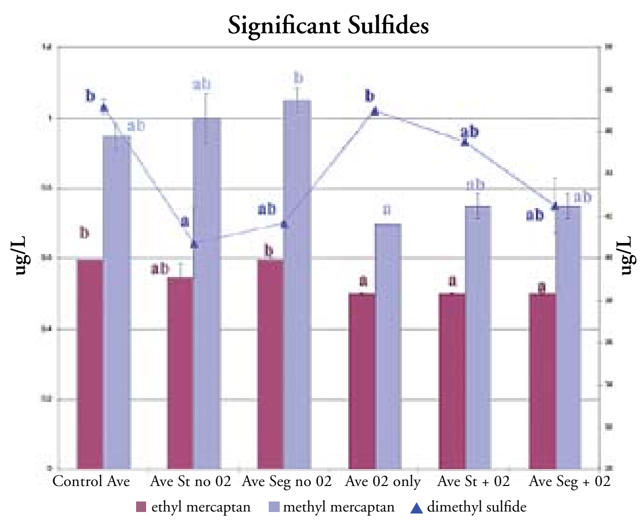
Production scale experiments with oak and oxygenation

The following experiments were done in replicate on production scale Cabernet Sauvignon wines to examine the effects of StaVin products and/or oxygenation during fermentation and aging.



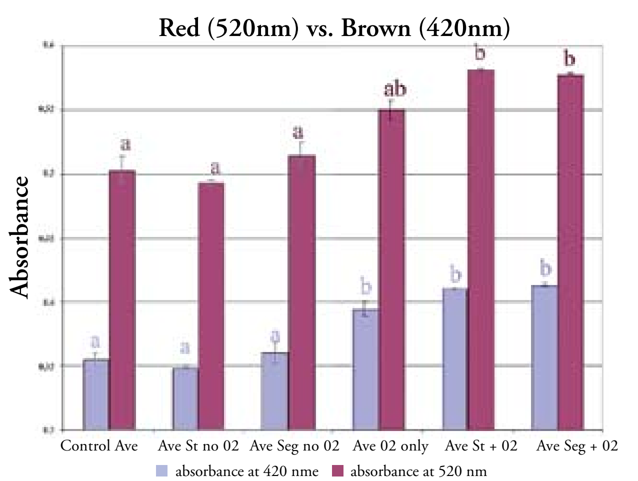
Increase in polymeric anthocyanins

The three oxygenated samples resulted in fewer monomeric anthocyanins with a concurrent increase in polymeric anthocyanins that tend to be more stable. Synergistic effects were seen with the addition of Segments to the oxygenated wines.



Diminished reductive aromas

The three oxygenated samples resulted in a decrease in methyl and ethyl mercaptan. No concurrent increase in disulfides was detected. (Disulfide production is common with the misuse of copper and aerative rackings.)



Increase in color

The three oxygenated samples resulted in more red (520 nm) and yellow (420 nm) coloration than all three of the non-oxygenated wines. However, there was a concurrent increase in brown (420 nm). Thus micro-oxygenation should be applied with care to lightly colored wines.

Control Ave = control wine
Ave St no O2 = StaVin French Oak Staves Med+, no oxygenation
Ave Seg no O2 = StaVin French Oak Segments Med+, no oxygenation
Ave O2 only = oxygenation only
Ave St + O2 = StaVin French Oak Staves Med+ with oxygenation
Ave Seg + O2 = StaVin French Oak Segments Med+ with oxygenation

Letters above each column denote statistical difference.

Analysis provided by ETS, St. Helena, CA.

TRACKS AMONG STACKS

MARK STUPICH

Not all toasted oak is created equal

Using premium oak is of paramount importance to your resultant wine quality. A critical evaluation of following factors will ensure higher quality products for your wine.

Stringent quality control

Demand stringent standards ensuring reliable inventory control including oak origin, integrity, seasoning, toasting and barrier packaging.

Three year seasoning

Three year natural seasoning allows indigenous microflora and the environment to soften tannins, reduce astringency and increase complexity.

Proper toasting

Toasting protocols must deliver reproducible flavors consistent with your winemaking goals.

Research and customer service

Technical research and customer service to help determine appropriate products and methods individualized for your winemaking desires.

TCA analysis

The increased consequences of TCA taint found in corks, cellars and barrels require adequate testing of potential sources. We have begun the testing of all raw materials to help eliminate the potential for TCA-type taints from StaVin products.

StaVin Oak Infusion Systems

The extraction rate and perceived quality of oak in wine are influenced by the percentage of available end grain. Oak infusion systems with a lower percentage of exposed end grain tend to have slower extraction rates that yield enhanced organoleptic properties. Timeline, economics and winemaking style are the main factors regarding the selection of our oak infusion systems.

Oak Bean

Dosage rate	For 100% new barrel impact, use 1.5 lb (680 g) per 60 gal (227 l)
Size	± $^{3}/_{8}$ inch (10 mm) cubed
Contact time	2 months minimum
Seasoning	3 years in natural elements
Toast method	Traditional fire
Toast levels	Medium, Medium Plus or Heavy
Useful life	1 year
Type of oak	American, French or Hungarian
Displacement	4 gal (15 l)
Package weight	20 lb (9 kg) bag
End grain %	40%
For fermentation:	
Pounds per ton	2–8 lb. (1–3.5 kg) per ton

French Oak Segment

Dosage rate	For 100% new barrel impact, use 5 lb (2268 g) per 60 gal (227 l)
Size	2–3 inches (5.1–7.6 cm)
Contact time	3 months minimum
Seasoning	3 years in natural elements
Toast method	Traditional fire
Toast levels	Medium, Medium Plus or Heavy
Useful life	18 months
Type of oak	French*
Displacement	2.9 gal (11 liters) per bag
Package weight	15 lb (6.8 kg) bag
End grain %	10%
Pounds per ton	6–10 lb. (2.7–4.5 kg) per ton

**Available by request in American or Hungarian oak.*

Tank Fan

Dosage rate	For 100% new barrel impact, use one 44 sq ft (4.1 sq m) Fan pack per 180 gal (681 l)
Length	36 inch (91 cm)
Width	1.5–2.5 inches (3.8–6.4 cm)
Thickness	± 3/8 inch (10 mm)
Contact time	3 months minimum
Seasoning	3 years in natural elements
Toast method	Traditional fire
Toast levels	Medium, Medium Plus or Heavy
Useful life	2 years
Type of oak	American, French or Hungarian
Displacement	4.3 gal (16 l) per packet
End grain %	1%

Staves are supplied in a 44 sq ft pack and can be installed as a Fan, Matrix or Tank Modular System. Please specify system.

Barrel Insert

Dosage rate:	
Insert	For 100% new barrel impact, use 1 Insert pack per 60 gal (227 l)*
Concentrated Insert	For 135% new barrel impact, use 1 Concentrated pack per 60 gal (227 l)*
Contact time	3 months minimum
Seasoning	3 years in natural elements
Toast method	Traditional fire
Toast levels	Medium, Medium Plus or Heavy
Useful life	2 years
Type of oak	American, French or Hungarian
Displacement:	
Insert	1.3 gal (4.9 l)
Concentrated Insert	1.6 gal (6.0 l)
End grain %	2%

* *These percentages are approximate, dependent upon the winemaker's taste threshold and variables in the production process.*

Barrel Replica

Dosage rate	For 100% new barrel impact, use one Replica per 60 gal (227 l)
Stave length	17.5 inches (45 cm)
Stave width	± 1 inch (2.5 cm)
Stave thickness	± 3/8 inch (10 mm)
Total staves	30, divided into 10 sections
Contact time	3 months minimum
Seasoning	3 years in natural elements
Toast method	Traditional fire
Toast levels	Medium, Medium Plus or Heavy
Useful life	18 months
Type of oak	American, French or Hungarian
Displacement	0.7 gal (2.7 l) per Replica
Surface area	12 sq. ft. (xx sq. m)
Parts included	One 304 stainless steel eye hook
End grain %	2%

StaVin oak addition rates

Fermentation only

	Addition rate grams/liter	Addition rate pounds per ton	Volume treated per package
Granular	0.06–0.24*	0.5–2*	40 lb package 20,000–80,000 gallons*
Chips	0.24–1*	2–8*	15 lb package 1,875–7,500 gallons*

*The low range is for *stabilizing color and adding body* while the high end is recommended for *minimizing vegetal characteristics* in combination with macro-aeration. These products have a high end grain percentage resulting in a rapid extraction rate. Overuse of these products can result in harsh bitter characters in your wine.

Fermentation and aging

	Extraction time (months)	Addition rate grams/liter	Addition rate pounds/1000 gallons	Volume treated per package
Beans	12 (minimum 2)	3	25**	20 lb package 780 gallons**
Segments	18 (minimum 3)	10	83**	15 lb segments 180 gallons**
Staves	24 (minimum 3)	13	111**	Full fan pack 180 gallons**

**The addition rates for beans, segments and staves are treatments used to achieve 100% new barrel equivalents. *Adjust these numbers according to the amount of new barrel equivalent you want to achieve* (e.g. one full fan pack treats 360 gallons of wine at 50% new barrel equivalent).

Sensory evaluation of StaVin oak flavor and aroma attributes

This tasting was conducted to give winemakers a reference for descriptors that were present across three oak origins and three toast levels. Wines were tasted with and without bottle age to give an impression of changes after only one month of bottle age. This experiment is not intended to be definitive, but rather as a reference point; more evaluations will be forthcoming using additional red and white wines.

Methodology

Finished white wine was in contact with 30g/l of oak for two months. The oaked wine was diluted in a finished, generic Chablis white wine for sensory evaluation to ¼ that level or 7g/l of oak. This concentration was purposefully higher than would typically be found in a finished wine to help us evaluate the characteristic attributes of each origin and toast level.

All samples were presented blind. Samples for the first tasting were fresh (ie, the oak was removed and the samples evaluated with zero bottle age). For the second tasting, the wines had been aged in bottles for one month prior to the tasting.

Organization of Tasting Sets I and II

To assist the group in standardizing descriptors, a vocabulary training session was conducted by Leslie Norris of FlavorSense, using the twenty-four references in her oak kit. Aromas were presented on blotters and in wine for discussion. The wines were evaluated in two sessions as described below.

Set I: **The three toast levels were compared for each origin of oak.** The wine had no bottle age. Eight experts (winemakers and wine scientists) participated. The attributes were generated for each flight, and were not the same for the three origins of oak. (See Table 1 on the next page.)

Set II: **The three origins of oak were compared at each toast level.** Eight expert panelists created the vocabulary and five trained panelists quantitatively evaluated the wines, using a 15cm line scale for each of the attributes important to toasted oak. (See Table 2 on page 13.)

Results

There was a vast difference in the wines from Tasting I to II, indicating that there was a large sensory change after the oak was removed and the wines were allowed to rest in the bottle. The panel described the changes as "dramatic." All the wines improved with time in the bottle; they noted a distinct increase in complexity and integration. The panel noted that the Hungarian wines had changed the most, from black pepper and leather attributes to more typical oak caramel, fruity and brown sugar characters.

Tasting Set I: Three toasting levels for each origin

Table 1: Two months contact with Oak Beans, *zero bottle age.*

See Key to evaluations below table on next page.	French			Hungarian			American		
Attribute	Med.	Med. +	Heavy	Med.	Med. +	Heavy	Med.	Med. +	Heavy
Vanillin intensity	++	+++	+++	+++	+	+++	+	+	+++
Caramel	++	+++	+++	–	–	–	++	++	+
Maple/brown sugar	+	+++	+	–	–	–	+	++	++
Custard/crème brulée	+	+++	++	–	–	–	–	–	–
Cinnamon/allspice	++	+++	+	–	–	–	–	–	–
Chocolate (milk/bittersweet)	–	+	+	+++	++	++	–	–	–
Campfire/roasted coffee	+	+++	+++	++	+	+	++	+++	+++
Meaty	_	_	_	++	+++	+	–	–	–
Baked apple pie	+	++	++	–	–	–	+	++	++
Walnut/nutty	–	–	–	+	+++	+	–	–	–
Perceived sweetness	+++	+++	++	–	–	–	++	+	+++
Mouthfeel: fullness	+	+++	+++	++	++	+++	++	+++	+
Coconut	–	++	++	–	–	–	++	+++	+
Fruity/bubble gum	++	++	–	–	–	–	–	–	–
Cooked fruit/raisin	–	–	+	–	–	–	–	+++	+++
Leather	–	–	–	–	++	++	–	–	–
Black pepper	–	–	–	++	+	–	–	–	–

French summary: All the toast levels showed a perceived aromatic sweetness and full mouthfeel. The French oak was characterized by a fruity, cinnamon/allspice character. As the toast level increased the fruity descriptor changed from fresh to jammy to cooked fruit/raisin in character. The French oak was also characterized by custard/crème brulée, milk chocolate and campfire/roasted coffee notes, especially the latter descriptor at higher toast levels.

Hungarian summary: The Hungarian oak at Medium toast displayed a high perceived vanillin content, with roasted coffee, bittersweet chocolate and black pepper characters. Medium Plus and Heavy imparted mouthfeel fullness, with only a slight amount of campfire/roasted coffee. Heavy also had pronounced Vanillin. At all toast levels, there were unique attributes such as leather and black pepper, not observed in other oak origins.

American summary: The American oak had aromatic sweetness and a campfire/roasted coffee attribute present in all three toast levels, with Medium Plus and Heavy having the highest intensity. American oak had cooked fruit more than fresh or jammy and imparted mouthfeel/fullness, especially Medium Plus.

Tasting Set II: Toasting levels across each origin

Table 2: Two months contact with Oak Beans and *one month in bottle.*

See Key to evaluations below table.	Medium			Medium Plus		Heavy		
Attribute	Hungar.	French	Amer.	Hungar.	French	Hungar.	French	Amer.
Vanillin intensity	+	++	++	+	++	++	++	+
Caramel	+	++	+++	++	++	++	+	+
Maple/brown sugar	+	++	++	+	++	++	+	++
Custard/crème brulée	++	+++	+++	++	+	++	++	++
Cinnamon/allspice	++	++	++	+	++	+	++	++
Chocolate (milk/bittersweet)	+	+	+	+	+	+++	+	+
Campfire/roasted coffee	+	+++	+++	+	++	++	+	+++
Meaty	+	+	++	+	++	++	+	+++
Baked apple pie	++	++	++	++	++	++	++	++
Walnut/nutty	+	++	+	+	+	++	+	+
Mouthfeel: fullness	+	++	++	+	+	++	++	++
Overall flavor impact	++	++	+++	+	++	++	+	+++
Complexity	++	+++	+++	+	+	+	+	++
Coconut	++	+	++	+	+	++	+	++
Fruity/bubble gum	++	+	+	++	++	+	++	+
Cooked fruit/raisin	+	++	+	+	++	++	++	++

Key: – not mentioned + slight ++ medium +++ high

Medium summary: The French and American oak had slightly higher perceived vanillin, caramel, maple/brown sugar intensity, higher campfire/roasted coffee character, and more complexity than Hungarian Medium toast. American Medium toast showed the highest overall flavor impact, with meaty, custard/crème brulée, roasted coffee and caramel attributes. The Hungarian oak displayed more fruity and baked apple pie characters.

Medium Plus summary: The French oak was slightly higher in perceived vanillin extract flavor, maple/brown sugar, cinnamon/allspice, cooked fruit, meaty, coconut and overall flavor impact. The Hungarian oak had a slightly higher custard/crème brulée note, but was otherwise slightly weaker (similar to the French profile). The American Medium Plus sample was not included above due to damage in transit.

Heavy summary: The Hungarian oak had high bittersweet chocolate character, slightly more walnut/nutty and vanillin character than the French and American Heavy toast. The American oak offered the highest campfire/roasted coffee flavor, with meaty and overall flavor impact and complexity.

QUADRALATERAL CORDON / OPEN CANOPY

MARK STUPICH

It all begins in the vineyard

Shortcomings of a wine may originate from vineyard practices and/or vineyard management. In the winery, these problems require a great deal of time and expense to correct. To minimize potential problems before grapes arrive at the winery, it is imperative to have good communication between the winemaking team and the vineyard personnel. Many problems created in the vineyard can be reduced by practicing the following:

Proper vineyard siting

It is important to match grape varietal to the meso-climate in order to ensure proper maturation of the grapes.

Canopy and vine management

Potential problems in the vineyard can be minimized with proper trellising, orientation, cropping, irrigation and fertilization. Canopy management is important in controlling vegetal character. Too much vegetation in relation to crop load and/or excessive shading can lead to the fruit retaining high concentrations of 2-isobutyl-3-methoxypyrazine (bell pepper) and related "green" compounds.

Disease control practices

Adequate but not excessive disease control practices are crucial for maintaining a healthy vineyard. Overdoing disease control or late application of dusting or wettable sulfur can lead to the overproduction of hydrogen sulfide (H_2S) in the fermentation. There is a direct correlation between the µg of elemental sulfur carried on berries into the winery and the production of H_2S. While a winemaker can control H_2S to a degree, increased levels can lead to the development of mercaptans that are often difficult to eliminate.

Tank preparation

A few minor tank modifications should be made prior to grape harvest. This will allow for a seamless transition into toasted oak addition and aging in tank.

Install C-rings to support Tank Fans

If the tank is going to be *stirred on the lees*, stainless steel C-rings should be welded to the inside of the tank at three-foot intervals at least four feet above the bottom of the tank to ensure that the staves are above the lees.

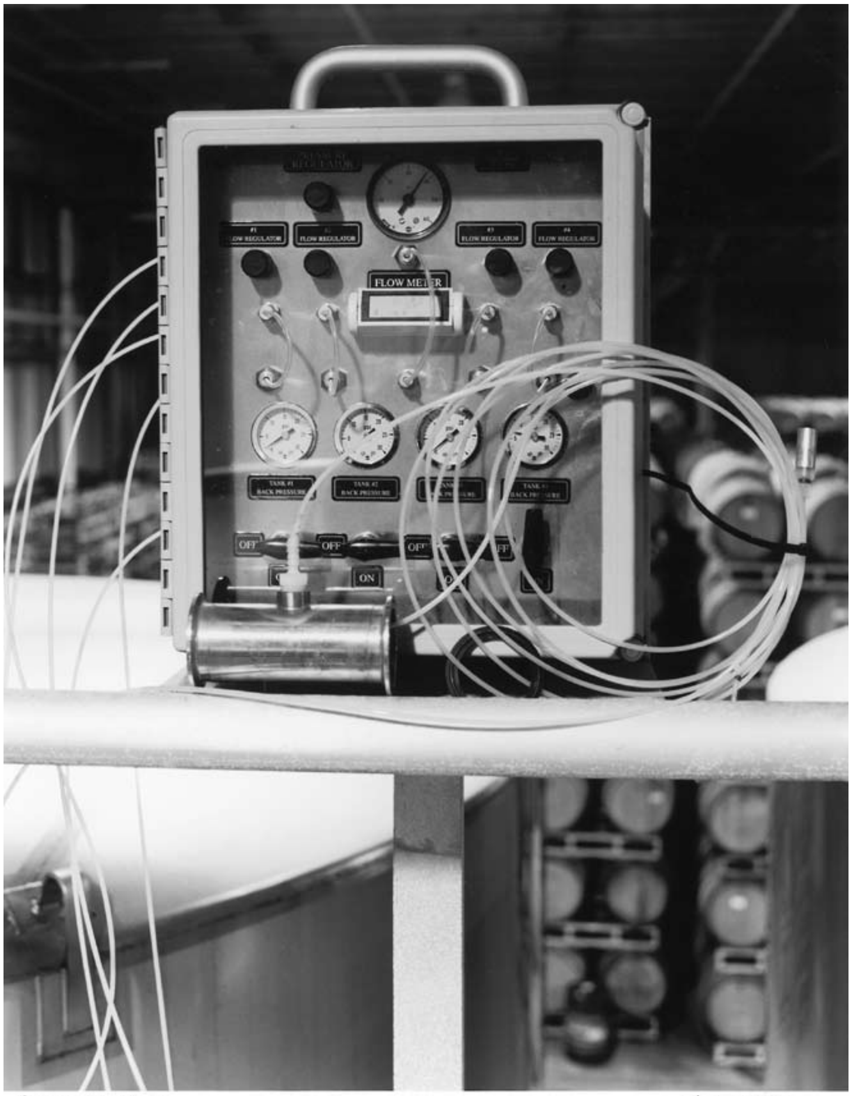
For larger tanks, a stainless steel chain can be threaded through the C-rings to allow for more stave attachment sites.

Red wine storage tanks *with no plans for stirring* can have rings mounted approximately three feet above the bottom of the tank so that the stave fans can rest on the tank floor. This limits the stress placed on an empty tank's walls when hanging large quantities of staves.

Set up the micro-oxygenation system

The downloadable OxBox manual (www.micro-ox.com/StaVin_oxbox_manual.pdf) will take you through the steps of oxygen tank hookup, mounting the box, setting up the sparge stones, transitioning the tanks, connecting the tubing, setting the flow rates and troubleshooting.

The OxBox



Ox Box with Fixins   Mark Stupich

The Westec OxBox, developed with StaVin, is an instrument capable of delivering minute amounts of oxygen to your wine. The OxBox uses a high precision flow regulator combined with mechanical flow controllers to set oxygen flow for each of four tanks. "Jumper" tubes are used to set the desired oxygen flow in conjunction with the flow meter. Once set, these "jumper" tubes connect the flow control to sparge lines going to each tank. Sparge lines in the tank are connected to 10μm pore size sintered stainless steel sparge tips. This small pore size produces very fine bubbles as oxygen is metered into the wine. See the OxBox installation, monitoring and care and maintenance instructions for complete setup details (www.micro-ox.com/StaVin_ox-box_manual.pdf).

Tips for trouble-free operation

- Place the OxBox above the height of the highest micro-ox tank to minimize potential siphoning of wine through the box if the oxygen tank is depleted or shut off. The box should still be easily accessible to trained users for operation.
- Industrial grade oxygen (purer and less expensive than medical grade) should be used with this system. Check the cylinder frequently to be sure it has not run out of oxygen. Inspect the system for leaks if the oxygen depletes rapidly.
- The four bottom gauges measure back pressure due to the depth of wine exerting pressure against the stone. Once set, the gauges measure a small amount of back pressure. Note this beginning pressure. If it rises more than 5–6 psi, the sparge stone may be clogged or fouled and should be cleaned.

- 3000 gallon tanks or larger can be oxygenated by constant or periodic additions. Constant oxygenation is probably the safest, since flow rates will be lower during the process and change will be slower and easier to control. Periodic oxygenation may be more similar to a barrel program, where wine gets occasional aeration during racking and topping. The method that is more advantageous remains to be determined. It is important to regularly check the level of oxygen in the cylinder so that it does not run out during constant additions.
- For tank volumes smaller than 3,000 gallons, the meter's limitations make constant oxygenation difficult to control due to the low rates of oxygen required. These tanks should be oxygenated *using the periodic formula*, turning the OxBox on and off at various time points. It is important to have a reliable person in charge of switching the OxBox on and off.

The OxBox will *not* measure oxygen flows in mL of O_2/L/month; it measures in mL /minute. To set the flow rate, the winemaker must know the size of the tank and desired oxygenation rate. Once determined, a spreadsheet (www.micro-ox.com/flowcalculator.xls) can be used to calculate the required flow in mL/min., depending on constant or periodic oxygenation.

Establishing a method for lees stirring

Several methods have commonly been employed to stir lees in tanks. The snake system, a rotating racking valve, compressed gas mixers, submersible pumps and active tanks have all been utilized. While there are undoubtedly more systems in use, we will focus on the snake mixing system due to its efficient stirring and cost effective nature. Some winemakers have used Guth mixers but were not satisfied with the results. The lees tend to accumulate on the sides and skin over hard. Also, the toasted oak must be attached securely; if any oak breaks free, the mixer could be damaged.

The snake stirring system

The snake stirring system employs flexible reinforced food grade tygon tubing, usually $^{3}/_{4}$" to 1" OD, attached to a barbed fitting at the bottom of the tank. Wine being pumped through the tube whips the snake into the lees skin, breaking it up.

The effectiveness of the snake system requires experimentation to determine the method best suited for your cellar conditions. Variables include the length of the flexible tygon tubing, a method to introduce the snake system into your tank, the number of snakes and flow rates required to efficiently break up the lees, and any additional pumping necessary to evenly distribute the lees to the entire tank.

Setting up the snake stirring system

Large Tanks (greater than 15-foot diameter)

- May require multiple valves with attached snakes evenly distributed around the bottom of the tank.
- Require concurrent mixing of the tank through separate racking and bottom valves.

Medium tanks

- An additional bottom valve with an attached snake is desirable to permit adequate mixing through the existing racking and bottom valves.
- Alternately, smaller midsize tanks may be able to get adequate mixing by combining a T-valve before a barbed adapter fitting. This setup will allow you to use higher flow rates through existing valves by pumping around the snake rather than through it.

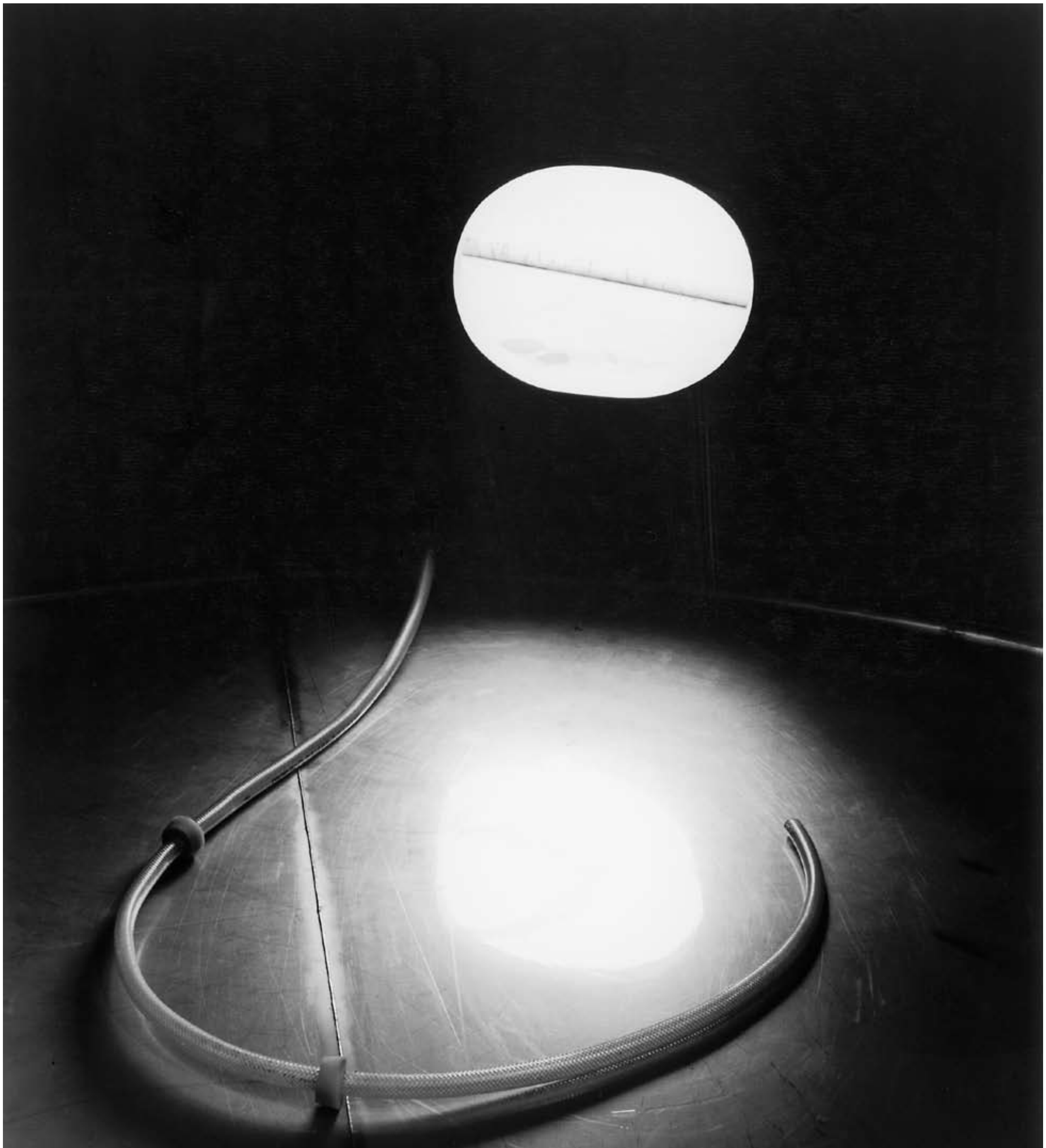
Small tanks (less than 5,000 gallons)

- A barbed adapter fitting can be used on the existing bottom valve.
- Wine flow through the snake should provide adequate mixing of the tank.

Setting up the tubing and flow rate

- The snake functions best when it is slightly longer in length than the tank diameter.
- If the tygon tubing used is too stiff it will not function properly.
- Weights should be placed along the snake so that it whips properly along the bottom and not vertically in the tank. The best weights appear to be fermentation bungs slid along the tubing. Bungs supply enough weight and also protect the tank from abrasion.
- A small stainless nipple should be attached to the end of the snake to give an indication of stirring as it taps the side of the tank.
- The system should be tested by filling the tank to the racking door with water and observing the snake's path. Flow rates required to get the proper whipping action from the snake can then be determined.

The above recommendations should be adapted to your unique cellar conditions.



Look Out

Mark Stupich

PRESS PAD

Managing aeration is vital during fermentation and aging

Historically, barrels were storage containers, sized according to the amount of grapes harvested from a set piece of land. They were not engineered to optimize oxygen transfer or wood surface area in the production of wines. It is now possible to evolve past the strict limitations that barrels have imposed on your winemaking ability.

Oxygen is a key component at two stages in the evolution of your wines. The addition of large quantities of oxygen, known as macro-aeration, should be initiated during fermentation. A controlled addition of minute quantities of oxygen, called micro-oxygenation (MOX), is utilized after the fermentation and pressing.

Macro-aeration during fermentation

- Increases yeast viability.
- Enhances polyphenol polymerization resulting in increased color and stability.
- Diminishes reductive and vegetal aromas.

Micro-oxygenation before MLF

- Can help resolve green or negative characteristics.
- Uses higher oxygenation rates (10–60 ml/L/month).
- Use to help initiate softening of overly tannic wines.

Micro-oxygenation after MLF

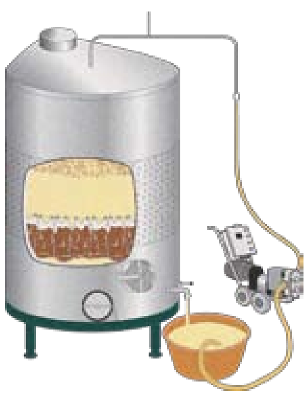
- Simulates the aging process.
- Develops middle body.
- Diminishes reductive and vegetal aromas.
- Helps color stability.
- Can eliminate or reduce the need for barrel aging.

Enhanced white fermentation protocols

Adding a few simple steps to your standard fermentation protocol may help improve your wine quality and economics of production. The combination of toasted oak and macro-aeration during fermentation, coupled with aging on toasted oak, enhances the structurization process and minimizes potential deleterious effects. These techniques will integrate harmoniously and have greater impact on your winemaking ability than other more expensive and rigorous techniques.

Whole cluster press

1. Add 50 ppm SO_2.
2. Enzyme additions (optional)
3. Press slowly and gently with a careful management of the press fractions.
4. In some instances destemming, crushing and cold soaking prior to pressing may be desired. Good temperature control is requisite for this methodology.



Fermentation

1. Tie off Tank Fans, Segments, or Beans in fermentation tank.
2. Cold settle the juice tank (< 50° F) and rack off solids to the fermentation tank.
3. Add back light solids to ~ 1%.
4. Acid and/or water addition (optional)
5. Alternatively move to barrels for fermentation.
6. Yeast rehydration, nutrition, and inoculation
7. Maintain temperature control to ensure complete fermentation.
8. Maintain yeast nutrition (aeration during fermentation optional).
9. Aeration during fermentation helps sustain yeast viability and control sulfides.

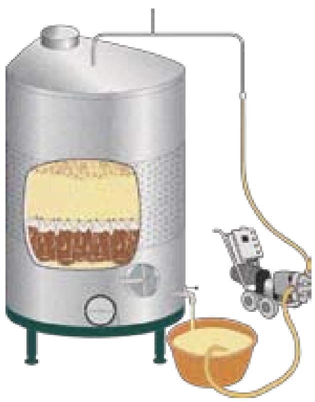
Wine maturation and development

1. Add malolactic culture (optional).
2. Add SO_2 to the required level (complete ML before SO_2 if desired).
3. Stir the tank (or barrels) twice weekly, completely mixing the lees
4. Micro-oxygenate one day per week *only after stirring*. Periodic dosing at initial rate of 2 ml/L/month for one day is a good starting point. Adjust as required to control reduction and autolysis.

Enhanced red fermentation protocols

Destem and crush

1. Add toasted oak Chips or Granular to the hopper.
2. Alternately tie off bags of Beans, Segments, or Tank Fans in the tank below cap level.
3. Evenly distribute 50 ppm of SO_2 to the must.
4. Deliver must to the tank as gently as possible.



Fermentation

1. Cold soak (optional)
2. Acid and/or water addition (optional)
3. Yeast rehydration, nutrition, and inoculation
4. Maintain temperature control.
5. Maintain yeast nutrition.
6. Cap management with macro-aeration (Venturi, sparge stone, Parsec, etc.)
7. Extended maceration (optional).

Drain and press

1. Gently move skins to the press avoiding maceration induced bitterness.
2. Careful management of press cycles and fractions: Limit rotation and maceration of skins in the press. Higher pressure fractions may be bitter, requiring separation if possible.

Wine maturation and development

1. Tie off quality oak staves, segments, or beans in the tank.
2. Add malolactic culture (optional).
3. Once ML is complete, settle and rack.
4. Add SO_2 to the required level.
5. Begin micro-oxygenation or rack to barrels.

Enhancing fermentation with toasted oak

Use Chips and Granular at fermentation

Clockwise from top left: Segments, Granular, Savour Oak Chips and Beans.

Toasted oak products added at the fermentation stage provide compounds to stabilize tannins and color while minimizing sulfide and vegetal aromas. Chips and Granular oak are simple to meter into the crusher and easily discarded with the pressed pommace. Oak added during this stage is not necessarily used for flavor. Winemakers should be cautious with the overuse of oak chips and granular since inferior brands can impart harsh, bitter characteristics to your wine. Savour Oak Chips and StaVin Granular should be used at a rate of 2–8 pounds per ton for chips and 0.5–2 pounds/ton for granular. The lower rates should be used for high quality fruit and the higher rates for green overcropped vineyards.

Tank Fans installed in a tank (top view).

Integrate Beans, Segments and Fans during aging

For higher quality oak extraction, StaVin Beans, Segments or Tank Fans should be used. Attach these products to the sides of the tank below cap level before filling the tank. Toasted oak with less total end grain percentage (generally larger pieces) extracts more slowly and develops softer tannin structure with enhanced mouthfeel. As fermentation progresses, the slow extraction of compounds provides a continuous pool of reactants, capable of stabilizing color and tannins extracted from grape skins and seeds. Addition rates vary based on winemaking style, notably the percentage of new oak desired. Rates yielding 100% new oak equivalents are given on page 10.

Enhancing fermentations with macro-aeration

Most fermentations will benefit from the addition of oxygen. There are several methods of incorporating macro-oxygenation into your current fermentation protocols. Shown below are a few of the established techniques currently used by wineries. Flow rates can be measured and adjusted with the help of a gas flow meter connected in-line. There is little risk of oxidation during fermentation due to the large volume of carbon dioxide (CO_2) released. However, care should be taken to not vigorously sparge wines (especially delicate aromatic white wines) toward the end of fermentation. In addition, aeration should be slowed during the final few degrees Brix to prevent any oxidation due to limited CO_2 evolution.

Venturi system (pumpovers/rack and return)

A venturi system would ideally consist of an inline device with check valve such as the Mazzei shown at left. Alternate methods include attaching a nipple and air intake tube to the top of your pumpover device, or carefully opening a valve on the suction side of the pump. Opening a valve, although inexpensive, can cause cavitation on some pumps and requires closing before completion of the pumpover.

Direct injection (all cap management styles)

Direct injection can be done using a sintered stainless steel sparging rod connected to a compressed gas cylinder. Using this setup, aeration or oxygenation rates are easily managed by adjusting the regulator.

Tub, screen, and aeration (pumpovers/rack and return)

Tub and screen pumpovers generally do not allow adequate aeration due to the evolution of CO_2 in fermenting wines. The same can be said for rack and returns. However, using fans to blow air over the tub as the wines are being pumped over can have positive effects. Blowing air towards the fermenting wine will permit a small amount of oxygen reactivity.

Wine style should dictate fermentation temperature

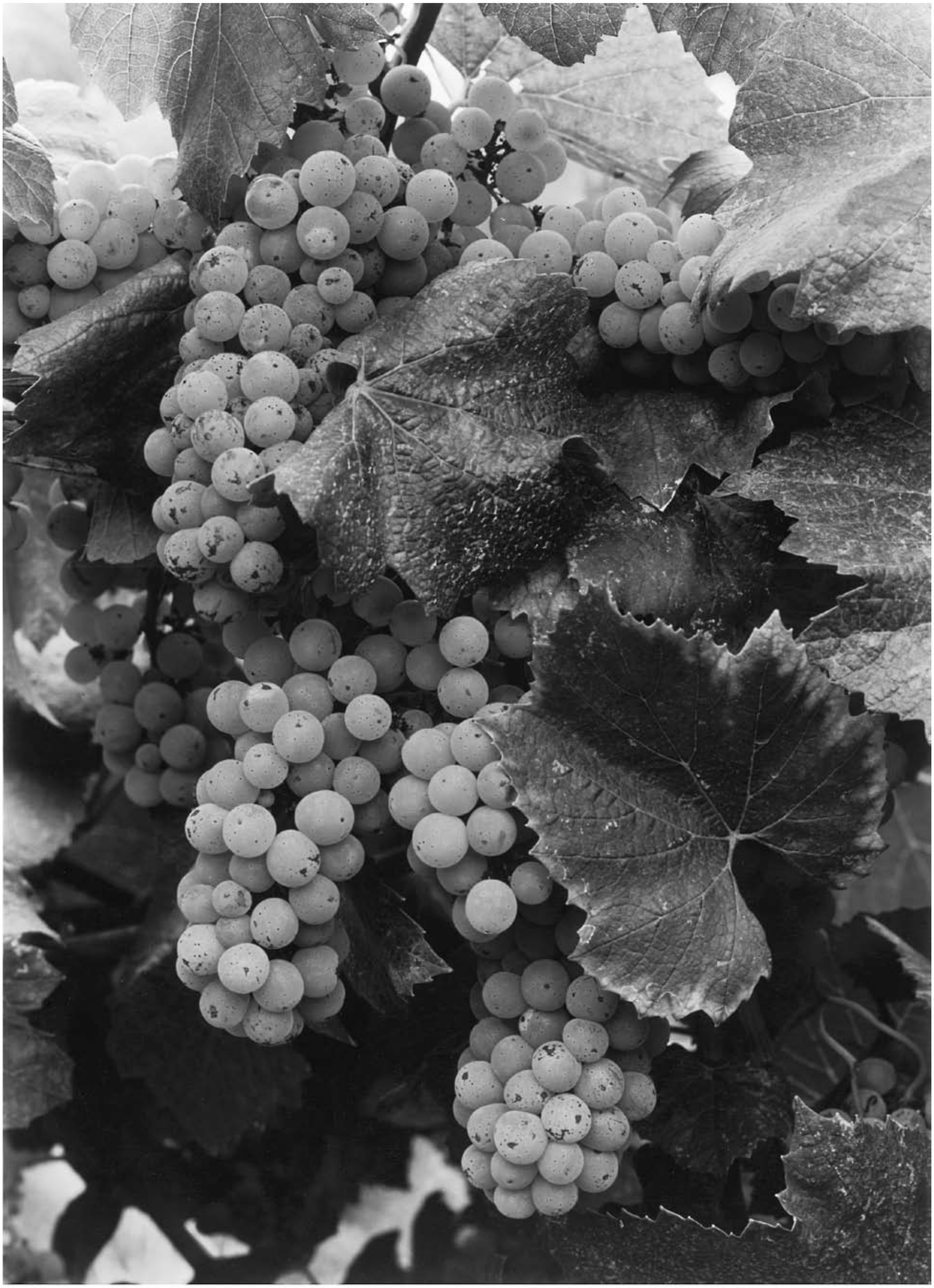
White wines

Generally, attempts are made to ferment white wines at low temperatures (45–65^{0} F, 7–18^{0} C) to preserve the delicate aromas and flavors. However, barrel fermented whites tend to have heat spike during the middle of fermentation due to the remarkable insulating power of oak. This elevated temperature may slightly diminish the fruity aromatics, yet it also allows increased complexity due to increased toasted oak extraction and metabolism. If complex oak characteristics are desirable for your wine style, efforts should be made to elevate fermentation temperatures in a controlled manner. These slightly increased temperatures can also minimize the potential for stuck fermentations.

Red wines

Red wines are commonly fermented at higher temperatures (80–95^{0} F) to extract increased levels of color, flavor and tannin from the grape must. Great care should be taken to ensure a uniform cap temperature. Generally, cap temperatures are colder than desired next to the cooling jacket and hotter near the center. Standard methods of regulating cap temperature include pumping wine over the cap and punching down the cap as desired during the fermentation process. More recent technology has brought about rotary fermentors, submerged caps and pulse-air systems for cap management. Regardless of your system, persistent management of the cap temperature will allow you to maintain viable yeast, control your fermentation time and obtain suitable extraction rates for the production of consistent wines.

Toasted oak extraction also benefits from the elevated fermentation temperatures of red wines. Our products allow winemakers to realize a trouble-free method for fermenting red wine on oak. It is important to use the highest quality staves if your goal is to emulate barrel fermentations of reds.



FOGGY MORNING / CHARDONNAY

MARK STUPICH

Malolactic Fermentation (MLF)

Current technology and winemaking practices render MLF a stylistic choice rather than an inevitable occurrence. It can be difficult to complete MLF even when inoculated with ML bacteria in wines with high alcohol, low pH, or stored in a cool stainless tank.

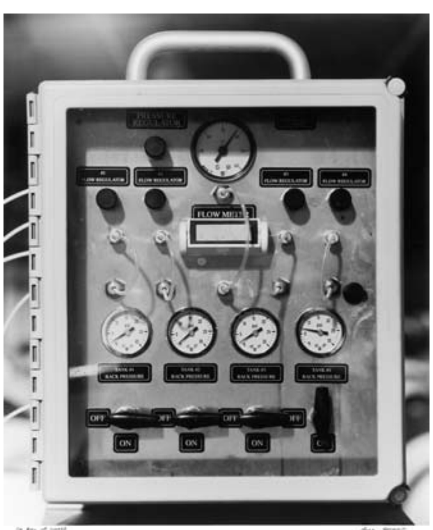
In contrast, wines aged in barrels usually finish MLF much more quickly due to the insulating properties of wood and the elevated microbial populations found in most barrels. MLF can result in the perceived attributes listed below. A critical evaluation of these attributes coupled with desired winemaking goals should aid in the decision of whether or not to induce MLF.

Perceived positives from MLF

- Decreases acidity, providing a softer mouth feel and increasing body.
- Inoculation with a ML strain prevents spoilage organisms from utilizing malic acid as a carbon energy source.
- Increases complexity in flavors and aromas (especially in combination with oak).
- Reduces the requirement for sterile filtration before bottling.

Perceived negatives from MLF

- Increases pH, reducing the effectiveness of SO_2 in preventing contamination.
- High pH reduces the rate of reactions that may help stabilize color.
- Increased volatile acidity is common.
- There may be some amount of color loss.
- Masks varietal characteristics.
- Uninoculated MLF can result in unpleasant aromas and flavors.
- ML bacteria inoculation cultures are expensive.



MLF and micro-oxygenation

- The timing of micro-oxygenation in regard to MLF is a complex issue.
- Micro-oxygenation prior to MLF can be done at higher levels (10–60 mL/L/month) to treat overly green or tannic wines. These wines should be tasted on a daily basis (if not more frequently to evaluate progress).
- Anecdotal information indicates that micro-oxygenation accelerates the completion of MLF without detrimental effects. Analyze these wines for malic acid and VA frequently.
- It is our philosophy that MLF (if desired) should be completed as quickly as possible. Subsequently the wine should be settled, racked off the gross lees and protected with SO_2.

Toasted oak can promote MLF

Toasted oak can also be influential in the completion of MLF. Oak contains many crevices that provide an excellent environment for bacterial growth. Toasted oak products can therefore act as ML inoculum cultures. Many wineries inoculate a single tank of wine on new oak products with the desired ML bacteria. Once this tank is finished with MLF it can be moved to an aging tank. Keeping the products in place, rinse and immediately fill the ML tank with another wine requiring MLF. The oak will serve as an inoculum for the new wine, saving time and money. Repeat this process as often as required as long as there is wine to immediately fill the ML tank which contains the oak.

CLEANLINESS IS...

MARK STUPICH

Tank aging theory

Three principle areas for the realization of enhanced wine aging are:

1. Obtain quality materials.
2. Prevent contamination.
3. Realistically assess wine quality, objectives, and methods.

Obtain quality materials

- Purchase or produce high quality fruit.
- Gentle handling of the must, pommace, and wine increases wine quality.
- Use only high quality oak products.

Prevent contamination

- Meticulous sanitation is essential.
- Dry wines that have properly maintained SO_2 levels are at a decreased risk for contamination.
- Minimize the potential for contamination and sulfides by racking red wines into the aging tank after a settling period of 1–2 days post-MLF.

A realistic assessment of wine quality, objectives and methods

- Critically assess wine quality.
- Has the wine finished primary fermentation?
- Is there enough time available before bottling or blending?
- Is it stable with regard to contamination?
- Are there sulfide or vegetal aromas?
- If you have any of these issues, consult the appropriate pages in subsequent sections of this book.

Plan your objectives and methods

- Do you desire crisp fruitiness, creamy complexity, buttery oakiness or some combination of those qualities in your white wines?
- Do your reds aspire to be big tannic wines that yearn for years of bottle aging, or a wine that is rapidly soft and approachable?
- What is your desired oak concentration and what amount can the wine integrate?
- Once a style has been identified, the last step is to recognize methodologies capable of producing those results. General protocols have been provided for you on subsequent pages.

Enhanced aging of white wines in tanks

The most important facets of aging white wine in tanks include SO_2 additions, maintaining tank temperatures, stirring lees (batonnage), and micro-oxygenation. Development of your wine style will be shaped by the use of malolactic fermentation, the frequency of stirring, the quality and quantity of oak, the amount of oxygen and the aging timeline.

SO_2 additions

The percentage of malolactic fermentation is a stylistic choice based on the winemaker's desires. Early additions of SO_2 after primary fermentation will help prevent the onset of MLF retaining the crisp acidity of the wine. Later SO_2 additions allow for MLF to progress decreasing the acidity and potentially adding some complexity to the wine. If MLF is desired, it is essential to add SO_2 immediately following the completion of MLF to help prevent spoilage.

Maintain tank temperatures

It is essential to maintain tank temperatures between 56–60° F (13–16° C). Lower temperatures result in slower reactions and increased levels of dissolved oxygen in the wine. After MLF, higher fermentation temperatures may decrease fruity character and increase the risk of spoilage.

Stirring of lees and micro-oxygenation

Two distinct phases of white wine aging are promoted by lees stirring and micro-oxygenation. The first phase occurs directly after fermentation, where stirring and oxygen help the yeast die with minimal sulfide production. During this stage, stirring twice weekly prevents the lees from skinning over and developing an anaerobic environment. A single injection of 2 mL/L/month of oxygen one time per week *after stirring* can be used throughout white wine aging to prevent reduced anaerobic conditions.

The second phase is the integration of compounds arising from yeast autolysis. As yeast cells die, their membranes start to break down in a process called autolysis. This process releases many compounds including polysaccharides, mannoproteins, amino acids and fatty acid esters. When yeast lees are frequently stirred into the wine, these compounds may collectively lead to improved creaminess, density, length, flavor/aromatic complexity and wine stability. Thorough stirring should be done twice weekly during the first 3–6 months of aging, depending on the desired style or mouthfeel. A single injection of 2 mL/L/month of oxygen one time per week *after stirring* may help integrate these compounds.

Enhanced aging of red wines in tank

Enhanced tank aging of red wine involves the careful handling of pommace, maintaining adequate tank temperature and protecting the wine. In addition, variables such as oak concentration, micro-oxygenation rate and timeline will help develop your winemaking aspirations. The smooth integration of tannins and stabilization of color during aging requires quality toasted oak, adequate body for the desired oak concentration, and oxygen to catalyze the reactions. Aging in tanks allows the complete control of oak and oxygen to fit your timeline.

Avoid skin maceration

Move pomace to the press as gently as possible to avoid maceration of skins that can lead to harsh, bitter attributes.

Maintain tank temperatures

Maintain a temperature of 56–60° F (13–16° C). Lower temperatures result in slower reactions and increased levels of dissolved oxygen in the wine. After MLF, higher fermentation temperatures may decrease fruity character and increase the risk of spoilage.

Protecting the wine

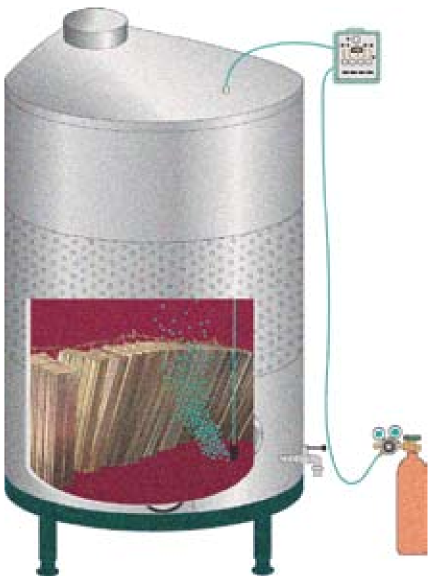
After MLF has been completed, settle the tank and rack off heavy lees. Subsequently, add the appropriate levels of free SO_2.

Utilize high quality toasted oak and micro-oxygenation

The combination of high quality toasted oak and micro-oxygenation will allow you to duplicate barrel aging in tanks. General guidelines for the micro-oxygenation of red wines are covered on the next page.

The general recommendations above can be altered based on your stylistic goals and sensory analysis.

Guidelines for the micro-oxygenation of red wines



Micro-oxygenation is not for every wine

Several questions must be answered before we can provide you with guidelines on how to best utilize micro-oxygenation. The starting point depends on volatile sulfides, vegetal characteristics, anthocyanin concentration (color), tannin concentration (astringency), end use of the wine and the time line for the wine. Understanding your goals for micro-oxygenation will have profound impact on our recommended methodology. Subsequent sections of this book illustrate suggested parameters for micro-oxygenation and toasted oak additions, based on wine and must characteristics. However, micro-oxygenation is not a cure-all for problematic wines.

Use your winemaking sense

The key element to successful micro-oxygenation is an active winemaking team. Traditionally, wines stored in new oak barrels receive approximately 1–3 mL/L/month (which includes the aeration from topping and racking). While oxygenation can be applied to wine at a rate more than 10 mL/L/month, a higher rate has the potential to generate compounds that bind SO_2 faster than reacting with phenolic compounds. Adjusting the oxygenation rate based on sensory analysis should be done on a weekly basis (if not more frequently).

Laboratory analyses

SO_2 levels, VA, temperature and dissolved oxygen should be frequently examined to ensure acceptable levels for wine quality. Charting these parameters in addition to sensory analysis will help you make informed decisions regarding the status of micro-oxygenation.

General observations

- Begin micro-oxygenation as early as possible to stabilize color and initiate the aging process.
- MLF finishes quicker with oxygenation so routine analysis is crucial for the timing of SO_2 additions.
- Wines with ample color and tannin are often the best candidates for micro-oxygenation and can utilize higher levels of oxygen if desired.
- If wines are of unequal quality but destined for the same program, it is best to blend before micro-oxygenation rather than treating each lot separately.
- The use of quality toasted oak enhances the effects of micro-oxygenation.
- Temperatures should be maintained between 56–60° F (13–16° C).
- If there is an overt presence of sulfides, low turbidity is desirable (through racking, centrifugation or filtering).
- On average, oxygenation rates of 1–3 mL /L/month will replicate barrel effects for high quality wines on toasted oak.
- Constant oxygenation is safer due to lower flow rates and greater control.
- Periodic oxygenation closely resembles conditions experienced by barrels during racking, topping and stirring.

Parameters for the critical assessment of oxygenation rates

Tasting

Tasting is by far the most important means of monitoring a wine's progress. Weekly evaluation of wine quality as it relates to tannin structure, offensive odors and oxidation is requisite. The assessment of whether or not these attributes are progressing or regressing will indicate the amount of oxygen the wine needs. Copious tasting notes and samples taken at various timepoints will help you evaluate the wine's evolution. The rate of oxygenation can be assessed by acetaldehyde, SO_2 and dissolved oxygen levels.

Acetaldehyde

One easy method to determine the proper rate of oxygenation is to take a sample of wine, fill a wine glass half full, cover it with a watch glass and allow it to set overnight. The next day, get a fresh sample of wine and compare the two samples for acetaldehyde in the aroma. A fresh pumpkin or chocolate character detected in the overnight sample, but not the fresh sample, indicates that the rate of oxygenation is generally correct for this wine. If acetaldehyde is detected in both samples, the rate of oxygenation is too high and should be reduced. If acetaldehyde is not detected in either sample, the rate of oxygenation can be increased. However, depending on the timing and end use for this wine, an increase in the rate may not always be necessary.

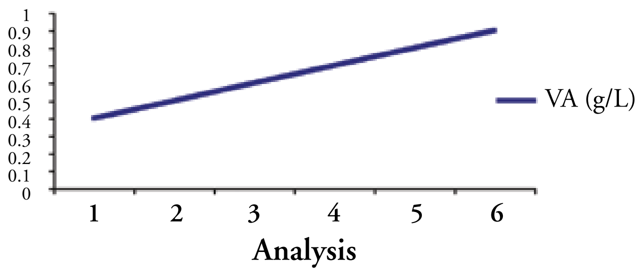
Charting parameters

Charting temperature, VA, DO, and free and total SO_2 over time will indicate the status of micro-oxygenation. If VA increases rapidly, turn off micro-oxygenation. Faster than normal drops in SO_2 levels or increases in dissolved oxygen are good indicators that the oxygenation rate is too high and should be turned down.

Turn the micro-oxygenation off

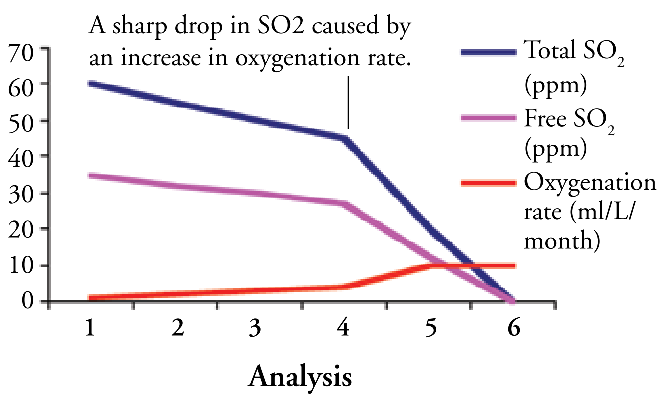
One simple way to assess if micro-oxygenation is still required is to turn it off for a few weeks. After this time, evaluate the wine by taste, analogous to the process used to evaluate barrel aging. If wine quality has regressed after the oxygenation was stopped, it is a good indication that it requires more time and micro-oxygenation. However, if wine quality is consistent without oxygenation, it has reached a point where stopping micro-oxygenation is feasible.

Chart parameters for quality control when using micro-oxygenation



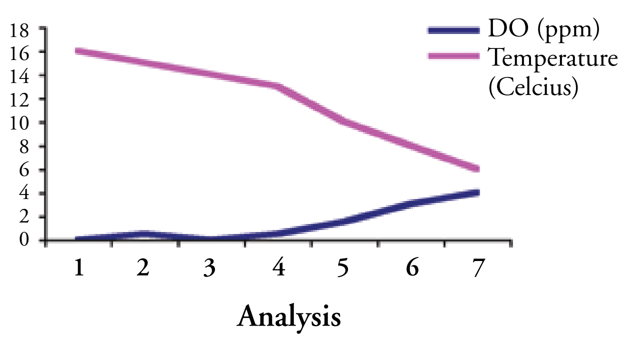
Rapidly rising volatile acidity

- Turn off micro-oxygenation.
- Maintain SO_2 at 0.8 ppm molecular.
- Sterile filtration and lysozyme treatments may be considered.



Rapidly dropping SO_2 levels

- A sharp drop in SO_2 may be caused by an increase in oxygenation rate.
- Turn down the micro-oxygenation rate if the dissolved oxygen (DO) is not rising.
- Turn off micro-oxygenation if there is a concurrent rise in dissolved oxygen.
- Resume micro-oxygenation when DO levels return to acceptable levels.
- Maintain adequate SO_2 levels.



Rapidly increasing DO levels

- This is usually due to low temperatures
- Ensure that temperatures remain between 56–60° F (13–16° C).
- Some degree of natural fluctuation in DO is common at low levels.
- Turn off micro-oxygenation until DO levels return to acceptable levels. Resume micro-oxygenation at a proper temperature and lower initial rate.

A GREAT GRAPE FUTURE

MARK S

Practical winemaking solutions

Sulfides

1. Limit the late application of sulfur in the vineyard.
2. Do not add excessive amounts of SO_2 to the must (50–100 ppm is adequate for clean fruit).
3. Ensure adequate nutrient levels for your yeast choice.
4. Use macro-aeration and toasted oak during fermentation.
5. Evaluate lees for off odors; rack the wine off its lees if it is foul-smelling.
6. Splash rack after fermentation if sulfides are present.
7. Age on toasted oak with micro-oxygenation.
8. Apply high initial rates of micro-ox (5–10 mL/L/month) until the sulfides dissipate (1–5 days).
9. *Do not* add copper after any aerative procedure; it will catalyze the production of disulfides.

Undesirable vegetal characteristics

1. Match the varietal to the meso-climate of the vineyard.
2. Maintain appropriate canopy management (avoid excessive shading).
3. Oxygenation appears to be the most effective tool post-harvest. In order of effectiveness, macro-aeration > micro-oxygenation pre-MLF (10–60 mL/L/month) > micro-oxygenation post-MLF (1–10 mL/L/month).
4. Add toasted oak during fermentation and aging in combination with oxygen additions.

Diminishing harsh tannins

1. Harvest mature grapes.
2. Minimize pulverization of the grape must.
3. Use a tub and screen for seed removal during pumpovers.
4. Separate press fractions to minimize harsh or bitter character in the free-run.
5. Age on high quality toasted oak.
6. Apply pre-MLF micro-oxygenation.
7. Micro-oxygenation regime depends on your timeline. Dosing 1 ml/L/month over numerous months will result in a gradual reduction of harsh tannins. Higher dosing rates will increase the aging process but care must be taken to constantly monitor wine quality, including sensory analysis, SO_2, VA and dissolved oxygen levels, and temperature.
8. Conduct blending, fining or additions prior to bottling.

Adding body and structure

1. Vineyard management
2. Enzymes
3. Saignee (red wines), skin contact (white wines)
4. Cold soak
5. Yeast choice
6. Use oak and macro aeration during fermentation to stabilize tannins.
7. Extended maceration (reds) or skin contact (whites) if fruit quality permits.
8. Add some of the press fraction back to the free-run.
9. White wines: Age on high quality oak with lees stirring and a single dose of 2 ml/L/month oxygen "post-stirring."
10. Red wines: Micro-ox dosing of 1–3 ml/L/month over numerous months with high quality oak will result in a slow and gentle development of tannin structure.
11. Conduct blending or additions prior to bottling.

Color deficiencies

1. Harvest mature grapes that are not overripe.
2. Enzymes (coupled with oak and oxygen)
3. Saignee
4. Cold soak
5. Use oak and macro-aeration during fermentation to stabilize color.
6. Aging on high quality oak with micro-oxygenation.
7. Minimal and careful additions of SO_2 to avoid bleaching.
8. Blending.

Acetaldehyde

1. If acetaldehyde is suspected simply turn off the micro-oxygenation; there is no need to sparge with nitrogen. Evaluate the wine periodically to determine if and when to resume micro-oxygenation.
2. Overt, irreversible oxidation of wine is highly improbable given the guidelines and methodology contained in this book. If oxidation is suspected, stop the oxygenation and bring the free SO_2 to acceptable levels.

Microbial spoilage/volatile acidity

1. Have adequate disease control practices in the vineyard.
2. Insufficient sanitation is the primary factor in wine spoilage.
3. Using contaminated old barrels is a frequent cause of microbial spoilage. The use of new StaVin toasted oak tank systems will greatly enhance microbial control.
4. Lysozyme treatments can work on certain wines to control spoilage.
5. Maintain appropriate levels of free SO_2 and pH.

6. Current data suggests there is little increase in volatile acidity in wines treated with micro-oxygenation when compared to those same wines without micro-oxygenation. However, do not micro-oxygenate wines made from suspect fruit. Monitor VA weekly during the first month of micro-oxygenation.
7. If VA is increasing in wines without oxygenation, the addition of oxygen will increase the rate of VA production. Stabilize the wines before initiating micro-oxygenation.

Brettanomyces

1. Insufficient sanitation is the primary factor in wine spoilage.
2. Using contaminated old barrels is a frequent cause of Brettanomyces. The use of new StaVin toasted oak tank systems will help eradicate this source of infestation.
3. Maintain appropriate levels of free SO_2 and pH.
4. Do not micro-oxygenate wines having Brettanomyces indicators.
5. Care should be taken to ensure clean, sound barrels if barrel inserts are to be utilized.

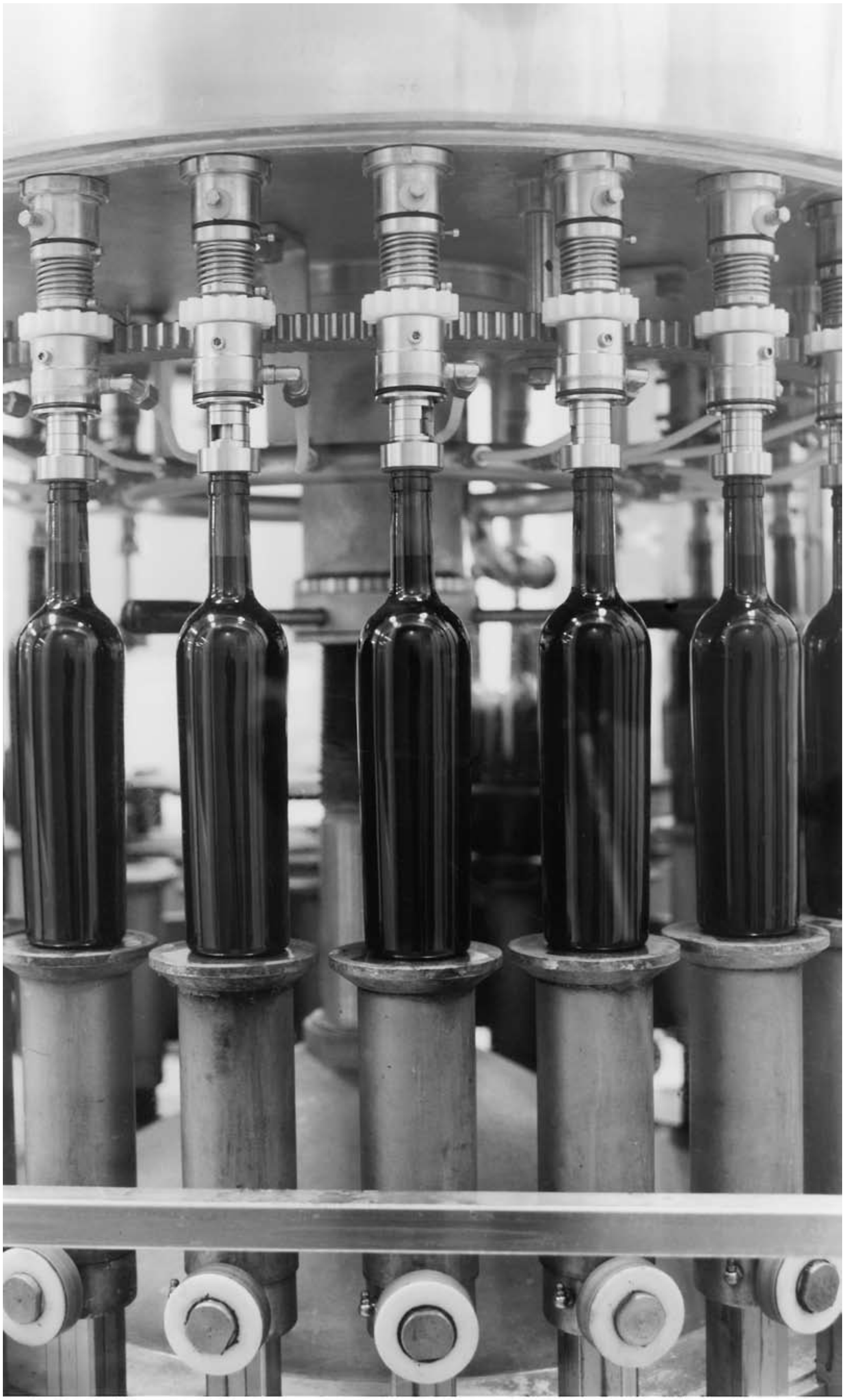
Stuck fermentations

1. Balance vineyard management and harvesting decisions to obtain mature fruit at lower sugar levels.
2. Properly rehydrate a strong yeast (43, 1116, S103, PDM) and water back to the must if necessary to minimize your risk.
3. Supply an adequate but not excessive amount of nutrients for your yeast choice.
4. Manage temperature control: Ferment at lower temperatures during the start of fermentation, ramp up to maximal desired temperature in the beginning/middle of fermentation and keep at elevated temepratures.
5. Macro-aeration
6. Refermentation protocols: www.vinquiry.com, www.scottlaboratories.com and www.wineserver.ucdavis.edu/lfbisson/PPT/VEN124_Sec_III_Lec_10.ppt
7. Maintain appropriate levels of free SO_2 and pH.

Short time frame

Honest evaluation of wine quality and establishing realistic objectives are crucial for the successful remediation of wines over a short timeframe.

1. Increased oxygenation rates can be used to refine tannin structure or slight sulfide issues.
2. Blending and additions can be particularly effective.
3. Oak extraction can be expedited with products containing a larger percentage of end grain such as our toasted Oak Beans.
4. Anecdotal evidence has demonstrated that Hungarian oak integrates well over a short timeframe.
5. For a short timeframe, we recommend oaking only a small portion of the total wine volume with the amount of oak desired for the entire wine volume. Once extracted, the treated wine can be back blended into the untreated wine to the desired level of oak.
6. Freshen up with micro-oxygenation.



BOTTLE GO ROUND MARK STUPICH

Pre-bottling adjustments

Micro-oxygenation freshen-up

There have been success stories when freshening wines with a small dose of micro-oxygenation two months before bottling. This procedure can have the effect of softening the wine while revealing more of the fruit character. Attention must be paid to the dissolved oxygen levels prior to bottling when using this approach. Allow one month for the wine to equilibrate without micro-oxygenation before bottling.

Oak and finishing tannins

Although it is not recommended, touching up wines with small amounts of oak prior to bottling is an available option. Brief timelines generally require the use of StaVin Beans at this stage. Be attentive and cautious regarding the level of oak being extracted into the wine. It is often advantageous to add oak to a small percentage of the total wine to be treated, followed by back blending.

Finishing tannins can be used to enhance the balance, structure and aromas of your wine. They are the perfect complement to fining trials, yielding superb results in resolving wine quality issues. Furthermore, accurate addition rates for the desired effects are easily determined in lab trials.

THE RIGHT STUFF

MARK STUPICH

Award-winning protocols by varietal

Case histories: Client A

Varietal	Price	Fermentation methods used	Aging methods used	StaVin product(s) used
Cabernet Sauvignon	$22	Oak used in fermenter Macro-aeration	Barrel Inserts % of blend in tank Micro-oxygenation	Fr. Med. + Inserts Fr. Med. + Stave Fans

- Selected in the Top 10 in Best of Year 2000 Cabernet Sauvignons out of 700 Cabernet tasted in a top magazine. Top 30 competitors had a price point of $85 per bottle.
- Orange County Fair Wine Competition: Gold Medal for 2000 Cabernet Sauvignon.
- San Francisco Chronicle Wine Competition: Double Gold Medal and Best of Class for 2000 Cabernet Sauvignon.

Client B

Varietal	Price	Fermentation methods used	Aging methods used	StaVin product used
Syrah	$12	Oak used in fermenter Macro-aeration	100% in tanks Micro-oxygenation	Fr. Med. + Segments

- Wine Spectator: 2001, 2002 and 2003 Syrah received 90 points and Best Value.
- The Wine Report: 2002 Syrah placed in Top 40 wines for 2004.
- The New York Times: Top 10 Syrahs for 2004 and Best Value.

Client C

Varietal	Price	Fermentation methods used	Aging methods used	StaVin product(s) used
Pinot Noir	$15	Aeration & small amount of oak used in fermenter Macro-aeration	% of blend in tanks Micro-oxygenation Barrel Inserts	Fr. Med. + Segments Fr. Med. + Inserts Fr. Med. + Stave Fans

- Wine & Spirits: Top 50, Wine by the Glass Top 5 for 2004.
- Wine Spectator: 2001 Pinot Noir received 87 points and Best Value.
- Dan Berger's Vintage Experiences: Very Highly Recommended.

Client D

Varietal	Price	Fermentation methods used	Aging methods used	StaVin product(s) used
Chardonnay	$15	Fermented on oak staves in tank	100% of blend in tanks Micro-oxygenation	Fr. Med. + Stave Fans Fr. Heavy + Stave Fans

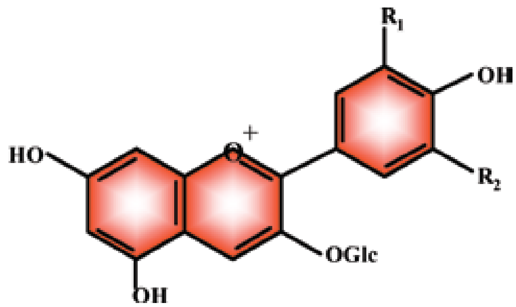
- Wine Spectator: 2002 Chardonnay won 88 points and Smart Buy for 2004.
- Ronn Weigand, Restaurant Wine: 4+ Stars. Excellent quality for its type, style and price. Highly Recommended.

TESTING, TESTING...

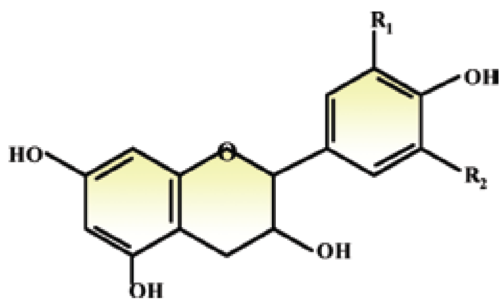
MARK STUPICH

Supporting chemistry

Basic building blocks of color and condensed tannin in wine



Anthocyanin (e.g. Malvidin-3-glucoside)

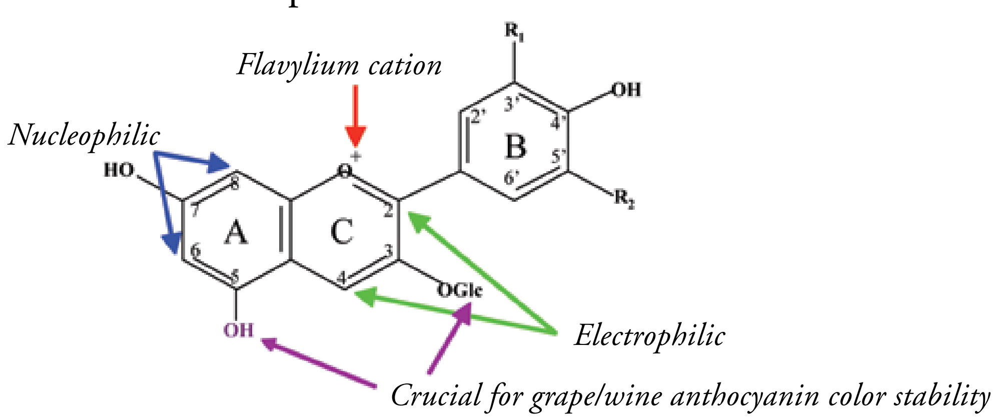


Flavan-3-ol

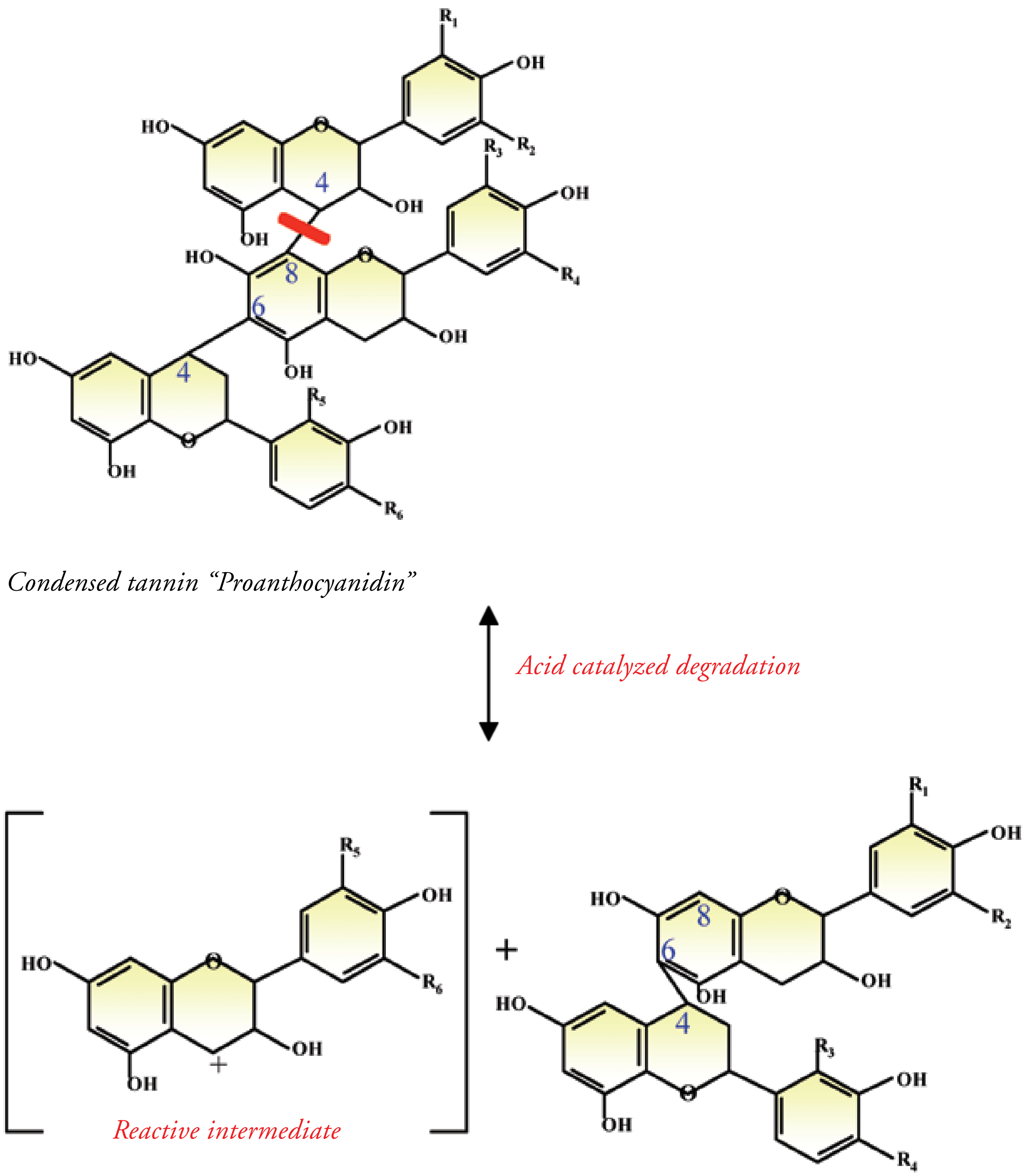
R1= H, R2= OH catechin or epicatechin
Basic building block of procyanidins – seed tannins

R1= OH, R2= OH gallocatechin or epigallocatechin
Basic building block of prodelphinidins – skin tannins

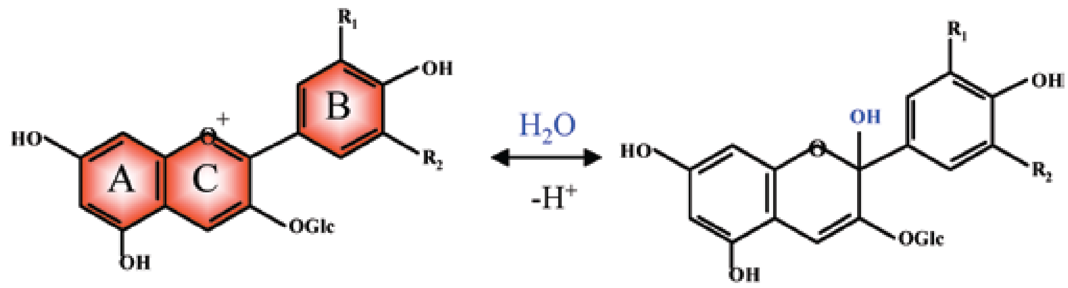
Polyphenols are reactive compounds



Wine pH induces acid catalyzed reactions

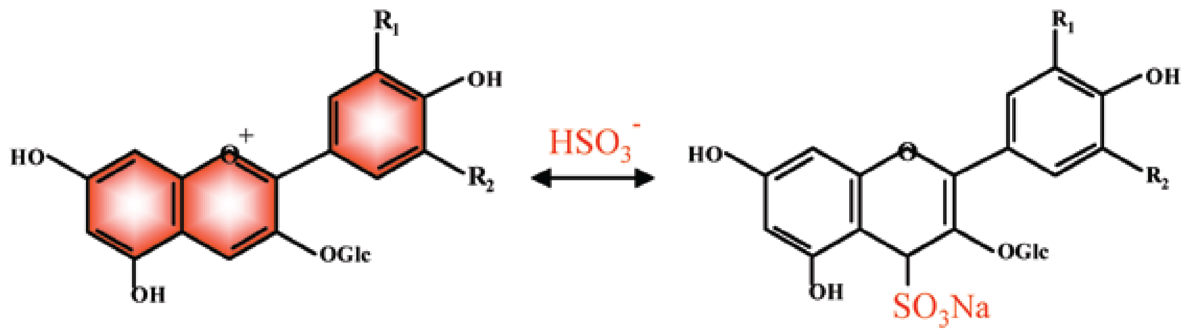


Wine conditions promote bleaching of simple anthocyanins

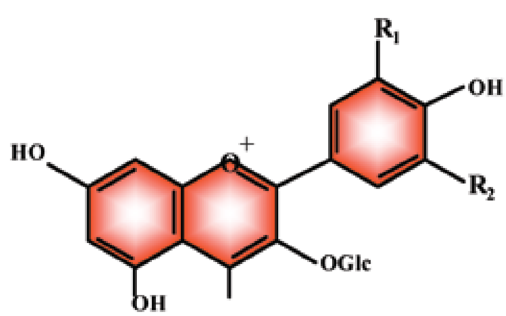


At pH < 2 the colored flavylium form of anthocyanins are predominant.

From pH 2-5 equilibrium shifts to the colorless hemiketal form of anthocyanins.



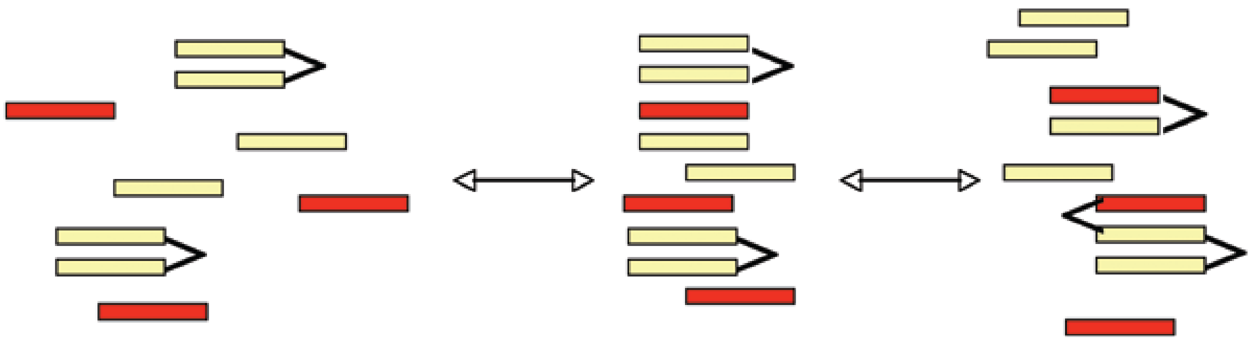
The addition of bisulfite bleaches simple anthocyanins.



Oxidative coupling at the anthocyanin 4-position stabilizes against bleaching.

Aggregation stimulates anthocyanin stabilization reactions

1. Aggregation is due to the optimization of hydrophobic and hydrophilic interactions of the compounds in solution.
2. The close proximity of anthocyanins and phenolics results in co-pigmentation and increased color.



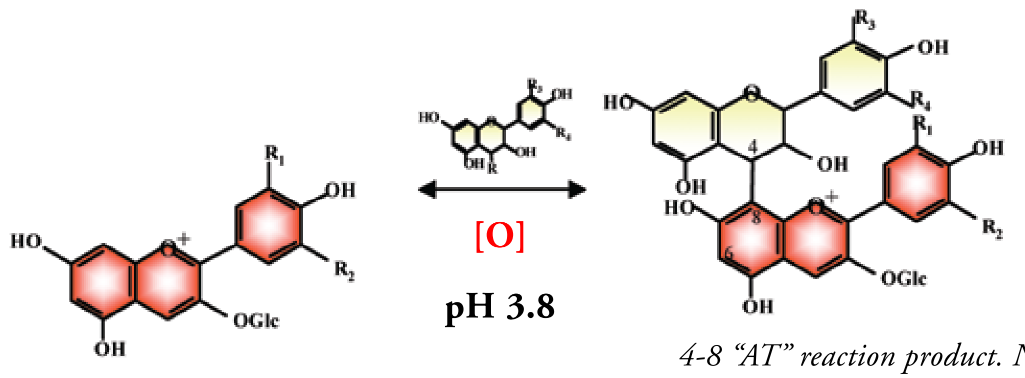
Release of anthocyanins and polyphenols from grapes and toasted oak

Association and aggregation

Stabilization and degradation reactions

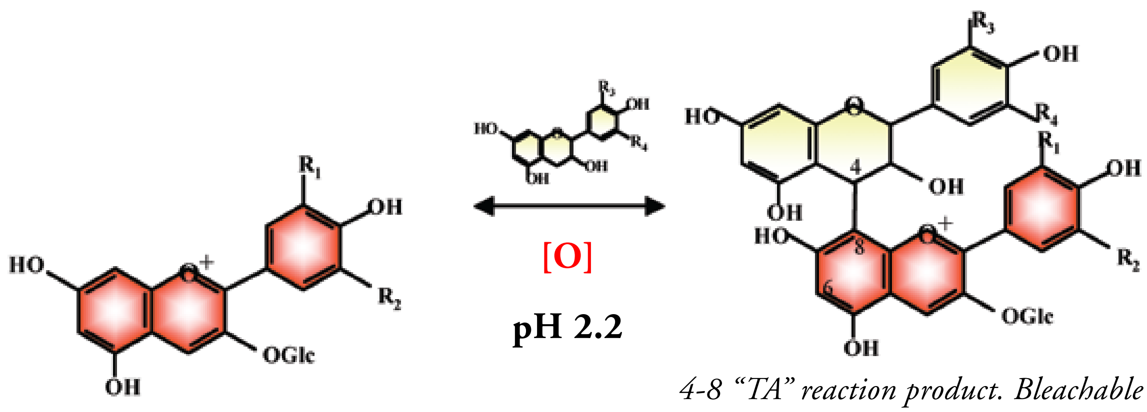
3. Increased levels of crosslinking compounds from oak under oxidative conditions stabilize color by covalently binding stacked anthocyanins.
4. Aggregation and co-pigmentation decrease as alcohol level increases. It is important to use oak and oxygen early during fermentation to take advantage of the close proximity of anthocyanins and phenolics.

Direct anthocyanin stabilization reactions



4-8 "AT" reaction product. Non-bleachable but may not be stable over time.

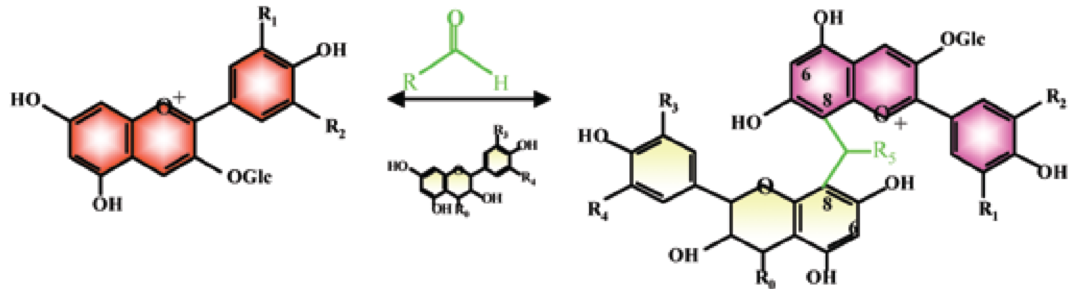
- Reactions occur at the 4-8 positions and/or the 4-6 positions.
- The nucleophile can be either the tannin or anthocyanin depending on pH.

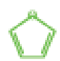
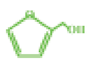


4-8 "TA" reaction product. Bleachable but the dimer appears to be stable.

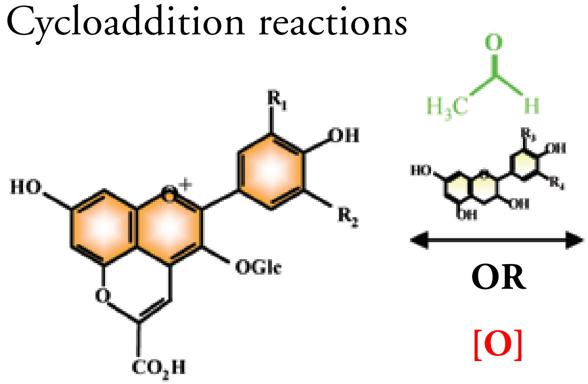
Acid catalyzed cleavage of tannins appears to be more prevalent than condensation reactions at wine pH.

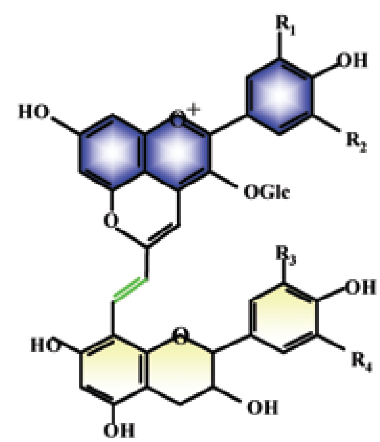
Aldehyde mediated anthocyanin stabilization reactions



- Reactions occur at positions 8-8, 6-8, and 6-6.
- Protonation of the aldehyde is the rate limiting step occuring faster at lower pH.
- Oak and oxidative conditions provide the reactants:
  - R_5 = CH_3 = acetaldehyde (oxidation of ethanol)
  - R_5 = CO_2H = glyoxylic acid (oxidation of tartaric acid)
  - R_5 =  = furfural (toasted oak)
  - R_5 =  = hydroxymethylfurfural (toasted oak)
- These non-bleachable violet pigments are stabilized by intramolecular association.

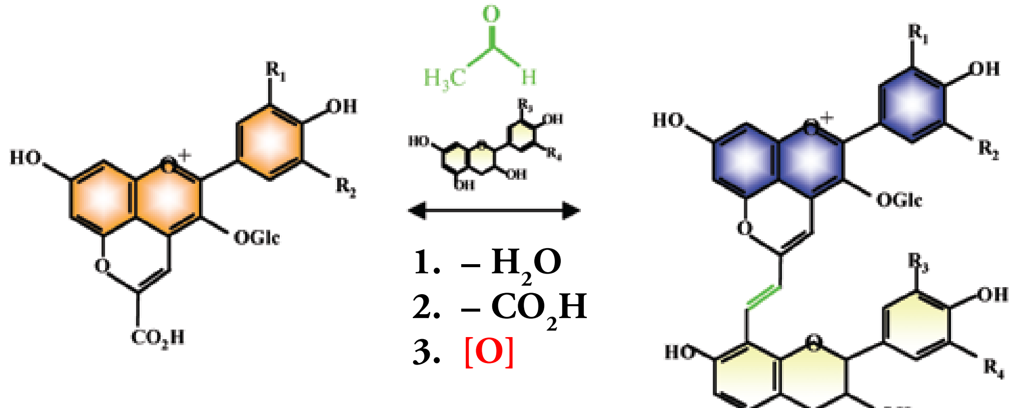
Cycloaddition reactions





- Reactions with vinylogous compounds:
  - R_x = Phenol (vinyl-phenol)
  - R_x = CO_2H (pyruvate)
  - R_x = Flavan-3-ol (vinyl-flavan-3-ol)
- Reactions with aldehydes:
  - R_x = H (acetaldehyde)
- Reactions with cinnamic acid derivatives:
  - Decarboxylation reactions
  - R_x = Various phenols
- The reaction can shift the color toward orange.
- These stable non-bleachable compounds may be an important component of aged wine color.

Complexity is increased by further reactivity

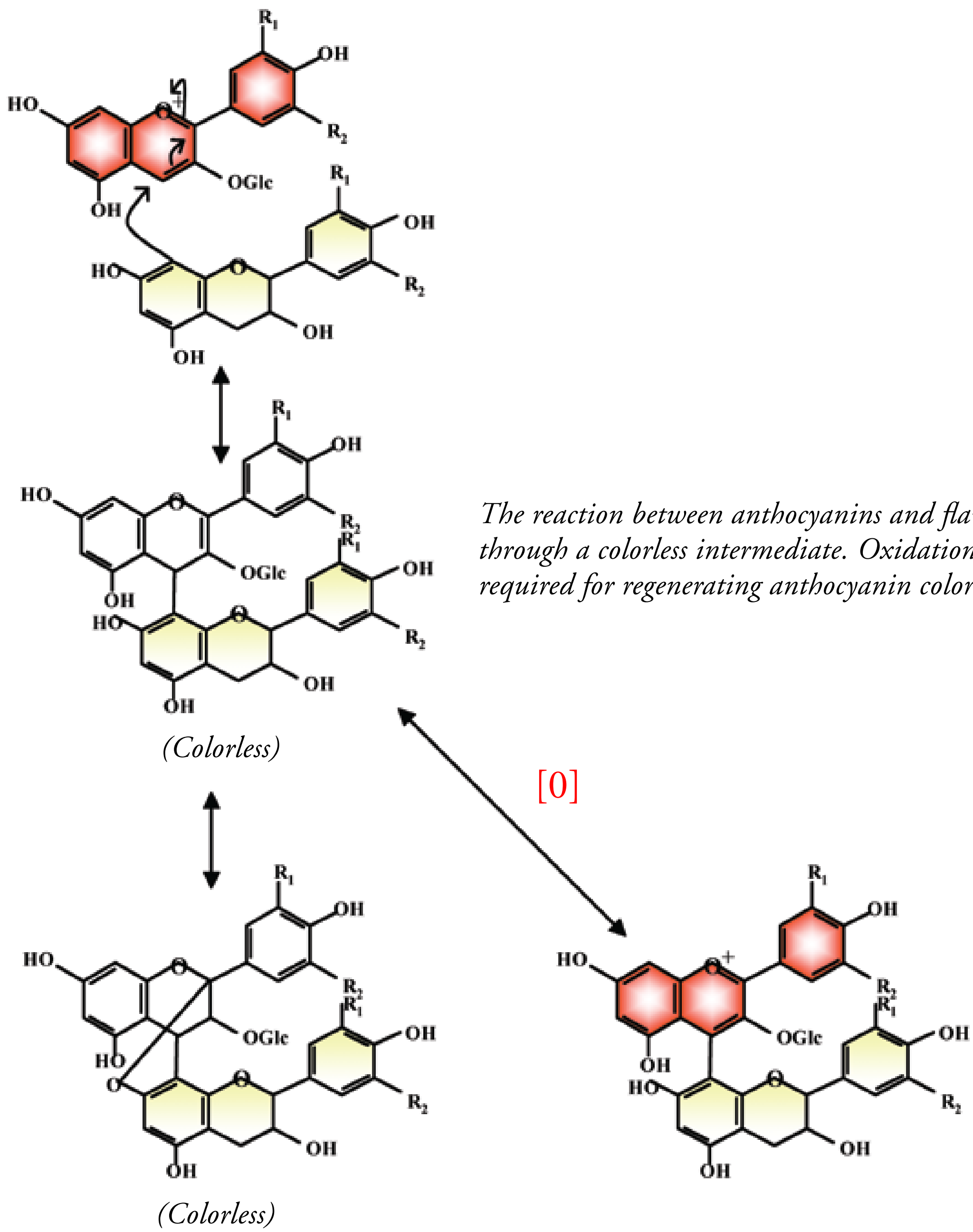


The cyclized product can further react with acetaldehyde and flavan-3-ol to produce a blue colored pigment.

These products are very stable non-bleachable pigments found in port wines.

- Over 50% of the total wine pigments are uncharacterized.
- Direct, aldehyde mediated and cyclized products can undergo further reactions as demonstrated above.
- Different reactants, regiochemistry and stereochemistry create a plethora of compounds.

Oxidation reactions [O] are required to regenerate colored anthocyanins



The reaction between anthocyanins and flavan-3-ols proceeds through a colorless intermediate. Oxidation reactions are required for regenerating anthocyanin color.

Summary: oak and oxygen additions can help stabilize wine color

Anthocyanins

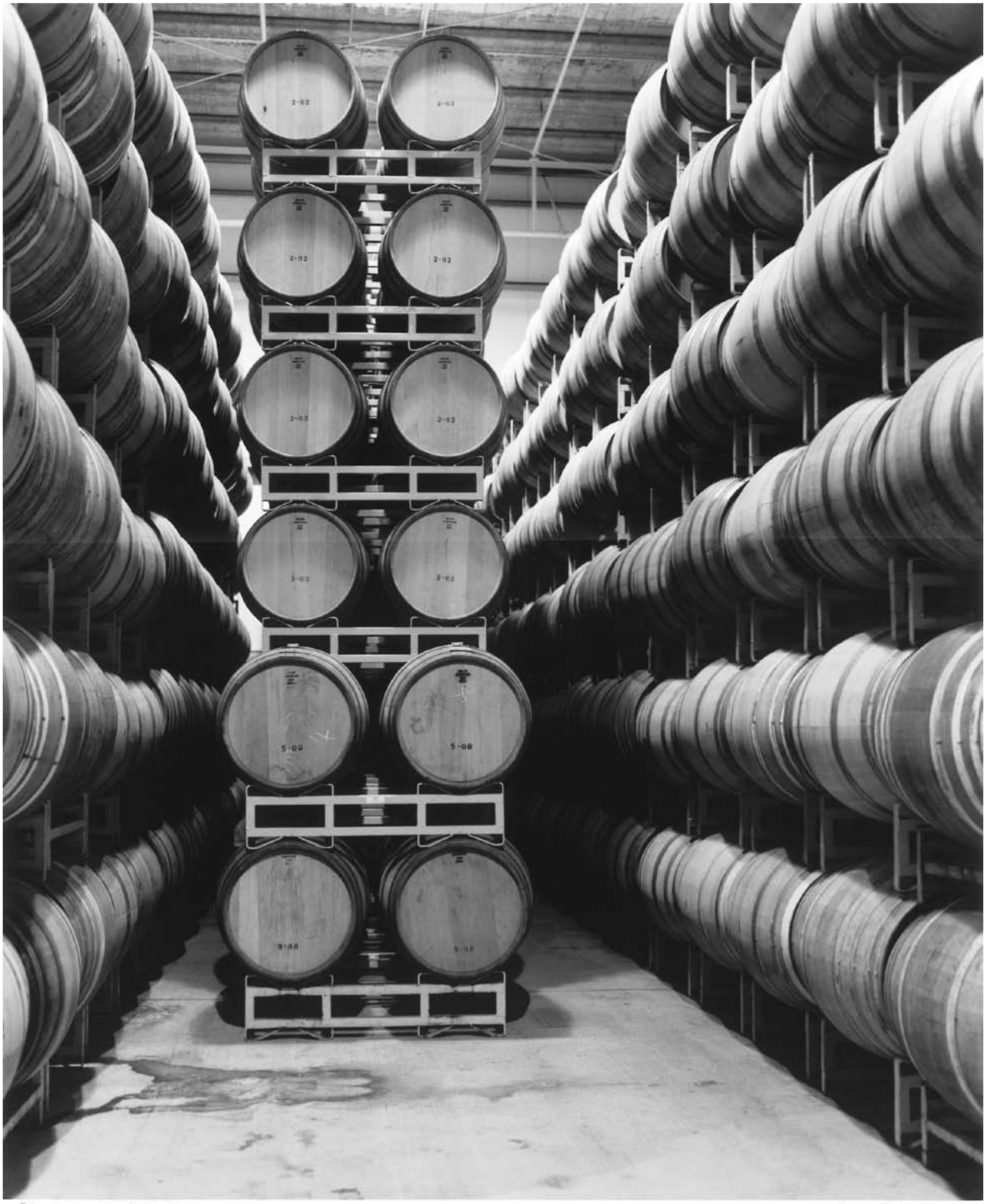
- pH, SO_2 and the hydroalcoholic media of wine make simple anthocyanins susceptible to bleaching.
- Direct, bridged and cycloaddition reactions with compounds furnished by oak and oxidation can stabilize anthocyanin color.
- Early additions of oak and oxygen during fermentation take advantage of the increased aggregation of polyphenols prior to alcohol production. Their close proximity during this stage should promote reactivity.
- Monomeric anthocyanins, bound either through a direct link or bridging, decrease the astringency of a given tannin.

Oak

- Supplies condensed tannins that aggregate and react with anthocyanins to form stabilized compounds.
- Furnishes aldehyde compounds such as furfural that are capable of stabilizing anthocyanins through crosslinking.

Oxygen additions

- Promotes color stabilizing reactions though the production of aldehydes such as acetaldehyde and glyoxylic acid.
- Provides the oxidative conditions required to regenerate the colored form of anthocyanin compounds.



BARRELS-IN THE WINGS

MARK STUPICH

Substantial cost savings

At StaVin our primary goal is to help winemakers increase wine quality. We can achieve results equal—or superior—to those obtained in barrel programs. We offer the tools and research to effectively evoke your ideal winemaking style. With StaVin Oak Integration Systems, you can effortlessly adjust oak percentage and origin as wine quality dictates, and let your own abilities establish oxygen levels rather than leaving it to history and fate. Our products increase your level of influence while offering the high quality of toasted oak you expect. In addition to giving you more winemaking control, our products present *a substantial cost savings over barrels.*

The table below shows the cost savings in materials, labor and ullage. Additional savings are apparent when issues of space, workers' compensation, and spoilage due to tainted used barrels are taken into account. All of these cost efficiencies save time, allowing winemakers to focus on matters relating to wine quality. Our mission is to provide cost-effective products that conserve resources and enhance the purest traditional flavors.

Comparison of StaVin French staves with micro-oxygenation in a tank vs. French barrels

Percent Savings 90% less than a French barrel budget
Cost Savings $1.34 per bottle

12,000 gallons produced	100% New barrel yield Quantity	Unit cost	Purchase cost	Yearly cost per 60 gal.[1]	Cost per bottle
StaVin Tank Program:[2]					
44 sq. ft. French stave Fan	66	$150	$9,900	$24.75	$0.08[3]
4-channel OxBox (4 tanks)[4]	1	$5,000	$5,000	$3.12	$0.01
Additional costs per 60 gal.[5]		$7/60 gal.	$1,400	$7.00	$0.02
Total: StaVin tank (12,000 gal.)			$16,300	$34.87	$0.11
French barrel program:[6]					
New 60 gal. French oak barrel	200	$750	$150,000	$375.00	$1.25
Additional costs per 60 gal.[5]	200	$60	$12,000	$60.00	$0.20
Total: Barrel (12,000 gal.)			$162,000	$435.00	$1.45

[1]Oak extraction period is two years.

[2]StaVin French oak tank stave system for a 12,000 gallon tank (200 barrels) = $9,900 or $49.50 per 60 gallons per year (or in a two-year oak stave program = $24.75 per 60 gal. per year).

[3]Many wineries will cycle (ferment and age) four wines over the staves in a two-year program, which reduces the oak cost per bottle to $0.04.

[4]Four channel micro-oxygenation system for oxygenating *four* 12,000 gallon tanks each year (equal to 1,600 barrels over two years) = $5,000 (or $3.12 per 60 gallons per year).

[5]Additional costs per year include: logistics, maintenance, labor, ullage, water and floor space = $60 per year per barrel, whereas the StaVin Tank Program is $7 per year per 60 gal.

[6]60 gallon French barrel price = $750 delivered (or $375 per 60 gallons per year in a two-year oak extraction program).

LAB LINE-UP

MARK STUPICH

Sample experiments to validate StaVin's concept

Prove it to yourself. The following are suggested trials to determine if oak, aeration and micro-oxygenation will work for you.

White wine (Chardonnay or any other oaked white wine)

1. Whole-cluster press one large lot into a large tank. Do any chemical adjustments at this stage.
2. Cold settle and rack the juice into another large tank. Adjust solids as desired and inoculate.
3. Constantly mix the large tank and move the juice into two equal lots: a tank with oak and micro-oxygenation capability, and barrels.
4. Make sure the oak style and relative amount is similar for both.
5. Do your best to maintain similar fermentation rates for each lot.
6. Stir the tank and barrels twice weekly, injecting a periodic dose of oxygen at a rate of 2 mL/L/month to the micro-ox tank once a week *after stirring*.
7. Conduct frequent sensory evaluations (including blind tastings) to see which method is preferred.

Red wine (Cabernet Sauvignon, Zinfandel, Merlot, etc.)

1. Crush a single grape pick into two tanks: one without oak/air and one with oak/air additions (install the oak in the tank before crushing).
2. Try to replicate identical conditions if adjustments (acid, water, etc.) are desired.
3. Inoculate the tanks with the same yeast buildup culture at the same dosage rate.
4. Cap management of the two should be identical, except that the oxygenated tank will receive aeration during pumpovers in the interval from 20–5 °Brix.
5. Analyze wines post-fermentation for sensory and fermentation parameters.
6. Once analysis has been done the two wines can be drained and pressed into the same large tank. Inoculate with ML bacteria if desired or proceed to the next step.
7. Rack the large tank into a topped tank with staves and barrels, making sure the oak style and relative amount is similar for both.
8. The tank with staves should be micro-oxygenated at 2.5 ml/L/month.
9. Conduct sensory evaluations (including blind tastings) to see which method is preferred.

Alternate experiments can be run using the same style

- Oak vs. no oak or air vs. no air during fermentation.
- Use different oak infusion systems (Tank Fans, Segments, Beans, Chips and Granular) during fermentation and aging. Alternate different amounts of each system.
- Compare oak companies (we're confident you'll confirm StaVin products are the highest quality).
- Vary oxygenation rates during aging.
- Apply continuous vs. periodic micro-oxygenation.
- Be creative; let your vision guide the experiments.

Creativity and innovation leads to discovery

At StaVin, we believe the research presented in these pages will provide you with a greater understanding of using toasted oak and oxygenation to produce the best possible wines. We hope this book will promote more questions and discussions among winemakers all over the world. The following is a summary of the preceding pages:

1. The presence of toasted oak and macro-aeration during fermentation helps to induce the stabilization of color, reduces sulfides and decreases perceived vegetal aromas.
2. The combined use of toasted oak and micro-oxygenation during aging will produce higher quality wines with enhanced body and color, substantially reduced labor costs, increased control of sanitation and minimized dependence on barrels.
3. The general recommendations in this book can and should be altered based on your stylistic goals, sensory analysis and observations.
4. Through our research, observation, creativity and innovation, we are constantly striving to improve wine quality.

StaVin is the world's leading supplier of premium toasted oak. Our mission is to provide innovative, cost-effective products that conserve resources and enhance the purest in traditional flavors. As an artisanal company, we are dedicated to fire-toasting by hand in the traditional method. We are also experts in the area of micro-oxygenation.

StaVin guarantees consistency in product flavor and aromas year after year. This commitment is accompanied by unprecedented technical research and impeccable service. Our ecologically responsible systems produce award-winning wines that are equal, or superior to, wines made in barrels. Combining StaVin's efforts with those of winemakers throughout the world, we will move this technology forward.

Dr. Jeff McCord
Vice President of Research & Development

Dr. Jeff Murrell
Director of Research

Black and white photographs by Mark Stupich

Mark Stupich grew up in Culver City, California and migrated north. He found himself a Psychology major at Sonoma State College, surrounded by vineyards and the burgeoning wine industry. Upon graduation he and friends embarked on a hike along the Pacific Crest Trail from the Mexican border to Lake Tahoe (regretfully without a camera). Upon returning to Sonoma County he joined a winemaking crew and took up black and white landscape photography as a hobby. He has been in the business of winemaking longer than he cares to admit. The photography continues to develop.