Winemaking Basics

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Sourcing grapes: good wine starts with good grapes

Ripeness: is generally expressed as percent sugar or °Brix (°B). The normal range is 22 – 26°B (17.5 to 19 for sparkling and 21 for some 'crisp' and austere whites). Use a hydrometer or a refractometer to check it. If you harvest much above 26, you should consider diluting the juice (must) with water to adjust it to downward a bit, depending on the alcohol level you are comfortable with. The problem with making wines from high °Brix grapes is that the resulting alcohol level will be high. The fermentation may stop (stick) and the wine may taste hot. Therefore, you should consider diluting the must or juice, if the sugar level is much above 26 (see adjusting the °Brix below). The alcohol conversion factor for most yeasts is about .57, but ranges from .55 to as high as .64. Multiply the °B by the conversion factor to determine the probable alcohol level: ex 26°B x .57 = 14.8%. If the °B level is 27, the resulting alcohol level will be 15.4 —very hot! If you dilute to 25, the alcohol will be 14.25%. If you dilute it to 24ºB, the alcohol will be 13.7% —quite acceptable.

Whites vs. reds:

- White grapes are de-stemmed, crushed, and pressed **before** fermentation.
- Skin contact is relatively short.
- Red grapes are typically de-stemmed, crushed, cold-soaked (optional), and he wine pressed off the skins and seeds **after** fermentation. Skin contact is lengthy, so color and tannins are more intense.
- Rosés are made from the juice of red grapes after they are destemmed, crushed, and pressed shortly therefore. The longer the skin contact, the darker the color. French style rosés are usually pressed within a few minutes of stemming and crushing.
- Rosés can also be made in the traditional method by draining off a portion of juice immediately or shortly after stemming/crushing *red* grapes and then fermenting it separately from the rest. The objective is to increase the skin-to-juice ratio so that the resulting red wine is more concentrated. Rosès, can be a useful byproduct or done expressly for that style of wine. The French call this traditional method: saignée (to bleed).
- Juice of white grapes is more prone to oxidation than that of red grapes.
- Red wines are more resistant to oxidation due to the high tannin content.
- Preserving varietal fruit aromas in white grapes requires lower (cool) fermentation temperatures.
- Whites, because they are prone to oxidation, are fermented in closed containers, e.g., stainless steel tanks, glass or specially designed plastic carboys, or barrels (Chardonnay, for example).

- Reds are generally fermented in open-top containers that allow the cap of grapes that rises to the surface during fermentation to be punched down, back into contact with the juice.
- Red wines are nest fermented between 70° and 85°F, while whites are best fermented near 60°F. A practical for fermenting whites is 55 to 64°F
- Reds typically undergo a secondary (malolactic) fermentation (MLF) that reduces the wines acidity. Chardonnays, however, are often allowed to undergo MLF or inoculated with a ML culture.

TEMPERATURE CONTROL: is important for successful wine-making:

- Warm grape are prone to microbial spoilage, particularly during the cold soak (see Cold Soak below). It's best to pick early in the morning so the grapes are cool.
- Warm-grapes should be cooled to <60°F using dry ice, frozen water jugs, or refrigeration.
- Early SO_2 additions will also help minimize microbial spoilage.
- For best results, ferment white juice at close to <60°F.
- Red wines are allowed to ferment at room temperature and temperature control is seldom needed, except to cool a particularly warm fermentation, or to raise the temperature to a desired level. *Be aware* that higher temperature may harm some yeasts the yeast, depending on the selection. Check the ideal temperature range for the yeasts you use and try to keep the temperature in the stated range.

THE USE OF SO_2 TO ENSURE GOOD QUALITY WINE:

SO_2 (Sulfur dioxide) is commonly added to juice, must, and wine to inhibit spoilage microorganisms, prevent oxidation (browning and formation of acetaldehyde—the smell of sherry or bruised apples, and formation of vinegar, ethyl acetate, and other off odors. SO_2 preserves a wine's freshness and fruity character by virtue of its antioxidative, anti-enzymatic (prevents browning) and antimicrobial properties.

SO_2 can be added by using Potassium metabisulfite (PMBS) in the powder form, in a solution, or as effervescent granules or tablets. Avoid the use of Sodium Meta Bisulfite

Why should you use SO_2?

Wines with little or no SO_2 typically:

- oxidize quickly—whites become more golden to brown, and reds turn brick-red and then brown.
- quickly lose their color, flavor, and aromas ('flatten')
- develop a sherry-like aroma (without enough SO_2, alcohol is quickly converted to aldehydes and ultimately acetic acid (vinegar).
- are susceptible to wine-spoilage organisms, e.g., *Acetobacter*, *Lactobacillus*, *Brettanomyces*, *Pediococcus,* and others) that can impart disagreeable odors, e.g., sherry, vinegar, nail-polish remover, staleness,

‘cooked’, leathery, earthy, barnyard, rancid, horse sweat, mousey, dirty sweat-socks, cheesy, sauerkraut, tanky or swampy etc.

What happens to SO_2 in juice or wine?

- It inactivates enzymes that cause browning and reacts with O_2 to prevent the formation of hydrogen peroxide, which reacts with alcohol to form acetaldehyde (sherry-like aroma).
- It also inactivates (binds with) harmful bacteria, wild yeast, including *Brettanomyces* and various wine components (tannins, aldehydes, pigments, acids, sugars, and solids)
- It exists in both active (free) and bound forms. Once bound, SO_2 is no longer available active, and cannot prevent oxidation or spoilage.
- There is some loss due to volatilization and precipitation in the sediment.
- Remember: the total is typically less than what has been added to a wine from start to finish.

Forms of SO_2: free, bound, and total

A portion of the SO_2 (sulfites) added to juice, must, or wine binds up with various components. The remaining portion is ‘free’ or available to perform its various functions. SO_2 testing measures how much is actually free. Testing can also measure the ‘total’. The total, however, is less important. By recording each addition, you know how much has been added. The concept is to add as little SO_2 as possible, yet provide adequate protection of your wine. The ‘tested’ total is not the same as the amount that has been added, as some is lost during fermentation and/or aging. ‘Bound’ SO_2 is the portion that is present, but largely unavailable. ‘Total’ is the sum of the free and bound SO_2

Free SO_2 and Molecular SO_2

When added to juice/wine, PMBS releases bisulfite (HSO_3^-) ions and a small amount of SO_2 — the active portion.

PMBS ($K_2S_2O_5$) + $H_2O \rightarrow 2K^+ + 2(HSO_3^-) \leftrightarrow SO_2$ (molecular) + H_2O

HSO_3^- + H_2O $\leftrightarrow$ SO_2 (molecular) + H2O

The level of free sulfur dioxide (SO_2) in wine is measured in parts per million (ppm). However, only a portion of this is active and is referred to as the *molecular level*. Molecular SO_2 is greatly affected by the wine’s pH. For example, a wine with a pH of 4 needs 3 times as much free SO_2 as a wine with a pH of 3.4. There is a 10 fold increase from a pH of 3 to 4. Another important consideration is that high pH wines are prone to bacterial spoilage.

The molecular level really reflects the amount of free (*active)* SO_2 that is available to protect the wine. White wines, having less tannins than reds, need a molecular level of 0.8 ppm SO_2 to provide adequate protection and to prevent MLF in the bottle. Tannins are natural antioxidants. Reds, on the other hand, need a molecular level of only 0.5 SO_2. As a rule of thumb, target a free-SO_2 level listed below, based on type of wine (red or white) and its pH.

White wines: free-SO_2 needed for a 0.8ppm molecular level:

pH	SO_2 ppm or mg/L
3.0	15
3.1	18
3.2	23
3.3	29
3.4	36
3.5	25
3.6	50
3.7	63
3.8	78
3.9	99

Red wines: free-SO_2 needed for a 0.5 ppm molecular level:

pH	SO_2 ppm or mg/L
3.4	25
3.5	30
3.6	35
3.7	40
3.8	50
3.9	60
4.0	78

The tables above list the level of free-SO_2 needed to keep a wine from oxidizing. Notice that the number goes up with pH. So, it takes more SO_2 to keep a higher pH wine safe from oxidation and bacterial spoilage than a lower pH wine. Lower pH wines are inherently more stable because they need less SO_2 for protection and provide a less favorable environment for spoilage organisms. This is why adjusting pH is important. It's not just a stylistic choice. Lower pH wines are generally more acidic, brighter and sometimes fruitier, while higher pH wines are softer, smoother, or flat. For reds, a pH of 3.6 to as high as 3.7 is generally acceptable. It's a good idea to do trials to see how the wine tastes at different levels of pH. If it tastes best at 3.65, adjust to that level and re-evaluate later. If it tastes better at 3.6 adjust it accordingly.

The tables above reflect the upward trend in higher additions with increasing pH. Most commercial winemakers, however, use a more moderate approach when making SO_2 additions. They can do so, because they have more options and greater control than home winemakers.

Five stages of the winemaking and SO_2:

- **Pre-fermentation:** The initial SO_2 addition is typically done immediately after crushing or just following pressing and before yeast inoculation. In some cases, the fermentation is initiated without adding any SO_2 (see below).
- **Fermentation:** once the initial dose of SO_2 has been made, it is not necessary or beneficial to add any more until after the fermentation is finished.
- **Post-fermentation:** Wines, having completed their primary or secondary (malolactic) fermentation are very susceptible to oxidation and bacterial spoilage. Therefore, a second timely addition is needed to keep them sound. Most white wines and rosés will need more SO_2. Most reds and traditional chardonnays, however, should not receive any further SO_2 until they have completed malolactic fermentation (MLF). The problem is that an SO_2 addition immediately after the primary (alcoholic) fermentation will inhibit MLF, which is desirable for most reds and some whites like chardonnay. Wait until the MLF is done before adding SO_2.
- **During settling, after racking and aging**: SO_2 levels will continue to drop throughout the winemaking process. Every time you rack or open the container to smell, taste, or to add something, you expose the wine to air. Barrel aging also exposes the contents to small amounts of air. As a result, free SO_2 in the wine, helps to protect it—as long as there is an adequate amount. Therefore, it's critical to monitor the SO_2 level and adjust periodically to maintain sufficient free-SO_2 to ensure the needed molecular SO_2 level.
- **Bottling:** The level of free SO_2 should be checked prior to bottling and adjusted as needed. Wines, even those that taste and smell fine, can go off quickly if bottled with insufficient SO_2. The proper level will ensure that the wine will remain sound longer.

Pros and cons of not using SO_2 until after fermentation: In whites, post-fermentation SO_2 allows for less SO_2 at bottling, more stable color, and a more rapid MLF. At first, juice tends to turn brown, but the oxidized compounds settle out during fermentation. Wines made in this manner may lose some fruitiness. The major drawback is often a higher VA (volatile acidity) level. With proper control measures, this method can be used to make very good wine.

Adding SO_2

Potassium metabisulfite, a concentrated powder, is used to add SO_2 to juice, must, or wine. It can be added directly or diluted with water in the quantities needed. Potassium metabisulfite (PMBS) powder contains 57% SO_2 (Winy, an Enartis product contains 56%).

How is SO_2 measured?

PMBS, when added to water, juice, must, or wine is measured in milligram (mg) of SO_2 per Liter (L) of the liquid. There are 1000 milligrams (mg) in a gram of SO_2 and a 1000 mls in a liter of water. This can be expressed as parts per million (ppm) — parts of SO_2 per million parts of juice or wine. One ppm is equivalent to 1 milligram (mg) (.001 g) in 1L of water, juice, must or wine.

Things to consider when determining how much SO_2 to add:

- color of grape: white or red?
- conditions of grapes
- temperature of grapes when harvested, crushed, and or pressed
- stage of winemaking
- pH of the juice or wine
- sanitation practices
- handling (number of rackings, type of storage container, type of additions)
- aging sur lie? Wines aged on the lees (sur lie) can get by with less SO_2
- type of storage container used
- how often you top
- whether or not you use inert gas
- storage temperature, etc.

Calculating how much SO_2 to add:
You can use the formula listed below to calculate how much PMBS to add, or the easy to use calculator: http://www.winebusiness.com/tools/?go=winemaking.calc&cid=1 (make sure you enter 5.6% or 5.7 when using a stock "10%" solution) or http://winemakermag.com/1301-sulfite-calculator

Formula for PMBS addition

$$\frac{\text{gal of wines} \times 3.785 \times \text{desired ppm}}{1000 \times 0.56} = \text{grams of PMBS to add}$$

- 3.785 converts gal to liters
- 0.56 is the fraction of SO2 in PMBS
- 1000 converts mg/L ppm to g/L

A simplified version is: gal of wine x desired ppm x .0066 = g of PMBS

Making the addition:
A convenient way to add SO_2 is use a "10 percent" standard SO_2 solution made by adding 100 g PMBS to a liter of water (~34 ounces), or 75 g in 750 ml bottle. This actually produces a 5.7% solution because the potassium metabisulfide

contains 56% SO_2. Some PMBS products contain 57% or slightly more. Enartis' Winy contains 56% —make sure you check the label

- 2.32 ml of a standard 10% (5.6%) PMBS solution adds **35 ppm** SO_2 to 1gal of must or juice. 3.32 grams increases the SO_2 to **50 ppm.**
- 3.32 ml of stock solution in 5 gal of must or wine raises the SO_2 level about **10 ppm**.
- For 5 gal of must/juice use 10 ml of a standard PMBS solution to add 30 ppm, 11.6 ml for **35 ppm**, 13.4 ml for **40 ppm**, and 16.5 ml for **50 ppm**.
- Use a pipette with bulb for safety and to make precise additions.
- Remember to stir the wine following an addition of the SO_2 solution to distribute the material throughout the juice or wine.

Example: to add 30 ppm of SO_2 to 15 gal of wine using a standard '10' percent solution use ~ 30 ml of the stock solution. (see below)

SO_2 addition: 10% (5.6%) solution (Winy: Enartis)

	5gal	10 gal	15 gal	30 gal	60 gal
10 ppm	3.38	6.76	10.14	20.28	40.56
15ppm	5.07	10.14	15.21	30.42	60.84
20 ppm	6.76	13.52	20.58	40.56	81.12
25 ppm	8.45	16.9	25.35	50.76	101.39
30 ppm	10.41	20.28	30.42	60.84	121.67
35 ppm	11.83	23.66	35.49	70.98	141.95
50 ppm	16.9	33.8	50.7	104.39	202.79

When using a PMBS product containing 57% SO2 to make a standard 10% solution add 3.32ml to each 5 gal to raise the SO_2 level to 10 ppm, add 6.64 ml for 20 ppm 9.96 ml for 30 ppm.

Other ways to add SO_2:

- Direct powder addition: to add 10 ppm of SO_2 to 5 gal of must or juice use .38g powdered PMBS (dissolve in water) (1.9 g to add 50ppm)
- For 15 gal of juice add 3.97 g (powdered PMBS) to add **35 ppm**, 4.54 to add **40 ppm**. 5.68 g to get **50 ppm**
- Packets of powdered effervescent SO_2, containing 2g or 5g of SO_2 are a convenient way to adjust SO_2. You don't need to stir the wine after adding as with other means of adding SO_2. The effervescent mixture helps to distribute SO_2 in the wine.
- When using the effervescent form, a 2 g packet will provide 528ppm of SO_2 per gallon of juice or must. For example, if you need to treat 25 gal of must/juice divide 528 (the amount of SO_2/gal in each packet) divided by 25. Therefore, the packet will add 21 ppm of SO_2 to 25 gal. Therefore, 2 full packets will add 42 ppm. That's fine for most reds or whites. For 10 gal of must a 2g packet will add 52.8ppm.
- One 2g pkg of (Efferbarrique or Inodose granules) will raise the free SO_2 level of a 59 gal barrel **~9ppm**

- A 2 g packet will add about **21ppm** to 25 gal of must in a 32 gallon fermenting bin.
- If you divide the packages, remember that there is actually 5 grams of material in a 2g packet — so 2.5 g of the granules will provide 1g of SO_2, enough to add 10.5 ppm to 25 gal.
- A 5g packet of Effergran or Inodose Tablet will raise the free SO_2 level in a 59 gal barrel to **23 ppm**.

Pre-fermentation: How much to add?

- For home winemakers, this can be very confusing. The amount of SO_2 to add should be based on the total volume (gal) of must or juice you have after stemming and crushing, even though grape must contains skins and seeds which will be removed at pressing.
- About 30 to 40 ppm of SO_2 is adequate to minimize microbial problems and retard native yeast for both *reds* and *whites.* Higher SO_2 levels are recommended for warm grapes and those with rots.
- Chilling your grapes will reduce the amount of SO_2 needed.
- Levels much above 50 ppm at fermentation are likely to inhibit malolactic fermentation (MLF), see MLF below).
- For each 5 gal of must:
    - ~10 ml of a standard 10% (5.7%) PMBS solution will add 30 ppm SO_2
    - 11.6 ml adds 35 ppm
    - 13.4 ml adds 40 ppm
    - 16.5 ml adds 50 ppm
- If you use powdered PMBS you will need to add 0.33 grams to provide 50ppm of SO_2. For 5 gal use 1.65 g.
- Some professional winemakers use as little as 20 ppm of SO_2 before fermentation. Home winemakers, however, would do well to use the higher rate because they generally lack the experience, technical know-how, specialized equipment, temperature control, and access to sophisticated testing equipment. Commercial winemakers also have greater control over grape quality and harvest temperature.

Note: not all of the SO_2 you add will remain in the finished wine, some will bind up with solids that settle out. In reds, some of the SO_2 is lost to the atmosphere during 'open-top' fermentation. More SO_2 is lost to the atmosphere when there is head-space in storage containers or barrels.

Post fermentation (second addition):

- By the end of fermentation, little or no *free*-SO_2 remains and the *total* is about ½ of the original addition is bound to various components.
- Some volatilizes and some precipitates out in sediment.
- About ½ of the SO_2 added post-fermentation, will bind up quickly, assuming that less than 50 ppm was added pre-fermentation, leaving ½ free.

- So, you'll need more than you think
- After that, most SO_2 added will be free (70 to 75% or more)
- How much additional SO_2 is needed will depends on pH, alcohol content, and sugar level. The lower the pH – the less SO_2, the higher the alcohol – the less the SO_2. The higher the sugar level the greater the SO_2.
- In general, for dry whites, add 50 ppm SO_2 at the end of fermentation.
- Do not add any more SO_2 to reds wines that have not undergone MLF.
- Most reds that have completed MLF will need 50 to 80 ppm SO_2 depending on pH.

Making the post-fermentation addition:

- Determine the current free-SO_2
- Use the molecular SO_2 tables
- Let's say you have 15 gal of a white, the pH is 3.3, free-SO_2 is 10 ppm, but you need 29 ppm (Molecular table)
- 29 – 10 = 19 ppm
- About ½ will bind up quickly.
- So, you will need to double that amount: 38 ppm.
- You should add an additional 10ppm to act as a cushion.
- Adjusting pH is a good option to minimize SO_2.

SO_2 additions during storage and aging:

- Determine a baseline (molecular SO_2) and avoid deviating from it too much.
- Test monthly at first and as the SO2 levels stabilize the drop in SO_2 slows, testing every 6 weeks may work.
- You don't want to find that every time you test your levels are well below the recommended molecular level.
- Maintain a small, stable reserve (surplus) to keep the free-SO_2 from dropping too much below the optimum molecular level between tests. A little cushion will ensure that the wine is adequately protected between additions.
- Fewer, larger additions are better than many small ones (it shocks the bacteria more and free/total ratio is more favorable).

Pre-bottling additions:

- test free SO_2
- adjust to the molecular level
- only part of the addition will be free — about 70% when added to a clean, dry wine
- Let's say you need to add 18 ppm to achieve the correct level. Some of it will bind up. So, you will need to add ~26 ppm to ensure that your wine is protected. (18/.7 = ~26ppm)
- If you use a standard bottler, add another 10 ppm to replace what will be bound up in response to exposure to air and volatilization.

Some commercial wineries us as little as 10 to 20 ppm, but their sanitation practices are very good. They harvest grapes at night, can chill grapes or juice and keep cellar temperatures very low. In general, they have good control over most factors. They also sterile filter their wines and bottle under inert gas. Their bottles are new and sterilized, and stored at the optimum temperature.

Ways to limit the loss or use of SO_2 and subsequent oxidation:

- Use clean barrels: Proxycarb, sulfur wicks, steam
- Top barrels every 2 to 3 weeks
- Purge headspace with inert gas every time you open a barrel or container, or add anything.
- Sanitize tools, hoses, stir-rods, pumps, etc.
- Add a little SO_2 when you add fining agents, oak products, or other wine-making agents to your wine.
- Air condition your cellar 55 to 57°F is ideal. There is at least one electronic device, e.g., CoolBot that can override the thermostat in most air conditioners, allowing them to refrigerate small rooms to the programmed temperature.

SANITATION:

- Basic sanitation of all winemaking equipment, including fermenters and storage containers is critical: clean all equipment used in winemaking to remove surface debris, dirt, staining and residue and then sanitize with a solution of Iodine-based sanitizer or Star-San to minimize the potential for introducing spoilage organisms.
- The best way to avoid spoilage problems developing before fermentation, is clean and sanitize picking lugs, buckets or trash cans and fermenting bins. Keep the grapes cool, add enough SO_2 during skin contact and cold soaking to inhibit undesirable microorganisms. For whites, keep fermentation temperatures below 60°F. Use a yeast that will tolerate the brix of your grapes to avoid stuck fermentations, and add yeast nutrients as needed to maintain a vigorous fermentation, and in the case of reds, moderate aeration (splashing) to keep the yeast active.

GETTING STARTED

Stemming/crushing

Once your grapes have been harvested, you'll need to crush and destem them. Red grapes, however, can be destemmed without crushing using destemmers rather than 'stemmer/crushers'. In this manner, whole berries are collected and allowed to ferment. Make sure that all your equipment has been cleaned and sanitized as well as practical. The must (juice and split berries) or whole berries alone should be chilled while you adjust sugar or acid levels, cold soak your reds, get skin contact (whites and rosés, or add various winemaking additives to the fermenters, SO_2 , such as enzymes, fermentation tannins, nutrients, etc.

Optional: enzymes:

White grapes, enzymes can help with clarification (settling of solids), enhance varietal aromas by increasing the rate of skin breakdown, and also reduce the amount of bentonite needed to stabilize white wines. In addition, it can increase yield by breaking down pectins.

- **Scott:** Cuvee blanc. Rate: 10 g/1000# fruit
- **Scott:** Color Pro. Rate: 30 to 50 ml/1000#
- **Enartis** Zym 1000S, Zym Arom MP (improved aromas, need for bentonite reduced)

Red grapes, enzymes can increase the rate of skin maceration (breakdown), releasing more pigments, flavors, and aromas. It can also reduce herbaceousness and stabilize color

- Scott's - Color Pro, Lallzme EX or EX-V
- Enartis – Zym color, Zym color plus

Important tip:

- Add SO_2 and stir to disperse, before adding enzymes. Allow enzymes several hours before doing a 'preemptive' fining (for whites only) discussed below.

Optional: fermentation tannins
Commercial wineries often use 'fermenting' tannins to reduce oxidation, enhance aromatics, improve mouth-feel, remove proteins, and bind with anthocyanins (pigments) to create more stable color. Add to crushed grapes or settled juice or red grapes during cold soak. **Rate**: 5 to 15 g/hL or 2.5 to 7.5g/15 gal or .8g/5gal. **Important**: if you are planning on using an enzyme, add the tannins about 3 to 4 hours after the enzymes have had a chance to work.

Some choices for whites:
Tan Elegance (Enartis). **Rate**: 10 to 15g/hL (26 gal)
FT Blanc Soft or FT Blanc (Scott) — also good for moldy or high protein grapes, e.g., Sauvignon blanc, Pinot gris, Gewürztraminer, etc.). **Rate**: 5 to 15g/hL

Some tannins available for reds:
Tan Color, Tan Fermcolor, Tan Rouge (Enartis), **Rate**: 18 to 36g/hL (26 gal)
FT Rouge or Rouge Soft (Scott). They bind with grape proteins, preserving more of the softer skin tannins. They also improve color and structure. **Rate**: 20 to 50g/hL.

Skin contact: *white* and red grapes when making rosé wines:

- Crushed grapes and juice can be pressed immediately or allowed to sit for 2 to 24 hours before pressing.

- Some skin contact enhances varietal character, but too much may increases astringency or darken color.
- It's important to keep the grapes cool <55°F. Use dry ice, frozen water-filled jugs or refrigeration.
- Add 30 to 40 ppm SO_2 to protect juice, and mix well to disperse.
- Blanket container with inert gas. Dry ice releases CO_2 that can provide protection.
- If you are unable to chill the grapes sufficiently to protect them from spoilage bacteria, e.g., *Lactobacillus*, *Pediococcus,* etc.), you can use Lysozyme**.** It can be uses in high pH wines to prevent spoilage. Lysozyme will also prevent MLF later. If you add Lysozyme you will need to fine the resulting wine with Bentonite for heat stability or to prevent a haze from forming.

Cold soak: Skin contact for red grapes

Unless you are making a rosé, red grapes are fermented on the skins and seeds. Red grapes, prior to fermentation, are widely allowed to soak on the skins. The juice and skins are chilled using various methods, and allowed to 'soak' for 2 to 3 days or longer to enhance color and flavor extraction. Chill the must to 50°F or less. Closer to 40°F is preferable. Many home winemakers skip this step because it's difficult chilling and maintain large quantities of juice without a natural fermentation starting or wine spoilage bacteria getting started. (More listed below under **Fermenting red grapes** below)

Pressing reds:

- Transfer the must to the press basket and collect the free run juice as it flows out of the press screen or basket. Take your time when pressing and avoid extreme pressure. Fill your basket press about 80% full. Bladder pressing is gentler than a basket press—it generally results in wines that are less harsh and bitter.
- When you get down to the bottom of the fermenter scoop up the seeds and remaining juice and run through a large sieve to collect the wine. Discard the seeds. This helps to minimize harsh tannins in the wine.
- The wine that flows out of the press before any pressure has been applied, and the wine that flows out under relatively low pressure is called free-run. Some people prefer to keep the juice produced under high pressure, separate from the free run-wine because it can be more astringent. Bladder pressed apply less pressure and the there is little difference between the wine that flow early on with that that flows later. It's not until you get down to a very narrow stream and the 'cake' (skins and seeds) is hard packed. Another option is to use a fining agent like Clargel (Enartis) or Colle Perle (Scott) to remove harshness and astringency due to seed tannins. You'll need to rack the wine from the sediment that collects on the bottom of the container.

- You can convert bladder presses, which normally use water pressure, to work using compressed air. You will need s small compressor with an accurate pressure regulator to prevent damaging the bladder and screen. That could be very dangerous, and of course, you would lose the wine or juice. You don't need much air pressure to press the grapes — 8 to 10 pounds (per square inch works well.

Pressing white grapes:
- Add SO2 immediately after crushing and keep the must chilled while waiting to press.
- Press after the desired period of skin contact.

Settling (clarifying) the pressed juice (whites):
- Removal of solids minimizes harshness, astringency, herbaceous notes, and chance of forming reduced smells (stinky sulfury smells).
- *Clarifying* enzyme (see above) are commonly used by commercial wineries to help settle solids. Juice should be allowed to settle for at least 12 hours, then racked (siphoned) off the solid material for fermentation. This is particularly useful for Sauvignon blanc, Pinot gris, and Muscat. You can get good clarification in 4-6 hours using (Enartis ZYM 1000 S, SL or RS for Sauvignon Blanc); Scott **-** Cuvee Blanc or Color Pro.
- Various gelatins can be used to facilitate settling, as well, e.g., Clargel, Hydro Clar 20, Hydroclar 30, Pulviclar S (counter fine with Silica gel or Bentonite
- For some grapes, settling occurs rapidly and without the need for additions.
- Consider a preemptive fining agent (see below)
- Allow juice to settle until the solids have dropped to the bottom and the juice is nearly clear. This may take up to 24 hours in carboys in a cool room <60°F.
- Other options to cool: cover carboys with wet tee-shirts and moisten them periodically. You can also or immerse carboys in cold water.

Rack (siphon) settled juice from solids:
- Once juice is relatively clear, rack as cleanly as practical into fermentation container(s).
- Use a siphon hose with a baffle on the end to draw wine from just above the solids (lees). Tilt bottle toward you as the level drops to raise the level above the siphon tip to increase yield and minimize uptake of solids. A little solid material is not a problem. Discard the remaining sediment.
- Some grapes like Sauvignon blanc do not settle well or form a compact layer of lees. So there is still a lot of juice mixed in with the sediment. In this case, you can reserve the mixture after you rack and ferment it

separately using a preemptive fining agent. You may want to use either fining agent: Clargel or Colle Perle after fermentation to remove any harshness. In my experience the result has been general quite good and can be blended into the rest of the wine.

Preemptive fining: is done during cold-settling of white juice *or* at the start of fermentation. The purpose is to help settle solids, reduce bitterness and harshness, remove browning, improve aging potential and aromas, and minimize oxidation. It can greatly improve the quality of 'hard-press' juice. In addition it is reported to have a minimal stripping affect.

Recommended fining agents:

- Bentolact S (Scott) Bentonite and casein, **Rate**: 20-100 g/hL
- Claril SP (Enartis)—includes Bentonite, PVPP, casein, and silica gel. It is also used to treat oxidized juice. It removes oxidized polyphenols, increases clarity, reduces bitterness, and removes unstable protein. **Rate**: 50 to 150 g/hL,
- Protomix (Enartis) Bentonite, PVPP, plant protein and cellulose. It is used for clarification of must and removal of polyphenolic cmpds. **Rate**: 50 to 100g per 25 gal of must
- Bentonite — is very commonly used and widely recommended fining agent to remove proteins (heat stabilization) that can precipitate in the bottle during storage, particularly when the wine is warmed. Bentonite (Calcium- or Sodium-based) plus silica gel can be used to settle any fine particles that are slow to settle once the main deposit has dropped out.
- Pluxcompact (Enartis) a calcium-based form of bentonite produces more compact lees.

  Note: Add enzymes several hours prior to adding preemptive fining agents. They can inactivate an enzyme before it has had a chance to work.

The need for bentonite fining of whites wines prior to bottling depends on the amount of proteins in a juice or resulting wine. Protein levels are largely dependent on the grape variety, vineyard location and practices, the vintage, and how the grapes are handled during pressing and crushing. The longer the juice is exposed to the skins and the more the skins are manipulated, the greater the protein content of the wine. Precipitation of unstable proteins can happen quickly when the wines are exposed to warm temperatures. It usually takes longer to develop under good cellar temperatures. Sediment detracts from the appearance, but does not affect flavor.

Other fining agents:

- PVPP — removes browning, bitterness in juice. **Rate**: 5 to 50 g per 25 gal
- Gelatins — can clarify juice, and reduce potential astringency in both red and white juice/must

- Potassium Caseinate — reduces astringency and bitterness by binding with excess phenolic compounds and is used to treat oxidized must. **Rate**: 20 to 50 g per 25 gal
- Silica gel — helps settle Bentonite (counter-fine). Rate 40 – 100 mls per 25 gal

Note: Hydroclar30, and Noblesse (not a fining agent) can help reduce sensation of heat and dryness in reds when added during or before fermentation

Websites: www.scottlab.com/products; www.enartisvinquiry.com

Testing the juice:

- Reserve a sample of juice/must to test: °Brix, TA, and pH. You may also want to get a nutrient analysis to determine the amount of nitrogen in the grapes available for the yeast (YAN—Yeast Assimilable Nitrogen)

Adjusting °Brix:

- 1°Brix = 1% sugar (wt/vol), or 1 gram sugar in 100 mL of water.
- Measure sugar by using a hydrometer or refractometer. You may need to adjust for temperature.
- **Raising °Brix** 1 degree add 1.25 lbs sugar/10 gal or 556g/10gal. That's 56g/gal of juice. When adding sugar to must you have to reduce the amount of sugar to account for the volume occupied by the skins and seeds. For example: 1000 #s of grapes usually produces about 100 gal of must or 70 to 75 gal of wine using simple grape presses, so the amount of sugar will be 20 to 25 percent less.
- **Lowering °Brix**, dilute must or juice with water. This is done to reduce the amount the alcohol in the finished wine. Alcohol produces a hot sensation in the mouth that distracts from the wine. Higher °Brix wines are also more difficult to ferment.
- When you harvest very ripe grapes >28 °Brix consider draining off a portion of juice equal to the amount of water that will be added.to reduce the sugar content because adding water will dilute flavor to some extent. This helps compensate for the added water by increasing the skin to juice ratio. You end up with the same liquid to skins ratio as you had before the water addition. The juice that is 'bled' off can be used to make a very nice Rosé. In that manner, the bulk of the resulting wine will have better balance.
- You must acidify the water by adding 6 grams of tartaric acid for every liter of water used (23 grams of tartaric acid per gallon to avoid raising pH.
- Calculating how much water to add:

  Equation 1: $(V^1 \times SB) / DB = V^2$
  Equation 2: $V^2 - V^1 = X$

  SB = Starting °Brix
  V^l = volume (in liters) of **undiluted** must*

DB = desired °Brix
V^2 = volume (in liters) of the **diluted** must
X = volume of water in liters to dilute the must to the desired °Brix

*To convert gal to liters, multiply by 3.79

For example, if you had 60 gal (228L) of must at 27 °Brix and you wanted to dilute it to 25 °Brix, you would need to add 18.24L of water:

228L x 27 = 6156/25 = 246.24
246.24L – 228 = 18.24 L of water

To convert to gallons *divide* 18.24 liters by 3.79 (liters per gal.) = 4.8 gal

Reference: 1hL (hectoliter) contains 100 liters (L) or about 26 gal (100 ÷ 3.79)

Wine/juice pH (H^+ conc.) is a measure of the chemical reactivity of a solution.

- pH is a measure of acidity (g/L) based on a logarithmic scale. Acidity increases 10-fold for each whole number on the scale 14 to 0. It decreases 10-fold for each whole number from 0 to 14. For example, the acidity of pH 3 is 10 times greater that of pH 4 and a 100 times greater than a pH of 5. A sparkling wine with a pH near 3 is much tarter than a red wine with a pH close to 3.8. A pH of 7 is considered neutral, neither *acidic* nor *basic*. Above 7, solutions are considered *alkaline* (*basic*), and below 7, they are acid.
- **The thing to remember about pH is that the higher the pH, the lower the acidity, and the lower the pH, the higher the acidity.**
- pH is important because it affects how a wine feels in the mouth and its stability with respect to microorganisms. Low pH inhibits undesirable microorganisms in wine. It also determines the level of SO_2 needed to keep a wine stable. **The lower the pH the less SO_2 is needed!**
- Malolactic fermentation lowers acidity or raises pH of wine. It's hard to prevent ML fermentation in a red or white wine with a relatively high pH.
- Test pH using a calibrated meter. GENCO offers this service.
- Normal pH range for most white wines is 3.2 to about 3.6. A wine with a pH of 3.2 will taste crisp or slightly tart depending on structure and balance. A white wine with a higher pH would be softer in the mouth.
- The ideal range for reds is 3.4 to 3.7. Often, very ripe red grapes are 3.7 to 3.8, occasionally higher. **In general, the higher the Brix, the higher the pH**.
- High pH wines (>3.75) can taste quite good but are relatively short-lived. In general, they should be adjusted to a more favorable level. It's critical to keep SO_2 levels high enough to avoid spoilage or oxidation.
- Tartaric acid can be used to lower pH as well as increase TA (see below).
- Adjusting the pH of a must/juice can be difficult. Each batch of grapes is unique and may respond differently to the same acid addition. Acid

additions will cause the TA to go up, but may do little to change pH. If you have a high TA and a high pH, there is little you can do to raise the pH without increasing TA to an undesirable level.

- Measure pH after the juice has settled
- **Lowering pH:** 1 g/L or 3.8g of Tartatic acid per gal of juice/must or wine generally decreases pH by 0.1 units (e.g., 3.7 to 3.6), but will increase TA by about 1.0 g/L. For example, to reduce the pH of 5 gallons of white juice/must from 3.6 to 3.4, you'll need to add 38 g of tartaric acid.
- Make acid adjustments *incrementally* to avoid over-acidification. After each addition, taste the juice/must and measure pH to see the result. Then determine if more acid is improves or diminished taste.

TA (total acidity)

- can be measured at a wine lab or with standard equipment sold at wine-making supply outlets. GENCO offers this test as well.
- is measured as grams of acid per L (liter) of wine/juice.
- A TA of 6 g/L can also be expressed as 0.6% TA)
- The TA of most white grapes ranges from 7 to 9, and 6 to 8 for most reds.
- Because TA will drop during fermentation and MLF, it's a good idea to adjust red must to 7 or 7.5.
- When adjusting TA for red wine must, consider that 60 to 70% of the must is actually juice when calculating how much Tartaric acid to add.
  - add 1g/L or 3.8 grams of Tartaric acid per gal to raise the TA of juice by 1 g/L or 0.1%
  - to lower TA add 2.35 grams of Potassium carbonate per gal (.62g/L) of wine to raise pH (reduce acidity) by 1g/L or 0.1%, add 2.55g/gal (.67g/L) if using Potassium bicarbonate
  - calculator: http://www.winebusiness.com/tools/?go=winemaking.calc&cid=24

Fermentation white grapes:

- Keep juice cool: <60F
- Used closed containers with airlocks.
- Allow plenty of head-space to avoid leakage due to vigorous foaming.
- Select a yeast appropriate for your grapes and with low to moderate nutrient needs.
- Add yeast at the rate of 1 to 1.25 g/gal. (for higher °B must)
- Experienced winemakers may allow their wines to ferment using the natural yeast on the grape skins.
- If you choose to barrel ferment your juice, consider using a neutral barrel or one that has been used previously. Wine made in new barrels, will need to be transferred to stainless steel or food-grade plastic containers once the desired level of oak has been extracted. Otherwise you'll end up with a wine that is over-oaked. Most used commercial barrels will be contaminated with ML, so MLF is likely to start on its own. To prevent ML, keep SO_2 levels high and/or use Lysozyme.

- MLF will soften white wines by reducing acid. Although this may be ideal for chardonnay it may be what you want for a Sauvignon blanc.

Fermenting red grapes: cold soak

- Cold soaking is thought to improve the extraction of color, flavor, and aroma. It's widely practiced within the industry, and used by many amateur wine-makers.
- If you do plan to cold-soak the must, keep it cold, 50°F or less, preferably closer to 40 °F until you are ready to inoculate with yeast. Chill the must with dry-ice, frozen-water jugs, or refrigeration. Replace frozen water jugs twice a day to prevent complete thawing. The cold will prevent natural yeasts from starting to ferment the juice, and spoilage bacteria from developing.
- You can actually add yeast to the must after crushing and then do a cold soak, as long as you keep it below 50°F. This will help prevent the development of spoilage organisms.
- In general, good extraction of color and flavor occur in 2 to 3 days.
- When you are done cold-soaking, allow the juice to warm up to above 55 °F and then inoculate with yeast. You can also allow the natural yeast on the grapes skins to ferment the juice. Typically, natural fermentations are slow to start. You have to be patient and ignore the smell of VA (volatile acidity), recognized as the smell of ethyl acetate (finger nail polish-remover) that often develops before the fermentation becomes vigorous. VA nearly always goes away once the fermentation begins in earnest.
- One novel approach to facilitate a natural fermentation is to place 5 to 10 pounds of grapes in ziplock bags and store them at room temperature. You may need to open the bags occasionally to release pressure, or the bags could burst if the pressure becomes too great. The native yeast on the grapes will build up in these bags and can serve as a starter for the bulk of the juice, assuming it reasonably smells good.

Yeast rehydration and nutrition:

- Most yeast cultures are freeze-dried and should be rehydrated as directed, rather than added directly to the fermenter.
- Follow instructions on the package. You can rehydrate the yeast in 10 to 20 times its volume in chlorine-free bottled water (like Geyser Peak), but <u>not</u> distilled water. You need water that contains minerals. Heat the water to 102 to 104, (a microwave oven work well) add the yeast and allow to stand covered for no longer than 20 minutes. Make sure that the water is not hotter than 104.
- Yeast often requires more nitrogen, amino acids, vitamins, micro-nutrients, etc., than is often available in the grapes, particularly very ripe grapes.
- This can result in the production of H_2S (rotten-egg smell), VA, and stuck fermentations.
- Adding yeast nutrients: some people add DAP (diammonium phosphate), an inorganic form of N, containing ammonium ions (commonly used in

agriculture as a fertilizer. Commercial wineries may use DAP, but usually in conjunction with other organic forms of N, and usually only when the Nitrogen level of the grapes is low.

Managing nutrient levels: Unless you had your juice/must tested, you will not be able to manage yeast nutrition accurately. Having the testing done is expensive, so most people 'wing it' and things generally work out OK. Low nutrient levels can result in H_2S production or a stuck fermentation. Fixing the H_2S problem is relatively easy, but restarting a stuck fermentation can be difficult. Stuck fermentations are prone to oxidation and microbial spoilage. Some winemakers just add a set amount of nutrients and hope for the best. Another approach is to select a yeast that has a low nutrient demand, and to use modest amounts of nutrients. Also, grapes less than 24°B are less problematic.

Method 1: Nutriferm Energy or Nutriferm Arom and Nutriferm Advance (Enartis)

- Use one gram of yeast per gal of juice or must (more for high°Brix juice or must).
- Rehydrate yeast according to label instructions. There is no rehydrating nutrient used with this method.
- Allow the yeast mixture to cool down, allowing the warm yeast to acclimate to the cold must. A temperature difference of more than 15°F is detrimental to yeast.
- YAN — a measure of Nitrogen availability is an important consideration for managing fermentations. YAN is the amount of available or assimilable N is in the must or juice. It is expressed as ml of N per liter (L).
- Low YAN juice/must will often result in the production of H_2S (rotten- egg smell) during fermentation, or the fermentation will stop before all the sugar is converted to alcohol. This can result in the oxidation of the wine. Resolving this problems requires a lot of work and expense.
- Must with a YAN <125 mg N/L is considered low.
- Must with a YAN >125 but <225 is considered moderate.
- Must with a YAN greater than 250 mg N/L generally doesn't need any nutrients.
- For a LOW YAN, add Nutriferm Energy or Nutriferm Arom (Enartis) at yeast inoculation. Rate: (Nutriferm Energy) at the rate of 15 g/hL (~25gal), or Nutriferm Arom at the rate of 40g/hL
- For MODERATE YAN add Nutriferm Energy at the rate of 10 g/hL or Nutriferm Arom at the rate of 30g/hL
- DAP may be needed when °Brix of the juice/must is 24°B or greater. Add DAP 12 hours after inoculation at the rate of 10 to 25 g/hL (.4 to 1g/gal

DAP addition for grapes at 24°B and above

low YAN)	*moderate* YAN)
24 °B add 10g/hl	5g/hL
25 °B add 15g/hl	10g/hL
26 °B add 20g/hL	15g/hL

27 °B add 25g/hL	20g/hL
28° B add 30g/hL	25g/hL

- Note: 1g of DAP in 1hL (~26 gal) will provide 2mg N/L per gal, so 25 g will add 50mg N/L
- Although DAP stimulates yeast growth because it contains high levels of Ammonium Nitrogen, it provides no additional nutrients. Therefore, it can't solve nutrient deficiency problems. It is recommended for higher sugar and if the YAN, is low <125mg N/L.
- Nutriferm Advance (20 to 30g/hL) is then added at 1/3 sugar depletion.
- Enartis (Vinquiry) has a Yeast Nutrient Guideline sheet. The use of this information is dependent on testing to determine the actual YAN.
- If you don't want to spend the money to test for YAN, you can assume that the YAN is low to moderate and use a yeast with low nutrient requirements. Then use moderate amount of nutrients. In this manner you won't add excess nutrient.
- If H_2S develops, your YAN levels were probably very low, and you can then add DAP to raise the YAN.
- Don't add nutrients, including DAP after the fermenting must/juice drops below to about 12 °Brix, as the yeast are unable to absorb it.
- You will just have to deal with the H_2S using CuSO4 or Reduless (Scott)

To convert mls to ounces divide by 29.4), Mililiters (mls) are roughly equivalent to grams.

Method 2: Fermaid K and Go-Ferm (Scott).

- Fermaid K is a yeast nutrient containing amino acids, organic and inorganic N, minerals, DAP, and other chemicals. It is added after yeast inoculation or as soon as the fermentation is visible active.
- Yeast inoculation: In general, below 24.5 °B, use one gram of yeast per gal of juice or must. Above 24.5 add 1.25 to 1.5 g per gal, depending on °B.
- Rehydrate the yeast using Go-Ferm, a yeast-rehydration nutrient.
  Use 1.25 grams of Go-Ferm mixed in 25 mls (.85 oz) of clean, chlorine-free water for each gal. *For example*: if you are fermenting 15 gallons of must you will add 18.75 grams of Go-Ferm mixed into 375 ml (12.75 oz) of water. Use a chlorine-free bottled water, like Geyser Peak or similar. Don't use municipal or distilled water.
- For °Brix over 24.5 — use 1.25 g yeast per gal of juice/must. You'll also need to use 1.5 g of Go-Ferm in 30 mls of water for each gal of juice/must. *For example*: for 15 gal of juice add 18 g of yeast, 22.5 g of Go Ferm in 450 ml (~15 oz) of water
- Heat (microwave) the Go-Ferm solution to 104° F, add the dry yeast and allow it to rehydrate for about 20 minutes. If the temperature is much above 104°F, you can kill or stress the yeast.

- Add a small amount of the must to the yeast mixture to cool it, and allow to stand for another 20 minutes.
- After 20 minutes add more juice to yeast mixture (about ½ the volume to the yeast solution to acclimate the yeast.
- Allow rehydrated yeast to cool to about 70°F before adding to juice. A temperature difference greater than 15°F is detrimental to yeast. Once the yeast mix is sufficiently cool add to the must and stir.
- Add Fermaid K at yeast inoculation or within a few hours. Application Rate: 25 g/hL (~1g/gal). Add .5g/gal at start of fermentation and another at ⅓ sugar depletion (usually an 8-10 °Brix drop). You can also add the full-1g/gal or at the 1/3 point. Avoid adding nutrients when the fermenting juice is below 12°B.

- **Other yeast-based nutrients or adjuvants** can be used at the start of fermentation to improve mouth feel, reduce astringency and bitterness, improve aroma and balance, reduce the perception of alcohol and dryness, reduce the potential for H2S, and/or reduce oxidation. In general. These products increase the levels of polyscahaarides.
    - For whites, Scott's OptiMUM White, Booster Blanc. Enartis': Pro Arom, Pro R, Pro Blanco, and Pro Round.
    - For reds: Scott's: Booster rouge or Opti-Red, at start of fermentation: Enartis: Pro R, Pro Tinto, Pro Blanco, Pro Round
    - Nobless can reduce the production of S-based compounds in white or red juice, reduce the perception of alcohol in the resulting wine and impart a perception of sweetness.
    - See **Aging wines** 'Sur-lie' (below)

During fermentation (whites):
- Stir the inoculated juice until the fermentation is visibly active.
- Try to keep temperatures below 65°F. 60°F or less is preferable)
- Evaporative cooling can be used to keep fermentation temperatures low. For carboys place small-sized T-shirts over the container and keep wet. Evaporation removes heat generated by the yeast, helping to cool the fermenting juice. Large-size T-shirts work well beer kegs. Larger stainless steel tanks can be wrapped in fabric. But the cooling effect is less for larger containers due to the small surface area in relation to volume. Smaller fermenters can be placed in low, flat tubs or trays, like those used under plants or water heaters to catch excess water and act as a reservoir, allowing water to wick-up the material.
- Household air conditioners can also be used to lower fermentation temperatures. Most air conditioners, however, don't cool much below 64F. So, it's necessary to use a specialized electronic device (CoolBot) to override the thermostat. Set to device to maintain a temperature around 58F.
- Stir daily to release any volatile sulfur-based compounds, keep yeast suspended, and to lightly aerate the fermenting juice.

During fermentation (reds):

- Red wines are fermented in open-topped containers: macro bins, 32-gal food-grade containers, open-topped stainless, or plastic tanks.
- The optimum temperature for growth of common wine yeast is about 77 F.
- According to yeast producer Wyeast, red wines should be fermented between 70 and 85 degrees F. Better color and tannin extraction at the higher end of this range.
- Allow the temperature to rise naturally after yeast inoculation. Temperatures often reach or exceed 85°F.
- Fermentation at higher temperatures may have adverse effect on the wine in stunning the yeast to inactivity and even "boiling off" some of the flavors of the wines.
- Once the fermentation becomes active and the skins rise to the top, carried by the CO_2 gas released by the yeast. They form a cap that floats on the juice.
- To extract pigment, fruit aromas, and tannins, the developing wine should remain in contact with the skins as much as possible. Therefore, it's necessary to push ('punch down') the cap that forms down into the juice 2 to 3 times a day. A commercial grade potato masher, available from restaurant supplies and the Beverage People, works quite well to do the punching.
- Punching down is a good way to keep the yeast in suspension and to introduce some oxygen needed by the yeast. It helps develop supple tannins, and reduces sulfide problems (reduced (stinky) smells). It also allows undesirable fermentations aromas to blow off.
- Mix up the sediment that collects at the bottom of the fermenter. Pull up the punching tool quickly, to create an updraft that will carry the sediment to the top. This also helps aerate the wine, facilitating the fermentation and releasing off odors.
- Another approach to ensure adequate aeration is to splash the fermenting wine by bucketing it into another similar container or back into the original container. This can be done when the juice is vigorously fermenting and evolving a lot of CO_2 that protects the wine from excess oxidation. It also minimizes the chance of H_2S production.
- If you detect stinky sulfur compounds (rotten egg -hydrogen sulfide) early in the fermentation, it's probably due to low nutrient level. The quick solution is to increase nutrient levels with DAP, Fermaid K or Nutriferm Energy/Nutriferm Advance. Hydrogen sulfide may also form if the grapes were sulfured close to harvest.
- Don't mash or grind the seeds that collect on the bottom, this will release astringent tannins.
- Temperatures in the wine under the cap (floating grape skins) should generally not exceed 75 to 78°F. The temperature within the cap, however, should reach 85°F or slightly higher, depending on the yeast, for a short time.

- Yeast tolerance to high temperature ranges from 80 to 90+°F.
- Check the temperature range of the yeast you're and try not to exceed it. High temperatures can stress the yeast and lead to a sluggish fermentation.
- High temperatures can result in stuck fermentations.
- Longer, cooler fermentations are thought to produce better red wines as long as the wine reaches the optimal temperature for a short period.
- Monitor for off-odors or sluggishness.
- **Something new**: One way to reduce tannins in the finished wine is to press early — at about 5 or 6 °Bricks and finish it in a barrel. Australian winemakers and others who have done this, say the resulting wine seems softer, and the color is unaffected. There is less tannin contribution from the seeds.
- Another innovation to minimize tannins and phenolic compounds is to remove the seeds from the fermenters once the fermentation is well underway. You could do this when you splash the fermenting juice. Because most of the seeds settle to the bottom. Transfer, the skins in the cap and juice below to another container, leaving the seeds at the bottom. The remaining wine and seeds can be separated by pouring it through a large kitchen sieve (restaurant supply).
- Fermentation is nearly done once the cap settles back into the wine on its own.
- Some wine-makers press at around 3°B and finish the wine in a barrel or aging container. At this point, an airlock is needed. Remove as many of the seeds as practical when you press. Once you transfer the skins and most of the wine to the press, remove the seeds on the bottom of the fermenter. Collect the seeds that remain in the container and separate them from the wine by using a sieve
- Advanced wine-makers may want to consider an extended maceration — leaving the finished wine in contact with the skins (see below).

Stuck fermentations: You will need to re-inoculate with a special yeast that tolerates high levels of alcohol, and add some nutrients. Consult with Vinequiry, Scott or the Beverage People for a protocol and products to resolve this problem**.** Lysozyme can be used to manage stuck fermentations to prevent spoilage (lactobacillus bacterial spoilage).

End of fermentation: When the hydrometer reads 0°Brix, the wine still has some remaining sugar. A reading of -1.5 to -2 indicates the wine is essentially dry.

For white wines:

- At the end of fermentation, the spent yeast (lees) settle to the bottom of the container.
- Check for off-odors. If you detect stinky sulfury compounds, add $CuSO_2$ or Scott's Reduless and then rack the wine several days later, leaving the precipitate behind.

- Add SO_2 ~ at least 45 ppm when the alcoholic fermentation is done to protect against oxidation, and prevent malolactic fermentation or bacterial spoilage.
- For wines that will age on the lees (sur-lie), retain much of the fine sediment (mostly dead yeast cells) and top containers to remove most of the head-space. (see ***Aging wines on the lees*** below)
- Measure pH again and adjust pH or TA as needed.

For red wines:

- *Extended maceration*: Finished red wine can be left in contact with the skins for 1 to 2 weeks or longer to soften tannins. It seems counterintuitive, but the additional time on the skins, seeds, and stems can actually soften the tannin structure of varieties that are typically tannic or astringent (cabs and syrah, etc.). The finished wine is covered and sealed with plastic wrap and blanketed with CO_2 or Argon. The temperature is kept warm — 68°F or higher — ideal for MLF. This technique is for advanced winemakers because problems are more likely to develop. It does not always result in a better wine. Color may be negatively affected. Some commercial winemakers are not fans of the practice. Do some research before you decide to experiment.
- Press finished red wine to remove skins and seeds. Try to remove as many seeds as possible before pressing. Most seeds remain on the bottom of the fermenter and can be screened out. The solids in the pressed wines will settle out quickly. Allow 1 to 2 days of settling before racking the wine into oak barrels, beer kegs, carboys, etc.
- It's important to get rid of the unwanted solids (gross lees) in the wine after pressing. The solids that settle out in the first 24 hours impart harshness and bitterness. If left in contact with the wine for an extended period, they can result in the formation of sulfides — smelly sulfur-based compounds that can ruin the wine unless you know how to handle the problem.
- It’s convenient to use 5-gal carboys to rack into, preferably those made from of food-grade plastic, for settling and handling. Rack the wine off the solids into barrels or other aging-containers as cleanly as possible.
- Use a siphon wand with a baffle to rack without picking much lees.

Malolactic fermentation (MLF):

- Although MLF is referred as a secondary fermentation, it is not a true fermentation. Fermentation involves the conversion of sugar to alcohol.
- ML bacteria convert malic acid to lactic acid, effectively lowering the wine’s acidity and raising the pH. Depending on the ML culture used, or the naturally occurring strains, it may impart a buttery (lactic acid) quality particularly in Chardonnay. It also improves mouth-feel or body.
- Some whites, like Chardonnay may benefit from MLF and most reds wines ‘automatically’ undergo MLF. Many winemakers, though, inoculate with a culture to better match the characteristics of the wine and control the timing of this important ‘secondary’ fermentation.

- Although MLF often starts spontaneously, commercially available cultures are convenient to use, take less time, start working quickly and have been selected for specific attributes, such as tolerance to high alcohol or certain pH levels.
- MLF is usually initiated at the end of the alcoholic fermentation. This is referred to as a sequential fermentation. It allows the yeast to complete the alcoholic fermentation without having to compete with the ML bacteria for nutrients. This is done because ML bacteria may convert some of the grape sugar to acetic acid (vinegar), particularly likely if the main fermentation sticks. This is more of a problem with high °Brix juice/must. Sequential fermentations are slow because the bacteria is added to wine high in alcohol and low in nutrients. That's why ML bacteria have been selected for their tolerance to high alcohol and why ML nutrients are used. The ideal range for MLF is 3.2 to 3.5, and the free SO_2 should be below 10 ppm and a total below 50 ppm. For wines with a pH greater than 3.5 use a MLF culture that is designed for high pH wines.
- A new approach is to inoculate ML bacteria 24 hours after the addition of yeast to the juice/must. This is referred to as co-fermentation. It is most appropriate for juice/must that is under 25°Brix and nutrient levels are relatively high or adjusted to a reasonable level. The advantage is that ML finishes quickly after the alcoholic fermentation. There is no need to keep the wine warm for a long period of time and the wine can be protected with SO_2 shortly after the main fermentation. So, there is less potential for oxidation and bacterial spoilage such as Brett. Newer research demonstrates that this approach produced wines that are much the same as those produced by sequential fermentations. Wines that are prone to stick should not be co-fermented. Fermentation temperatures should be keep to >85 F to avoid killing the ML bacteria. Don't add ML nutrients until after the alcoholic fermentation is done. ML bacteria can absorb ammonia Nitrogen.
- MLF is done in an enclosed vessel with an airlock to minimize oxidation.
- Adding SO_2 after the primary fermentation may inhibit MLF.
- It's important to understand that if you add 50 ppm at the start of fermentation in an open top fermenter, some of it will be lost to the atmosphere, much of the remaining SO_2 will bind up with various components in the wine, and some will remain in the free form. More than 10ppm free SO_2, however, may inhibit MLF
- According to MoreWine: If you add 50ppm SO2 (total) before fermentation you will probably wind up 20–25ppm (total and 0–10ppm free. Levels that won't inhibit MLF.
- It is important to use selected and reliable strains of ML that will dominate the MLF and complete the process.
- Scott Labs makes several freeze dried bacterial cultures for inoculating wine. Alpha works on wines up to 15.5% alcohol, and up to 50 ppm (total) SO_2. It also works at temperatures >57ºF. Beta work on wines up to 15 alcohol and up to 60 ppm SO_2. Enartis products include Enoferm ML

Silver (alcohol to 15+, pH >3.1, 45 total and 10 free SO_2) and Enoferm ML One (alcohol level to 14, pH >3.2, 40 total and 10 free SO_2).

- Nutrients contained in the light lees that remains in the wine after the gross lees is removed at the end of the primary fermentation can provide adequate nutrients for the developing bacteria. It is important, though, to stir the lees 1 to 2 times a week until MLF is done to keep the dead yeast in suspension allowing them to release their bound nutrients. If the spent yeast settles and forms a compact cake at the bottom, nutrient availability will cease.
- To be ensure that the MLF goes quickly and finishes, use an ML nutrient such as Acti ML or Nutriferm ML, particularly if the MLF is sluggish, or you had a H2S problem during the primary fermentation, or the grapes were very ripe.
- Use Acti-ML at the rate of 20g per 60 gal wine. Mix in 5 times its weight in chloride-free water at 77°F, and add bacteria. Wait 15 minutes before adding to the wine.
- If using Nutriferm ML, add 20 to 30 g of per hL (~25 gal) and dilute in 100 mls of chloride-free water, mix and add to the wine. Hydrate the ML bacteria in the foil packets as recommended by the manufacturer, and add to the wine. The packets contain 2.5g of Ml bacteria,—enough to treat 66 gallons of wine.
- Ideally, the temperature of the wine during MLF should be 68 to 70 for a quick ML conversion. This may require heating a room for several weeks or using an electric blanket to keep the barrel/container warm. Some amateur winemakers use a small aquarium heater inserted into the wine. It's important that the wire attached to the unit can be securely sealed to prevent oxidation.
- CO_2 bubbles are released from the wine during the conversion process. If you put your ear to the bung hole you can hear the popping or pinging as the bubbles break the surface. As long as the fermentation is active, CO_2 gas is being releases and the wine is protected from oxidation. But when the reaction is slowing down and the airlock is being removed to frequently to check on the progress, oxidation can occur.
- It's a good idea to gas the tank or barrel every time you remove the airlock to stir or check progress.
- When you can no longer hear the bubbles popping, test the wine to see if the MLF is done.
- It usually takes 3 to 4 weeks to complete, depending on temperature. The warmer it is, the faster the process.
- Wines that have not completed MLF will generally start again in the bottle, resulting in a carbonated wine and off-aromas.
- A test reading of 30ppm or less indicates completion.
- Sulfite the wine as soon as the wine tests negative for ML.
- Check the free SO2 a few days after the addition.
- Lysozyme can be used to prevent ML or stop it at some point to maintain acidity at a desired level. White wines above pH 3.3 may start on their own

in the bottle if SO_2 the level is not kept high enough. **Note**: You will need to use Bentonite to remove proteins that will settle out, when wines treated with Lysozyme are exposed to warming. Other clarifying agents do not perform this function.

Aging wines on the lees ('sur-lie'):

- The intent of aging wines on the lees (sediment) is to increase the level of polysaccharides and mannoproteins. They are non-fermentable sugars and derived from grapes and dead yeast.
- Polysaccharides have been shown to reduce oxidation, to improve wine stability, aroma, body (mouth-feel), protein stability, and to reduce astringency.
- It is suitable for wines with no off-aromas.
- You can age the wine in the original container (carboy, keg, or stainless tank).
- If you transfer the wine, stir up the lees, add SO_2, and allow to settle for an hour of two and then rack (siphon) into the new container, leaving the heavies sediment behind.
- Stir 3 to 4 times a week for the first month to prevent sulfur problems (H_2S, and other S-based compounds (reduction). The lees will absorb O_2 for about 6 weeks, reducing oxidation potential. Stir 1 to 2 times a week thereafter.
- Length of time on lees will depend on the complexity desired.
- Carefully smell and taste at each stirring to make sure the wine is progressing as intended.
- Rack if wine develops off-aromas or desired character is achieved.
- Maintain proper SO_2 levels at all times during sur-lie aging unless the wine is undergoing ML.
- If you prefer to rack or the wine has developed an off-aroma, you can increase the polysaccharide content by adding various products, such as Pro R, or Pro Arom (Enartis) or Booster Blanc, Optimum White, Opti-White, or Nobless (Scott) at the start of fermentation. Nobless has the added advantage of Imparting a sensation of sweetness, reducing off-odors, and the sensation of dryness and hotness from too much alcohol in the final wine.
- Enartis' Surli Elevage, Surli Round, and Surli One can be added to racked wines during maturation to increase polysaccharides. Surli Elevage works quickly and can be added just before bottling to soften a wine.

Post fermentation: aging and clarification

- Rack 2 to 3 times during the aging process.
- Do final racking just before bottling.
- Smell wines every couple of weeks for a month or two after fermentation for off-notes, rack if you detect stinky sulfur compounds. Additional copper or Reduless can be used —followed by racking.
- Maintain adequate free-SO_2 levels.

- Purge air space in storage or aging containers with argon gas or other inert gas every time you open to smell, taste, or test for free SO_2.
- Consider using oak barrels for reds. Uses barrels are readily available and inexpensive. They will need to be sanitized and properly stored. Because a 60 gal barrel holds about 24 cases of wine, you may want to form a partnership, so you don't have more wine than you can deal with.
- You can occasionally purchase used 30-gal barrels or reconditioned (like new) 30s (ReCoup). The problem is that a new or reconditioned barrel will impart too much oak in the wine, so it will have to come out early and be stored in another container, preferably a neutral barrel.
- Whites can be aged in barrels, but will probably undergo MLF unless the barrels are new or ML-negative.
- Oak cubes, sticks and barrel-inserts can be used to impart the desired level of oak in the wine.
- Keep barrels topped (check every 2-3 weeks, at the very least, monthly).
- Use fining agents as necessary to clarify wines, remove haze, browning, heat-unstable proteins (whites), or reduce sulfur defects, astringency or bitterness. Do this well before bottling.
- You may want to use a polysaccharide product, like Surli Elevage (Enartis) at this point to improve mouth feel or use a cellaring tannin to, improve structure, improve aging potential, lower sensation of alcohol, add a sensation of sweetness, or a note of vanilla or toasty oak.
- Cellaring or finishing-tannins such as Riche (Scott) can be used to add a note of French oak, vanilla, and sweetness, and reduce sensation of alcohol. Enartis has a number to choose from: Tan Nature, Tan Rich, Tan Extra, etc. They're not cheap.
- Cold stabilize wine over the winter. Allow temperature to drop below 40F degrees in cellar for 4-5 days.
- Aging— bottle most fruity whites aged in stainless or glass after 6 to 8 months. Barrel-aged chardonnay is best after 10-12 months of barrel time. Big reds are best after 18 to 24 months. Pinot noir needs 12 to 14 months in wood.
- Filtering may be beneficial depending on objectives.

Sulfite (SO_2) levels:
- Keep barrels topped-up and minimal head-space in containers.
- Top frequently — cellars with low humidity need to be topped more frequently. Top evert 2 weeks if evaporative loss is more than a few ounces.
- Purge air that enters containers with inert gas each time they're opened.
- Avoid SO_2 additions after primary fermentation is done if you plant to do MLF.
- When MLF is complete, add sulfite and store in a cool area once.
  Measure free SO_2 monthly and keep close to the recommended levels based on the wine's pH (see **USE OF SO_2 TO ENSURE GOOD QUALITY WINE** above:

- SO2 management above). Keeping the SO_2 levels a little higher than what's recommended for the pH, will help avoid levels dipping significantly below the desired level between SO_2 testing.
- Wines can easily lose 15 to 20 parts of SO_2 during racking, so it's important to either add additional SO_2 before racking or check the free SO2 level a few days after racking to see where the wine is.

Wines with residual sugar:

- Potassium sorbate is used to help stabilize a wine that "finishes' with a little residual sugar or one that you want to add a bit of sugar to reduce dryness or enhance fruit. It inhibits yeast reproduction and will stop the fermentation or prevent the added sugar from fermenting in an already dry wine. It will not, however, stop an active fermentation.

- Add at the rate of .5 to .75 grams per gallon (125-200ppm) in conjunction with 50ppm SO_2 per gallon. Use the higher end of the range (200 ppm) as the wine's pH approaches or exceeds 3.5 or when the alcohol content of the wine is below 10%.

- Don't add Potassium sorbate to a wine that has not undergone or is likely to undergo ML fermentation because the bacteria will metabolize the sorbate and create an odor in the wine similar to rotting geraniums!

- Bottle with high SO_2 to prevent ML or sterile filter to remove it. **Lysozyme** can prevent a wine from undergoing ML.

Fining agents:

Bentonite: is the recognized treatment for white wines to remove solubilized proteins that can be settle out later when the wine is warmed. Rate: 20 to 120 g/hL (25 gal.) (see discussion on **Preemptive fining** above)
Silica gel: a counter-fining agent to facilitae removal of bentonite. Rate: 25 - 75 mls/hL
Isinglass (Finecoll Enartis): gentle clarification, removes bitterness, oxidative and herbaceous character. *Rate*: 1 to 4 grams/hL (25 gal)
PVPP: Stabyl (Enartis): removes bitterness
Sparkolloid (Scott Labs) can be used to create brilliant white wines, and does not strip character if used in moderation. It can be used after bentonite to help compact lees or to remove haze left by other fining agents. Rate: Hot Mix: 12-48 g/hL/ (26.4 gal) or 2.5-10g/5gal wine or .5g to 2g per gal.
Egg white: used to remove excess tannins and reduce astringency. Rate: I to 3 eggs
Potassium caseinate: milk protein used to treat oxidized and bitter wines.
Clargel (Enartis): removes excessive astringency. Rate: 50 to 150ml/hL
Claril SP (Enartis): bentonite, PVPP, potassium caseinate, silca. Use for pre-emptive fining. Added at start of fermentation 50 to 150 g/hL
fining, reduces bitterness.
Colle Perle: a gelatin sold by Scott that removes excessive astringency.

Copper sulfate: When added to wine, copper sulfate's copper ions chemically bind undesirable sulfides, e.g., H_2S, and fall to the bottom as a solid precipitate. The reaction occurs quickly and the deodorized wine can then be racked off the lees.

Gum Arabic: more of a stabilizing agent than a fining agent. Use to reduce tartrate formation in refrigerated wines, prevent deposits from forming in the bottle, enhance moth-feel and impart a sweet sensation.

Potassium caseinate: milk protein intended to remove bitterness, oxidation slight off-flavors, excess oak flavors, and bitterness

Gelatins: Used to reduce astringency. There are many to choose from. Both Scott and Enartis have a number to choose from.

Fenol (Enartis): an activated charcoal, can reduce the aroma of Brett or smoke taint.

Ascorbic Acid, (Vitamin C) added as an antioxidant 0.05 to 0.15 g/L (5 to 1.5 #/1000 Gal) works a little better than SO_2. Works well for white wines when added before bottling. For Ascorbic acid to work properly you must have significant Free SO_2

Racking: The sediment that collects on the bottom of carboys, tanks and barrels following grape crushing, fermentation, or aging of wine should be removed (aging sur lie is an exception) to improve clarity and stability. This is done by siphoning the clear wine/juice through a flexible hose using the force of gravity or an electric pump. A siphoning tube with a baffle on the end is inserted into the wine down to a point just above sediment. The baffle prevents uptake of the sediment by drawing the wine from above. In this manner, most of the sediment remains behind. For gravity to work the wine container must be higher than the receiving vessel. This may present a problem for containers larger than 5-gal carboys. Special lifting devises are available for beer kegs and even full barrels. Barrels on tall racks can be siphoned into carboys, which can then be elevated to siphon the clear wine back into the barrel once it has been racked cleanly.

Winemakers commonly rack 2 to 3 times during the aging process. Some people rack after MLF is done or in the early spring to remove sediment, and again mid-summer and/or just before bottling. There is merit to leaving wine on the lees, but you'll need to do a little reading about it. Reds can be left on the lees without racking until just before bottling. The bottom line is to rack if the wine develops off-odors. Racking aerates the wines usually dissipating most objectionable odors.

Electric pumps are a quick and efficient way to transfer wine. One concern though, is that they agitate and aerate the wine to some extent. It's important to make sure the hoses attached to the pump are tight fitting and do not draw air from the outside. Most of the aeration occurs as the wine move through the air-filled hose and mixes in the pump. Once the hose and pump are filled with wine, there should be no further aeration. Aeration also occurs when the container empties or when the level falls below the siphon hose and the pump is allowed to run. It's important to turn off the pump when the barrel empties and air begins to enter the hose. You can hear this when it occurs and also hear the wine bubbling. Any wine remaining in the hoses and pumps can be poured out into the new vessel. Wine near the bottom of the container is usually mixed with sediment. This can be collected, placed in a glass container and allowed to settle for several days. Rack the relatively clear wine off the heavy sediment. Sparkaloid (hot mix) (.5 to 1 gram per gal) can be used to clarify whites. It takes at least a week for a cloudy wine to become clear. Reds that have been settled can be used to top up the container. You'll have to add some topping wine to replace the sediment and whine that couldn't be salvaged. If you don't have any topping wine, one solution is to buy Two (now) '*Three Buck Chuck*.'

The exposure to air during racking and pumping and transferring to other containers will cause some of the free SO_2 in the wine to bind up with the oxygen. So, it's a good idea to test for SO_2 in a few days and adjust as necessary. You could also add 15 ppm of SO_2 as a safeguard and test in a week.

Filtering

Filtering is done to help stabilize wines, improve appearance, and, in some cases, how a wine tastes. Standard 1micron filters can be used to remove most particulates, a .45 micron filter can be used to remove bacteria and yeast, but it may not remove all of them. Nominal filters, which are normally inexpensive, are those that remove most of the particles equal or greater than micron rating. Absolute filter cartridges, those that remove all particles equal to and larger than the stated micron rating are more reliable, and are available for the standard filter housing used by many home wine-makers. They are about $75 each (More Wine), but can be used repeatedly after back-flushing. They can be used to prevent ML in the bottle or protect a wine with residual sugar, remove Brettanomyces, or just polish a wine. Unless there is a bacterial problem, most reds can be filtered with nominal filters. Absolute filters are best suited to white wines. There is really no truth to the claim that filtering strips a wine of some of its character. This claim is not supported by research and many commercial winemakers are split on the issue. In general, it improves a wine, and in many cases quite significantly.

Other resources:
Fermentation Handbook from Scott Labs www.scottlab.com
White wine-making guide available from morewinemaling.com

Helpful numbers: conversions
1 pound per 1000 gal, = .012 g/l or .453 g/gal
1 egg white = ~30 g
1 g = largely to 1 ml
1 ml =.001 liter (l) or there are 1000ml in 1 liter
1 pound = 453 g
1 ounce = 29.4 ml. To convert mls to ounces multiply by .0338 or divide by 29.4
1 gal =3.785 l
1 T = .5 oz or 14 g
1 T = 3 tsp
1 tsp = 5 ml
1hl (hectoliter) = 26.4 gal
1 liter = 0.26 gal
1 gallon = 3.785 liters
1 kilogram = 1000 g or 2.2 pounds,
1 gram = 0.0353 ounces
1 milliliter (ml) = 0.2 tsp
1 tsp = 5 ml

1.0 g/L
= 0.10 g/100 mL
= 100 g/hL
= 100 mg/100 mL
= 1000 mg/L
= 1000 ppm
= 1.0 mg/mL
= 1000 µg/mL
= 0.1% (wt/vol)

1 lb/1000gal
= 454 g/1000 gal
= 0.45 g/gal
= 0.12 g/L
= 120 ppm
= 12 g/hL

Reduction in wines is one of the most common problems in winemaking. Hydrogen sulfide and other volatile sulfur-containing compounds are commonly produced during alcoholic fermentation, but they can also develop during storage and ageing, as well as after bottling. The aromas generated by these sulfur compounds are usually described as rotten egg, burnt rubber, skunky, burnt match, asparagus, onion and garlic.