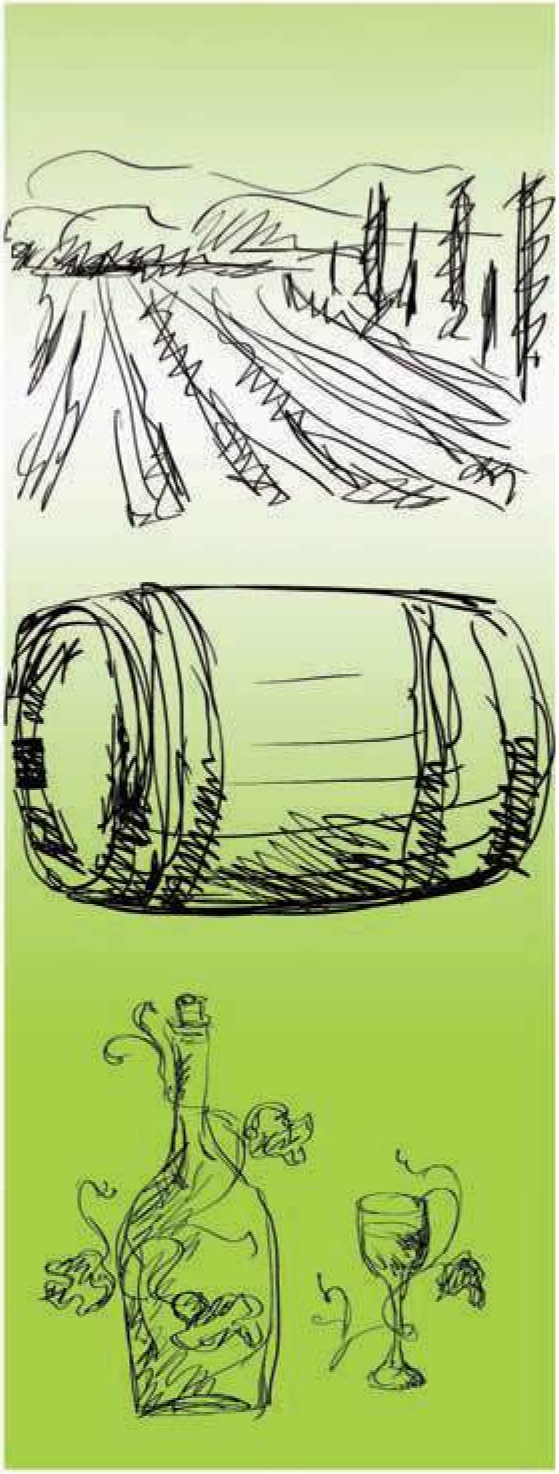
MoreWine!™

Guide to White Winemaking



Written by Shea AJ Comfort

Contributions by Tristan Johnson

Edited by Tristan Johnson, Mike Theisen

Goal of this Manual: **To make <u>Great</u> wine at home in your first try!**

It is highly recommended that this paper be read through completely before you start to make your wine. Wine-making is made up of a series of consecutive steps which build on and directly affect each other from the very beginning to the very end. In order to make the best wine possible you will need to make the best decisions possible at each of these steps, and in order to do that, you will need to have a general understanding of the overall process as a whole.

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Introduction

Hello, and welcome to *MoreWine!*'s Guide to White Winemaking. We're excited that you're interested in learning to make wine, and we're hoping that you're at least as excited about the idea as we are! We think that you'll find winemaking to be at the same time relaxing and invigorating, rewarding and taxing, and a practically limitless source of entertainment and learning. Winemaking has the ability to teach us not only about the world around us, but about ourselves as well.

Winemaking is certainly a very old and established activity, the roots of which go back thousands of years. Over the history of the practice, many great texts have been written outlining the process and giving direction to generation after generation of winemaker. Today is no different; there are currently quite a few great books about winemaking available on the market. The purpose of this booklet is not to take the place of a more complete text, so much as to give the new winemaker a more digestible place to start from.

The basic process for making white wine is pretty straightforward. Fresh grapes are pressed to release their juice and strained to remove the solids. Specialized yeast is added to the juice (now called *must*) and fermentation begins. During fermentation the yeast consumes the sugar from the fruit, converting it to alcohol and carbon dioxide and the juice becomes wine.

Once fermentation is completed, the wine is set aside for ageing. Over the next 6-12 months the wine will be allowed to age and develop its flavors. During this time you may choose to add oak, tannins or a variety of other types of additives to the wine to augment or change its flavor. Also, depending on the style of wine you are making, the wine will be transferred one or more times to a fresh container (called *racking*) in order to separate it from the sediments that naturally settle out of the wine during the ageing period.

At the end of the ageing phase you may choose to add a clarifying agent to improve the wine's appearance and increase its stability over time. Treating a wine this way is called *fining* and the additives used to do it are called *fining agents*. In addition to fining you may also choose to filter your wine to clarify it. Finally, based on a variety of factors that we'll expand on as you read further, you'll decide that the wine is ready to put into bottles. After a short period of recovery from the bottling process, your wine will be ready to drink!

While reading through this booklet, there are a few things we'd like you to keep in mind. The first, and most important, is that there is very little in winemaking that can really be considered a "right" or "wrong" way to approach a problem or procedure. The favorite maxim on this subject is that if you ask 10 winemakers the same question you are likely to get 11 different answers. Another favorite maxim on the subject of winemaking is that it takes a lot of good beer to make great wine – but more on this later (please contact us if you're interested in making beer, we can help you with that too!). So, if, with the exception of a few cardinal rules, there is no real right or wrong way to make wine, then why have we dedicated the time and energy to adding yet another booklet on the subject to those already available? The answer is that over the course of many years we have found that certain techniques offer the greatest chances of success, especially to the first-time winemaker. It is only too easy to have something go wrong which spoils a batch and causes the new winemaker to lose interest or inspiration. Our goal with this booklet is to minimize the chance of this happening and maximize the chance of you sticking with this wonderful, rewarding pastime. There will be things in this booklet that contradict what you have read in other books, or have heard from your friends or relatives who already make wine. We want you to understand that neither we nor they are necessarily wrong. The steps and techniques laid out in this booklet are simply what we have found to work best for the majority of our customers after years of experience and feedback. We'd like to encourage you to experiment with new products and techniques - and to please contact us with any questions you might have about anything that you see in here.

We'd also like to encourage you to start and maintain a winemaking logbook. Keep track of all the measurements you make regarding sugar, acid and sulfite levels (don't worry if you don't know what these things are, we will go over everything!). Record tasting notes and detailed notes about any procedure that you put the wine through, including any changes that you notice as a result of your procedure. Too often we get phone calls from home winemakers that have a question about their wine and we are unable to help out because the winemaker has kept no or very poor records. We really cannot stress enough how important good record-keeping is. Imagine pulling a wine that you made 3 or 4 years ago and just loving it, but not having any records to refer back to about what additives or fining agents you used. Unless you can remember everything you did with the wine 4 years ago, a record book will be the best resource for you if you want to recreate your best wines. Conversely, if you make a wine that has problems or that you just don't like very much, a record book is the best way to avoid repeating the mistakes or procedures that led to the bad wine.

Finally, a quick word about the format of this booklet: The text is divided into 9 chapters and is designed to take you through the winemaking process in a step-by-step fashion all the way from picking (or picking up) your fruit through to bottling. Each chapter of the booklet covers a particular phase, stage or aspect of the whole winemaking process. What you'll find in Chapter Nine is an Expanded Information section which corresponds to each of the other chapters of the booklet. We've set the text up so that you'll get the "nuts and bolts" of what you're doing at each stage up front. If you wish to learn more about the "why" as opposed to just the "what" of that particular process just flip back to Chapter Nine and find the corresponding section. Our aim here is for you to have a quick reference guide show you what you need to do, as well as the basic theory behind it, in an easy to navigate package that will stay within arm's reach in the winery for years to come.

So, all that said, let's get to it!

Chapter 1: Preparation & Preplanning

(Any time before fruit arrives!)

Getting ready to make wine

Before we can get into the mechanics of making wine, we need to go over the steps required to prepare.

1. **Source Your Fruit**

There are a variety of resources available to home winemakers nationwide when it comes to sourcing fruit. These sources range from the vineyard down the road to a commercial broker of wine grapes. Many home wine and beer making shops maintain a bulletin board where local grape growers can post ads for their fruit. M*oreWine!* offers high-quality frozen juice from Brehm Vineyards which is available in 5 gallon pails and can be shipped straight to your door by UPS. We also maintain a free online bulletin board that you can find at www.MoreGrapes.com. As much as possible, we encourage you to develop a direct relationship with the grape grower. We suggest this for a couple of reasons. First, a direct relationship often gets you the best price on the fruit and the best chance of getting the fruit again in subsequent seasons. Second, working with the same fruit year after year will give you the best chance to develop as a winemaker, because you will be able to see how different yeasts and additives affect wine made from the same vineyard. You will also see how differences from one growing season to the next can influence the fruit.

2. **Get Your Equipment Together**

If this is your first season making wine, there are a few different options for obtaining equipment. We suggest, if possible, that you rent the major equipment like a grape crusher and a wine press if from a local shop that offers these. Many regional winemaking clubs have group equipment available. If renting or borrowing equipment is not an option for you, you can also try to find the major items you need in used condition either through a local classified ads website like Craigslist or, again, through a local home winemaking club. Be wary of used equipment as the condition of the equipment can be substandard. Check any steel equipment for rust and any rubber parts for cracks or brittleness. These flaws cannot be effectively repaired. If you find any rust or cracked, brittle rubber these parts must be replaced. This can be difficult if you're looking at older equipment as spare or replacement parts may not still be available.

3. **The one with the most information wins**

There are important differences between red and white winemaking. Unlike red winemaking, where you can crush the fruit and immediately begin the fermentation without any other steps or preparation, white winemaking requires carrying out a series of steps before the juice undergoes fermentation. In addition, the juice for white wine is more delicate and prone to oxidation. This means that it is less forgiving to technical mistakes, so special attention must be paid to protect it during processing. On average, white winemaking is more technical and less forgiving than red winemaking.

However, this doesn't mean you should be scared off from trying your hand at making white wine! If you take the time to learn about the techniques and required handling procedures that are laid out for you in this manual *before* you begin crushing your grapes you will find white winemaking can be extremely rewarding- you just need to know the proper steps to take to be successful. This manual has been designed to present this information. Many of the concepts and techniques that will be discussed such as pre-emptive fining and lees management may be new to some of you, but don't worry. You do not need to adopt every single one of them to see improvement in your wines. However, many of these techniques will allow you to make nicer, more stable wines. Ultimately you will need to decide if they are right for your style of winemaking. Let's get started!

Chapter 2: Prepare the juice for fermentation

(Days 1-2)

White wines are made using only the juice from the fruit, the solids are not included. In order to separate the juice from the solid parts of the grapes, we must crush and press the grapes before the fermentation begins. Once we the juice is processed (also called "must") we test the pH, TA, and ºBrix. pH and TA are measures of acidity, while the ºBrix tells us how much sugar is in the juice. There are general ranges where we would like each of these to be in order to create a nicely balanced wine. If the pH, TA or ºBrix of our juice happens to fall outside of the recommended ranges, we will need to adjust them (determining and adjusting these factors will be explained in detail later). Then, yeast is added and fermentation begins. These steps make up the basic foundation of white winemaking and will be the focus of this chapter. In addition, there are a few "advanced" processing steps that we can incorporate into this basic foundation which can really help improve the stability and overall quality of our finished wines. These "advanced" techniques are not hard to do, but success lies in understanding what is required from a technical standpoint to avoid doing more harm than good. Let's take a closer look at how everything comes together**.**

We Picked up the Fruit!

Ok, so you've harvested your fruit or purchased some grapes and brought them home. First, examine the fruit and remove any raisined or rotted/molded clusters. Hopefully the grower will have picked the fruit when the sugars are in the correct range (17°-24° ºBrix*). You can request this service, so don't be afraid to ask. If the sugars are outside of this range, you will have to address this after the crush. (Either by adding sugar to raise the ºBrix, or by diluting the must to lower the sugars. See section **2.8 A** for a full explanation of adjusting sugars.)

**Note: Brix is the scale most often used to measure sugars in winemaking: 1ºBrix = 1% sugar (wt/vol), or 1 gram sugar in 100 mL. You can measure ºBrix with a refactometer (MT700) or a standard hydrometer (MT310) - just take your reading off of the ºBrix scale and not the Specific Gravity scale. The grower or your source for the grapes should be able to tell you the ºBrix level because this should determines when they are picked.*

2.1) Prepare to Fill the Press: Crush and De-Stem the Grapes, or Leave as Whole Clusters

When processing white wine grapes, there are two options; either crush and de-stem them first or just add them straight into the press. The pros and cons to both techniques are listed below, but for the most part the majority of white wines are made by de-stemming and crushing before going into the press.

Note: Whichever method you choose to obtain your juice, <u>we recommended processing the grapes cool if at all possible (50-55F)</u>. Doing so will help retain delicate aromatics in the final juice, slow oxidative reactions, and help the SO_2 delay any unwanted microbial activity! Picking/processing early morning or at night is a very effective means of achieving this. If you are lucky enough to have access to a walk-in fridge/freezer this is a great way to get the grapes cool before processing. However, you will need to make sure they don't get too cold either or the yeast may have a hard time getting started!

Crushing before pressing:
Since you will be pressing the fruit anyway, the berries don't need to be completely mashed – just removed from the stems. For small amounts, this can be done by hand. If using a crusher-destmmer, unwashed grapes are added directly to the top hopper on these machines. The grapes are crushed by the rollers and fall through the grate below into your fermenter. The separated stems are ejected out of the unit by the "destemming bar." These machines are available in manual and electric versions. The combination of juice, skins, seeds, and pulp that falls into your holding vat is now called "**must**".

Pros:

- Allows winemaker to work with skins if desired (so any style of wine can be made).
- No fear of extracting harsh stem tannins during pressing.

Cons:

- Requires crusher-destemmer**.**
- Exposes juice to oxidation before it gets to the press (this can be avoided and we'll explain the techniques needed to protect against oxidation in the next section).
- Some grapes may clog the press and require multiple breaking-ups of the press cake in order to drain completely (this can be addressed by adding rice hulls or a portion of the stems along with the must when filling the press; see "pressing" section below).

Whole Cluster Pressing:
Not all white wine grapes are destemmed before being crushed. In fact, Champagne production exclusively uses *whole-cluster* pressing. This creates a delicate, lighter-styled wine that is great for making sparkling wines, but if you are after something that will be more full-bodied, destemming and crushing before pressing may be a better choice. However, if you do choose to whole cluster press, remember that the presence of the stems can create an over extraction of harsh tannins and other potentially undesirable compounds if you squeeze the fruit too hard. Remember to taste often once the pressure is being applied during the press cycle to avoid picking up too much astringent/green characteristics in the pressed juice.

Pros:

- Does not require a crusher-destemmer.
- Limits the juice exposure to oxidation before going into the press.
- Stems help the press cake drain completely, increasing the yield of juice/grape solids.

Cons:

- Does not allow winemaker to work with skins, can only make light and delicate wine.
- Very possible to extract harsh stem tannins during pressing.

2.2) Let's Clean the Slate – Adding SO_2 (Potassium Metabisulfite) During Processising

One of the keys to a successful fermentation is removing any native wild yeast and bacteria from the must prior to adding your special winemaking yeast. Wild yeast and bacteria can consume sugar from grape juice just as easily as your special yeast can, but generally produce some pretty terrible flavors in the process. In addition, many wild yeasts are less tolerant to high alcohol levels, and may stop fermenting before all of the sugars have been consumed, creating a "stuck" fermentation. If this happens, left-over sugar could be used as a food supply for any spoilage organisms present, and the wine will be compromised. Therefore, Potassium Metabisulfite (A.K.A. "sulfite", "meta" & "SO_2") is added immediately after you crush to "clean the slate" of these unwanted guests*. The amount used is usually just enough to kill or at least inhibit spoilage organisms, but not enough to bother the more sulfite-tolerant, cultured yeast strains that we recommend using. If your grapes are in good condition, free of mold etc., add 50 ppm ('parts per million') of SO_2 based on the <u>total volume of the must</u>. If the grapes are not in good condition, add more sulfite to counteract the presence of the mold and bacteria- up to 100 ppm. However, be aware that levels of SO_2 above 50 ppm will inhibit a Malolactic Fermentation if you choose to do one (a full explanation of MLF can be found in **Chapter 5**, and section **9.10**). The 50ppm dosage rate at the time of the crush is usually fine. For each 5 gallons: 50ppm equates to 1/4 tsp or 1.6 g SO_2.

> ** SO_2 is used extensively in winemaking to control oxidation and microbial contamination. This is the first of several points in the process where you will be adding SO_2 to protect and preserve the wine.*

To best protect the delicate white wine juice from oxidation it is best to add the sulfite as soon as the grapes have been broken open. Therefore, the timing for when you add the SO_2 will be different depending on the type of juice processing technique you choose to employ. Either way it is recommended to sulfite a little at a time as the juice is coming out of the crusher or press to start protecting the juice as soon as possible:

- For every 5 gallons of must coming out of the crusher or juice coming out of the press, add 50ppm of SO_2 (1/4 tsp, or 1.6 g SO_2).

Note: The sulfite addition made during the crush usually becomes entirely "bound-up" by the end of the alcoholic fermentation. During the wines' ageing and storage, only the "free" portion of the SO_2 addition is actually contributing to the protection of the wine. Therefore, keep in mind that this first addition isn't part of the sulfite level that will be later needed to protect the wine during its storage and ageing.

For more comprehensive information on SO_2, see sections 6.5 and 9.4

Types of SO_2

We recommend SO_2 in 2 specific forms for addition to your wine, Potassium Metabisulfite (most common) and Efferbaktol. Potassium Metabisulfite is often shortened to "meta," "SO_2," or "Sulfite," and comes in a white powder form. It can be dissolved into water and added to must or finished wine. Our preferred format for sulfite is in the form of effervescent, self-dissolving and pre-measured granules called Efferbaktol. SO_2 is also available as "Campden tablets", which look like aspirin. Campden tablets are made from Sodium Metabisulfite, a less desirable form of SO_2 and must be crushed prior to use. However, they're easily measurable in small doses.

Efferbaktol packets:

Sizes: Available in **2g** (AD503A), **5g** (AD504A), and **10g** (AD505B) packets.

2g adds 528ppm per gallon, **5g** adds 1320ppm per gallon, **10g** adds 2640ppm per gallon.

To add the right amount of SO_2 for your fermenter using Efferbaktol, divide the ppm by your gallons of must to see how many ppm of SO_2 will be added:

Let's say you have 10 gallons of must. The 2g packet offers 528ppm per gallon; divide 528ppm by 10 gallons to get 52.8ppm, close enough to our desired 50 ppm. To use: Tear the bag open and add directly to the must or wine. Mix thoroughly. Easy and clean.

About Efferbaktol: It takes 2.5 grams of product weight to give 1 gram of SO_2. So, the 2 gram packet of Efferbaktol actually weighs 5 grams. This is useful to remember when dividing dosages between vessels while using a scale. If the individual dosages are done at the same time, this is not a problem. Once opened, you should immediately use the entire contents of the package because it begins to lose its effectiveness when exposed to moisture in the ambient air.

SO_2 in Powered Form:

Sizes: Available in 4oz (AD495), or 1lb (AD500) bags

0.33 grams per gallon results in 50ppm. For 10 gallons you would need 3.3 grams of powdered meta-bisulfite. If you do not have a gram scale, ½ teaspoon (level) is about 3.3 grams and adds 50ppm to 10 gallons. To use: Dilute the sulfite powder in water until the crystals are completely dissolved and thoroughly mix into the must.

2.3) Fill the Press: Now or Later

The timing of filling the press depends on the technique of processing the fruit you decided to use:

- <u>Whole clusters:</u> Fill the press immediately, add SO_2 to the juice as it gets released during the pressing cycle.
- <u>Crush with no cold soaking:</u> Fill the press as soon as SO_2 has been mixed into the must post crushing/de-stemming.
- <u>Crush with cold-soaking:</u> Add SO_2 after the crush. When the soaking period is over, we fill the press.

<u>2.3 A) Soaking on the skins (A.K.A.: "Cold Soaking"): Wait to Fill the Press</u>

If you have chosen to de-stem and crush (remember to add SO_2), you have a choice of how soon to press. You can either start filling the press immediately or you can choose to allow the skins to soak in the juice for a period of time before separating them. The longer the skin contact, the more varietal characteristics will be infused into the juice. This makes for a bolder, richer wine. Enzymes can be added to the must to help with extracting desirable compounds from the skins (see below). However, there is a caveat: the longer you soak on the skins, the greater the phenolics (tannin), protein and potassium levels will be in the final juice! This is important because, depending on the grape varietal and the amount of time the skins are allowed to soak for, can cause a greater shift in the treatments needed to stabilize the wine when it is time to bottle. It *is* possible to overdo the soak and wind up with “too much of a good thing.” We recommend starting in the 4-8 hour range when trying cold-soaking for the first time. This allows you to get a good portion of the benefits of the technique while limiting the potential negative side-effects on future stability (more on this later).

If you are going to initiate skin contact here are some key points to keep in mind:

- Soaking times generally vary from 2-16* hours, with the 4-8 hours range being a good place to start.

- Yeast double every four hours at 68F (20C) and every 6-8 hours at 59F (15C). The SO_2 we added at crush inhibits bacteria and *most* indigenous yeast. However, there are wild yeast strains that are SO_2 tolerant. If present, they can become established in your must and potentially create off flavors and aromas. The way to control unwanted fermentation is by using both SO_2 and temperature:

    1. As long as you are adding your yeast within 4 hours of crushing any wild yeast that happens to be SO_2 tolerant will not have enough time to take hold and harm your must.

    2. If you will be soaking for more than 4 hours it is important to be able to keep the temperature of the must at 55F or below to avoid contamination problems. Any higher and you could get a spontaneous fermentation starting before you have a chance to inoculate! This is why this process is referred to as a "cold soak".

    3. <u>In summary:</u> If you cannot keep the must below 55F, then your options are to only soak for up to 4 hours or not do a cold soak. (Tip: refrigerating the fruit before processing, frozen water/soda bottles (sanitized before going into the wine!) or even dry ice can help keep temps down for extended cold-soaking.)

- If there are signs of any mold or rot on the grapes, *you will want to limit the skin contact, not extend it!* Grapes that are not perfect are not to be used for cold soaking.

- Taste the fruit: unripe fruit that tastes herbaceous will only magnify this flaw in the must when cold-soaked. If the fruit is not fully ripe, do not cold-soak.

- The SO_2 you added at the crusher is your friend, but it is only temporary. Using a blanket of inert gas (Argon, or CO_2) will help avoid oxidative problems during the cold soak period. The SO_2 and the inert gas should be thought of as internal and external protection respectively and work together as partners to protect the must from oxidation during the cold soak period.

- **Lallzyme Cuvee Blanc (AD353)** is a specialized enzyme that was designed to help release a greater amount of desirable aromatics from the skins during cold-soaking. To use: Cuvee Blanc is simply mixed with a small amount of water then added to the must during the crushing-destemming.

    Note: make sure that your SO_2 addition has been mixed into the must before adding the enzyme as high levels of SO_2 could interfere with the enzymes ability to do its job!

- **Tanin Galalcool (AD150)** can also be added to the must at the crusher to give oxidative protection during a cold soak.

2.4) Press the Grapes!

Pressing involves straining the liquid off of the solids, then squeezing the remaining skins and seeds (called *pommace*) to get the residual wine out, much in the same way you squeeze a sponge to release residual water. You can use anything from a nylon mesh bag (BAG24) draining into a food-grade bucket (FE345) for smaller batches to an actual wine press that can be purchased or rented for the day.

Presses can be broken down into two design types: traditional ratcheting basket presses; and newer style bladder presses:

- Traditional Basket Presses work by pressing down the pommace from the top of the holding basket using a heavy, cast iron, ratcheting mechanism (a very tedious and tiring process). Basket presses are affordable and time-tested, but there are a few drawbacks. During pressing they develop a pocket of juice in the center of the basket which needs to be broken up and re-pressed to get all of the wine out. In addition, the pressing forces required by basket presses are usually much higher than for bladder presses. As a result, it is very easy to get harsh and aggressive characteristics from over-pressing the seeds and skins. Finally, basket presses are difficult to sanitize and heavy to move around.

- Bladder Presses work by expanding a bladder using household water pressure via a garden hose. Since the bladder is situated in the center of the press, the grapes are squeezed from the inside outward in an even fashion, avoiding the formation of juice pockets. Bladder presses are quite gentle on the must and create a higher quality wine than basket presses. Furthermore, bladder presses don't require any physical effort to operate; a hose will do all of the work for you. Finally, bladder presses are easy to sanitize and lightweight enough to move around easily.

  **Note: If you do not already own a press and are lucky enough to live close to a winemaking supply/retail store like MoreWine!, you may be able to rent one. This is a great way to get the benefit of using a high quality machine on your wines without having to buy it up front. If you do decide at some point to go ahead and purchase your own press, (or Crusher / Detstemmer) you will know exactly which one is best for you.*

2.5) Pressing

There are several ways to get the must into the press. With small volumes, the most common method is to scoop the must out of the holding vat with a small bucket and pour it into the press. For larger volumes, you can purchase a must pump, which is a specialized large diameter pump with a rubber impeller to pump the must into the press. A must pump is a serious investment, but if you find that your production has increased over the years, it will be worth looking into at some point.

Free-Run **and** *Press-Run*

When you transfer the must into the press, a large portion of the liquid will run through the press before any pressure has been applied to the skins. This is called *free-run.* If kept isolated, it makes a lighter, more stable wine than the portion that is squeezed out of the skins, referred to as *press-run*. The pressed juice always has a higher level of protein, potassium, tannins, and solids than the *free-run* juice. These elements are concentrated in the skins, pulp, and seeds of the grape, and are extracted under the pressure of pressing. This can be both good and bad: on one hand, the skins contain a large amount of the varietal characteristic of the grape and extracting some of this character is often a benefit to our juice. However, at some point during the pressing cycle the tannin, potassium, protein and solids levels become over-extracted and we end up with a juice that has bitter, astringent characters that will be harder to stabilize (excess potassium creates cold-stability problems, excess protein creates heat stability problems. More on heat/cold stability in sections **2.7 & 7.3**).

In the end, you will need to be the judge of how much press fraction will go into your final juice and this is where the art of winemaking comes in! There is no set recipe for volumes and pressures to determine when the press is done; it will be different for every grape varietal and vintage. However, the following are good guideline to follow as you learn how to determine the end of the press cycle:

- Press lightly and taste the run-off frequently.

- Each press load will contain a unique ratio of seeds/skins/liquid. This means that even though two consecutive press loads may be coming from the same must, they will not behave the same. The end point of the press will be different for each of them!

- The major signal to stop is a "thin" taste from the must along with an astringent quality. Some winemakers separate these two portions of the press and age them individually. This practice can be difficult due to the need for two different sets of containers. You are welcome to experiment with separating the two runs. However, our winemaking has shifted back to blending free run and carefully-monitored press run together, as there are certain flavors in the pressed wine that we really enjoy (along with the lack of hassle).

A note about press draining: in some instances, depending on the type of grape you are working with (i.e.: Muscat and Muscadine) or the ripeness level of the fruit, you may have trouble getting the must to flow freely during the pressing because the quality of the skins causes them to clog the outlets. When this happens pockets of juice within the inner sections of the press cake are left un-drained and multiple actions of breaking-up/fluffing the pommace cake are needed for each press load. Each time the cake is broken up there is grinding. Ideally, as winemakers we would like to keep the amount of grinding of the grape solids to a minimum in order to avoid extracting too many harsh and bitter compounds from the solids. Therefore, if you are having trouble getting the press to flow freely and require more than two breaking-ups of the press cake to complete your press cycle, you may want to consider using one of these two suggestions: either reserve a portion of the stems for adding back to the must when filling the press at a rate of 10% stems/total must volume, or use rice hulls at a rate of 1:100 when filling your press (sprinkle the hulls in at a constant rate while you are filling the press). These will help to maintain the flow of the pressed juice through the press cake.

2.6) Refining our Pressed Juice: Settling Out the Solids

Once we finish pressing we will have a light green/yellow colored juice that will be very cloudy. This cloudiness is coming from fine grape particles/solids that have been created during the crushing-destemming and pressing stages. Removing these solids is highly recommended because doing so dramatically lowers the production of heavy, harsh, green/herbaceous, and sharp notes from potentially developing in our white wines during the fermentation. When the solids are removed we get cleaner, more aromatic and fruity wines. Quite simply: a clean juice makes a clean wine.

However, there are some technical requirements that may not make this a viable option for everyone. Settling our juice takes time and is only possible if we can ensure that during that time required to settle-out the solids our juice can be protected from oxidation and contamination from unwanted yeast and bacteria. In order to establish this protection we will need to be able to ensure the following:

- Correct, immediate SO_2 additions are made at the crusher-destemmer at regular intervals (see the SO_2 section above in **2.2**).

- If the juice will be exposed longer than 4 hours before being inoculated, (starting from when the juice is first exposed to the air) the temperature of the must should be kept at ≤ 50-55 F (closer to 50 F is better than 55 F) to delay microbial growth and slow oxidative reactions. Besides the danger of undesirable flavors and aromas being created in our wine by unwanted yeast and bacteria, the bubbling action of an active fermentation will effectively keep the solids in suspension and they will never settle out!

Note: A couple of ways to maintain cool temps are: chilling the fruit before processing (if you are working with your own vines or are close to the vineyard then harvest and process in the early morning); use a series of sanitized ice jugs submerged in the must during the settling period; settle carboys/covered buckets in a fridge; work in a cool cellar (air-conditioned/glycol).

- <u>The juice should also be protected from oxidation with a blanket of inert gas during the entire settling process</u> (for more info on inert gas, see section **9.5**)

- **Lallzyme-C MAX (AD354)** is a pectolytic enzyme preparation that was specifically designed to speed up the settling process. Typical results see clearing in 4-6 hours, even in difficult conditions, such as low pH, low temps, high pectin content.

NOTE: It is important to understand that any benefit that might come from allowing the solids to settle out of the juice is negated if a wild fermentation starts in your must and the solids never settle out due to the swirling/churning action of an active fermentation. If you are not able to keep the must at 55F or lower for the couple of hours required to settle out the solids then we recommend skipping this stage. In this case just go ahead and adjust the pH/TA and Brix right after you press and then add your yeast as soon as possible.

Once the settling has finished, you will have a layer of a light beige colored sediment at the bottom of the vessel and a layer of clear juice on top of it. The clear juice will need to be transferred off of this sediment layer into a clean vessel. This is called "racking" and can be done by using a gravity siphon set-up for small vessels (carboys and demi-jons), or with a pump. If you have access to inert gas it is highly recommended to purge the receiving vessel before it gets filled to eliminate the oxygen and avoid any oxidation reactions (*For a complete explanation of transferring wine, see section 9.6*).

Note about sanitization: At all stages in the winemaking process any tools and equipment that are going to come into contact with the juice or wine will need to be sanitized. This is done to eliminate spoilage yeast and bacteria that could contaminate our wine and ruin it. Sanitization is done in two steps:

1. *Make sure the surface area to be cleaned is free of any dirt, film or grime. If it isn't you will need to scrub it off with a sponge or scrub pad and water. Brushes and hoses can be cleaned with a long hose/line brush made for this purpose.*

2. *Once the surface is clean it can now be sanitized. This is done by preparing the sanitizer* and pouring, wiping, or swirling to make sure the sanitizer wets all surfaces needing to be sanitized. After a few minutes contact time, rinse the equipment off with fresh, clean water.*

   ** We recommend using Star-San (CL26) as your sanitizer, as it is much friendlier and easy to deal with than the traditional SO_2 and citric acid solution that is often referred to in many winemaking books. Unlike the SO_2 solution, Star-San has no dangerous fumes and is perfectly safe to come into contact with. In fact during our winemaking, often the first step when we begin working is to dunk our hands into a bucket of prepared Star-San!*

The clear juice can now be adjusted for pH/TA and Brix and fermentation initiated (see section 2.8), or we can choose to carry out one additional processing step and preemptively remove some of the browning agents and a portion of the protein before they can cause us problems later!

2.7) Preemptive Fining

<u>Fining: not just post-fermentation!</u>

Remember from chapter one that *fining* is the process of improving the wine by adding a specific product that will remove/lessen an unwanted element? Examples of this are egg white fining for removing excess tannins/astringency in red wines, or using Bentonite/gelatin to help a white wine clear out quickly post fermentation. However, fining is often done for more than aesthetic reasons in white winemaking, such as to reduce harshness, bitterness, and astringency along with limiting the potential for oxidative browning. In addition, fining is the only way to ensure heat stability (prevention of a potential protein haze) in a finished white wine.

The various compounds responsible for harshness, bitterness, astringency, and haze (phenolics, tannins, proteins, etc) come largely from the seeds, skins, and pulp and are released into the juice as soon as we process the fruit. In fact, the more the fruit is handled during processing; the greater the quantity of these undesirable compounds that will be in our final juice. The important part to understand here is that these compounds are already here in our juice before the fermentation has even begun. Once the fermentation is underway all of these compounds start knitting themselves together, becoming evermore intertwined as the wine ages.

All fining, by nature, alter the wine. A good way to think about this is to use an analogy of a house of cards. As the wine ages its various elements become increasingly interconnected through polymerization and a balance is struck in the overall balance of the parts. The longer we go the higher we build. However, when we remove one of these pieces by fining (for example to remove out a protein that could potentially cause a haze in the bottle) we will cause a shift in the structural balance of the wine and the wine will have to put itself back together again. Depending on how much of the compound that was removed, this can be a slight shift or the wine can change dramatically. This is why fining is a compromise and the goal should be to use the least amount needed to achieve the desired effect.

Now we come to the practical part: the best time to fine for removing a large portion of undesirable elements is in the juice phase before the wine has started to put itself together! This pre-emptive fining does not create a loss of aromatic quality, and it gives a greater heat and oxidative stability to the wine from the very beginning.

How fining works

The elements in wine that are subject to fining are usually positively or negatively charged. As with magnets where opposites attract and stick together, fining is the act of selectively removing a targeted element in the juice/wine. Tannins or proteins can be removed by using this principle. Add an oppositely charged element to the wine, and your targeted compound and the two smaller molecules interact to form a larger molecule that will stick together. Depending on the size of this newly created molecule, it will get pulled down by gravity and eventually settle out of the wine, or it will need to removed by filtration.

Preemptive Fining is used in juice to help treat the following problems:

- **Heat Stability**: All grapes contain protein. Depending on the grape varietal and the growing factors the amount of protein in our juice can be very little or quite a bit. In the beginning this protein is in a clear, solubulized form and it is relatively harmless. However, over time this protein can become unstable and flocculate out of solution (one way to think about this is to picture the way an egg white starts clear then turns opaque white when dropped into a boiling broth). The reactions are sped up when the wine is heated and this is referred to as a "heat stability" problem. The result is that a once clear wine will now suddenly see the appearance of wispy, white, fluffy clumps of material that look like a snow-globe when agitated. To avoid this from happening in finished wines, we need to remove this protein. In white wines***** this is done by adding Bentonite clay. The clay is negatively charged and grabs the positively charged protein out of solution and settles it out. This is a very effective treatment, but there is a downside: depending on the type of Bentonite used the lees can be very fluffy and result in a loss of wine volume when the treated wine gets racked off of the deposit. Sodium based Bentonite is very fluffy and for that reason it is usually accompanied by a light gelatin ("Ichtyocolle" (**FIN74**)) or silica-gel dosage to help compact the final treatment lees and therefore reduces volume loss. Calcium based Bentonites are not quite as effective as Sodium based ones so you wind up using a bit more to get the job done. However, they have the benefit of being very compact in the final lees so there is little loss of wine post treatment. Calcium based Bentonites also benefit from a light gelatin or silica-gel dosage, not for compacting the lees during settling but for clearing out any fine particles that may be slow to settle once the main deposit has dropped.

** Red wine must also contains protein at the early stages but the presence of seeds and skins during the fermentation creates a greater tannin presence in the* *finished wine. Since tannin is reactive with proteins the protein gets fined out as a natural by-product of red winemaking.*

- **Oxidation/Browning:** There are certain compounds (oxidative polyphenols) in must/wine that react with oxygen to create an undesirable brown color (the same way an apple turns brown after being cut open). When this happens, as an added insult to injury, a wine that was once fresh and lively becomes flat a dull. These polyphenols can be removed by fining with Casein, usually supplemented with PVPP. These are usually more effective when used together ("Polylact" **(FIN73)**).

  Note: If there is any rot in the grapes this will greatly increase the browning phenomenon. However this is from a highly reactive protein called "laccase" that is produced by the mold and is treated with Bentonite (not Casein or PVPP).

- **Bitterness/Astringency**: These negative qualities come from tannins and other phenolics and are found in the seeds, pulp and skins of the grape (especially if the fruit is not completely ripe). Depending on the source these can be softened or removed by using Bentonite, Casein, PVPP, and or Gelatin.

How to choose the specific product(s) and determine the dosage rates for fining is determined by when you will be using them:

- <u>Juice stage:</u> One of the beautiful things about preemptively fining in the juice stage is that the amount needed for each of the various fining agents is not as precisely regimented as it would be if treating the final wine. In fact, when treating the juice, we recommend following more of a "kitchen-sink" approach. Great results can be had by using a combination of products to cover all of your bases! This is why we recommended preemptively fining our white wine juice with "Polylact" a combination of Casein, and PVPP, followed right after with a dosage of Bentonite:

  "Polylact" (FIN73) use at a rate of 2 g/gal. Mix with 10x its weight in cold water and let it soak for 2 hours. Then mix a little bit at a time into the juice while stirring. <u>*It is important to mix it into the wine slowly while stirring or pumping because if you pour it in too fast it will clump and just float on the surface of the wine.*</u>

  "Albumex" Bentonite: (FIN51), use at a rate of 8 grams/gallon. Albumex has been prepared so that no swelling is needed before it is used. Just add it directly to the must right after adding the Polylact. Add a little bit at a time while stirring or pumping to ensure an even dosage on the entire juice volume.

  > <u>*Important Note: Albumex is a Calcium-based Bentonite which, as explained earlier, means a larger dosage (8 g/gal) is needed compared to Sodium–based bentonites to be effective. However, if you are using a Sodium- Bentonite, then we recommend you use a dosage rate of 1 to 1.5 g/gal.*</u>

  Once you have added the Polylact and Albumex, we recommend mixing the tank again around 1-2 hours after the initial dosage. This allows the fining to be more effective. The juice is racked once the deposit settles.

- Wine stage: Unlike the juice stage, when we get into fining in the wine stage we must be very careful and *bench-trials are definitely recommended!* (For complete information on bench trials see section **9.7**)

A final word about preemptive fining of the juice before fermentation: it does require extra handling and you do lose some juice to the process. However, what you lose in volume you definitely gain in quality... This may not be the technique you use for all of your white wines, but if you have the ability to keep the must cold, can protect the juice from oxidation with inert gas, and can be thorough with your SO_2, we highly recommend giving it a try.

Set Aside a Sample for Testing

Once you have your pressed juice and finished any refinement of the must, it is time to take out a cup or so (230 mL) for testing.

2.8) Test and Adjust the Juice

Before you add the yeast, you need to test the must to determine if any additions/corrections are needed. Very rarely will you get a grape that naturally has the required balance of acids, sugars, and pH necessary to create a harmonious wine. When one or more of these elements are out of their ideal ranges, the quality of the wine suffers. Any potential the fruit had to make a nice wine is significantly lowered. However, if you take the time to correct any possible problems and balance the must early on, the quality of the resulting wine will be better maintained. Correcting a must lays the foundation on which the wine will be built. Even slight adjustments can raise a wine from being just good to great.

2.8 A) Test the Sugar:

Before making any adjustments, double-check your °Brix after the grapes have been crushed and the must has had a chance to be completely mixed together. There is usually a bit of variation in sugar levels between each and every bunch of grapes that make up the whole volume. Interestingly enough, these differences are not only found in fruit coming from different sections of the same vineyard, but even off of the same vine. Therefore, the only way to get a truly accurate sugar reading for any must is to wait until the fruit has been completely processed and thoroughly mixed together. Ideally we are looking for the reading to be 17-24°Brix (17-24 g/L).

**Note: Testing the whole must once it has been homogenized also helps to make the TA and pH testing more accurate as well. (Information on TA and pH and why they are important will be explained shortly)*

You can measure the sugar level with a hydrometer or a refractometer

A hydrometer works by measuring the density of the liquid you're testing compared to water at a certain temperature. Temperature affects density, so it is important to have a sample close to your hydrometer's calibration temperature. If using a hydrometer: make sure to strain the sample of juice to remove any seeds and skins before filling the hydrometer jar. If the solids are left in the sample, these may cause the hydrometer to stick to the side of the jar, compromising the accuracy of the results. Another good technique for getting a clear juice sample is to place the sample in a freezer for 15-20 minutes. Decant off of the sediment that settles out. However, because a Hydrometer works off of the principle of density, and density changes with temperature, you will need to allow the sample to warm back up to 68º F before the results will be accurate because this is where most hydrometers are calibrated. The hydrometer jar should contain enough sample that the hydrometer is always floating. Wait until it stabilizes and read the number where the top of the liquid meets the scale on the hydrometer.

Note: Depending on the temperature of the sample, you should also add or subtract the amount indicated by the thermometer at the bottom of the hydrometer for the greatest amount of accuracy.

If using a refractometer, add a drop or two of the juice to the lens and close the flap onto it. This will cause some of the juice to squish out, which is normal. Next, wait 30 seconds for the sample to adjust to the temperature of the refractometer's prism. Then, hold it up to the light and look through it to see where the colored bar extends to on the scale. This is your ºBrix reading.

<u>When using a refractometer, make sure the glass lens is clean and dry, and reads 0 ºBrix when testing with plain water. If not, adjust/calibrate it with water according to the instructions that came with it. This usually involves turning a knob or a small screw while looking through it until it reads "0".</u>

<u>Once you have gotten a ºBrix reading for the must, record this in your notes and determine if you need to adjust the sugars or not:</u>

As mentioned earlier, you want a sugar level of 17°-24° ºBrix for the start of a white wine fermentation.

- If your sugar level is lower than 17° ºBrix, we recommend adding sugar to bring it up to the standard level (called *chapitalizing* the must). This is done with table sugar: 1.5 oz. of table sugar per US gallon of projected liquid raises the ºBrix by 1°. Measure the amount of sugar needed and completely dissolve it into a small quantity of warm water. The warm water ensures that the sugar will dissolve completely into the wine. This small amount of water will not be enough to dilute the wine. Alternatively, you can dissolve the sugar directly into the liquid from the must, but depending on how much you are adding, this may be difficult. Mix thoroughly into the must so that the sugar (which is heavier than must) doesn't wind up sitting on the bottom of the fermentation vessel.

- If your sugars are higher than 24 ºBrix, you may choose to leave the must as is and make a "big" wine. However, depending on your yeast strain, you may get a wine that does not ferment all the way "dry" (less than 1% residual sugar). To avoid this, you can dilute the juice to 17°-24° ºBrix with water.

For complete notes on dilution and chapitalization, see section 9.1.

<u>If you don't have a scale (MT358)</u>:
1 tsp of table sugar = 5 grams (.17 oz.)
8.8 tsp of table sugar = 43 grams (1.5 oz.)

2.8 B) TA and pH

The next two sections deal with testing pH and TA. These are very important elements to monitor during winemaking because they give us an indication of what is going on with the overall balance of the wine. TA measures all of the combined acids in the wine, (there are many different types) and tells you how acidic/tart the wine is. TA is expressed in either %TA or in g/L of Tartaric Acid. For example, a wine's TA could be expressed as 0.65% TA or as 6.5g/L TA. These two values are equivalent, and you can easily switch between the two common ways of expressing TA by moving the decimal point one place left or right. We prefer to express TA in of g/L because we feel it is easier to visualize: We are literally saying that the wine has 6.5g of TA per **L** of wine. The pH is a measure of how these acids balance out against buffering compounds such as Potassium. pH value also indicates how effective the blend of acidic and basic compounds will be at helping to protect the wine. pH is measured in pH units, pH values of less than 7.0 are acidic. The typical pH range for white wines is between 3.2 and 3.5.

Let's take a look at how these two parameters interact. Assume we have two white wines that each have the same TA, but different pHs, 3.1 and 3.6 respectively. The wine with a pH of 3.1 will have bright fruit flavors, but it will also be thin, acidic and aggressive on the palette. On the other hand, the wine at 3.6 will be softer and rounder than the wine at 3.1, but also less vibrant; the fruit characteristics will flatten out quickly. Ideally, we are after a wine that has the freshness and strong fruit characteristics of the lower pH wine, but with the roundness and approachability of the higher pH one. The key to achieving this lies in making sure the pH of the wine ends up somewhere in the middle of these two extremes, between 3.2-3.5 pH. Vigilant monitoring of your TA and pH will help you achieve this goal.

The importance of correctly preparing a sample for both the TA and pH testing: TA and pH are sensitive tests. It is important to properly prepare samples or we may get false results. The sample should be taken once the press is over and the entire volume can be homogenized by stirring. This is done because the free run will have a different level of acids and other compounds than the press fraction will. Stirring will even everything out and represents what we will be working with in the fermenter. Straining a sample of the must is also recommended because the grape solids (both large and fine) all have a different pH and TA than the juice itself. If they remain in the sample, they can skew the results. We only want to test the final liquid that is free of solids. To achieve this, first strain the blended fruit to get the larger solids out (a stray seed or skin that made it through the press). A fine mesh bag (*BAG10)* is great for this. Next, filter the resulting liquid to obtain a clean juice free of the finer solids (particles that make the juice cloudy). Paper coffee filters pushed into a wine glass are great for this. The resulting clean juice is optimal for TA and pH determinations.

<u>Steps to prepare sample</u>:

1. Strain blended must through a mesh bag into a bowl or jar to remove solids. Lightly squeeze bag if needed until enough sample has been collected: 50-100mL

2. Place coffee filter part way into a wine glass or jar (maybe use rubber band to secure it around the rim to keep it from falling in.) Pour sample into the filter and allow it to drip into the glass/jar: 30-50 mL. Use this sample to do the pH and TA testing on.

Test for the Total Acidity%

There are three methods used by the home winemaker to test for acidity:

- Method 1 – Basic: Test the must with an acid test kit (W501).

- Method 2 – Better: Use a pH meter with our Test Kit (W501). Run the same test using the acid test kit from the first method, only this time stir with the pH meter while titrating until it reads pH 8.2. Use this as the endpoint for the test in place of the color change. Calculate the results by following the acid test kits instructions exactly as in the first method.

- Method 3 – Best: Use the Hanna Acidity titrator (MT682). This is a machine that takes 30 seconds to give you a highly accurate TA reading. Great if doing large batches of multiple samples. Used by hundreds of commercial wineries.

Once you have tested your TA, you can decide whether it needs adjusting. Keep in mind that that wine chemistry is very complex. Often, the amount of acid we have calculated on paper is not the amount that winds up being the best choice for taste. This is especially true when working with larger acid additions (>.2%TA or 2 g/L). We recommend making ½ of the addition you think is needed, and then test <u>and</u> taste to see if the balance is correct or if the wine still needs more acid. This is definitely one of those times where art and science come together. Ideally, we are looking for the must to be in a range of 6.0-9.0 TA at the start of fermentation. So:

- If your acids are in the 9g/L-1g/L range, you will want to consider lowering them. One of the best ways to do this is a MaloLactic Fermentation, or “MLF” after the primary, alcoholic fermentation has finished (for more complete information on MLF, see sections **3.3**, **5**, and **9.10**).

- If your TA is significantly lower than .6g/L, you will need to raise it at least to this level by adding tartaric acid. Calculate the amount needed to raise your volume to the desired acidity level. Dissolve it completely into some wine or warm chlorine-free water and mix it thoroughly into the must/wine.

3.8 grams Tartaric Acid per US Gallon raises TA by +.1% (1 g/L)

<u>If you don’t have a scale:</u>
1 level teaspoon Tartaric Acid per US Gallon raises TA by +.12%
1 tsp Tartaric acid = 5 grams.

For in-depth information on acidity and adding acid to a must, see section 9.2

For a complete example of adjusting the TA of a must, see section 9.3

Check the PH:

A general fact that might be helpful when taking a wine’s pH into account is the higher the acid, the lower the pH. So, if your pH is high and you need to make an acid adjustment, the acid will also help to bring your pH down. The inverse is equally correct: if your pH is low, then lowering your acids (with a cold stabilization, chemical adjustment, or MLF) will raise your pH.

Optimally, the pH of a white wine should be in the 3.2-3.5 range. A pH above 3.6 indicates and unstable wine and will not have a long shelf life. pH under 3.1 generally indicates a wine that will be too sour. If you have a pH meter, now is the time to use it! If you do not (*MoreWine!* has a variety of models to choose from), it is probably safe to say that if your TA and sugars are at their correct levels, then your pH level is fine. However, be careful in years where you see rain on the vines just ahead of harvest, as this can cause the vine to leech additional buffers – compounds which interfere with an acid's ability to express itself in terms of pH – from the soil as a result of the rain. This often yields higher pH values than would be expected for a given TA value. Testing with a pH meter is always the best way to be certain.

For a complete, in-depth example of adjusting the pH of a must, see section 9.3

2.8 C) Additives

Once the pH, TA and sugars have been taken care of, you may want to consider incorporating some of the beneficial specialty winemaking additives into your must. For quite a while these additives have been readily available to commercial wineries but not packaged in smaller quantities for home winemakers. *MoreWine!* changed that when we began a program of sterile repackageing under HEPA Filtered laminar flow hoods. This is why you will only now begin to see these additives appear in articles and newer home winemaking books. They are great tools for making well-rounded, beautifully structured wines of character and are definitely worth exploring.

Opti-White (AD356)– Adds body and structure to a wine, as well as helping to avoid browning. Opti-White also serves to protect fresh aromas during ageing. Opti-White is added to the juice at the start of fermentation.

Lysozyme (AD352) - Use Lysozyme for controlling lactic acid bacteria growth in your wine. Isolated from egg whites, this enzyme will degrade the cell wall of gram positive bacteria, but note that it will not affect yeast or gram negative bacteria such as Acetobacter. Lysozyme can be used for both delaying and prohibiting Malolactic Fermentations. *Note: if you use lysozyme, you will have stability problems if you do not heat stabilize the wine before bottling (see Chapter 7)!*

Enological Tannins – Enological tannins are added to help structure the wine. They are used in both fermentation and during ageing. In addition, tannins also have an antioxidant property that helps to protect the wine during its maturation. Enological tannins are both wood and grape derived, and are available in various formulations according to their intended use.

- <u>Galalcool SP (TAN150)</u>: Can be used during fermentation to minimize reductive odors and enhance mouthfeel. It is usually used for white wines, but can be used for fruit wines and mead, as well.

- <u>Toasted Oak (chips/cubes)</u>: Economic source of wood (also called *ellagic*) tannin that will help stabilize color and add body during fermentation. Toasted oak will also give some finished flavor complexity to the wine. Can be used with enological tannins as a spice/flavor component. (For a complete explanation on the use of oak in winemaking see section **9.9**)

  -Dosage rate for chips/cubes is <u>1-4 lb per 1000 lb of fruit</u> (or 1.6 to 6.4 ounces per

100 lb of fruit), with the low end being used for stabilizing color and structure, and the high end being used to minimize vegetal characteristics.

**Important note regarding enzymes and tannin interaction: Since all tannins can strip out enzymes if added too early into the must, add the enzymes, let them work on the skins for 6-8 hours, then add your tannins to the must.*

Once the juice has been adjusted we are now finally ready to prepare our yeast and begin the fermentation.

Chapter 3: Add the Yeast and Begin Fermentation

(As soon as the must is ready)

Now that our juice is prepared, it is time to add our yeast and begin fermentation!

3.1) Choose Your Yeast

Wild yeast can be found everywhere. They are in the vineyard, coming in on the fruit, covering winemaking equipment, floating in the air, everywhere you can imagine. While they all are capable of fermenting to various degrees, few are strong enough to provide good flavors and finish a fermentation. Yes, it is possible to just crush the fruit and let whichever yeast(s) present at the time be solely responsible for the fermentation. However, this is essentially fermentation by Russian Roulette. At some point you will eventually get a wine that will develop off-flavors and/or stop short of finishing, both equally undesirable. In order to avoid this situation, we recommend using a known, dependable strain that was carefully chosen from past successful fermentations. This is why *MoreWine!* offers over 30 cultured strains of yeast to choose from. There are yeast specific to varietals, yeast for emphasizing certain flavors, and yeast known for improving body and structure, etc. You can use a single strain, or a couple of different strains to blend them later and create a more complex final wine. The only caveat with using more than one yeast strain is that you can only use one strain per fermenter. So, if you want to explore using blends, then you will need more than one fermenting vessel.

We encourage you to look through all of the strains we offer, read our Yeast Strain Selecting Guide, and make a choice based on what sounds good to you. **Realize that there is no single, "right" choice of yeast strain.** In fact, for each varietal there are actually a number of possible choices that will all make lovely wine. It is *up to you* to choose the one that will best give the desired characteristics you are looking for.

3.2) Hydrate with Go-Ferm

Go-Ferm is a specialized yeast nutrient created by Lallemand to help the yeast during the delicate hydration process. It helps the yeast to become as strong as possible before they start fermentation. We at *MoreWine!* strongly recommend using Go-Ferm during the hydration of all of our yeasts. By using Go-Ferm, yeast are more healthy throughout the entire fermentation, make better flavors, are less apt to create H_2S (Hydrogen Sulfide, a rotten egg smell) and are much more likely to finish fermentation.

<u>For every gallon of must</u>:

For every 1 gram of yeast, add 1.25 grams of Go-Ferm into 25 mL clean, chlorine-free water (not distilled, you want the minerals). Yeast is added to warm water (104º F) containing Go-Ferm and allowed to soak for 20 minutes. Then a small amount of the must is added to the yeast starter and the mixture is allowed to sit for another 20 minutes. The yeast is then ready to be introduced to the must.

> *<u>*Important note regarding yeast starter and cold must temperature differences:*</u> *if the temperature difference between the yeast starter and the must is over 18º F, you need to bring the yeast to within 18º F of the must temperature. Otherwise, you run the risk of damageing the health of the yeast due to cold shock. Using the cooler must, just add a portion of it into the yeast starter until you achieve a 15º F drop. Wait at least 20*

minutes (longer is better, but often not practical during winemaking) before repeating the process as often as needed until you are finally within 18º F of the must temperature. Now you can safely introduce the yeast into the must.

Once the yeast has been properly hydrated, add it to the must and thoroughly mix it in. Congratulations, you have just inoculated your must and the fermentation has officially begun. However, even though things are taking place, it will probably be a day or two before you see any visible signs.

For complete, in-depth information and instructions on yeast hydration and nutrients, see section 9.8.

Further information is also available in our Yeast Re-Hydration manual and video online.

3.3) "Co-Inoculation" (advanced technique)

This next section will talk about an advanced winemaking technique called "co-inoculation". If you are already familiar with Malolactic fermentation and/or have heard about co-inoculation, then the following information will help you learn more about it and decide if this technique is right for you. If Malolactic fermentation is new to you – don't worry, it will be introduced and discussed fully in chapter **5** & section **9.10**. You can choose to read this section now or just skip ahead to chapter **4** and come back to this later if you are curious.

Traditionally, most winemaking involving Malolactic fermentation is done by first completing the alcoholic fermentation to dryness then doing the ML fermentation second. This is the most tried and true' protocol and is the one we recommended for most winemakers because it offers the highest degree of success in most wines.

However, for the more adventurous, it is possible to add both yeast and ML bacteria at the beginning of the fermentation so that both can start working on the wine at the same time. This shortens the time needed to complete fermentation (conveniently freeing-up vessels for use sooner) and it does indeed create a different wine than is made by the traditional two-stage MLF schedule. Wines made using co-inoculation let a little more of the yeast impact and original fruit character come through. Both ways make delicious wines, just different.

If you are curious to try a co-inoculation it is critical you understand the following: ML bacteria always consumes the malic (then citric) acid that is in the wine/must first. Once these have been depleted, if there are residual sugars present they will then begin to degrade these. *If the pH of the must/wine is above 3.5, a byproduct of the sugar degredation will be VA (vinegar)!* However, if the pH remains below 3.5 we will not get VA production. Therefore, if you wish to try a co-inoculation you need to be able to guarantee the following:

1. If the pH of the must/juice is above 3.5 you need to make sure that the yeast consume all of the sugars *before* the malic acid is completely metabolized and the ML bacteria start to look for sugars! This is potentially a very tricky scenario because you have to be able to precisely monitor the falling malic acid levels in the must/juice during fermentation. Most of us do not have access to this kind of lab service, so trying to work above pH 3.5 represents a very real risk and is not recommended.

- If the pH is below 3.5 at all times we can safely do our co-inoculation: keep in mind that that a must or juice with a pH of 3.4 can start off fine, but as the malic acid is degraded by the bacteria (and certain yeast strains!) it is possible to have the pH rise above 3.5 during the fermentation and VA will start to be produced!

- If we do choose to co-inoculate remember make sure you do not choose a fermentation temperature that will cause the ML bacteria to struggle- yes, 54º F makes a lovely Riesling, but most ML bacteria will have a hard time working this cold! In this case you may want to ferment at around 64º F as a compromise between the yeast and bacteria's ideal fermentation temperature ranges.

If Co-inoculating, add the Bacteria Early!

Due to a number of complex reasons ML bacteria have a difficult time getting acclimated and may not finish their job if they are added after the 1/2 way point of a fermentation. Therefore, if you choose to do a co-inoculation, prepare the bacteria according to the instructions and add it to the fermenter at the beginning of the fermentation along with the yeast.

Chapter 4: Monitor Fermentation

(Next 2-3 weeks)

Your fermentation should become active anywhere from 1-3 days after introducing your yeast to the must. An important factor in determining how long it will take is the temperature of the must. Yeast's rate of metabolism is directly affected by temperature: cold musts start fermenting more slowly, while warm musts get off to a quicker start. This equally applies to the fermentation itself: cold temperatures make for slower fermentations and warmer temperatures make for quicker ones. Once the fermentation has begun, the yeast will proceed to consume the sugars in the must/juice, producing CO_2 (bubbles) and alcohol.

4.1) Stir Daily

***Note:** For each day the fermentation is underway it is important to get all of the lees (the layer of yeast that settles out on the bottom of the fermenter) stirred back up into suspension. You are looking for the must to become beige and creamy. This allows the fermenting wine to expel many negative fermentation odors that are a natural product of fermentation. It also helps to keep the wine from developing sulfur problems.

How to Stir the Fermenting Wine

MoreWine! offers several models of punches and lees stirrers to accommodate a variety of fermenter sizes from 1-gallon carboys to 600 gallon stainless steel tanks. They are made of durable food-grade metal or plastic and are easily sanitized and cleaned after each use. Of course, any object made of food-grade material can work as a punch down tool, as long as it can move the wine and stir the lees. It is a good idea to make sure the material can be sanitized, however. Food grade plastic or stainless steel is great, but wood is not, due to its porosity.

4.2) Yeast Nutrition During Fermentation

When we removed the solids during the refinement of our juice, we also removed nutrients. As the fermentation progresses, the must becomes a more difficult place for the yeast to work in: the alcohol level starts to rise (slowly becoming more and more toxic) and the original nutrients have been depleted. The Go-Ferm addition you made when hydrating our yeast was only designed to get them through the hydration process. Yeast requires more nitrogen, amino acids, micro-nutrients, etc. in order to stay healthy during fermentation. When those nutrients are not present in sufficient amounts, yeast produce off-flavors (Hydrogen Sulfide and VA) and have difficulty finishing fermentations. In order to avoid this scenario, provide the needed nutrition in the form of a complete specially formulated yeast nutrient that gets added to the must during the fermentation.

That said, many people have told us: "I never used any nutrient and my wine was fine." Yes, that can certainly be true. However, by feeding the yeast during fermentation, you can easily avoid the most common problems in winemaking, such as Hydrogen Sulfide (rotten egg smell) or VA (Volatile Acidity) production, stuck ferments, and various other off flavors. Studies have shown that even in wines with no fermentation problems, the ones with the full nutrient supply made better flavors and aromas than the musts utilizing no nutrient additions. **Using nutrients is a cheap and easy insurance policy that always makes a positive difference and becomes even <u>more</u> important if you settled and removed the juice solids before starting your fermentation!**

Fermaid-K: To complement your Go-Ferm addition once fermentation has started, we suggest using Fermaid-K, a complete yeast nutrient also made by Lallemand. Fermaid-K is usually applied at the beginning of the fermentation and again at 1/3 sugar depletion (usually an 8-10 ºBrix drop). A double addition supplies the yeast with enough nutrients to maintain a healthy metabolism throughout the fermentation. Some winemakers choose to add Fermaid-K in smaller amounts on a daily basis, usually starting on day 1. This is also a fine approach. However, yeast will utilize few nutrients after 10% alcohol (a 15 ºBrix drop). Additions made after 10% alcohol may only serve to feed spoilage organisms.

Note: If you do not have good temp control and have a warm starting fermentation (≥65º F), an 8-10 ºBrix drop may take place in the first 2-4 days, so be sure to start checking your ºBrix early in order to not miss the window.

DAP (Di-Ammonium Phosphate): DAP is a traditional yeast nutrient that is still widely used. However, DAP is solely a non-organic source of nitrogen – it offers no additional nutrition. DAP should be only considered a supplement to a complete nutrient set when a must is known to have a low nitrogen content. DAP does make yeast grow and produce more cells, but it does not feed them. A good analogy here would be to say that Fermaid-K is a bowl of fresh fruit salad that is chock full of vitamins, minerals and natural sugars, and DAP is a packet of high fructose corn sugar, offering quick energy but no nutritional value.

If a ferment is suffering from a lack of nutrients and making H_2S, there is a deficiency of nutrients available per yeast cell. Adding DAP would not feed them, it would only increase the number of starving cells. It does not make sense to increase the population in a famine zone. You should use a complete nutrient set instead of DAP to address and avoid H_2S problems during fermentation.

If you are using Go-Ferm and the recommended two Fermaid-K feedings, which contains DAP as one of its ingredients, there should be very little reason to use DAP separately.

For complete information on Yeast Nutrients, see section 9.8

4.3) Fermentation Temperature

Every winemaker has a theory on what temperature to ferment at. We have seen great wine fermented from a variety of different temperature schedules. You should pay attention to the temperature. It's definitely a good habit to note the temperature of the must each time you stir the wine (a good way to do this is to use a fermometer (MT410)) for future reference. The act of fermentation produces heat and can cause the must to be 10°-15° F higher than the ambient temperature.

A Typical Temperature Schedule

If you have control over fermentation temperatures, a recommended white wine schedule is to start slowly and inoculate at slightly warmer temperatures, such as the low 60s. Then, once activity starts, gradually allow the must to cool down to the desired temperature as the fermentation gets underway (such as the mid to upper 50s).

Yeast create different compounds at different temperatures. The general rule of thumb is that more esters are produced at higher temps, while more clarity of the fruit will be had at lower temps. However, this can also be strain dependent and there are no hard and fast rules. We encourage you to experiment with fermentation temperatures, but we do recommend staying within the tried-and-true 55°- 65° F range.

Controlling Temperature

For white winemaking, the best ways to control fermentation temperatures are to either ferment in a space that already has cool ambient temps (a basement or cellar), or use some form of refrigeration to create cold (air conditioner or glycol system). Each option has advantages and disadvantages:

1. **Ambient cooling:** Naturally occurring cool ambient temperatures as found in basements and cellars are great because they are free! However, you have no direct control over the temperature of the fermentation. If the fermentation temperatures start to run hot, you can make an ice bath for a smaller vessel. For larger tanks, there is really nothing you can do about it.

   Watch out that the ice bath doesn't become too cold or you risk shocking the yeast and causing a stuck fermentation and H_2S and VA production!

2. **Air Conditioned Rooms:** This is basically an ambient cooling system that you pay for. Air conditioning is a low-cost way to help keep fermentation temperatures low but you still have the same lack of temperature control at each fermenter if fermentation temperatures start to run away on you. As with any ambient cooling situation, air conditioning is more effective with smaller fermentation vessels.

3. **Refrigerator:** If you are making a small amount of wine, a refrigerator or chest freezer can be used with a temperature controller (FE610) with great success. The nice thing about this set-up is that you can also cold-stabilize the wine, then set the temp back to maintain cellar temps for year round storage. The only downside is that you can only fit a small amount of wine into a fridge!

4. **Glycol System:** The most serious home hobbyist purchases a small glycol cooling system such as our GLY100 which can precisely dial in temperatures. They work by circulating cold water or water/glycol mix through a jacket around the tank or a cooling snake/cooling plate submerged in the fermenting must. They are the best way to achieve total control over your fermentation temperatures. The only downside with these systems is that they're relatively expensive.

   Note: In addition to perfectly controlling fermentation temperatures, the same glycol set-up can be used to cold stabilize wines! What's more, with the addition of a fan unit, you can use it as an air conditioner to maintain cellar temps throughout the year. How's that for getting the most out of your investment!

4.4) Monitoring your Sugars, Timing the End of Fermentation

In about two weeks most of the sugar will have been consumed by the yeast and fermentation will slow, making it easier to keep track of the falling sugar level of your wine. You want to be aware of your sugar levels because they will give you an overview of how the ferment has been progressing. You may wish to stop the fermentation early and leave a bit of residual sugar in your wine.

Note: This time frame is dependent on yeast strain selection, the starting ºBrix and fermentation temperatures. Just like people, yeast are more active when they are warm. So, if you are fermenting at 65º F the sugars will drop much sooner that if you are fermenting at 55º F. Each wine's rate of fermentation will be different so you will need to check it throughout the fermentation to monitor the progress.

Measuring the Sugar Levels

The easiest way to test your sugar levels during fermentation is to use a hydrometer or a refractometer. You may have heard that you cannot use a refractometer after the onset of fermentation, because the presence of alcohol distorts the reading. You are correct, but *MoreWine!* has a very nifty and FREE spreadsheet that you can use to adjust the reading for the presence of alcohol allowing you to take readings all the way to the end of fermentation. *MoreWine!* stocks three different styles of refractometer, as well as offering a comprehensive selection of various hydrometers.

- You can use your Refractometer (MT700) to test for dryness, as long as you remember to compensate for the alcohol using the spreadsheet.

- If you are using a hydrometer, the alcohol in the sample will skew the accuracy of the result; a reading of 0° Brix is not actually dry. Because alcohol is lighter than water, you will need a reading of –1.5° to –2° for true 0° Brix determination. A "+5/-5" ranged hydrometer (MT318) will give the most accurate reading.

- **"Clinitest" test-kit (MT918):** As soon as you get into the true 0° Brix range with your Refractometer or Hydrometer, you will now need to do your testing with a Clinitest test-kit. The Clinitest is designed to only measure the narrow range of 0 to 1% (0 to 1 g/L) and is the most precise way to test for residual sugar in a finished wine. The accuracy of both Hydrometers and Refractometers is great for monitoring the drop in sugars during fermentation. They are not precise enough to give reliable results for determining the final Residual sugar (“RS”) level in a finished wine at the end of fermentation.

  Note: You cannot use the Clinitest to measure the sugar levels above 1% (1g/L) you still need a Hydrometer or Refractometer for that!

When is the Fermentation Over?

The fermentation is considered done when you either reach your desired sugar level or go "dry" at 0° Brix. A wine with 0.2% residual sugar contains two grams of sugar in a liter of wine. Dry wines are typically in the 0.2%-0.3% range, off-dry wines in the 1.0%-5.0% range, and sweet dessert wines are normally 5.0%-10%. However this can be a little subjective on taste and a wine with .5% or 5 g/L may taste completely dry depending on the wine. In the end there is no "correct" sugar level for your wine, it just comes down to your personal preference.

Creating a dry wine

Fermenting to dryness simply involves letting the yeast continue the fermentation until all of the sugars have been consumed. If a secondary malolactic fermentation (MLF) is desired, no SO_2 is added and ML bacteria are added to the wine (see chapter **5** & section **9.10**). If no MLF is desired then the wine is immediately sulfited (with a thorough stirring) and we proceed to the ageing period (see Chapter **6**).

Creating a wine with residual sugar

Finished wines with residual sugar can be made in one of two ways; by either fermenting to dryness then sweetening at bottling, or stopping fermentation before reaching dryness so that some residual sugar remains in the wine. The techniques for each are as follows:

- **Ferment to dryness, sweeten later:** Prior to starting fermentation, a small percentage of the refined and sulfited must can be set aside and put in the freezer (A zip-lock type freezer bag works great for this- remember to squeeze all the air out before sealing it to limit oxidation). This reserved must will be used to sweeten the wine before bottling and is called the "sweet reserve". The rest of the wine is fermented to dryness. Whenever the wine is to be bottled, the sweet reserve is taken out and added to the dry wine until the desired level of residual sugar has been achieved. A bench trial will help determine the ideal ratios to add (see section **9.7**). The wine is then filtered and bottled (see Chapters **7 & 8**).

  Note: household sugar can also be used to sweeten the wine, but depending on the amount used the flavor in the final wine will not be as rich as if you used the original juice.

- **Stopping fermentation before dryness:** Once the desired sugar level has been reached the wine is sulfited in the fermenter (with a final stir to distribute the SO_2) and immediately chilled to 40° F or below. Depending on how exact you want to be with your chosen RS% level, you may want to start the cooling a little earlier than right when the must is at the desired sugar level. Yeast will still be consuming sugars as they are being chilled. When they finally do get cold enough to stop being active, you may find you have a lower °Brix level than you wanted. To avoid this scenario start cooling 1-2° Brix higher than where you want to end up. Whenever the wine is deemed ready it is filtered and bottled.

  Note: An active fermentation can also be stopped by adding spirits to the wine, as in Port winemaking. However, unless you are after this kind of specialized winemaking, the added alcohol will make your wine very out of balance and this technique is not recommended for making non-fortified wines with residual sugars.

A word about Potassium Sorbate

Potassium sorbate is used to help stabilize a wine that contains residual sugar. It inhibits yeast reproduction and will stop a renewed fermentation from taking place. However, it will not stop an active fermentation.

- Add at the rate of .5 to .75 grams per gallon (125-200ppm) in conjunction with .3 grams of meta-bisulphite (50ppm) 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%.

Note: Potassium sorbate should *<u>never</u>* *be used in a wine that has undergone MLF because the bacteria will metabolize the sorbate and create an odor of rotting geraniums in the wine!*

Once the primary, alcoholic fermentation is over it is time to take a look at malolactic fermentation (if we haven't already) and the ageing period!

Chapter 5: Malolactic Fermentation ("MLF")

(next 2-6 weeks)

Once the primary, alcoholic fermentation has finished it is time to decide if you want to do a malolactic fermentation ("MLF"). Unlike for red wines where doing an MLF is considered standard practice for creating a high quality wine, delicious white wines can be made with no, partial, or full ML impact. It is simply a matter of style and personal preference:

- **No MLF:** Wines made without any MLF will focus on the fruit, such as Germanic whites (Riesling & Gewürztraminer) and New World Sauvignon Blancs.

- **With MLF:** Wines that are made with a complete MLF may not have the singular focus of fruit intensity in them, but they make-up for it by their complexity. The MLF adds desirable flavors and aromas while also contributing positively to the mouthfeel of the wine- indeed the white wines of Burgundy, Bordeaux, and the Loire owe a lot of their complexity to malolactic fermentation!

- **Partial MLF:** In recent years, there has been a move to try and get the best of both worlds (intensity of fruit and complexity) by doing partial MLFs. The MLF is initiated then stopped by the winemaker when he/she feels they have gotten enough complexity in their wine without covering-up the original fruit qualities.

Note: If you do not want to do an MLF, then you will sulfite the wine as soon as the primary fermentation has finished (see below). However, if you do want to do an MLF then you need to inoculate the wine with your chosen ML bacteria and let the MLF take place. Once it is done (fully or partially, whichever you decide) then add sulfite to the wine.

A note about MLF and the "Lees": If you do want to do an MLF, it is important to make sure you have either all or a portion of the "lees" present. The lees are the layer of sediment made up of spent yeast that, once the fermentation is over, stop working and settle out on the bottom of the vessel. Spent yeast release nutrients into the wine that provide an important source of food for the ML bacteria. Whether you want the full lees or a partial amount is a stylistic decision discussed fully in **section 6.2**, but it will come down to the following:

- **Full lees** requires no racking, you just prepare and add the ML bacteria into the original fermenter.

- **Partial lees** will require you to rack the wine from the fermenter into a new vessel before you begin the ML fermentation. Once this is done you can then add the ML bacteria and start the MLF.

Please refer to **section 6.2** for complete information regarding Lees Management.

5.1) Malolactic Fermentation

The "ML" is a type of bacteria that metabolizes malic acid (the harshest of the three acids naturally found in the grape) and turns it into lactic acid, which has a much softer flavor. The process lowers acidity and causes the wine to become more rounded and approachable. ML bacteria also produce compounds that add to the body of the wine. Given the proper conditions, MLF should take about 2-6 weeks to progress to completion. Adequate nutrients, frequent stirring and correct temperatures will help speed the completion of MLF. More on this below).

Note: Because CO_2 is produced during the process, the conversion of malic to lactic acid is commonly referred to as "fermentation". However, MLF is not a true fermentation because no alcohol is being produced from the metabolism of sugars. Despite this technicality, Malolactic Fermentation, or MLF, is still the accepted term.

Important thing to keep in mind when doing a MLF:

- We're just going to keep saying it - If you will be doing an MLF on your wine, it is critical that you **NOT** add any SO_2 until after the MLF has completed. Adding sulfite before then will impede or possibly kill the ML bacteria.

- **CO2:** Just like the primary fermentation, MLF creates CO_2 that will need to be released. Therefore, you will need to make sure that you use an airlock on the top of your fermenter until the bacteria finish doing their job. Once the MLF has completed, you will need to switch over to a solid stopper for the rest of the wine's ageing/storage period.

- **Oak:** Adding oak to the MLF is a great idea for a variety of reasons. It starts the integration of the oak into the wine a little earlier, and the impact of the ML bacteria helps the wood's contribution blend nicely into the wine. In addition, the crevices of the wood create an environment that is excellent for microbial growth. (For more information about using oak in wine, see section **9.9**)

Step-by-step guide to a successful MLF

These next sections will explain and guide you through the individual steps necessary to successfully carry out a Malolactic Fermentation in your wine. (For complete, in-depth information on MLF, see section **9.10**, or download MoreWine!'s in-depth manual on Malolactic fermentation from our website: www.morewinemaking.com/manuals).

5.2) Prepare and add the ML bacterial culture into the wine

ML bacteria come in various forms, most commonly as a freeze-dried powder in a packet, though occasionally in a liquid form. Using ML is quite easy to do and is no more involved than hydrating yeast. Each ML bacteria type will have its method of preparation (if needed) and you should check the step-by-step instructions clearly listed on the packageing itself to make sure your bacteria gets hydrated correctly.

Prepare the ML bacteria as follows: For every 1 gram of bacteria being added to the wine, you will be adding 20g of Acti-ML to 100mL of distilled water at 77°F (25°C). After sitting for 15 minutes, gently but thoroughly stir this solution into your wine. The following example will use the 2.5g (most common) size ML bacteria packet to illustrate this.

1. In a sanitized container: dissolve 50g of Acti-ML* into 250mL of distilled water at 77°F (25°C). A 500mL Erlenmeyer flask (Y410) makes for a good choice of container.

   **Note: The addition of Acti ML into the hydration water for ML bacteria is done for the same reason we use Go Ferm for yeast hydrations: it ensures that our bacteria are getting the best start possible. Since this feeding occurs outside of the wine, it also prevents other unwanted organisms that may be in our wine from being able to benefit from this food source.*

   <u>**Important:** only use the "Acti-ML" nutrient in the hydration water; other ML nutrient formulations contain ingredients that in the concentrated dosage levels found in our hydration formula can actually harm the bacteria during the delicate hydration process.</u>

2. Add the bacteria (2.5g) to the solution and gently stir/swirl to break up any clumps if needed. Wait 15 minutes.

3. Add the entire bacteria/nutrient solution into your wine and mix it throughout the entire wine volume.

   Note: It is a good idea to stir the bacteria starter solution just before adding it into the wine. This ensures that any of the nutrients and/or bacteria that may have settled-out during the 15 minute soaking period do not get left behind in the hydration vessel.

5.3) Manageing the MLF

- Once the bacteria get introduced into the wine, the Malolactic Fermentation has begun. You need to gently stir the **entire** contents of the wine vessel twice a week. This means getting the lees at the bottom of the fermenter back up into solution with each stirring. Thorough stirring prevents the bacteria from being buried at the bottom of the vessel. It also separates the nutrients from the lees in suspension so the bacteria can benefit from them.

- If possible, keep the wine at around 65-70°F to help the bacteria do the job in a timely fashion. If it gets colder (<60°F), they may slow down or even stop altogether depending on the bacterial strain and other conditions in the wine.

- During an MLF, you need to be very careful about exposing the wine to oxygen at all times. The amount of CO_2 being produced by the MLF is much lower than during primary fermentation. It cannot be relied upon to help protect the wine from oxygen exposure. Furthermore, during MLF, you do not have the protection of SO_2 yet. Therefore, if you have access to it, it is a good idea to flush headspaces with inert gas (CO_2, or Argon) each time you stir the wine (see **9.5** for complete information on using inert gas).

5.4) After 2-3 weeks, begin checking with Chromatography

Around the second or third week, start paying close attention to your secondary fermentation and begin testing to measure your progress. The easiest home method of testing MLF progress is a Chromatography Test Kit (MT930). The reason to test the wine before fermentation has finished is to gauge the strength of your bacteria. If there is still quite a bit of malic acid present (as indicated by a bright malic spot on the chromatogram) and fermentation is slowing down, the bacteria may be telling you that they are having a hard time finishing. Keep stirring as you normally would and check it again in a week. If at that time you are not seeing any more of a decrease in the spot and the signs of activity are weaker than they were during the previous week, we recommend feeding the bacteria with an ML nutrient Acti-ML (AD347) at a rate of .75g/gallon in order to help them complete the fermentation. However, if the second test shows a smaller spot and you still see signs of activity, this is perfectly normal. If this is the case, you don't need to add any more nutrients, as anything not used by these desirable bacteria could be used by undesirable ones at some point in the future. Just keep stirring and working the wine as you normally would until all signs of fermentation have finished. Test again to make sure it has completed.

Quick reference guideline of the steps needed for a successful MLF:

When the sugars fall to 0° Brix (once the initial fermentation is over): decide how much lees you want to work with and (see section **6.2**), then:

- Prepare the bacteria as per the instruction listed above.
- If possible, try and maintain the about 65-70° F. If it gets colder (<60°F), the bacteria may slow down or even just stop altogether depending on the specific strain and the wine's conditions.

  Note: Different brands of bacteria will have slightly different temperature tolerances, but around 70°F represents an ideal range for any ML bacteria to work in.

- During the fermentation, stir the lees back up into the wine twice a week. If you don't happen to have a Lees Stirrer (WE590), you could use a rod or dowel. Stainless steel or food-grade plastic would be preferable. It is best to avoid wood, as it is difficult to sanitize given its porosity. Overall, lees stirrers are highly effective and inexpensive, we strongly suggest investing in one.
- Once you have initiated your MLF, you need to let it go through to completion in the interest of quality wine. It is often difficult to re-initiate a stuck fermentation, but if you follow the steps as noted above, chances are you won't have to try.
- After 2-3 weeks begin checking for completion with a Chromotography kit.
- Dose the wine to the correct SO_2 level as soon as MLF has finished. With the wine protected, you can safely rack off of the lees into your carboys, tanks or barrels and begin the ageing process.

For in depth information on SO_2 additions see section 9.4

These next few months will consist of tasting/monitoring the wine to be sure no problems develop, oak level/integration, lees management, checking pH/TA balance as wine evolves, and maintaining proper SO_2 levels.

Chapter 6: Ageing/Storage & Lees Management

(next 6-12 months)

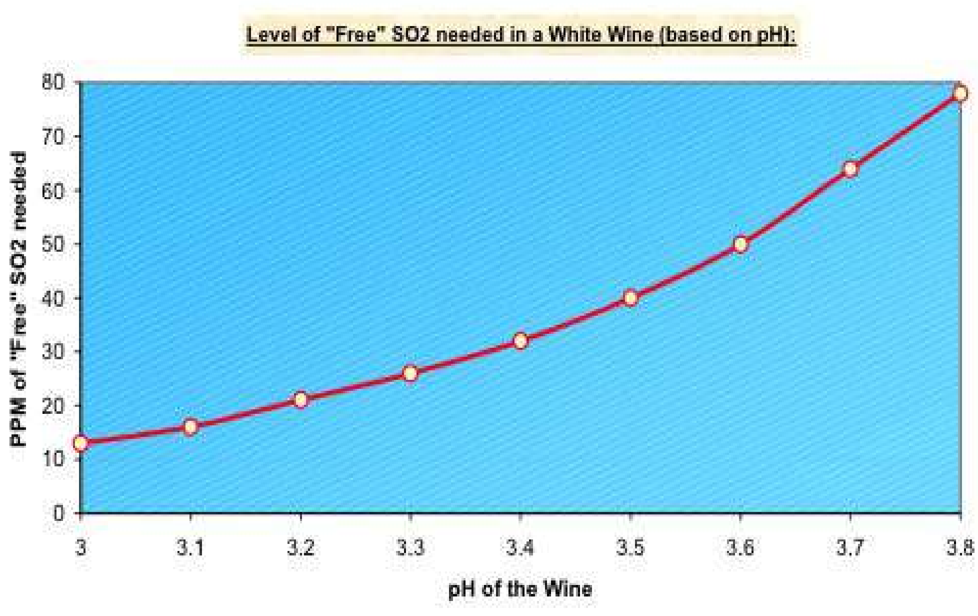
With the fermentations over, we need to test/correct the pH/TA and SO_2 in order to prepare the wine for ageing/storage. Once this is done, depending on the style of wine we are aiming to create, we will either be periodically racking off of the lees to minimize its impact on the wine, or we will be stirring the lees back up into the wine at regular intervals to create complexity and mouthfeel. We'll get to this in a moment, but first let's take a look at getting our wine ready for ageing/storage.

6.1) Preparing for ageing/storage

6.1a) Adjust SO_2 Levels

Once the fermentations (primary & MLF) have completed, we need to prepare the wine for the ageing/storage period. Adding a specific amount of SO_2 into the wine and mixing it thoroughly is the first step. By adding sulfite, you are establishing protection for the wine that will help guard it against oxidative browning and potential spoilage organisms. From this point until bottling, you need to maintain a level of SO_2 protection in the wine at all times.

Note: The precise amount of SO_2 needed is based on the wine's pH (see chart below). So, if you will be adjusting the TA /pH of the wine post MLF, keep this in mind when calculating your SO_2 addition. A good working method is to add the SO_2 addition into the wine, test and correct the TA/pH, then adjust the SO_2 as needed based on the new TA/pH value. For a complete explanation of SO_2 management, see section 9.4



6.1b) Adjust TA and pH If Needed

Once the correct SO_2 level has been established, check the TA and pH to see if they need to be adjusted. During the MLF, TA will drop along with a corresponding rise in pH. Once it finishes you will need to test and taste the wine to see if the drop in acid is acceptable, or if it will need to be corrected. White wines should end up in the 3.2-3.55 pH range, but ultimately, your palette will be your guide. For a review of adding acid to adjust the TA and pH, refer back to section **2.8b**.

6.1c) When Transferring: Carry the Oak Through!

If you have used any oak cubes or staves in the primary or secondary fermentations, they will still have a good amount of life left in them. If you feel you could still use more oak impact in your wine after tasting it at this point just keep them in the wine (if racking, carry the oak through with the transferred wine into the ageing/storage vessel).

Note: At the end of fermentation the oak will probably be coated with yeast, bacteria, and tartrates (acid deposits that naturally settle out of the wine over time). In order to allow the oak compounds to continue being extracted during ageing/storage you may need to rinse these deposits off in order to re-expose the wood. Hot water (between 140-170 F) and a sanitized, food-grade brush work well for this. Although oak and other woods are typically naturally antibacterial, we recommend sanitizing the clean wood with a light SO_2 solution (no citric acid) before returning the wood to the wine. Alternatively you could also microwave them with a little bit of clean water until they reached a slight boil (allow to cool first before adding back into the wine).

Helpful Hints on the Timing of Additions & Racking:

For this first adjustment/racking of the wine post fermentation we recommend adding the SO_2 (and any other needed additions) directly into the original fermenter with a thorough stirring. This will get the necessary protection started immediately in the wine as it enters the ageing/storage period of its life.

All future adjustments/transfers: Whenever you need to do any future racking it is a good idea to test your wine for needed additions (especially SO_2). Any additions can easily be added during the transfer. **By consolidating multiple tasks into the same winery operation, you can limit the amount of times that the wine comes into contact with oxygen and possible contaminants**. In addition, making your addition(s) at the time of a transfer allows the wine to mix itself nicely as it fills the receiving vessel. You can take advantage of this by adding your addition(s) to the bottom of the receiving container before, or in the early stages of the transfer.

6.2) The Lees: Formation, Management, & "Sur-Lie" Ageing

At the end of the fermentation(s) there is a large population of yeast (and possibly ML bacteria) in the wine. Once they run out of sugars or are inhibited by an SO_2 addition these organisms become inactive and settle out at the bottom of the fermenter forming a layer of solids called the "lees".

If during a white wine fermentation; A) the yeast did not get the proper nutrition it required, B) the wine was not stirred daily to release the volatile sulfur compounds created by the yeast during fermentation, and/or C) the temperature was allowed to run warm (≥70 F) the yeast become stressed and produce H_2S as well as other undesirable compounds. If this happens, when the unhappy yeast settle out to form the lees at the end of fermentation, the source of these negative sulfur compounds is localized and concentrated at the bottom of the vessel. The longer the wine stays in contact with these undesirable compounds the more it will incorporate them- to the point of spoiling the wine pretty quickly. Therefore a good safe-guard to avoid creating sulfur problems in our wines is to quickly rack off of the lees as soon as fermentation is over. This is the approach that is recommended in most white winemaking texts.

However, it would be a shame to just leave it at that and proclaim that "all lees are bad". If we adopt proper white winemaking protocols like removing the press solids pre-fermentation, use nutrients, stir the entire lees daily, and control the fermentation temperature, chances are you will not have any negative, sulfur compounds at the end of fermentation! This is a good thing because when there are no undesirable sulfur compounds in the lees they can be a fantastic source of positive attributes. If managed correctly, working with clean, untainted lees can bring complementary flavors and aromas of honey, nuts (hazlenut, almond), toasted bread, and spice to a wine. The lees can be used to create complexity and a creamy mouthfeel in the wine while helping to better integrate oak, fruit, tannins, and acidity into a unified whole. The yeast lees maintain a reductive capacity for 6 weeks post primary fermentation which means their presence in the wine helps to protect it from oxidation at the beginning of the ageing/storage period. Finally working with the lees can actually help a wine become both more heat and cold stable when preparing for bottling.

The compounds responsible for creating most of these positive reactions are proteins that come from the yeast (and ML bacteria), called "mannoproteins" and "polysaccharides". Yeast (and ML bacteria) are like little water balloons in that they have an outer skin that retains a liquid center. This liquid center contains various proteins. When the cell dies, the balloon eventually breaks open in a process called "autolysis," releasing proteins into the wine. Much in the same way cream cheese can smoothly coat the rough texture of a piece of toast, making it more unctuous in the mouth, autolysis proteins help round-out and smooth-over the potential edginess that tannins, firm acidity, and undesirable polyphenols can sometimes create in our wines. Working with these proteins is a very powerful tool that white winemakers can use to raise the quality of their wines.

As fantastic as all the benefits of working with the lees are, it is important to remember this technique may not be suited for every wine. If you are trying to create a very delicate, light wine that just highlights the gossamer essence of your grape, having a noticeable impact from the lees may actually detract from the targeted style. In this case you may be best served by not doing any lees contact during the ageing/storage period. One winemakers "complexity" may be another's "masking-over/shellacking of the original fruit"! In the end, just how much lees contact (if any!) we choose to employ comes down to personal preference and the style of wine we are making. There is no right answer. The important thing to come away with after reading this section is to understand that working with the lees is just a tool and as long as the benefits and drawbacks of using this tool are understood, it can be modified to fit our needs. Often in winemaking, the best decisions are not purely black or white, but lie between the two extremes in a well-informed shade of gray! Experiment, taste often, and if you don't like what is going on, all you need to do is simply rack off the lees.

If you will be ageing on the lees ("sur-lie") here are some important points to keep in mind:

- **Only wines that finish fermenting with no reduction can provide suitable lees for sur-lie ageing**. This means there can be no burnt match, rotten egg, garlic, onion, or funkiness in the wine. If there are sulfur problems, we recommend you do not use the lees for ageing and should rack off of them ASAP.

- By racking off of the press solids during the juice preparation, providing proper nutrition to our yeast (and bacteria), keeping temperatures ≤65 F, and stirring daily during the fermentation we maximize our chances of getting a clean fermentation and lees. This makes a better wine and gives us the option of a sur-lie ageing if we choose to.

  Note: If you do have a sulfur problem and need to rack off of the lees, it is still possible to get some beneficial protein impact into your wine: Specially inactivated yeast products such as Opti-White, Sur Lie (Bio-Lees) and Noblesse can be used to help positively modify the aromas and flavors of your wine during ageing/storage. Keep in mind the amount used post fermentation will be much less than the amount added at the beginning of fermentation: <u>0.1 - 0.5 g/gal</u> A quick bench trial will help find the best ratio for your wine. Remember, be conservative with your addition amount: as with any addition, it is easy to add more later but hard to remove if you use too much!

- **It is important to stir the wine 3-4 times a week during the first 3-4 weeks**. Each time you stir the wine you will need to get the entire lees back up into suspension. The wine will have a stronger tendency to become reduced (make H_2S) in these first few weeks post fermentation. By stirring often, you are continuously exposing the entire wine volume and lees to a small amount of oxygen (2-5 mg/L) and this helps to counter-act the reduction. Because the rate of the reactions that cause oxidative flaws (browning, flat flavors, etc.) are slower than the rate of yeast oxygen scavenging and SO_2 binding, the wine is protected and will show no oxidative flaws. However, the reduction power of the yeast lees to absorb oxygen diminishes in roughly 6 weeks. After this point, the SO_2 will be doing most of the protection duties in the wine.

  Note: If you do <u>not</u> have lees in solution then you will want to limit the wines exposure to oxygen at all times (as well as maintaining proper SO_2 levels and sparging with inert gas if possible).

- **Maintain proper SO_2 levels at all times during sur-lie ageing,** even in the beginning when the lees are helping to scavenge any oxygen that gets introduced into the wine. Remember that required SO_2 levels are determined by the pH of the wine (see **9.4**).

- After the initial 3-4 weeks, the rate of stirring can be reduced as determined by taste and the amount of lees impact desired in the wine. All wines will be different but here are a few theoretical examples:

- If **less** complexity coming from the lees is desired: first month: stir 3-4 x week; second month: 1-2 x week; third month: 1 x 1-2 weeks; fourth & fifth months: 1 x 3-4 weeks.

- If **more** complexity coming from the lees is desired: first month: stir 3-4 x week; second & third months: 2 x week; fourth & fifth months: 1 x week; sixth & seventh months: 1 x 2 weeks; eighth & ninth months: 1 x 3-4 weeks.

- **Stir and taste often to make sure the wine is progressing as you would like it to**. Keep in mind that the rate of autolysis is different between yeast strains, CY-3079 is faster than D-47 for example. Also, the temperature of the wine will affect the rate the proteins are released into it; a wine cellared at 65 F might be ready after 6 months, whereas a wine cellared at 55 F might require 10 months to reach its ideal potential. Faster is not always better!

- **If at any time during the sur-lie ageing process you start you detect an H_2S problem you will need to rack off of the lees ASAP!** Keep in mind that a wine that seemed fine at the end of fermentation can still develop sulfur problems during ageing! This is why it is important to carefully smell and taste the wine at each stirring when ageing on the lees.

If you will not be ageing on the lees then you will be racking 2 or three times during the entire ageing process (maybe once every 2-3 months) to separate the wine from the lees and help clear it out.

6.3) First Transfer (Lees Management Begins)

Once the correct TA/pH and SO_2 levels have been adjusted, the lees will have been stirred-up during the addition and the wine will be cloudy. We can either transfer the wine now to our ageing/storage vessels or we can wait. The timing and how we carry out this racking will determine the amount of lees we end up with in our ageing/storage vessels after the transfer:

1. If you will **not** be working with the lees and are trying to keep the wine as clean as possible, rack after a large portion of the lees have settled back out after being stirred-up from the SO_2 addition. Usually in 1-3 days.

2. If you **will** be working with the lees, how soon you rack after the SO_2 addition determines the quantity of lees you will be working with:

   - **Full lees desired:** We can rack immediately after the SO_2 addition has been made. However, since we will be using all of the lees, it is also possible to not rack at this time and carry out our ageing/storage in the original fermenter (assuming we don't need the vessel).

   Note: We can use the full lees from the fermentation with no problem because we already racked off the press solids during the juice preparation. This eliminated the pulp, skin particles, vineyard residue, etc that could be the cause of H_2S formation if present in the lees. If we did not settle the solids out of our juice before the fermentation began, we need to follow the "partial lees desired" protocol below to eliminate them from the wine. The unwanted grape solids are heavier than the yeast and will settle out first after each stirring. Thus they will *be on the bottom layer when the lees settle back out. Racking only the top layers post settling will ensure the unwanted elements stay behind!*

- **Partial lees desired:** You can rack before all of the lees have settled back out after stirring in our SO_2 addition (usually after 12- 24hrs), or we can rack after settling completely (1-3 days) and just stir a portion of the lees back up off of the bottom of the vessel during the transfer.

6.4) Ageing/Storage

The French use the term *élévage* to refer to the ageing/storage period in a wine's life. It roughly equates to our term "to raise" in English, as in raising a child. An appropriate term, since our job as winemakers during this stage is to watch over the wine while providing the care and proper environment needed for it to have the best chance of developing positively. Ageing/storage of white wines is made up of three parts: letting the wine continue to work on its own or with our assistance, i.e.: stirring the lees, monitoring its progress both by testing and by tasting/smelling, and carrying out a series of rackings for clarification if needed (except when ageing sur-lie). Each of these elements work together as a complete system that allows us to keep the wine safe as it continues its maturation. Throughout this period, winemakers will need to properly maintain the SO_2 levels, hold the temperature at a constant 55°F (see the "Temperature" section below), and taste the wine every 4-6 weeks to monitor its evolution (or at each stirring if ageing sur-lie to monitor the lees impact and H_2S formation).

Note: If you are working with barrels, you need to maintain the humidity at around 65-75% as well as top-up the barrels each time they are tasted. For complete information on working with barrels, see our MoreWine! Guide to the Use and Care of Oak Barrels online: www.morewinemaking.com/manual.

Helpful tip re: toasted oak and wine: Yeast metabolize vanillin and furfural (the strong vanilla and butterscotch/caramel aromas and flavors found in toasted oak) during fermentation. So if you would like to use oak yet want to avoid the vanilla/butterscotch notes from overpowering your delicate white wine, we recommend fermenting in contact with the oak (either in your barrels, i.e.: "barrel ferment", or adding the oak cubes/staves directly into the vessel at the start of fermentation). Fermenting with oak also gives a really nice structure to the wine and provides a nice head-start on integrating the fruit, acidity, alcohol, and mouthfeel of the wine right from the beginning.

Understanding Polymerization and the need to remain vigilant

It is important to remember that wine is never static. It is always moving, shifting, and alive; it continues to develop throughout the entire ageing/storage period whether we are involved or not. At work is a phenomenon called *polymerization*. Essentially the process of smaller molecules connecting up to create larger ones, polymerization creates more complex flavor, aroma, and structure.

While we have all heard that complexity is good in a wine, realize that just because a wine gains in complexity does not mean that it will always be better. The following two examples illustrate how polymerization can be either positive or negative:

- On the positive side, a well-made white wine that has the right amount of polymerization will have a soft, round mouthfeel, with no edginess coming from either the acidity or alcohol. If any oak was used then the tannins and aromas will be also be well-integrated into the wine.
- On the negative side, a wine that has an untreated H_2S problem will also experience a transformation. When the H_2S molecules eventually polymerize together to become mercaptans, it's an even bigger problem than the original H_2S.

Both of these are examples of a wine gaining complexity, but they couldn't be further apart in terms of their desirability. In addition, polymerization can cause a wine that seemed sound just after fermentation to develop problems (such as H_2S) during the ageing/storage period - yet another reason to keep checking in with the wine as it ages. The important thing to take from each of these examples is that, whether good or bad, wine will continue to evolve/polymerize as it ages. We have to constantly pay attention to the process in order to not get caught off-guard by any potentially negative developments.

Now that we have an idea of how constant polymerization in wine creates the need to monitor it, let's look at the other elements involved in developing the wine. We'll first look at temperature and later focus on SO_2 management.

Temperature (control)

Temperature plays a large role in the speed at which complexing reactions take place; at higher temperature the process is accelerated, at lower ones they are slowed. There are pros and cons to both high and low ageing/storage temperatures:

Warmer wine/cellar temperatures

Pros:

- Warm temperatures of >60°F cause the polymerizing reactions to happen at a faster rate. This can be convenient; it saves time, making the wine ready for bottling/consumption earlier.

Cons:

- Higher temperatures can cause an imbalance in the ratio of compounds that are being extracted from the oak (if you are using oak) or the lees (if you are ageing sur-lie) and integrating into the wine. This can lead to the wine becoming overloaded and out of balance. The following analogy can help illustrate this: If, while in the process of making gravy, we gradually add flour into the simmering broth a little bit at a time, everything becomes well integrated and we get a nice, smooth gravy. However, if we add the entire amount of flour as a single condensed dump, we can see that the broth has difficulty integrating the elevated amount of flour. The broth becomes overloaded, and we end up with lumpy gravy. The same happens with wine and oak or lees. In this case, the temperature of the wine/barrel determines the rate of extraction of compounds coming from the wood into the wine. If the temperature is too high then we get a larger percentage of compounds – most notably tannins - being introduced into the wine in a short period of time. So, just like the gravy reacted to the flour, we run the risk of overloading the wine before it can gracefully integrate these extracted compounds.

- Elevated temperatures promote quicker oxidative reactions if the wine becomes exposed to oxygen. This often creates a rapid loss of free SO_2 levels that leave your wine unprotected. When this happens quickly, there is a shorter window in which you can catch the problem and address it. Even if you do catch the problem, while it is still treatable, the wine will have a more serious flaw than it would have if it had been stored at a cooler temperature.

- Finally, the rate of microbial spoilage becomes accelerated at higher temperatures. Again, this means that if there is a contamination problem, the impact of that infection will be more advanced by the time you realize it and take corrective action.

Cooler wine/cellar temperatures

Pros:

- Cooler temperatures of <50°F slow down and limit the activity of microorganisms. This is quite helpful if the wine becomes exposed to any spoilage organisms. If the wine is cold enough, they will not be able to establish themselves enough to cause damage. This is extremely useful in keeping wines with residual sugar and wines that have had no/partial MLFs from re-fermenting during ageing/storage.

  Note: Cold temperatures will not necessarily kill these microbes; the cold just retards their rate of reproduction. If they are present and the SO_2 is not correctly maintained, the microbes can still come out of "hibernation" and spoil your wine if it were to warm up again.

Cons:

- When wine is kept at cooler than normal cellaring temperatures (<55°F) the complexing reactions are slowed down and the amount of time the wine needs to become ready for bottling takes longer. This does not have an ill effect on the wine; it just ties up carboys, tanks and barrels that will not be available if you happen to need them before the wine being stored in them is finished.
- Cooler temps increase the amount of gas that can remain saturated in a solution. For winemakers, this means that you need to be careful when racking cold wine in order to avoid picking up too much oxygen on the transfer. Purging headspaces with inert gas will help to limit any oxidative uptake problems.

Ideal wine/cellaring temperature

The ideal cellar temperature is a compromise between the two extremes. For white wines this equates to maintaining 55°F. This allows the wine to be cool enough to limit microbial growth while effectively regulating the extraction of compounds from the oak, the lees if sur-lie, and the rate of polymerization. However, if you are storing a wine that has enough development and do not want any chance of biological activity from taking place (maybe there is some RS, or a partial MLF), then <50°F is a better temperature for holding the wine.

6.5) SO2 Management

Sulfur Dioxide, or SO_2, is a chemical compound used by winemakers to help keep their wine protected from the negative effects of oxygen exposure as well as spoilage microorganisms. Sulfur Dioxide is known by a variety of different names to winemakers, the most common being

"SO_2", "Metabisulfite", and just plain "Sulfite." In winemaking, the SO_2 concentration in a wine is measured in Parts per Million, or ppm, which refers to the number of **Parts** of Sulfite **per Million** parts of wine. This unit of measure is equivalent to mg/L, or **milligram** of SO_2 per **Liter** of wine.

Sulfite Management is one of the toughest aspects of home winemaking to master, but also one of the most critical aspects of creating a high quality wine – commercial or home-made. Proper sulfite levels in a wine create a protective buffer that helps the wine withstand any accidental oxygen or microbial exposure that may occur during the ageing/storage process. The sulfite acts as an intermediary force that quickly intercepts and reacts with the offending element or organism before it can damage the wine. However, this is a one-way ticket. Once the sulfite becomes used-up, it is no longer available to react with future threats. In its most basic form, SO_2 management simply comes down to understanding how to create and maintain a small, stable reserve of *free SO_2*. However, just having a generic amount free SO_2 in a wine does not guarantee you are safe. When we go back and look at the SO_2 chart back in section **6.1a**, we see that the free SO_2 levels required to protect a wine are pH dependent. As the pH goes up, a higher free SO_2 level is needed to protect the wine. This means that you can have 25 ppm free SO_2 in your wine, but if your pH is above 3.3, the wine is still not adequately protected… Let's take a moment to examine the nature of sulfites and how we as home winemakers can best manage them in order to help us make the best wine possible.

The basic timeline of sulfite additions needed to keep the appropriate levels is actually not as simple as it might seem. Many of the solids and chemical compounds in the wine interact with sulfite, and their concentration/presence has a direct effect on how any given sulfite addition behaves. To begin with, no two wines are ever the same; each one possesses a unique ratio of chemical compounds and solids that are present at varying concentrations. Depending on winemaking techniques, handling, or even sanitation issues, the differences can be quite pronounced. Because of the differences between two seemingly identical wines, they will often end up with different free SO_2 levels after equal sulfite additions. This is important because it means that if we want to be accurate in our sulfite management, each wine will have to be evaluated individually once the SO_2 has been added. Then, based on test results, additional sulfur can be added to achieve the target level. The simple formula used to make sulfite additions is a great starting point, but we cannot rely on this theoretical calculation alone in order to achieve our desired free SO_2 level – it must be tested and corrected if we want accuracy. *Remember: It does not matter whether based on your calculations you have added enough SO_2 to achieve 35 ppm free if your test lets you know you only have 10 ppm free in the wine!*

The discrepancy mentioned above between what we've calculated on paper and the amount of free SO_2 we actually wind up with in the wine is coming from a phenomenon known as "binding" and is based on the fact that when sulfur is added to a wine, portions of the addition react with and become chemically bound to the aldehydes, acids, furfural, sugars (glucose), solids, yeast/bacteria, etc. Binding continues until all of the various reaction-able elements in the wine have either become bound up or there is no more free sulfite to interact with. This binding action actually serves to protect the wine; as long as there is free sulfur present, it is available to react with and effectively neutralize both oxidation and microbial spoilage threats. In effect, free SO_2 can be viewed as an insurance policy that the winemaker takes out in case the wine has any problems during its lifetime: As long as you have the recommended amount of free SO_2 your wine is protected.

Note: Barrels and tanks with headspace tend to lose their free SO_2 more quickly than do fully topped inert vessels, due to the wine's interaction with oxygen in the environment/headspace. In addition, even if there is no oxygen exposure, free SO_2 levels can still decrease gradually *during ageing due to normal chemical reactions taking place in the wine as it continues to evolve. Therefore, it's a good idea to check the free SO_2 levels of all of your vessels even if they are topped-up and have not been opened since you last checked them.*

Maintaining this reserve of free sulfur means that once a wine starts to lose its free SO_2 content, we are obligated to add more to raise it back up again. Yet, there can be too much of a good thing. If we don't monitor our amounts and keep adding sulfur to the wine in an effort to maintain the required pool of free SO_2, it is possible to add so much that the sulfur becomes detectable in taste, negatively impacting the wine. This is one of the fine lines that we as winemakers walk, one more example of the junction between artistry and science that is winemaking. We need to have a sufficient quantity of sulfur present in order to maintain the free SO_2 levels needed to protect the wine, but we don't want the levels to be so high as to be noticeable when we drink it. Therefore the goal of proper sulfite management in winemaking is learning to create the required amount of free SO_2 in the wine while using the lowest total amount of sulfite possible. In order to help us do this it is important to take a further look into the implications of the binding process.

Please bear with us. We know that this is complex, but we have found again and again that increasing your understanding makes it more likely that you will be able to respond to a problem situation quickly and correctly. If you feel like your head is spinning a little bit from all this, we recommend that you go get a glass of wine – or in extreme cases perhaps even coffee…

Ok, back to it: Post fermentation, when we make our first SO_2 addition (by calculating, testing the results and correcting to our desired level if necessary) we establish our starting point for free SO_2 in the wine. If the wine remains completely sealed, apart from the normal and slight drop in the free SO_2 levels, the level of free SO_2 will remain fairly stable over time. However, as soon as we start to open the vessels up for tasting, testing, blending, fining or topping up barrels, we will begin to see a drop in the free SO_2. This drop can be slight or quite drastic depending on how the wine is being handled. There are three main causes of the binding phenomenon responsible for a drop in the wine's free SO_2 levels: aldehyde formation, spoilage organisms, and the introduction of solids into the wine.

- **Aldehydes:** When a wine is exposed to oxygen the alcohol in it oxidizes into chemical compounds called aldehydes. Aldehydes are a class of chemical compound that bind with SO_2, resulting in lower free SO_2 levels. In fact, there is a snowball effect often associated with aldehyde formation: As the aldehydes develop and react with the free SO_2 in the wine, less SO_2 is available to intercept oxygen. As a result, the incoming oxygen then reacts with more alcohol to create more aldehyde – and so on and so forth. This is the most common cause of a drop in a wine's free SO_2 and the most common cause of oxygen-related spoilage that we see in homemade wines.

- **Spoilage Organisms:** If conditions are favorable and spoilage organisms contaminate the wine, this can create a cell mass that binds with the SO_2. The end result is a lower free sulfur level in a wine. Most commonly these organisms will be A*cetobacter* (vinegar bacteria), *Lactobacillus*, or *Pediococcus*. Spoilage problems usually gain a foothold when depleted free SO_2 levels – usually due to excessive oxygen exposure - make the wine vulnerable.

- **Introduction of solids:** Any time we add solids into our wine, such as oak (which, being porous, also brings some oxygen with it), tannins, specialized yeast products, fining agents, etc. we will have some amount of binding going on, lowering the free SO_2.

Now that we have taken a closer look at the elements that can bind-up our free SO_2 levels, we can focus on how to eliminate or at least minimize the impact they have on our wine. For each of these three problems, (essentially large losses of sulfite concentration) there is a corresponding course of action we can take to counteract potential ill effects.

- **Aldehyde formation:** Since aldehydes form when alcohol oxidizes, if we eliminate or limit the amount of oxygen the wine comes into contact with then we also effectively eliminate or limit the amount of aldehyde that gets formed in our wines. This can be accomplished by flushing any air spaces that the wine will occupy with inert gas. Examples of these “air spaces” include the headspaces of vessels, transfer lines, pump cavities, filter housings, etc.

- **Spoilage Organisms:** Good sanitization practices and being vigilant about keeping free SO_2 at the required level will help to keep any microbial issues at bay. This not only keeps the wine from developing off flavors from unwanted microbial action, but also limits the total SO_2 additions to a minimum, lessening the risk of a negative sensory impact from SO_2.

- **Introduction of solids:** Finally, when adding any solids into the wine, realize that a small portion of the sulfite will become bound to the newly introduced element in the wine. Therefore, we will need to add a little bit more SO_2 to compensate for this. After its initial impact on sulfite levels, your oak or other additives should not continue to adsorb portions of future SO2 additions.

Hopefully, the information in this section will help you to better understand how maintaining proper sulfite levels in a wine is about more than just doing a calculation and adding it to the wine. The actual quantity of sulfite needed to maintain the recommended free levels in a wine is never a fixed, “one size fits all” amount; it will be different for each of our wines. The way that individual elements in the wine interact and bind with the SO_2 needs to be understood and taken into account if we hope to create the stable free SO_2 level needed to protect our wines during élévage. However, remember that stable sulfite levels in a wine do not mean you can suddenly become negligent with your handling. As we have seen, improper handling of the wine will only cause the binding reactions we are hoping to avoid and as a result, the free SO_2 will drop and force us to keep adding more and more sulfur into our wines. By understanding how the system works, you are now better to able to prevent this scenario.

For a complete explanation of how to calculate the exact amount of SO_2 needed for our wines, along with further information on sulfur management, see section 9.4

6.6) Tasting and Adjusting During Ageing

Throughout the entire maturation period we need to occasionally check in on the wine’s progress by testing and tasting it. We like an interval of roughly every 4-6 weeks. What we are looking for is the following:

- **Is everything all right?** Is the wine still fresh and fruity? Or, are there any funky, undesirable flavors or aromas developing since the last time you checked the wine? If there are any problems, they will need to be dealt with ASAP, because *the longer problems are left uncorrected the harder they are to remedy*.

  Note: In the midst of analyzing/troubleshooting, don't forget to check both the SO_2 levels and the pH/TA to see if these have shifted from the last time the wine was tested. This will help you – or us - to figure out what is going on with the wine if there is a problem.

- **Assuming there are no signs of spoilage, then how is the wine developing?** You'll want to look at a few different aspects of the wine to check to see if there's anything that you want to alter or adjust.

  A. **pH/TA:** How does the wine taste? Is it too acidic or too flat? Check what you taste against the pH and TA results. If you need to raise the pH because the wine is too acidic you can use one of the two products:

     - <u>Potassium Carbonate</u> used at a rate of 3.8 grams per gallon will raise the pH by approximately 0.10 units (a bench trial is highly recommended). When you use Potassium Carbonate you will need to chill the wine to below 40°F for a minimum of two weeks. Potassium Carbonate requires cold temperatures in for the treatment to be effective. Chilling the wine also has the beneficial effect of making the wine cold-stable at the same time. <u>*However, if the wine cannot be chilled then the Potassium Carbonate will never drop out and remain in solution, thus ruining the wine. So do not use Potassium Carbonate unless you can chill the wine to at least 40F for a two-week period.*</u>

     - <u>Calcium Carbonate</u> used at a rate of 2.5 grams per gallon will raise pH by approximately 0.10 units (a bench trial is highly recommended). Calcium Carbonate does not require cold to work; in fact cold temperatures delay settling (so make sure it has dropped out of a wine before you cold-stabilize it). However, Calcium Carbonate can takes months to precipitate out of a wine and it can effect flavor more than Potassium Carbonate. So, if possible it is recommended to use Potassium Carbonate to reduce acidity in your wines.

     When done with either Potassium or Calcium Carbonate, rack it off of the deposit, double check the pH, TA% and SO_2 level and return to the normal ageing/storage schedule.

     - If the wine is too flat and could use a little brightening-up, it can be remedied by a Tartaric acid addition. (3.8 grams per gallon raises the TA by approximately 1.0 g/L, a bench trial is highly recommended to determine the best dosage rate).

     Refer to section 9.2 for a complete explanation of raising or lowering the pH/TA.

  - **Mouthfeel/Structure:** How does the wine seem when you roll it around in your mouth? Is it thin or full? Depending on the varietal and the style of the wine being made thin may be perfect - a delicate Riesling, for example. However, if you are looking for a wine that is a little more full then you may want to look at using a small amount of yeast-derived additives such as Opti-White, Noblesse, Sur-Lie, or enological tannins to help round things out.

Note: If you are ageing on the lees, just keep stirring to gain fullness.

- **Tannin/Oak Extracts/Level of Barrel Impact:** If you are using oak, each time you taste the wine you need to pay attention to how well the tannins, flavors and aromas coming from the toasted oak are interacting with the wine. It is always easy to add a little more oak or tannin to the wine if the levels are not high enough, but be careful to not over do it. The only way to tone it down is by blending it out with another wine that has less oak/tannins.

  For more information on using oak in winemaking, see section 9.9

  Note: Due to the complexity of wine, the only way to precisely gauge how much of each product is needed to achieve your desired results for any of these addition/adjustments is to do a bench trial. This cannot be stressed enough: the place to find out that the 0.2 pH rise in your wine that was supposed to come from a 2 g/L addition of Potassium Carbonate has now resulted in a 0.4 pH shift due to an unforeseen buffering reaction is in the test bottle and not your entire wine volume…

  For complete information on bench trials, see section 9.7

6.7) Additional Transfers

If you are <u>not</u> working with the lees: Depending on how much sediment has settled out during ageing, you can choose to rack the wine off the deposit during its maturation to help promote clarity. If you are careful during racking and don't stir-up a lot of sediment when you transfer the wine you will probably only need to do this once or twice.

If you <u>are</u> working with the lees: You will only be racking it once the desired lees impact has been reached.

We recommend, if you are so equipped, purging the transfer lines and the receiving vessel with inert gas before making any white wine transfer. This will keep the wine from excessive contact with oxygen and thus retain more of the wine's aromatic character. The following basic check list should be gone over before any racking:

- **Test your free SO_2 level**. Make sure you have at least a portion of your free level in the wine *before* you make your transfer. This will serve as an internal protection during the transfer in case of oxygen exposure or potential spoilage organisms. Once the transfer is complete make sure to bring the free SO_2 up to the required level before closing the wine up for the next 4-6 weeks.
- **If you made any acid adjustments, it would be a good idea to test the TA and see if it needs more**. However, don't just go by the numbers alone, taste the wine and see what you think it needs, if anything at all.

- **Check the amount of oak/tannin integration.** Oak compounds are continuously being released from the wood into the wine throughout the ageing/storage process. It is important to monitor their integration into the wine during this period so that the oak character does not become too strong, overpowering the wine. In general, if you use the recommended level of oak in your wines (1.5 - 2 oz. of oak cubes per 5 gallon carboy, or actual barrels themselves), and taste/monitor the progress every 4-6 weeks, you will be able to avoid accidentally over-oaking your wine.

Chapter 7: End of Ageing / Bottle Prep (Fining/Filtration & Stabilization)

7.1) Fine-Tuning, Clarification (Fining/Filtration), Stability!

At some point in the next 6-12 months, depending on the type of wine you are making, the wine will have come together enough to be considered finished. If you are making a straightforward, fruity wine that does not have any oak in it and is not being aged on the lees then you will usually have a rounding of the flavors around 6 months post fermentation. If you are making a more complex wine that involves oak and/or sur-lie ageing then it usually takes around 9-12 months before all of the elements integrate properly. In all cases, the ultimate guide to when to prepare the wine for bottling is when it tastes right to you! As soon as you like where the wine is, the end of the élevage/maturation period is nearing, signaling the beginning of the bottling process. Even though we have been testing the wine throughout the ageing/storage period, (along with tracking and correcting any problems), run the numbers a final time. There will be no going back and adjusting the wine once it is in the bottle. The following checklists will help guide you through the steps needed to prepare the wine for bottling.

Pre-Bottling Checklist

If the wine tastes fine and you are happy with the level of clarity and are not worried about stability (see below), an SO_2 test is all that's left to do (see **6.5** & **9.4**). Once this has been taken care of, we can proceed to the actual bottling of the wine. However, more likely than not, there will be one or two elements that need our attention before we can bottle the wine:

1) Check The pH/TA: How is the wine's acidity? If the pH/TA needs to be corrected you should do it now. Keep in mind if you will be cold-stabilizing your wine (see below, **7.3**) you will need to double-check the pH/TA once again after the treatment is over because this procedure will cause the pH/TA to shift by an unknown amount.

- **Lower the pH:** If the pH is high (above 3.5) then you will want to lower it before bottling by adding tartaric acid: 3.8 g/gal (1 g/L) raises the TA by 0.10% (see section **9.2**).

- **Raise the pH:** If the pH is low (below 3.2) and the wine tastes harsh and edgy, you may want to consider raising the pH it by adding potassium carbonate and chilling the wine: 3.8 g/gal (1 g/L) lowers the TA by *about* 0.10%.

Note: Using potassium carbonate requires that the fermenter be stored cold (below 40 F) for several weeks after the application. During the period of cold stabilization the tartaric acid drops out as potassium bitartarate. Calcium carbonate can be used in a similar manner and does not require cold stabilization. However it can adversely affects flavor if you are trying to make an adjustment of more than 0.3 pH units, and takes a month to precipitate out of solution.

Note: Every wine will react differently to the same amount of potassium carbonate. The only way to know for sure how much is needed for the desired pH shift in your specific wine is to do a bench trial before treating your entire wine volume (section **9.7**).

2) Check the clarity: Is the wine's clarity satisfactory? If you will be heat stabilizing the wine as part of the pre-bottling preparation (see below, **7.3**), then the bentonite/light gelatin fining used in this procedure will have the added benefit of making the wine brilliantly clear. If you are not concerned with heat stability and/or don't mind if the wine is not crystal-clear, then careful racking during the ageing/storage period may be enough to clear up a white wine enough to bottle. Keep in mind that clarity does not equal stability: it is possible to have a crystal clear wine that is not heat stable.

Note: If you are keeping some Residual Sugar in the wine or have had no/partial MLF, we highly recommend filtration at 0.45 microns Absolute (see the next section). This filtration will also serve to clarify the wine.

3) Check the Residual Sugar %: In general, the Residual Sugar (often just RS for short) level does not need to be adjusted for a dry white wine. The juice usually ferments dry and is left where it stopped. However, in cases where RS is desired in the wine, this should be tasted and adjusted just prior to bottling. In addition to having proper SO_2 levels we encourage you to consider a sterile filtration in order to guarantee the microbial stability of the wine. If you don't filter the wine it is possible to pick up a spoilage yeast or bacteria during the ageing or bottling period and any Residual Sugar could be used a food source- allowing them to spoil the wine. *Running your wine through a sterile filter (0.45 microns Absolute) as it goes into the bottle will effectively remove all yeast and bacteria from the wine so that the Residual Sugar will remain untouched.* (For complete information on filtration, see **7.2 B** below)

4) Check the free SO_2: The final treatment: make sure that your free SO_2 is at the correct level; adjust if needed (see *sections 6.5 & 9.4).*

5) Check the stability of the wine: Most commercial white wines are tested/treated to be both hot and cold stable. This allows the wine to keep its taste and appearance unaltered even when exposed to extremes of hot and cold temperature. A stable wine also holds-up better over time in the bottle. Heat stability is done by fining the wine with bentonite, cold stability is done by subjecting the wine to ≤40 F for at least two weeks. For complete info on stability treatments, see section **7.3** below.

7.2) Fining and Filtration

Both fining and filtration are treatments that can be done to further polish or finish the wine just before bottling. Fining works by introducing an agent to the wine that physically binds with a targeted element, most commonly tannins or proteins. Once the reaction finishes and the agglomeration precipitates out to the bottom of the vessel, the wine is racked to remove it from the sediment. Filtration works by passing the wine through a material that contains a series of very small holes (or "pores") similar to a coffee filter. Liquid and particles small enough to fit through these holes are allowed to pass through; particles that are too large get held back and are effectively removed from the liquid. Depending on what is going on in our wines, we may decide to do one, both, or neither of these treatments. It all comes down to our personal winemaking philosophies and whether or not we feel the wine needs maintenance. Let's take a quick look at both fining and filtration before we move onto bottling.

7.2 A) Fining

A white wine is usually fined in order to soften a harsh or astringent character, to improve clarity, and/or to create heat stability. Fining agents should be used at the lowest possible dosage needed to achieve the desired effect. Over dosage can often create a loss of mouthfeel, aroma and/or flavor. Due to the complexity of the chemical structures in wine, different fining agents will be more or less effective at achieving a desired result. We strongly recommend conducting a bench trial first to determine which product gives the results you are looking for. Then, once this has been decided, do a second trial to determine the ideal dosage rate that will give the desired results for the least amount of product used.

<u>Subtractive fining treatments</u>

Subtractive fining agents work by physically removing offending elements from the wine. (Addition by subtraction.)

- **Bentonite** is a special type of clay that is used to remove proteins from wine. Bentonites for winemaking are either sodium-based or calcium-based. Sodium-based bentonite is added to a small amount of water and allowed to swell for 24 hours until it become a thick slurry that is then added to the wine. Calcium-based bentonites are made to be added directly to the wine. This is a very effective treatment, but there is a downside: depending on the type of Bentonite used the lees can be very fluffy and result in a loss of wine volume when the treated wine gets racked off of the deposit. Sodium based Bentonite is very fluffy and for that reason is usually accompanied by a light gelatin or silica-gel dosage to help compact the final treatment lees, reducing volume loss. Calcium based Bentonites are not quite as effective as Sodium based ones, so you wind up using a bit more to get the job done. However, they have the benefit of being very compact in the final lees so there is little loss of wine post treatment. Calcium based Bentonites also benefit from a light gelatin or silica-gel dosage not for compacting the lees during settling, but for clearing out any fine particles that may be slow to settle once the main deposit has dropped. Once added to the wine, the reaction product is allowed to settle out and the wine is then racked away from the deposit.

  Bentonite reacts most effectively at 60-75 F, so if possible allow the wine to warm up to 60-65 F for the fining. Once the reaction takes place go ahead and cool the wine back to the desired cellar temp.

  Note: you can do both a cold and hot stabilization by warming the wine to 60-65 F, doing the bentonite fining, and then cooling the wine to ≤40 F. The cold and the potassium bitartrate crystals that form will help compact the bentonite/protein lees and will help minimize loss of wine volume!

(for more information on bentonite and heat stability see below, **7.3 B**)

- **Gelatins/Isinglass** are specially purified proteins that can be used to reduce tannins and help clarify a wine. Depending on the specific type, gelatins are mixed with either hot or cold water to form a solution, which gets mixed into the wine. After waiting the prescribed time, the wine gets racked off of the sediment.

  Note: there are many types of gelatin available to winemakers; some are generalized and have a “blanket” effect of working on the entire range of tannins in the wine, while others are more specialized and target a specific type of tannin/polyphenol. Make sure *the one you use is designed to give the results you are looking for. In white wines, we recommend using "Ichtyocolle"* **(FIN74)** *for clarification and for helping compact bentonite treatment lees.*

- **Casein (Potassium Caseinate), "Casei Plus" (FIN70)** is a milk-derived protein that is used to reduce astringency and soften a white wine's tannin structure (i.e.: removing the aggressive oak character from an over-oaked wine). In addition, casein can also be used for removing browning from oxidative reactions. Once added to the wine, Potassium Caseinate is quick to settle and the treated wine can usually be racked in 4 days.

  Note: If used to correct browning from oxidation, casein is often more effective when used in conjunction with PVPP.

- **PVPP** (Polyvinylpolypyrolidone) is a synthetic polymer that is used for removing bitter and astringent oxidizable polyphenols (the compounds responsible for wine turning brown when it oxidizes!). PVPP can be used preventatively (as it is when it is used as part of "**Polylact**" to treat the pressed juice pre-fermentation) or as a cure for removing bitterness and brown color from oxidized wine.

  Note: If used to correct browning from oxidation, PVPP is often more effective when used in conjunction with casein.

- **"Polylact" (FIN73)** is a specialized blend of casein and PVPP in a pre-mixed, easy to use solution. Use it anywhere you would use either PVPP or casein, such as removing bitterness and as a curative or preventative treatment for oxidized browning in whites, rosés, and fruit wines. Can be used in both musts and finished wines (see product descriptions for directions/dosages).

<u>Additive treatments (A.K.A.: "coating")</u>

The following treatments are considered to be "additive" because instead of removing the offending element, they work by coating or adding to the molecular structures that are responsible for creating the perception of harshness in the wine. While this may seem counterintuitive, "additive" treatments are often able to modify the aggressive/harsh character(s) you were trying to eliminate so that the need for further fining can be reduced or even unnecessary. Since the "coating" of tannins is an additive process, there is no danger of stripping anything out of the wine during the treatment. However, the one caveat to additive treatments is that if overdone, they can overpower subtle elements in the wine. Once again, bench trials and a conservative approach to your additions will help to avoid any problems.

- **Oenological tannins** are used during the ageing/storage period to help develop mid-palate structure and positive mouthfeel characteristics in the wine. These tannins can be used to help round out a thin or aggressive wine. In addition, oenological tannins also add a layer of protection against oxidation.

  Note: some oenological tannins are designed only for use during fermentation and others are specifically made for the ageing/storage period. So, make sure you choose the right one for the task at hand.

  - <u>Galalcool SP (TAN150)</u>: Can be used during fermentation to minimize reductive odors and enhance mouthfeel. It is usually used for white wines, but can be used for fruit wines and mead, as well.

- **Toasted Oak (chips/cubes)** is an economic source of wood (also called *ellagic*) tannin that will help stabilize color and add body during fermentation. Toasted oak will also give some finished flavor complexity to the wine. Can be used with enological tannins as a spice/flavor component. (For a complete explanation on the use of oak in winemaking see section **9.9**)

  -Dosage rate for chips/cubes is 1-4 lb per 1000 lb of fruit (or 1.6 to 6.4 ounces per 100 lb of fruit), with the low end being used for stabilizing color and structure, and the high end being used to minimize vegetal characteristics.

- **Opti-White/Sur-Lie** are specially designed, yeast-derived protein fractions that can be used to add mouthfeel, body, and perceived sweetness to a wine. Normally used in the fermentation, these products can also be used to round harsh/aggressive tannins and bright acidity in finished wine during ageing/storage. Like tannins, Opti-White/Sur-Lie (Bio lees) add a layer of protection against oxidation to help protect the wine during the ageing/storage period.

  *Note: When Opti-White/*Sur-Lie *additions are overdone, they can create a candied sweetness that comes across as artificial. Watch out for this during your bench trial.*

7.2 B) Filtration

There are two reasons to filter wine: aesthetics and microbial stability. On the aesthetic side, filtration can make a wine more polished both in the glass and in the mouth; often creating a rounding effect that softens the wine's edges. If your wine is sound with no flaws, then you can decide if you want to further shape your wine by filtering it. However, if you have residual sugar or Malic acid left in the wine, or there was a problem with Acetobacter or Brettanomyces during the ageing/storage period, then filtration is no longer an artistic decision; it becomes the only way to guarantee microbial stability for the wine.

Pore sizes of filters are measured in microns. Typical winemaking sizes are 5, 3, 2, 1, and .45 micron media. The smaller the holes, the "tighter" the filter is said to be. Filtration's guarantee of microbial stability comes from the fact that the pore size of filters can be made smaller than the actual yeast and microbes themselves. As the wine passes through the filter the larger microbes become stuck and are removed from the wine. *Note: 2-micron filters are used to remove yeast, and .45-microns are needed to remove bacteria.*

Filters are rated as being "Nominal" or "Absolute". A nominal filter will remove most particles that are equal or greater than the rated micron size. An absolute filter will remove all particles larger than the micron rating. Nominal filters are cheaper than absolute ones, and if you are only doing a general cleaning up of the wine, a nominal filter may be all you need. However, if you are filtering to remove either yeast or bacteria, you will need to rely on an absolute filter. Note that an absolute filter is only needed at the final filtration of the wine (usually during bottling, right before the filler to minimize exposing the sterile wine to contamination).

The effect that filtration has on wine becomes more pronounced as the micron-size becomes smaller. Filtration does remove certain elements from a wine; however, these are often elements that are worth losing. Filtration can stress a wine and cause it to temporarily "fall apart" right after the process. However, just as with "bottle shock", filtered wines put themselves back together just fine over the following weeks.

Filtration set-ups are based on the two different forms of filtration media: cartridges and pads. Cartridges use housings, whereas pads require a “plate and frame” set-up. Both require a pump to move the wine (*note that small lots can also be done without a pump using a keg and pressurized gas if you have this equipment*). Cartridges are more expensive than pads because they are more intensive to produce, but they can be cleaned and stored for future use. Pads are cheap but they can only be used one time. Both pads and cartridges are tried and true, and choosing between the two technologies just comes down to personal working preferences: cartridges are clean to work with but they are more expensive and time intensive for maintenance. Pads are economical and somewhat messy, however when you’re finished you just toss them.

Note: Only cartridges can provide .45 Absolute ratings. In other words you cannot achieve a sterile filtration using a plate and frame set-up with pads.

<u>Filtration Summary</u>

In the end, filtration is a very effective winemaking tool that can be used to gently polish a wine or to make sure it is microbiologically stable. However, the initial investment for the housing(s) or the plate and frame system make it a bit of an economic hurdle for the beginning winemaker. Fining requires no equipment and offers a cheap way to clarify a wine and have control over its tannin profile. Fining is the only way to achieve heat stability in a wine- as filtration does not remove the proteins responsible for heat instability. The only caveat is that fining is not very selective. You need to be careful about preserving the balance of all of the elements. Finally, keep in mind that the two actions are not mutually exclusive and a light fining is often done to improve a wine’s filterability.

7.3) Stabilization

Depending on the style of wine you are making you can begin preparing the wine for bottling as early as 6 months. However, bottling somewhere in the 7-12 months range is most common for white wines. Remember that these timings are only generic guidelines; the only criteria that matters here is that you like the way it tastes.

While you could just bottle the wine now, it is recommended to consider stabilizing your white wine before it goes into the bottle. Not doing so creates a situation where the wine could change its taste and appearance over time as it ages. Two main criteria for stabilizing a white wine are cold stability and heat stability. Let’s take a closer look at each of these.

7.3 A) Cold Stabilization

If an unstabilized bottle of wine becomes cold (i.e.: chilled in a fridge before being served) it can trigger a crystallization reaction between the potassium and the tartaric acid which combine to form a deposit of crystals (potassium bitartrate, A.K.A.: "tartrates"). When this occurs the pH of the wine will shift. Depending on how extreme the shift is, the wine can end up tasting out of balance and it is impossible to correct unless you open the bottles, treat the wine and then re-bottle the entire lot. Best to address this before bottling to avoid this scenario.

- Cold stabilization is done by just exposing the wine to temperatures as close to freezing as possible (32F - 0C) for a minimum of two weeks (longer will not hurt the wine, it just will slow down the ageing process). A minimum of 40 F for two weeks is necessary for successful stabilization.

Note: if you happen to have a way to chill the wine to 32 F within a 12 hour period, you will become stable after only 4 days and do not need to wait for the two weeks it usually takes.

- Ageing on the lees can actually build tartrate stability into the wine so that a less extreme precipitation of tartrates is seen in wines which are lees aged as compared to those that are not. This is a colloidal stability that comes from the polysaccharides and mannoproteins extracted from the yeast during the lees ageing process.

7.3 B) Heat Stabilization

If an unstabilized wine has an excess of protein, this protein can come out of its solubilized form, flocculate and deposit at the bottom of the bottle. Usually this happens fairly quickly when an unstable wine becomes sits at a warm temperature for a couple of days. It can also happen at cellar temps, but usually takes a longer period of time to develop because cooler temps delay the flocculation reaction. Either way the result is that a wine that was clear going into the bottle now contains fluffy, white clumps that swirl back up into the wine each time the bottle is moved, just like a snow-globe. Depending on how extreme the reaction is, the effect on the wine's taste can be negligible to definitely detectible – though usually not enough to ruin the wine. However the visual impact is always pronounced and negative.

As we've seen, protein is removed by **bentonite**. Protein has a positive charge, and bentonite clay has a negative charge. When exposed to each other the two opposites attract and stick to each other like a pair of magnets. Clear wine will go cloudy when bentonite is added as the charged reaction pulls the protein out of solution. The protein/clay reaction product will then settle out at the bottom of the vessel, forming a deposit that the clear wine will need to be racked off of. By weight, sodium-based bentonite is more reactive than calcium-based bentonite but creates very fluffy lees so we have a higher wine loss post-treatment. Calcium-based bentonite lees are more compact so we get a lower wine loss when we rack off post-fining, but calcium-based bentonites can be less effective so you often use more of the product to get the job done.

Helpful Hint: The deposit for either type of bentonite can be condensed by the use of a small amount of gelatin, such as "Ichtyocolle" (FIN74) which also helps to clear the wine out.

Bentonite is a powerful tool. If you use too much of it your wine will indeed be stable, but you will strip out flavours and aromas at the same time! Determining the least amount needed to achieve stability is critical when planning to make your wine heat stable. The amount of bentonite needed to stabilize a white wine depends on the type of grape, vineyard location, growing practices, and vintage. In addition, the way the fruit is handled during pressing and crushing also has an effect on the final protein content of the wine (more movement/exposure time on skins = more protein). In short, each wine will have to be tested individually because there is no other way to know. This is done by doing a stability test (see below). Interesting Different bentonites will have a differing effectiveness as well as their own organoleptic impact on the treated wine. Each bentonite has a different molecular make-up, and each wine has a series of different proteins in varying ratios that make up the instability. This means that one type of bentonite may need a dosage rate of 4 g/gal to achieve stability, whereas another type of bentonite may need only 1 g/gal. As previously stated, using the least amount needed to achieve stability is important to avoid altering the original wine's desirable characters too much. So bench trials are best done in 2 parts: 1) which product is best at preserving desirable qualities of your wine, then 2) how much of this one is needed to make the wine stable. Or just use the most effective one and call it a day.

Heat stability test protocol:

- Fine filter a 100 mL sample of wine (a coffee filter works great for this). If the sample is not filtered, other forms of precipitation may settle out with the protein and it will be difficult to get an accurate assessment of the results.
- In a non-reactive container, heat the sample of wine to 176 F (80 C) and hold it there for 10 minutes.
- Turn off the heat, let the sample cool for 15 minutes.
- Place the sample in a laboratory flask which can go from hot to cold without cracking
- Place the flask in the freezer for 4-6 hours.
- Take out the sample; let it come to room temp.
- If the sample shows any haze or precipitation it is not heat stable. You will need to use bentonite (or more bentonite if you are checking the effectiveness of a treatment) to fine the wine.

All fining, by nature, alters the wine. A good way to think about this is to use an analogy of a house of cards. As the wine ages its various elements become increasingly interconnected through polymerization and a balance is struck in the overall equilibrium of the parts. The longer we go the higher we build. However, when we remove one of these pieces by fining (for example: to remove a protein that could potentially cause a haze in the bottle) we cause a shift in the structural balance of the wine and the wine will have to put itself back together again. Depending on how much of the compound that was removed, this can be a slight shift or the wine can change dramatically.

The best time to fine for the purpose of removing a large portion of proteins is in the juice phase. Since this is before the wine has started to put itself together, removing protein at this stage does not create a loss of aromatic quality. Later when it is time to heat stabilize the wine, since we already removed some of the protein during the juice preparation, the amount of protein which remains to be removed will be reduced. This means that less bentonite will be needed and the wine will be less altered by the heat stabilization process.

Additionally, ageing on lees can build stability into the wine such that up to 50% less bentonite is needed.

Timing of treatments

- If you will only be doing cold stabilization, then this can be done during the ageing of the wine at any time. In cold climate areas, carboys and tanks are allowed to cool down during winter by being left in unheated garages or sheds. However you do it, the wine must be at least below 40F for 2-3 weeks. If you can achieve colder temps it may not take quite as long to stabilize.

Note: Air conditioned cellars are not cold enough to properly cold-stabilize a wine. You may see a little bit of tartrates being formed at cellar temperature during ageing, but more will be thrown when it finally gets cold enough.

- If you are doing both cold and heat stabilizations, then we would like to suggest the following order. Bentonite is more effective at room temp (65-70F). The benonite reactions are quick and once complete they settle better with cooler temps. So, whenever you feel that the wine is ready to start prepping for bottling, allow the wine to come up from cellar temp (50-55F) to 65-70F and treat in with bentonite/gelatin. Stir the wine the next day to encourage complete reactivity with the fining products. On the third day start to cool the wine and begin cold stabilization. The tartrates that will settle out during cold-stabilization will form a crust on top of the bentonite finings and along with the gelatine/silica gel will help to compact the fluffy bentonite lees - thus minimizing wine loss.

Post fining: rack off the fining lees, decide on filtration

Once the wine has cold stabilized you should have clear wine sitting on top of a layer of crystals that form a crust on the bottom and occasionally the sides of the vessel. If you also heat stabilized then you will also have a layer of bentonite/protein lees under the crystal crust. Now you need to rack off of these to remove them from the wine. If working with small vessels that will be moved before racking, be careful about agitating the wine too much during the transport to keep the lees from swirling back up into the wine and making it cloudy again. If possible, move the vessel a day or two before racking so that what little bit of sediment that is released back up into the wine during movement has time to settle back down again before you begin your racking.

Filtration

At this point you will have a very clear wine but if there was a partial or no MLF then it will not be stable. You can choose to leave the wine as is and just rely on SO2 to keep you safe, but **the only 100% guarantee for microbial stability for wine with RS% or no/partial MLF is .45 micron "Absolute" filtration.**

Note: Lysozyme is a product that can be used in the winemaking process to delay or avoid MLF. However, you should not bottle with residual lysozyme in the wine, because it is a protein and can cause heat instability in the bottle. If you use it during winemaking then it should be fined out with bentonite before you bottle!

Chapter 8: Bottling

Bottling the wine

Once we have gone through the pre-bottling check-list and the wine has undergone any needed treatments, we are ready to bottle the wine. Make sure that the bottles are rinsed clean, sanitized, and that your corks (W430) and corker (W405) are at hand. Then, bottle the wine using one of the following methods:

- **Basic racking cane set-up:** You can use your same racking set-up (R310) to bottle the wine by attaching a bottle filler attachment (B420) to the end of the transfer tube. This simple set-up gives you an economic way to fill single bottles at a time. This is great for doing small lots.

- **Enolmatic filler:** Since the Enolmatic bottle filler (WE620) uses a vacuum to move the wine, two positive things happen; the wine avoids damage caused by pumps, and oxygen exposure is greatly reduced. In addition, the Enolmatic has the ability of adding an optional in-line filter assembly (WE628) so you can actually filter the wine using the same vacuum during the bottling operation. By performing these two operations in one pass this limits the amount of times the wine gets agitated and exposed to the elements. The only caveat to the Enolmatic is that it is a single spout, but if you are only doing a couple of carboys at a time it is really great. Fill rate is around 20 seconds per 750mL bottle.

- **Express Fill:** (WE651, WE652) For lot sizes that are larger than a few carboys, the Express Fill is your best option. 2 or 4 spout machines feature a closed pathway and self-priming pump. An optional built-in sparging option allows you to flush your bottles pre-fill with inert gas at the push of a button- an important advantage for preserving fruit and delicate aromatics when bottling both reds and whites! The specialized digital flow controller regulates the accuracy of the flow to within +/- 1.5mL. Manual mode allows for topping-up bottles or filling odd sizes (example: connect a bit of tubing and you can fill magnums). Fill rate is 200 bottles/hour for the 2-spout, and 400 bottles/hour for the 4-spout.

Note: Regardless of the filling method used it is important to fill the bottles so that when the cork is inserted there will be a 1/2 inch of airspace between the cork bottom and the wine.

<u>Helpful hint: Whatever bottling method you use, if you have access to inert gas we recommend flushing the bottles with gas before you fill them. This extra step will limit the oxygen exposure to the wine and will help maintain the delicate fruit and overall freshness of your wine as it goes into the bottle!</u>

<u>Alternative, non-traditional bottling options</u>

- In addition to corks and wine bottles, wine can be bottled using 16 or 22 oz “beer” bottles with a crown cap. This is a good way to set aside small samples for future evaluation. Remember that crown capped bottles do not need to be stored on their sides- in fact the caps will degrade if in constant contact with the wine itself. So, store them upright to avoid any problems and you should be fine.

- Your wine may also be kegged, which is a great method for storing top-up wine for other vintages if needed. Using kegs also allows you to take off a glass without having to open a whole bottle, and if you want more than just a single glass you can always fill a carafe.

Once bottled, it will take about two months for the wine to get over the shock of the sulfite addition and bottling process, so you really should wait to try it. When you finally do taste the product of your labors, know that it is only going to get better as it ages. Some wines may take a few years before they really come into their own. True, it might be quite drinkable now, but only with ageing will it acquire all those extra flavors and an added complexity. So, knowing this, you might want to try and set some aside. You will be happy that you did. After all, up to now you have worked for the wine; now let the wine finally start to work for you.

Chapter 9: Expanded Information Section

9.1) Must Adjustments

A few notes on the Dilution and Chaptalization of Must

- Use filtered water rather than straight from the tap if you can avoid it. Chemicals found in tap water (ie: chlorine) could possibly contaminate the final flavor of your wine or even be a precursor to TCA formation (cork taint)! A good source of clean water in a winery can be simply and conveniently achieved by attaching our filtration kit (FIL32) to a garden hose.

- Whether you are raising your starting sugars or diluting them, the process requires you to add water to the must. Dilution only requires water; chaptalization is achieved by dissolving sugar with a small amount of water. Water additions will also dilute your TA, which should be taken into consideration. Unless you have a very high acid/low pH must to begin with, you will want to compensate for this potential loss of acidity. To every liter of water used for either dilution or chapitalization, add 6 grams of tartaric acid. This gives the water you are using a TA of 6 g/L (0.6%TA) to prevent it from adversely affecting the acidity of your must. However, if you have a very high acid/low pH must to begin with it is possible that diluting the existing acidity by not adding acid to the water used for the sugar correction will work in your favor.

To *acidulate* the adjustment water:

6 grams of tartaric acid per liter of H_2O,

23 grams of tartaric acid per gallon of H_2O.

Reducing Sugar Content

Once you decide that you need to add water to lower the ºBrix, how do you know how much water will be needed? The equation and example below will show you how to do this.

Like any other addition to the juice or must, add a portion of the amount you think you need, mix it in, and retest the must to make sure you don't overdo it. It is much easier to add the rest of your addition right after than it is to compensate back after over-doing it.

Equation for diluting your must:

This calculation is a 2 step process. Because Brix is a measure of *concentration* of sugar, meaning the total amount of sugar is fixed, we are first going to calculate what the total volume of liquid is that it would have to be dissolved in to give us our desired Brix concentration (**DB**). Next we will determine the difference between that volume and the volume of juice that we have to start with, which will tell us how much to add.

OB = the **O**riginal **ºBrix** of the must or juice
L1 = volume (in **L**iters) of the juice* in the **undiluted** must that will become wine
DB = The **D**esired **ºBrix** you want the must/juice to be diluted to
L2 = volume (in **L**iters) of the juice* in the **diluted** must that will become wine
Y = volume (in liters) of acidulated water needed to dilute the must or juice to the desired ºBrix level, **DB**.

Equation 1: *(L1 x OB) / DB = L2*
Equation 2: *L2 – L1 = Y*

So, putting it together in an example: Let's say we have 8 gallons of Sauvignon Blanc must at 25ºBrix. How much acidulated water do you need to add to dilute this to 23ºBrix?

Equation 1: *(L1 x OB) / DB = L2*
L1 = 30.28 liters *(1 gal = 3.785 liters; 8 gallons of must x 3.785 = 30.28)*
OB = 25 *(original starting ºBrix)*
DB = 23 *(desired ºBrix level)*

(30.28 liters x 25 ºBrix) / 23 ºBrix = L2,
L2 = 32.91 liters

Equation 2: *L2 – L1 = Y*

32.91 L – 30.28 L = Y
Y = 2.63 liters

We need to add 2.63 liters of acidulated water to our must to lower it to 23ºBrix. In keeping with our practice of adding tartaric acid to the water used in the dilution, we can say that 2.63L of water x 6 g/L = 15.79g of tartaric acid should be added to the water prior to using it to dilute the must.

9.2) About Acidity and Adding Acid to Must/Wine

Acidity in wine grapes is the product of several organic acids naturally found in the fruit. Tartaric and Malic make up the lion's share of these acids. We mostly focus on them during winemaking. Depending on when the fruit was picked and how the wine was made, these acids will be present in varying amounts. The concentration of these acids determines how tart/sour the wine will be, as well as how long the wine will remain stable after bottling. As a result, adjusting the acidity of a wine/must involves lowering or raising these concentrations.

Acidity has several functions in a wine/must. The tartness helps to balance the fruity, sweet elements that would otherwise become too cloying if not present. Acidity also helps to trick our palates into perceiving the alcohol in wine as a sweet component, rather than a burning sensation. It also creates a harsh environment that helps keep the wine from becoming spoiled by microorganisms (both from a pH perspective and because the acidity makes SO_2 more effective). Finally, acidity in wine promotes good ageing characteristics and helps ensure that the wine will hold up well in the bottle during its years of ageing/storage.

There are two ways to look at acidity in a winemaking: TA or pH:

- The TA is a measure of the actual physical grams of acid in one liter of your wine and is expressed as "_ g/L of acid", or in tenths of a percent of acidity as in "0.1% total acidity". Both terms are equivalent and can be used interchangeably by moving the decimal point; e.g: 6.5 g/L = 0.65% TA.

- The pH is a measure of how strong the acids are in relation to all of the other compounds in a wine/must. The lower the value, the more strongly acidic the sample will be; i.e: a pH of 3.3 is more acidic than 3.9. In winemaking, most pH values will be between the 3.0 and 4.0 ranges, with most of the focus happening in the range of tenths between these two ends ("3._ pH"). While the TA will tell you how much physical acid there is in the wine/must, the pH tells you how this acidity will be perceived.

To illustrate how even a single added element can alter the perception of acidity, let's use the following example: you squeeze the juice of one lemon into a glass of water and taste it. At this point the combination of only lemon juice and water will be quite sour. However, if you add some sugar to it, the sharpness gets balanced out, you have lemonade. The amount of acid has not been altered, yet the perception of the acidity has shifted from sour to tart and refreshing.

This same type of modifying phenomenon is also taking place in the must/wine but in a much more complicated fashion. A complex variety of different compounds are responsible for not only altering the perception of the acidity, but for defining how the wine will react to any changes made to its acid structure. Because the ratio of these modifying compounds varies for each must/wine, it is difficult to predict exactly how the pH will shift as a result of a calculated acid addition or reduction.

While both TA and pH can be used to measure and discuss acidity, they are not directly related to each other in a predictable manner. If you add 1 g/L of Tartaric acid to a wine/must already containing 6 g/L, you TA test will clearly reflect this addition and let you know there is 7 g/L of acid present. However, when testing how the same sample for pH, it's highly unlikely to get a 'one-to-one' reaction. A pH of 3.7 will not go straight to 3.6. We could even get a final pH of anywhere from 3.65 to 3.5! That extra 1g/L has interacted and balanced out with all of the other elements in the must/wine, accounting for the final pH value. The only way to know for sure how the wine/must's pH will react to an acid adjustment is by doing a bench trial. When this is not possible it is recommended to make a partial addition, test/taste the results, and then add the balance if needed.

In Practice

Generally, if either TA or pH is within the recommended ranges, the other will be as well.

When adding acids, a wine will more gracefully absorb large acid additions during its earlier stages than it will as time goes by. Therefore, if you do need a large acid adjustment, we recommend making a relatively large correction early on (preferably in the must), so that you only need to make minor changes later on.

Acid additions become more apparent in wine as it ages and the fruitiness starts to fade. An adjustment that seemed just right early on might end up being a little too tart in six months to a year. As a result, when making large adjustments to your must or wine, it's best to use a conservative, two-step approach: make one addition now (in the middle range of what you are shooting for), then, if it needs it, add a little more later.

Another thing to consider: TA will drop 0.5-1.0 g/L (0.05-0.1%), or possibly even more, as a natural result of fermentation. Additionally, if you choose to do a Malolactic Fermentation this will lower your TA by another 1.5-4.0 g/L (0.15-0.4%). As a result, it's important to consider both the TA of the must prior to fermentation as well as the techniques you will be using when making additions at crush. If you are not sure of your approach, shoot for the 7g/L TA range for the must and go from there.

Whatever amount you decide on, it's a good idea to mix the acid in a small portion of juice, wine or even warm, chlorine-free water before adding it to the must or wine. You want to make sure that the acid crystals are completely dissolved before the addition goes into the wine so that your correction will be evenly and thoroughly mixed throughout the whole volume of liquid.

9.3) Complete Must Adjustment Example: ºBrix, pH, TA

For this example, let's put everything together by taking a look at how we might deal with 25 gallons of Chardonnay must that is at 25.5º Brix, with a pH of 3.6 and 5g/L TA. Fruit with these starting numbers will definitely need some work before yeast can or should be added. The first step is to dilute the sugars, and *then* tackle adjusting the pH and TA. Adjusting the sugars first is advisable because the amount of water needed to make the dilution is usually much greater than the amount needed to make a pH and TA adjustment. Once the sugars are within the desired range, we can then go ahead and address the pH and TA without notably impacting the ºBrix at that point.

1 A) Adjust the sugars: With the must at 25.5ºBrix, let's look at dropping this to 23ºBrix. Using our equation (introduced in section 8.1) we come up with the following:

OB = 25.5 (starting ºBrix)

L1 = 94.62 liters (<u>25 gal of must</u> x <u>3.785 (1 gal = 3.785 L)</u> = <u>94.62 liters</u>

DB = 23 (desired ºBrix)

Equation 1: (94.62 liters) x (25.5ºBrix) / (23ºBrix) = 104.91 liters (L2)

Equation 2: (104.91 liters) – (94.62 liters) = 10.29 liters (Y)

So, we will need to add <u>10.29 liters of water</u> to the must to drop it to 23 ºBrix.

B) Acidulate the adjustment water: In order to try and keep the must as consistent as possible when making the water addition, we will need to acidulate the water. This is done by adding 6 grams of tartaric acid to every liter of water used to dilute the must. It helps to heat some of the water to dissolve the acid crystals completely and then add the rest of the dilution water.

-For our 10.29 liters of water: 10.29 liters x 6 grams = 61.74 grams

So, we will need 61.74 grams of Tartaric acid to acidulate our dilution water.

- **Looking at the pH and the TA:** With a pH of 3.6 and a TA of .50, we want to lower the pH and raise the TA. Fortunately, we can do both by adding tartaric acid to the must. However, we must be careful not to overdo it. Must/juice is very complex. Each wine's unique make-up will cause it to respond to the adjustment in a unique way when making additions to the pH and TA. Two different wines with the same exact pH and TA will respond differently to an equivalent acid addition. Yes, the numbers are important, but ultimately, they only give you an idea of the boundaries you're working in, not absolute answers. A good analogy for this is thinking about driving at night: Not testing your pH is like driving in the dark with your headlights off- you have no idea which direction you're going. Testing not only illuminates the road ahead, but it also lights up the reflectors and paint lines. You can see where you are going along with the boundaries that promote safe driving. Furthermore, since it is quite difficult to know how any must or wine will react to an acid addition, we cannot express enough that it is always best to add a portion of the amount you think you need, then taste and test to be sure. It is very easy to overdo things. With a patient and measured approach, you'll be saved from having to fix an over-correction. Once you have tasted the partial addition, you can decide if the rest will be needed.

Let's discuss the method we'll use to lower the pH from 3.6. Our goal is a wine that finishes around 3.3-3.4 pH. If we will also be doing an MLF (raises pH), then we could add enough acid to bring the pH to 3.2. Once the completed MLF brought it back up to 3.3-3.4ish, we'd be in great shape.... on paper. However, in reality, adding enough acid to create a .40 pH drop is quite intense and we may find ourselves shooting even lower than our targeted range of 3.2 by accident. In addition, the taste will be very sharp. This much artificially introduced acid will have a hard time integrating harmoniously into the wine. As stated before, it is true that large acid adjustments are ideally made during the must stage, but there are limits.

With that in mind, it is probably best to compromise and target the acid adjustment to end up in the 3.4 pH range. Calculate the amount of tartaric acid needed to raise the TA of the must by 2 g/L (or 0.2%). Given our original figure of 5g/L, our TA will be 7 g/L along with a drop in the pH to around 3.4. The numbers won't line up perfectly like this once the addition is made, but it will put you into a generally acceptable pH and TA range. When tasting after the addition, it's possible that it will be in balance already. Your original "too small" addition may be all that is needed. As with any addition, even smaller ones, we should still effect it in a conservative manner. Add a portion of the addition, mix, test, and taste. Decide if the rest is needed.

Note: Besides being safe, this incremental acidulation *while tasting* will teach you how the balance of the must changes as the pH and TA come into the correct range. This will help you to develop your palate for the future- not only for must adjustment, but for the finished wine as well!

- **Adjust the pH / TA:** Since we already did our calculations for lowering the ºBrix earlier, we can use our new juice volume obtained when we corrected the ºBrix level:

  (94.62 L orig. volume of must) + (10.29 L dilution volume) = **104.91 L**. (or 27.7 gal)

  So, for our 104.91 L (27.7 gal) of must, we are going to look at acidulating by 2.0 g/L TA (0.2%)

Since: 3.8 grams Tartaric Acid per US Gallon raises TA by + 1 g/L (or .1%)

Then, we can just do the following calculations to determine how much Tartaric Acid will be needed:

Gallons: (27.7 gal) x (7.6 grams, from: 2 x 3.8 grams per gallon) = **210.5 grams**

Liters: (104.91 liters) x (2 grams per liter for .2% TA) = **209.82 grams**

If you don't have a scale:
1 level teaspoon Tartaric Acid per US Gallon raises TA by +1.2 g/L (0.12%)
1 tsp Tartaric acid = 5 grams.

Dilute the addition in just enough warm water to dissolve the crystals completely. Add a portion to the must. Mix thoroughly, test and taste. Add the rest if needed.

In the end, to correct our must starting at 25.5ºBrix with a pH of 3.6 and a TA of .5, we added 10.29 liters of water acidulated to 6.0 g/L TA (with 61.74 grams of Tartaric Acid). This brought the ºBrix to around 23º without changing the TA or pH of the must.

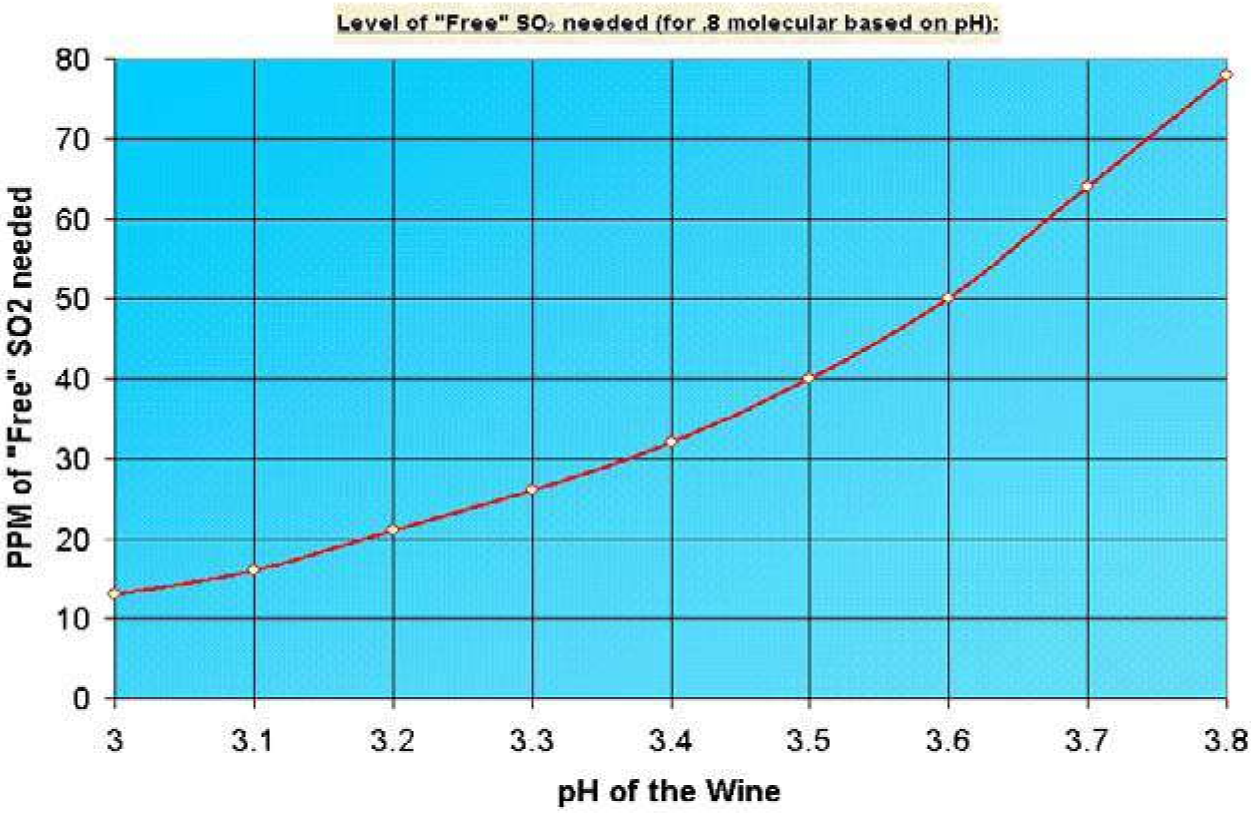
With the dilution was finished, we were able to hone in on the pH and TA. Because of the inexact nature of TA and pH adjustments, we saw a combination of the "art and science" of winemaking. Sugar dilution techniques are relatively straightforward and easy to predict. TA/pH adjustment involves a number of factors, ranging from unpredictable end results to judgment calls regarding the size of acid additions. We didn't make the full "on paper" addition of the quantity needed (+4 g/L% TA or 0.4%), which may have been too extreme. The actual ending amount of acid used (+ 2.0 g/L TA, or 0.2%), was a safe compromise that placed both the pH and the TA within acceptable ranges and was verified by taste. More can be added later if needed.

9.4) Testing SO2

It is important to start this section with some information. Potassium Metabisulfite ("Sulfite", "Meta", "SO_2") (AD495) is used in winemaking in the post-crush/pre-inoculate stage for killing unwanted bacteria and wild yeast, thereby effectively creating a "clean slate" for the more desirable and SO_2-tolerant cultured yeasts to get in and do their job. It's used as a general sanitizer at all stages of the winemaking process. Post-ferment, it also prevents the enzymatic browning of white wines and guards against premature oxidation in both reds and whites. It preserves freshness and colour and it stabilizes a wine, thereby extending the shelf life of your labors. If a wine does not contain the required amount of SO_2, chances are that it won't gracefully make it past one year in the bottle (depending on the pH). As all wine benefits from the ageing process, wouldn't it make sense to try and understand what we need to do to in order to make sure it will go the distance?… Of course it would. And therefore, I invite you to read on and enter the exciting world of sulfite additions!

To begin with, the actual amount needed is quite small, and is referred to as "ppm" (parts per million). There are two forms of sulfite that you need to be aware of: *Bound* SO_2 and *Free* SO_2. When you make your SO_2 addition, a portion of it binds with elements in the must or wine (acetaldehyde, yeast, bacteria, sugars, and oxygen) and is referred to as *bound*. The rest of the addition remains unbound and is referred to as *free*. It is this latter portion that we are interested in because only the free SO_2 brings you all of the previously mentioned benefits that your wine both needs and deserves.

The goal with SO_2 additions is to try to use the least amount needed in order to attain a beneficial saturation level (0.8 ppm molecular SO_2 for whites), while trying to avoid adding too much, which would flaw the wine by giving it a sulfite smell and/or taste. What makes adjusting to this ideal level interesting is that the actual amount of SO_2 that will end up as free after you make your addition actually varies in direct relation to the pH of the must or wine! In short, the higher the pH the more SO_2 will be needed, and conversely, the lower the pH the less SO_2 will be needed to attain the ideal level. Take a moment now to look at the following chart and you will see how this all comes together:



So, by now you are asking "What does all this really mean to me?", and more importantly, "How do I use this information?"….Well, it's actually fairly straightforward. To begin, you will need to test the must or wine for its "free" SO_2 level. There are a few ways to do this:

- **"Titrets":** By far the simplest solution for the home wine-maker would be to use a kit made by CHEMetrics. It is a Ripper-method titration cell and it's manufactured under the brand name "Titrets" (W510).These are relatively cheap and fairly easy to use, but they are not very accurate. However, reliable SO_2 testing set-ups do require a bit of an investment. As a result many folks choose to accept this inaccuracy and use the following work around: While the exact ppm of "free SO_2" given by the endpoint of the test may not be correct, this result still can serve as an accurate reference point to figure out how much of an SO_2 addition wound up being "free". To do this, you test your sample before you make an SO_2 addition and note the endpoint. Next, you make your SO_2 addition, then test again. Then, all you need to do is to subtract the first tests' ppm (pre SO_2 addition) from the second (post SO_2 addition), and you will get an accurate indication as to how much free SO_2 remained after you made your addition.

  If you are making a small amount of wine and will consume it quickly, then taking a risk that the Titrets will be close enough to get the job done is probably fine. However, if you are making larger volumes that will represent a significant amount of time and money we recommend you make the investment in an accurate SO_2 testing set-up.

- **MoreWine!'s A.O set-up (MT130):** This is a manual, wet lab SO_2 testing set-up. 15 min/test.

- **Hanna SO2 Titrator (MT680):** Fully automated, very easy, free + total SO_2 out of the box. 2 min/test.

Following the directions, test the must or wine with your sulfite test kit and find out where the "free" SO_2 level is. Now, if you happen to know your pH, you can then reference the chart and see exactly where the must or wine's ideal sulfite level should be. The difference between these two numbers* will be what you will want to make up in order to bring the "free" SO_2 in the must or wine up to the appropriate level (*Note that, contrary to what you may think, this is indeed applicable to the must at the time of the crush because SO_2 is often used in the grape-growing process and it may already be present even if you have not added it, yet..). So far, so easy… However, you can't just add in the difference as a straight quantity because, as you will remember, a portion of your addition will become "bound" and therefore will be useless to you…So, knowing this, how do you make sure that your SO_2 addition will contain the exact amount of the "free" SO_2 needed? Well, you could bite off the end of a bag and shake it until the billowing cloud "looked about right"…, or, if you're not feeling lucky that day, you could opt to use the following equation!:

$$\frac{\text{PPM of "free" SO2 needed} \times 3.785 \times \text{Gallons (US) of wine you are adjusting}}{0.57 \text{ (the actual \% of } SO_2 \text{ that will become "free" in your addition)}}$$

<u>So, as an example:</u>

If your sulfite test kit indicates that your wine has a "free" SO_2 level of 12 ppm, and say that it is a red with a PH of 3.5, then you know that according to the handy chart, a red with a PH of 3.5 would ideally like to have a "free" SO_2 level of 24ppm. So, 24 (where the ppm of "free" SO_2 should be according to the chart based on the wines pH)

-12 (what the actual sulfite level of your must or wine is currently at, based on your test)

= **12** This is the amount of "free" SO_2 that you will want to add in order to bring it up to the ideal level. So, let's plug it in to the equation:

***Note:** *It is important to note that the number you get for the "ppm of "free" SO_2 needed" for your adjustment needs to have its decimal point moved three places to the left before you plug it in to the equation! In this example, the 12 ppm of "free" SO_2 needed to be added goes into the equation as .012…*

$$\frac{\mathbf{.012} \times 3.785 \times 5.5}{0.57} \text{ (say you have 5.5 gallons)} = \mathbf{.438} \text{ grams of meta}$$

So, the magic number to add in order to get your 12 extra ppm of "free" SO_2 (to bring you up to the 24 ppm that you needed), is .438 grams.

If you don't have a scale:

¼ tsp SO2 per 5 gallons (US) = 50 ppm. Fudge accordingly.

1 tsp SO2 = 5.9 grams.

You can also make a 10% stock solution and add it via a graduated 5 ml pipette: In a 750 ml bottle (standard wine bottle size), put in 75 grams (circa: 12 tsp) of potassium metabisulfite. Fill the bottle ½ full with warm water shake until crystals are dissolved, then top up with cold water. Add it according to the following table:

Amount of 10% SO_2 Solution Needed to Add:

	10 ppm:	**30 ppm**:	**50 ppm**:
Per Liter:	.18 ml	.53 ml	.88 ml
Per Gallon (US):	.67 ml	2.00 ml	3.33 ml

If you don't have a pH meter or an SO_2 test kit:

Typically, you can just add 50 ppm (1/4 tsp per 5 gallons) of SO_2 at the crush. On the other hand, if there were rotted or blistered clusters mixed in with your grapes, or you run your tests and find that you have a high sugar/low acid/high pH must, then you may want to add as much as 80-100 ppm for this first addition. True, this sounds like a lot to add, but keep in mind that the must just after the crush will have a lot of solids in solution, so a good portion of the 80-100 ppm SO_2 will become bound at this stage. (However, you will want to keep the SO_2 levels low if you will be doing a MLF (depending on the strain). In this case, do not add more than 50 ppm before you ferment).

Post-ferment (and if the MLF is done), you may also want to augment the SO_2 level during your transfers, but by very little (25ppm…). Finally, you will add another 40-50 ppm at bottling time. By doing this you will only be maintaining a generic level of SO_2, and you obviously run the risk of having it be too much or too little. Still, this is still far better than not doing it at all.

Just an important reminder: with all the benefits of potassium metabisulfite comes a need to respect its nature. Its fumes are highly caustic and care should be used when handling it (depending on how sensitive you are to it, you may want to use rubber gloves). You should avoid breathing it and do not get it in your mouth, or eyes.

9.5) Inert Gas and Winemaking

Any space in a carboy, tank or barrel that is not occupied by liquid is filled with gas. As we all know, the air around us is actually a mixture of gases, roughly 20% of which is oxygen. We have all heard of a flawed wine being described as *oxidized*. Oxygen can react with unprotected finished wine to create undesirable imperfections like browning, loss of freshness, sherry-like flavors and aromas, and VA (vinegar). Unless you are in a situation with a guarantee of temperature stability, as with a glycol-jacketed tank, or a temperature-controlled tank/barrel room, vessels that are completely "topped-up" should maintain a small headspace at the top. This compensates for expansion and contraction of the liquid due to ambient temperature changes (remember things expand when heated and contract when cooled). Since gas compresses more readily than liquid, no significant additional pressure is exerted on the storage vessel. This is why you see a ¼-1/2" space below a cork in a finished bottle of wine, and also why it is recommended to leave a 1" gap below the stopper in a sealed carboy. However, if the headspace is not present, as the temperature rises and the wine expands, the resulting pressure will not be mitigated by the gas' ability to compress and the full force of the liquid will push up against the lid/bung. Depending on how extreme the shift in temperature is and the volume of wine, this pressure can be enough to either bow the lids/walls of tanks outward and/or push bungs out entirely. While it may seem like an extreme result, this can and does happen. The opposite is also true: when a storage vessel gets cold, the liquid (i.e.: wine) inside contracts and this forms a vacuum. If there is no headspace in the storage vessel to help compensate for this negative pressure, then it's possible that the force of the vacuum will suck the bungs or lids back into their respective carboys or tanks. In extreme cases vessels may actually implode! Besides creating a loss of wine and a mess, your wine has now become exposed to the elements and potential spoilage. In order to prevent this scenario from happening, it is best to leave headspace at the top of your vessels if the wine will be exposed to any temperature variance during its ageing/storage.

However, this poses a problem: how do you create a space for expansion and contraction while avoiding any negative oxidative reactions? The answer lies in being able to replace the oxygen-containing air in the headspace with an *inert gas*, such as Nitrogen, Argon or CO_2. Unlike oxygen, inert gas does not react with wine to create any negative characteristics. In addition, Argon and CO_2 are actually heavier than air and winemakers can use this property to their advantage*. When done correctly, purging headspaces (also referred to as *flushing* or *sparging*) with either of these gases can remove oxygen by lifting it up and carrying it out of the storage vessel, much like the way oil floats on the surface of water. Inert gas will have effectively displaced the oxygen in the vessel and the wine can now be safely held during its ageing/storage with no ill effects. The trick to successfully achieving this level of protection lies in understanding the techniques needed to effectively create this blanket. Let's take a closer look at just what's needed to do so.

***Note:** *Nitrogen is actually lighter than air and while it is perfectly safe for use in winemaking from a non-reactivity point of view, unless you are using a sealed tank that will never be opened during the wine's storage, the fact that it will not act as a protective blanket makes it a poor choice for purging headspaces.*

Recommended steps for creating a protective blanket of inert gas:

- Avoid turbulence: The key to creating an effective blanket with CO_2 or Argon lies in understanding a basic physical property of gases: they readily mix with each other when agitated. In the case of a mixture containing a heavy gas and a lighter one, we get a "snow globe" type of effect. When there is no movement the elements remain separated (the heavier gas forms a layer below the lighter one). When the mixture becomes agitated the heavier "snow" mixes back up into the solution (the gases combine). However, once the agitation stops, eventually the heavier "snow" (the heavy gas) settles back out again.

  It's the ability for heavier and lighter gases to temporarily combine that winemakers need to be aware of. We use Argon or CO_2 to protect our wines because these gases are inert and are heavier than air - they possess the ability to exclude oxygen from interacting with the wine. However, if oxygen from the ambient air becomes mixed into our Argon or CO_2 while we are dispensing it, then the inert gas will no longer be pure and we will not be getting the same level of protection we thought we were.

  When purging headspaces with inert gas, the flow rate of the gas as it exits the tubing will determine the make-up/purity of the final volume of gas that you will end up with. The stronger the delivery force, the less pure the dispensed gas will be. To better understand this, think of the following analogy: let's say the pure gas coming out of the tubing is like cream being poured into a clear cup of coffee. Pouring at a high flow-rate causes a lot of turbulence and as the cream and coffee roll and swirl around in the cup they quickly mix themselves together. On the other hand, if we gently pour the cream into the coffee at a slow enough rate to keep the turbulence to a minimum, we can see that the cream will form a layer in the coffee that remains there until we stir it. Dispensed CO_2 and Argon gases behave just like the cream does. In order to create that pure, unmixed layer we will need to make sure that our method of delivery takes steps to avoid turbulence as much as possible.

  The ideal flow-rate needed to achieve this is a gentle bleed, similar to a warm breath that fogs up a window, rather than an extended, strong, blast we would use to blow out the candles on a birthday cake. The flow should feel soft to your skin. This will generally be just about the lowest setting your regulator can be set to and still flow. Depending on the size of your tubing this usually means between 1-5 PSI.

- The diameter of the tubing will determine how fast you can safely flow your gas: We would like to achieve the highest volume of gas that can be delivered while maintaining the low-turbulence flow rate needed to avoid mixing the gas with the air we are trying to get rid of. Any size tubing can be used to deliver an effective blanket of inert gas; the amount of time it takes will increase as the diameter of the delivery tubing decreases. To illustrate this, let's take a look at two different scenarios using an analogy of filling a bucket with a garden hose.

For the first example, imagine we have the spigot turned on and the water is flowing freely out of the end of the hose. We can see that although a large volume of water is being delivered, the stream only travels a few feet before it hits the ground. We have a large amount of water being delivered under low turbulence/force. If we were filling a bucket, then we could do so quickly and with little splashing.

In our second scenario, without increasing the flow-rate at the spigot, if we partially cover the open end of this same hose with our thumb, the stream now becomes forceful enough to shoot across the yard. Filling our bucket in this style would generate quite a bit of unwanted splashing/turbulence and in order to avoid this we are forced to turn down the flow-rate. As a result, the time it takes to fill our bucket has just become longer than it was in the first scenario.

Therefore, we can see from the two above examples that if we wanted to speed up the sparging process while not compromising the gentle flow needed to create an effective blanket, we should look to expand the diameter of the output tubing. This can be done by simply attaching a small length of a larger diameter tube to the existing gas line that is running from your regulator.

- <u>Laminar is best</u>: Instead of aiming the flow of gas directly at the surface of the wine, the best way to deliver it with the least amount of turbulence is to have the flow be situated parallel to the surface of the wine, or *laminar*. This way, the inert gas will be less likely to churn-up and mix with the ambient air on delivery, because it will not “bounce” off the surface of the liquid. The gas will behave more like fog rolling over a landscape- creating a nice, thick, pure blanket of protection over the wine.

  A simple and effective way to achieve this is by attaching a diverter at the end of your gas tubing. For working in carboys, an aerator attachment (BE510) works well. For barrels and tanks, a large stainless “T” works great: providing both the greater diameter output needed to be able to safely sparge at a quicker rate, and an added weight that will help keep the tubing straight while it’s being positioned for use.

<u>Putting it all together: *MoreWine!s* recommended method for sparging a headspace with inert gas</u>

Adjust the regulator to create a flow-rate that will be as high as you can go while still maintaining a soft, low-pressure bleed. Turn off the gas.

- Lower the tubing* into the vessel to the purged so that the output will be close to the surface of the wine, around 1-2” from the surface is good. (A flashlight can be helpful here.)

- Turn on the gas and begin sparging

- Using a lighter, hold and lower the open flame until it goes just below the rim of the vessel. If it stays lit, then there is still oxygen present and you will need to keep filling. Eventually the inert gas level will reach the rim and all of the oxygen will get floated out. Keep checking with the lighter test until eventually the flame goes out, indicating a lack of oxygen (note: for barrels or tanks with small openings, BBQ or "candle" lighters, along with 12" fireplace matches work well).

- Once the flame has gone out, your headspace is now safely purged with inert gas.

**Note: Remember to sanitize the diverter and whatever length of tubing that may come into contact with either the surfaces of the vessel or the wine ("Star-San" (CL26) works great for this). That way, in case the tubing slips and comes into contact with the wine as you are lowering it into place you will not contaminate the wine.*

Some Final Notes on Using Inert Gas

In order to use inert gas you will need to make the investment in a small gas set-up. This is quite simply a small tank of CO_2* (D1050), Nitrogen** (D1054), or Argon (also D1054), a regulator (D1060 for CO_2, and D1070 for both Argon and Nitrogen), and some tubing (D1704).

<u>*Note:</u> *CO_2 is only to be used for a non-pressurized headspace. If you will be using gas to push the wine (filtration, serving from a keg, etc.), you will want to use Nitrogen or Argon. <u>The reason for this is that CO_2 will go into solution under low pressures and the other gasses will not. In other words, if you use CO_2, you could inadvertently carbonate your wine!</u> On the other hand, if that was what you were after, this would be a perfect way to do sparkling wines for the home wine-maker!*

A final bonus to having a gas set-up is that not only can you flush half-consumed bottles of wine (thereby preserving their flavor better than if they are just left to react with the oxygen that entered the bottle when you poured it); you could even use it to push the wine in a kegging system (KEG420). The beauty of the kegging set-up is that you can use gas-pressure in place of a pump for a gentler filtration, pull off a single glass of wine without having to open up an entire bottle, blend at any time in the ageing process, and best of all, store your wine in an entirely enclosed system! Once again, no oxygen contact!

9.6) Transferring/Racking

In winemaking, transferring the product from one container to another is referred to as *racking* and can be done in one of three ways:

<u>Siphoning</u>

With small volumes, racking is usually done by gravity using a simple siphon set-up. This is a good, low-cost solution that works well and is ideal if you only have a couple of carboys. However, there is a catch: since siphoning relies on gravity, the transferring vessel must be situated higher than the receiving one in order for the process to be effective. If you are using a vessel larger than a carboy, this setup may not be physically possible. An alternate method of transferring the wine will be preferable. In addition, siphon set-ups are pretty slow, which may or not be a factor for you if you happen to be working with larger volumes.

<u>Pumps</u>

For situations where a gravity transfer is not possible or you are working with larger volumes, you will need a pump. There are different kinds of pumps that are suited to different jobs. Some are made for must transfers and “pump-overs” (pumping wine from the bottom of the vessel back over the cap during fermentation) because they are able to pass solids. Others are made solely for pumping liquid, and are used for wine transfers, barrel work, mixing/stirring tanks, filtering and bottling.

Pumps are very helpful and are indeed convenient to have around. That said, they do have some potential drawbacks. Any pump will introduce some level of physical agitation to a wine. At strong enough levels this handling can become damageing to the wine’s structure. In addition, if not set up correctly some pump styles will stop flowing the wine even though the pump is still running. This is due to an air/gas pocket forming in the pump head and is referred to as *cavitation*.

When investigating which pump might be best for you, the following questions are a good place to start: Will the pump be used for fermentation (must) or cellar work (liquid only)? This will determine which kind of pump you may need. Will you only be working with carboys or perhaps doing a lot of larger barrel/tank work? This will influence what kind of flow-rate/throughput size you may be looking for. In any case, a *MoreWine!* specialist will be happy to help you choose the most appropriate model that will best address your specific winemaking needs.

Pressurized Gas

For barrel work, one of the most ideal systems for moving wine is a barrel transfer tool that uses pressurized gas to push the wine instead of a pump (R657). This is a very gentle and effective way to move wine between barrels. The downsides to gas are that it can only be used with barrel-to-barrel transfers, it requires a gas set-up, and it uses a large volume of gas.

9.7) Bench Trials

What, Why & When

A bench trial is a small-scale trial meant to simulate the addition of an additive or fining agent to a larger volume of wine.

The idea is that by trying an addition or fining out on a small scale, you can try a range of dosages, or even different products, without having to treat all of your wine. This allows you to accurately determine the exact process and dosage that will have the optimal impact on your wine allowing you to move forward and perform this process on your whole batch.

Ideally, we’d be doing a bench trial ahead of the addition of any product that has a dosage *range* rather than a fixed dosage that is appropriate. Indeed, this is most additions in winemaking. For example, most of us have seen how fining agents like bentonite come with a range of potential dosages on the package rather than a predetermined “correct” dosage level. You may have also read about how there is a danger of stripping away much of a wine’s character when performing a fining, including bentonite. Wouldn’t it be nice to know exactly how much bentonite will take care of your hazy wine so that you don’t have to risk stripping out more flavor, aroma and color than necessary? Enter the bench trial.

Bench trials should be performed immediately ahead of a fining or addition procedure. Your wine is always changing. If you wait too long after a trial to make the actual addition or fining, the effect may be different from what you experienced in the trial itself. This means that you might schedule a bench trial for egg white fining a week ahead of the actual fining, but plan on doing a TA addition trial just 2-3 days ahead of when you plan on making the addition to the whole batch of wine.

How To

The bench trial process can be broken down into 6 basic steps: 1) Determining your sample volume, 2) Determining your range of dosages for the trial, 3) Scaling the dosages down to your sample size, 4) Creating a model solution, 5) Dosing the samples and 6) Evaluating the results. Let's go through these step by step.

1) **Determine your sample volume.** There is no perfectly correct sample volume for a trial. The correct volume depends on how much wine you have to work with, how small the dosages of the product you're trying are and how exact you can be with a pipet and scale. So, select a larger sample size if you have plenty of wine to work with, if the additive or fining agent needs a very small dosage or if you feel that you may not be too accurate with measuring out the test dosages. Remember that the smaller the sample and/or dosage are, the more significant any small error on your part becomes. If you are trying to measure out 10 mL of liquid and are off by 1 mL, that is a 10% error – pretty significant. However, if you are measuring out 100mL of liquid and are off by 1 mL, a 1% error is not such a concern. We recommend sample sizes anywhere from 50 mL up through 500 mL.

2) **Determine your range of dosages.** Most additives and fining agents have a recommended range of dosages for treating wines. For instance, *MoreWine!*'s unique, pre-soaked bentonite product Albumex can be added in a range between 1 and 3 g/L of wine. Your first step is deciding how many samples you are going to run. We typically run 4 or 5 samples. Remember to always keep one untreated sample off to the side as a control. Also, it is a good idea to try to keep the step between the dosages uniform. If we were running a trial with Albumex, 5 samples and a control would be a good idea. The dosages for the samples would be 1 g/L, 1.5 g/L, 2 g/L, 2.5 g/L and 3 g/L. You may have noticed that we are working with the metric system here. While it may take some getting used to, it's the best and easiest way to do this. If you're having trouble wrapping your head around it, try keeping the conversions page at the end of this manual handy while you're working out your dosages.

3) **Scale down the dosages to your sample size:** As we mentioned in the previous step, the dosages that you choose will likely be in terms of grams/liter, or perhaps in oz / gallon, though metric units are recommended. No matter what units you use, it is unlikely that you'll be running the trial on samples as big as 1 liter (or 1 gallon). You'll need to do a little math to scale down the dosage to match your sample size. The basic idea here is that you ask yourself the following question: "If I want to achieve a dosage of 1 g/L, how much product do I weigh out for my 50mL sample?" Since 50mL is 5% of 1L, you also need 5% of 1g, which is 0.05g. The easiest way to set up the math is as follows: (Dosage)x(Conversion Factor)x(Sample Size)=(Amt of Product for Sample). For example; (1g/L)x(1L/1000mL)x(50mL) = 0.05g. Notice how both the terms for L and mL cancel out leaving only g in the end. If you ever wind up with a unit related to volume at the end of

the equation then you know that you've made a mistake somewhere and need to go back to the start.

4) **Create a model solution:** Most of us don't have a scale that can weigh down to 0.05g accurately. Even a scale that claims to have a resolution of 0.1g will not weigh out accurately until you have at least 0.5g on the scale, unless you are using a very advanced laboratory scale that costs thousands of dollars. How do we get the small amount of product that we need for the trial? The answer is to create a solution of the product you are trying and add a measured amount of it to each sample. This is also very straightforward. The first step is to take a look at the range of dosages: is the increment between each dose more or less than 50% of the first dosage? In our Albumex example it is exactly 50%: the first dose is 1g/L and the dose rises by 0.5g at each step. When the increment between doses is 50% or more of the original dose, you want to set up the solution so that 1mL of the solution is equivalent to the smallest dosage itself. For Albumex this means that you'd create a solution where 1mL of the solution would add 0.05g of Albumex to your 50mL sample (equivalent to 1 g/L addition). To make the second sample, where you need 0.075g of Albumex (50% increase over the first dose, 1.5 g/L), you then just add 1.5mL of your model solution. In order to create the model solution you must first determine how much of the product you are testing you wish to have contained in 1mL of the model solution. In our case the answer is 0.05g. Weigh out 1g of your product and dissolve it in 10mL of water. Note that a graduated cylinder is the best tool for this. Now you have a model solution where each mL contains 0.1g of Albumex: (1g/10mL)x(1mL)=0.1g. To reach your desired 0.05g/mL then simply cut this solution with another 10mL of water, cutting the amount of Ambumex in each mL in half to 0.05g. Now, If your interval between doses is less than 50% of the initial dose(dosages of 0.5g/L, 0.6g/L, 0.7g/L, etc, for example) then it is best to make a solution where each mL will contain enough to make up the interval rather than enough to make the initial dosage.

5) **Dose your samples:** Now that you have made up your model solution it is time to add the doses to the samples. This is probably the easiest part of doing the bench trial. Simply add enough mLs of the model solution to each sample in order to achieve the dosage rate that you are looking for. In our example with Albumex, this would mean adding 1mL to the first sample, 1.5mL to the second, then 2mL, 2.5 and finally 3mL to the last sample. The easiest way to do this is with a pipette. However, you must take care not to add too much model solution or you will have to discard the sample and start over. A good technique for this is to fill a pipette to a given level, then seal the end with your finger tip. Since you have to push pretty hard to get a good seal, it is possible to allow liquid out of the pipette by simply reducing the pressure you're using to keep it sealed. You should not have to actually take your finger off the pipette in order to allow liquid to flow. Try practicing this with water a bit and you'll get the hang of it pretty quickly.

6) **Taste your samples:** Now for the fun bit. After allowing enough time for the product you're testing to work, you want to come back and taste the samples to see which dosage (if any of them) you liked the best. It is a good idea to do this tasting with one or two

other people there as well – many palates are better than just one. Here's an important note: ideally you would be able to leave your samples for as long as it normally takes the product to work. With many additives, you would want to flush out the sample vial with Argon gas prior to closing them up. If you do not have the equipment necessary to do this, then you really only want to allow the sample to sit for about 24hr or it will begin to oxidize while you're waiting for the product to work. It is acceptable to taste the samples after 24hr, but recognize that you will not be getting a fully clear picture of products benefits or negatives. If this is the case for you, it is best if you only add about half of whatever dosage you decide on as best when you treat your whole volume of wine. Allow enough time for this addition to work completely, and then taste the wine again to evaluate whether or not you think a further addition is necessary. We can promise you that in some cases it will not be.

<u>Tips and Tricks</u>

Finally, here are a few general tips and tricks to keep in mind:

1) We'll keep saying it: get comfortable with the metric system. It makes all of the math for scaling up and down much easier, as everything works on the same base 10 system.
2) Invest in a decent scale that measures in grams and has a resolution down to 0.1g. our MT351A is a perfect choice.
3) Erlenmeyer flasks are not marked exactly and should not be trusted for exact measurements of volume. They typically have a $\pm$ 5% error. Measuring your liquid with a pipette is always best. We have pipettes that measure up to 50mL with very high accuracy.
4) A 50mL or 100mL graduated cylinder is pretty much required if you want to do this correctly.

9.8) Complete Yeast Hydration and Nutrients

Whether we realize it or not, yeast hydration is the first moment that we as winemakers have a direct effect on the ultimate success of our finished wines. Properly hydrated yeast is healthy yeast, and the initial health of our yeast does determine its ability to gracefully ferment our wines. Learning to properly hydrate yeast is a cheap insurance policy that is 100% guaranteed to make better wines. Properly hydrated yeast are more apt to create a full expression of beautiful flavors and aromas than poorly treated yeast - even in well managed fermentations. In fermentations that are more challenging - due to high initial sugar levels or elevated temperatures - a healthy, properly hydrated yeast is better able to work through these problems, often finishing these difficult fermentations without stopping early and with a minimum of off-flavors. Ultimately, when we go to weigh the pros and cons of taking the time to do a proper yeast hydration, there are no cons. It's just a good idea based on sound winemaking theory. Moreover, it's straightforward and easy to learn. Let's take a moment to review the whole hydration process. Time spent now learning this simple technique will reward you many times over in the future and be well worth the effort. We talk to winemakers every year who tell us that they never thought all of this was necessary until the year they had a stuck fermentation…

Yeast Hydration:

Successful hydration essentially involves bringing together four separate elements in a specific set manner: nutrients, water, temperature, and yeast. Each one of these elements has its own considerations and is worth reviewing individually before we bring them all together to make our final, unified protocol.

Nutrients: "**Go-Ferm**" was specially designed to aid the hydration process and is added directly into the water used to hydrate the yeast. This represents a new approach, opposite the old method of adding nutrient directly to the must. By feeding our yeast Go-Frm outside of the must, we are able to eliminate potential problems early-on: the binding-up of yeast nutrients by SO2 (thus making them unavailable to the yeast), and the possible depletion of nutrients by other organisms that may have gotten into the must before the yeast have reached the cell-density needed to begin fermentation (again, lowering the level of nutrients ultimately available to the yeast). "**Go-Ferm**" additions ensure that the yeast receive all of the nutrient addition without any interference. This translates to the start of a clean and healthy fermentation.

Water: In general, the presence of minerals, or the "hardness" of the water has a greater impact on the hydrating yeast than anything else. Basically, around 25+ppm mineral content is needed for yeast to avoid negative reverse osmotic effects. If the hydration water has very little or no hardness, the natural concentration of minerals found inside the yeast's own cell is higher than in the surrounding liquid. Since water always flows in the direction of the higher concentration of minerals, a reverse osmotic effect will cause water to keep flowing into the yeast cell until it ruptures due to stress. This makes using distilled water a bad idea when hydrating yeast and is not recommended. Along these same lines, if using bottled or filtered water, check and make sure that there are some minerals present to avoid any problems, if possible. Fortunately, the minerals found in **Go-Ferm** help to mitigate this problem quite a bit when using low-mineral content water for hydration (yet another plus to using the **Go-Ferm**!).

Interestingly, potable tap water usually has more than enough mineral content and works quite well for the yeast hydration water. Yes, there are some chemicals that have been added during its processing to make it potable, but the usual 0.5 ppm chlorine and <0.5 ppm flouride content does not adversely effect the yeast. Although not as technically "pure" as filtered/bottled water, clean tap water winds up being a good and economical choice to use for yeast hydration.

Temperature: The ideal temperature for hydration is 104º F. This represents the best balance between the water being warm enough to maintain an ideal elasticity of the yeast's cell membrane, while not being hot enough to damage the cell itself. While higher temperatures are definitely not recommended, slightly lower ones are acceptable. When the hydration water starts to go below 95º F, there is a lack of adequate heat required to make the cell wall fluid enough to fold back out and reform itself during the delicate, yet critical hydration process. As a result, parts of the cell wall can remain permanently wrinkled and the yeast will never fully recover from the folded, crinkled form it took when it was dehydrated. In the end, the yeast will essentially be mortally damaged and it will eventually die. If you can try and target the 100º F - 104º F range for your hydration water you will be doing both yourself and the yeast a great favor.

Yeast: When the yeast has been introduced into the hydration water, it will take a few minutes to come to life. From a visual standpoint, after around 15 to 20 minutes you will usually start to see activity in the liquid. In general, it will look like a low level boiling or simmering kind of motion, with a few bubbling "eruptions" happening at the surface from time to time. The amount and strength of this activity will actually vary quite a bit from strain to strain, which is perfectly normal. More importantly, foaming is not an indication of viability. Some yeast are actually very mellow at their start, but they will eventually kick in and be every bit as effective as another strain that was foaming like crazy during its hydration phase. The bottom line is this: each one of these strains was chosen after years of extensive trials, and if they didn't work they wouldn't be on the market. So just enjoy the fact that, like people, they each have their own unique and endearing personalities and this just adds to the whole winemaking experience.

Note: *Once the yeast has been introduced into the hydration water, you need to be aware that the clock is ticking. The yeast will soon completely use up whatever stored energy they previously had in them from their preparation at the factory to complete the hydration process. From this point on, if they don't get the nutrition they need they will quickly begin to starve, deteriorate and lose viability. It's best not to prolong this moment, so begin feeding them immediately. Fortunately, the timing of this critical feeding is based on an easy-to-read indicator: once you begin to see signs of activity at around the 20-30 minute mark, the yeast are letting you know that they are hungry and ready to be exposed to the must. You should never let the hydration process extend beyond 30 minutes without giving them food.*

Recommended Yeast Hydration Procedure:

Now that we have a better understanding of each of the individual elements involved in yeast hydration, let's bring it all together into a unified protocol we can actually use.

Dosage Rates: The amount of water and Go-Ferm needed for the hydration water is based on the quantity of yeast being used, and this in turn is determined by the initial sugar concentration of the must. In general, for fermentations with initial ºBrix levels of up to 24.5º, 1 gram of yeast per gallon of must is sufficient.

However, when you start looking at must that is 25ºBrix and above, an elevated sugar level (which will later become an elevated alcohol%) represents a higher degree of stress that the yeast will endure as they try to survive in this difficult environment. As a result, fewer viable cells will make it to the end of the fermentation than would have with a lower starting ºBrix. Since we know that we will be incurring a higher percentage of loss in our yeast population, we highly recommend to adopt a "safety in numbers" approach and raise the addition rate to 1.2 grams of yeast per gallon of must. Since we added 1/5 more yeast, we will add 1/5 more Go-ferm and water as well:

For every 1 gallon of must:

Up to 24.5 ºBrix:	**25 ºBrix and above:**
1 gram of Yeast 1.25 grams Go-Ferm 25 mL H_2O	1.2 grams of Yeast 1.5 grams Go-Ferm 30 mL H_2O

MoreWine's recommended protocol for successfully hydrating Active Dry Wine Yeast

- **The volume of H_20 needed = 20 x the weight of the Go-Ferm addition**

For this calculation you need to know that the definition of a gram is the mass of one mL of water. When you calculate the total number of grams of Go-Ferm needed, you can multiply this number by 20 resulting in the number of mLs of water to use for the re-hydration. Using clean potable water, calculate the amount needed and heat it to **110º F (43ºC). (**110º F is an arbitrarily chosen number. You want a temperature higher than 104ºF for your initial water because mixing in Go-ferm and the yeast will lower the temperature. 110º F should get you very close to 104º F.) **Remember that the hydration water needs to have sufficient mineral content, and that filtered water or from the tap is fine. Do not use distilled because it has no mineral content whatsoever.*

- **The amount of Go-Ferm needed = number of grams of yeast being used x 1.25**

Add the required amount of "Go-Ferm" to the heated water. Mix it in well so that there are no clumps, and let it stand until the temp of the mixture falls to **104º** F (40ºC). You can also adjust the temperature of the water downwards by just adding a little bit of cold water to the solution until it falls to **104º** F. Having slightly more than the calculated amount of water is not a big problem. If you use significantly too much water, the yeast and Go-ferm will not be in close enough contact to make the process effective.

- Add the required amount of yeast to the mixture. Stir it gently to break-up any clumps. Wait 15-30 minutes, stir a second time. **Do not go beyond 30 minutes in the hydration solution or the yeast will begin to starve.*

- At this point you will start to see yeast activity. You will want to add a portion of the must/juice into the yeast mixture equal to 1/2 the volume of the yeast starter. This not only helps the yeast become accustomed to the pH, TA, ºBrix level (sugar), and temperature of the must, but lessens any shock the yeast may encounter upon being pitched. Newly awakened yeast are not yet completely hardy and need to adjust themselves to your must. By introducing must/juice early on, you create a buffer zone between the water (pH of around 7.5), and the must (pH of around 3.5, presence of a great deal of sugar, SO_2, etc…). This ensures that your initial population will be well adjusted, healthy and as vigorous as possible right from the start.

  Helpful Note: Since you have just fed the yeast with a little bit of the must, they are OK to wait a little while before being pitched. This available pause may be quite helpful if you would like to do an acid correction on the must before you start the fermentation. Since they have just been fed, you can safely delay the inoculation, do your correction, and finally pitch without compromising the health of the yeast.

- After a 10-15 minute wait, the yeast should be ready to introduce into the must. However, if the temperature difference between the yeast starter and the must is over 18º F, you need to bring the yeast to within 18º F of the must temperature. Otherwise, you run the risk of damageing the health of the yeast due to cold shock. Using the cooler must, just add a portion of it into the yeast starter until you achieve a 15º F drop. Wait at least 20 minutes (longer is better, but often not practical during winemaking) before repeating the process as often as needed until you are finally within 18º F of the must temperature. Now you can safely introduce the yeast into the must.

- When you are ready to inoculate the must, disperse the yeast completely throughout the entire volume, not just over the top layer. In the past you may have heard that the yeast should be spread out over the surface of the must in order to have access to oxygen. This is not the case. In reality, between the oxygen that has been saturated into the must from mechanical processing of the fruit, the amount picked up during the hydration process, and the elements found in the Go-Ferm addition, the yeast already has all the nutrients it needs to get off to a great start without beginning on top of the must. In fact, it's often beneficial to spread the yeast through the entire volume of the must to decrease the chances for any spoilage organisms to take control.

A Recommended Guide to Yeast Nutrient dosages during fermentation:

A day or so after you have inoculated your yeast into the must, you will begin to see the first signs of fermentation. With white wines you will see a prickling activity, often with some foam on the surface. With red wine, you will see the formation of the cap. Whether you are doing whites or reds, we recommend doing a first feeding at this point.

- **Fermaid-K (#1):** 1 gram of Fermaid-K per gallon of must. Combine the amount needed with a small portion of warm water and stir until dissolved. Mix thoroughly into the wine.

During the course of the fermentation, must becomes a difficult place for the yeast to work in: the alcohol level starts to rise. (slowly becoming more and more toxic) All of the nutrients that were present at the beginning of the fermentation (both naturally found in the must and coming from the first Fermaid-K addition) start to become depleted. A second "**Fermaid-K**" feeding is then necessary at 1/3 sugar depletion (usually an 8-10ºBrix drop) so that the nutrients required by the yeast to maintain healthy metabolism all the way through to the end of fermentation are available to them. The second addition timed to an 8-10º Brix drop will help the yeast before they become stressed. As a result, you should avoid signs of a stuck or sluggish fermentation (not to mention excessive VA and Hydrogen Sulfide production!).

- **Fermaid-K (#2):** 1 gram of Fermaid-K per gallon of must. Combine the amount needed with a small portion of warm water and stir until dissolved. Mix thoroughly into the wine.

When trying to understand the whole yeast/nutrient interaction, it may be helpful to think of the following analogy: "**Go Ferm**" & "**Fermaid-K (#1)**" are the complete breakfast that is eaten on the morning of the 20-mile race. The "**Fermaid-K (#2)**" addition is the energy bars and sports drinks that are consumed at the mid-way point to help get you to the finish line!

A quick summary of the complete process, using an example of 8 gallons of

24.5ºBrix must (1 gram yeast/gallon):

Example of volumes needed:

-You are inoculating 8 gallons of must. This would mean that you would be using:

A) 8 grams of yeast

B) 10 grams of "Go Ferm"

C) 200mLs of water at 110º F

D) About 100mls of must/juice

E) 8 grams of "Fermaid-K" at first signs of fermentation

F) 8 grams of "Fermaid-K" at 1/3 sugar depletion

- Combine water and **Go-Ferm**, wait or adjust to **104º F**
- Add yeast. Stir gently, wait 15-20 minutes. Stir again.
- Add 100 mLs of must to the starter. Wait 15-20 minutes until signs of activity.
- Mix thoroughly into the must. (Make sure to be within 18º F of the temperature of the must when inoculating. If not, adjust accordingly.)
- At first signs of fermentation, add **Fermaid-K (#1):** 1 gram per gallon of must.
- At 1/3 sugar depletion (8-10**ºBrix** drop), add **Fermaid-K (#2):** 1 gram per gallon of must.

  Now watch your temperatures, get the lees up on each punch cycle, and enjoy the process!

9.9) Oak

Toasted oak has been an integral part of winemaking for centuries, and for good reason. Its unique combination of structuring tannins along with the sweet toasty vanilla, butterscotch, floral, smoke, and spice elements perfectly compliment the fruitiness of the fermented grape. Oak and wine support each other in a way that truly brings out the best that both can offer. As winemakers, the more we can learn about using oak the better we become at crafting our wines. This is because just as with any good chef, the ability to create a work of art is based on how well we have understood the individual components that went into to making it. So let's first take a closer look at the complexities of the wood itself, and then we can focus on its use during winemaking.

All About Oak

American oak (*Quercus alba*) has about 21% non-tannic phenolic content while its French (and Hungarian) counterpart (*Quercus robur*), contains around 14%. However, French (and Hungarian to a lesser content) has 2.5 times the extraction of total phenolics than does the American oak. In everyday English, this means that American Oak will be much more perfumed, but French and

Hungarian will generally have better inherent structuring abilities. Other than these basic differences, the two different species generally react in the same way to toasting (more on this later).

The way in which the raw wood is processed has a major affect on the final flavor and aroma profile of the oak, regardless of species variation. When oak for winemaking is cut, it has to undergo a period of drying and conditioning before it can be used, and this is referred to as *seasoning*. This period usually lasts between 2 to 3 years and basically involves stacking the staves in the open air and letting the elements (rain and sun) work its magic on the oak. The stacks are usually stacked and re-stacked throughout this period so that the staves on the top one year are at the bottom during the next year, and so on. This is done to in order to better equalize the seasoning differences that exist between the top of the stack (more exposure to sun and air) and the bottom (more moisture and less light). All throughout the seasoning period, basically what is going on is that various fungal micro flora attack and colonize the wood. As they do so, they release a series of enzymes that are responsible for the following desired reactions: the wood extract becomes lighter in color and less astringent, the harsher and bitter elements of the wood are greatly reduced, and various positive aromatic compounds are boosted; including vanilla, clove, and especially coconut. Besides being interesting on its own, what is even more fascinating about all of this is that it turns out that the amount and ratio of these compounds that are transformed in the wood turns out to be site-specific. In fact, experiments done at the Bouchard cooperage in France with the same wood that was seasoned in two different regions and then brought together and identically coopered to the same toast level in the same facility produced two different sets of flavors and aromas! This was directly attributed to the differences in the seasoning conditions of the two woods. Therefore, in addition to species differences, it is important to keep in mind that the way in which a wood is seasoned also will affect the final qualities of the oak once it is toasted.

As for the toasting itself, it should be noted that the duration and the intensity of the heat during the coopering and toasting process has a tremendous effect on the amount of individual compounds that are produced in a barrel, even from the same woods which have received the same seasoning. However, this being said, there are in fact some basic, generalities for how some of the various compounds in oak will behave when they become toasted. Understanding these can only help when trying to decide which level of toasting will be more apt to give the desired character to a particular wine:

Hemicellulose: A class of compounds comprised of several simple sugars that when toasted give caramelized products which have a sweet, toasty quality and which help to contribute to the "body" of a wine. The more intense the heat, the "darker" the caramel flavors become.

- *Furfural* is "sweet" and "caramel-like",
- *5-methyl-furfural* is more of a "butterscotch" type of flavor.

Lignin: is made up of two building blocks: *Guaiacyl* and *Syringyl*. Sweet vanilla increases up to a medium plus toast, but then it starts to decrease as the heat is raised towards a more heavy toast or a char. Interestingly enough, with the higher heat also comes the appearance of more smoke and spice (clove) notes.

- *Vanillin* is vanilla,
- *Guaiacol* is "smoky",
- *4-methyl-guaiacol* is "spicy" & "smoky",

- *Eugenol* is “clove-like”.

Lipids: are made up of the oils, fats, and waxes found in the wood and are responsible for the oak lactones. Seasoning greatly increases the level of lipids in the wood. With toasting levels up to medium/medium plus, the level of oak lactones increases, however it breaks down and decreases after that as the heat is raised further.

3. *Cis-oak lactone* is “woody” and “fresh oak” like,

4. *Trans-oak lactone* is “coconut-like”

Summing-up, some applicable generalizations of toast levels on oak:

- The lower the toast, the more tannins (“structure”) and lactones (“coconut”) will be present in each of the oaks.

- The higher the toast, the more spice and smoke notes will be present

- The deeper the toast, the more deep the caramel tones will be (moving into butterscotch at medium plus).

- Vanilla will increase up through a medium-plus toast and then decrease with a heavy toast and char

- American oak will be more aromatic, but French oak will give more structure (Hungarian will give less than the French but more than the American).

- The greater the toast level, the lower the lactones (“wood” and “coconut”) for all three woods.

Medium plus is the most complex of all of the toast levels, and the most popular. Depending on the wine being made, this may or may not be a good thing!

A comparison of French, Hungarian, and American Oaks

The following are results from research done at Stavin and should only be used to give an approximation of what each of these three varieties of oak can bring to your wine. Each sample was made using oak cubes with a two-month contact time and evaluated with no bottle ageing. *Please note that due to the complexities of flavor chemistry these findings may or may not translate to your wine 100%. However, this information should be helpful in finding out which type of oak may the best to start with as you refine your oaking tastes.*

French Oak Flavor Summary

- All toast levels have a perceived aromatic sweetness and full mouthfeel.

- French oak has a fruity, cinnamon/allspice character, along with custard/ crème brûlée, milk chocolate and campfire/roasted coffee notes*. (*Especially at higher toast levels.)

- As the toast levels increased the fruity descriptor for the wine changed from fresh to jammy to cooked fruit/raisin in character.

American Oak Flavor 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 a fresh or jammy quality.
- American Oak imparted mouthfeel/fullness, especially in Medium Plus.

Hungarian Oak Flavor Summary

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

Oak in winemaking: Barrels and their Alternatives

Barrels

Up until about twenty or so years ago, when we spoke of oak in winemaking it was understood that we were talking about barrels. Barrels have been in use throughout the ages and have many positive characteristics. They contribute the tannins and flavor compounds we are looking for in our wines, and they have the ability to positively structure our wines by micro-oxidative processes due to the limited porosity of the wood itself. The ideal ratio of wine volume to wood surface area is found in a 60 gallon barrel, and final wine quantities larger than this are often the result of blending a series of these 60 gallon vessels together. Since every barrel is slightly different in its make-up of flavors and aromas, by blending together a larger lot of wine that was aged in several different types of barrels, we can create a greater complexity in the wine than would have been the result of only using a single wood source.

However, there are also some negative qualities to barrels as well. First, they are expensive, and as the majority of their extractable compounds are usually spent within four years they can represent a constant high dollar investment. Second, they require a high degree of maintenance, and being porous they are almost impossible to keep sanitary in cases of microbial spoilage. Still, due to its micro-oxidative capabilities, a barrel will be able to structure a wine better than any inert glass or stainless vessel would ever be able to do on its own.

For complete information on using barrels, see MoreWine!s Oak Barrel Care Guide.

Beans/Cubes and Stave Segments

While a barrel itself may best at structuring a wine, its ability to add tannins along with complementary flavors and aromas is no longer unique. Thanks to companies like Stavin, modern winemaking now includes alternative forms of oak available as chips, beans/cubes, and staves. Used by many of California's finest wineries, these beans and staves are crafted from carefully selected tight-grain French, American and Hungarian oak that has been allowed to naturally season in the open air for three years. The staves and beans are cut to a precise thickness that takes into account the exact dimensions that the wine will penetrate into the wood from all 6 sides over time, which maximizes the efficiency of the extraction process, meaning that you will get to use 100% of the oak flavors that you paid for. The beans are made from the same exact wood as the staves; the only difference is that they go through the additional step of being cubed. Once sized, both the cubes and staves are traditionally fire toasted using Stavin's proprietary methods. The result is an oak product with a gradation of toasting that gradually delivers a multitude of complex, positive oak flavor compounds into the wine throughout the entire ageing process, just as the highest quality barrels would do, but without the cost or added work associated with a barrel itself.

Chips

When comparing cubes and staves to chips, it is important to keep in mind the following: chips are often made from lower quality, un-seasoned wood and depending on the source this will most definitely come through in the finished wine with various degrees of harshness. That being said, there are exceptions and some sources do get their chips from actual cooperages - instead of a cabinet shop or furniture mill - and the flavors and aromas from these can be quite good. However, the reason why these should be viewed as a tool rather than a complete oaking solution is directly related to their thin shape and size. During toasting, due to their lack of mass chips react quite quickly to the heat and they all toast to a comparable level, leaving them monochromatic with no gradations of color or toast level. Since, when toasting oak, what you see is also what you taste, this lack of gradations unfortunately translates into a lack of complexity in the toasted chips final flavors and aromas. In addition to the toasting issues, the smaller size of the chips makes for a full release of all of their compounds in a very short period of time. This may be great for quickly getting toasted oak components into a fermentation, indeed this is probably the single best use for the chips. However when the ideal scenario is a slow and steady extraction rate over a period of several months to a year or so, unless a winemaker finds himself in need of a quick fix, he should probably forego the chips in favor of the cubes or staves.

Alternative Oak products and fermentation

It is interesting to note that during a white wine fermentation, compounds derived from toasted oak are a highly effective, natural additive responsible for helping to build mid-palate structure, and for getting an early start to building complexity in the flavor and aromas of the young wine. These components can come from chips, cubes, segments or staves and all are effective. However, each will differ in their rate of extraction based on surface area and exposure to end grain (the end grain extracts at a quicker rate than the rest of the wood surface). The extraction rates for the different oaks can be broken down as follows, from quickest to slowest:

- <u>Chips</u> (around 7 days),
- <u>Cubes</u> (2 months minimum, up to 1 year of useful life),
- <u>Segments</u> (3 months minimum, 18 months of useful life),
- <u>Staves</u> (3 months minimum, useful life of 2 years).

So, with the exception of the chips, we can see that once the 2 to 4 weeks of a primary fermentation are over, each of the toasted oak products still have a significant amount of useful life left in them. Therefore, the winemaker has the choice to either continue to use the same oak in a subsequent alcoholic fermentation*, for instance if you have more grapes coming around the corner; or to just carry the oak through with the wine into the next tank in order to continue the extraction during the structuring and maturation periods.

**When saving an oak product to add to an upcoming alcoholic fermentation, it is best to get the next ferment started as quickly as possible to avoid spoilage of the wine-soaked oak if it were to become exposed to oxygen.*

When using toasted oak to help structure a white wine fermentation, it is important to realize that in order to be effective, the oak really needs to be in constant contact with the liquid portion of the must and not get buried in the lees at the bottom of the vessel. This could be a factor if loose wood were being used to structure a second fermentation and it was already saturated enough to sink to the bottom of the fermenter - being buried in the lees will also effectively separate the oak from a working wine! So, with this in mind, it is recommended to use a food-grade nylon bag (usually for the beans and segments) and either weight it down or tie it off in the fermenter so that the wood remains unburied. The nylon bag also makes transferring the oak into the next vessel post-press all that much easier.

<u>Stavin's Recommended Oak Dosage rate for Fermentation:</u>

Per the research conducted at Stavin, the minimum amount of toasted oak needed to achieve cross-linking and structuring is: <u>4-8 lbs per ton</u> (1 ton gives around 160 gallons or 606 liters of must when crushed).

Broken down, this works out to:

<u>.025</u> to <u>.050</u> lb per gallon (<u>.4</u> to <u>.8</u> ounces per gallon), or (<u>.1</u> to <u>.2</u> grams per liter).

MoreWine! recommends using: <u>2 to 2.5 ounces of oak cubes per 5 gallons</u> of liquid wine (not must). More can always be added later, if needed.

<u>A final note on gaining complexity by blending</u>

Wineries use American, French and increasingly, Hungarian & Russian oak at various ratios in their wines to garner the best qualities that the different woods have to offer. You can easily simulate this by either creating your own blend in a single addition or by using some of one type of oak in one addition, and some of another in a second one.

Note: that if you happen to have more than one carboy/tank of the same type of wine, it is a great idea to take advantage of this and use a different type of wood or toast level in each of the different carboys/tanks. This way you have a real-world example of how these woods interact with your wine and you can better choose the combinations that will give you the qualities you are after when they are blended together.

9.10) Malolactic Fermentation

It has been speculated that MLF happens in all wines (especially homemade), whether it has been added on purpose or not. In other words, use of an ML bacteria that is known for contributing positively to the wine is strongly recommended for the same reasons as those surrounding the selection of a yeast strain. Using well established strains of yeast and ML eliminate the potential off flavors that can be generated by wild strains. In addition to the positive flavor, aroma, and mouthfeel contributions, another good reason to utilize an MLF is to make the wine stable enough to discourage unwanted fermentation, during the storing, bottling or ageing processes. If there is malic acid present in the wine and the SO_2 levels aren't high enough, you run the risk of having an unknown strain of bacteria establishing itself. On the other hand, by choosing to preemptively degrade the malic acid with a chosen strain that was selected for its positive winemaking attributes, you can easily avoid potential problems.

In the end, you may choose to not do an MLF and that is also perfectly acceptable. Just know you will just have to be especially vigilant about your sanitation as well as maintaining proper SO2 levels in the wine at all times in order to prevent a wild MLF from taking place. You should probably be thinking about sterile filtration at bottling, as well.

ML bacteria and acid adjustments

Adjustments in acidity should be done using tartaric acid only. Since ML culture metabolizes specifically malic acid, it makes no sense to keep adding malic acid to the must/wine in an attempt to raise the acidity when the bacteria will just keep eating it and cause the acidity to drop. In addition to being counterproductive, malic acid has a very sharp, unpleasant flavor. Lastly, citric acid will cause the ML bacteria to produce VA (vinegar), making it unsuitable for MLF as well.

- *Note that this is one of the reasons that we recommend against the use of Citric/SO_2 solutions for sanitizing your winemaking equipment.*

- *Note that many pre-made acid blends are equal mixes of citric, malic and tartaric acids, and therefore should be avoided as well.*

ML nutrients

Like yeast, ML bacteria benefit greatly from nutritional supplements. A good example would be Acti ML (AD347) by Lallemand, which has been designed to provide specific vitamins and minerals for the ML bacteria. Acti ML is used both in the hydration phase and then later in the actual wine itself if needed. While being not as effective, in a pinch you may also use a generic yeast nutrient formulation as long as it **contains no DAP**. Unlike the yeast, the ML bacteria does not use any DAP, so this should not be a part of any nutrient mix used to feed the ML bacteria. If you are unsure of the formulation of your nutrient set, just use the Acti ML. *Note: Fermaid-K does contain DAP and should not be used for feeding MLFs*.

Choosing an ML strain

Initiating an MLF is easier for a red wine than it is for a white. ML culture likes to be in an environment where there is a temperature of around 70-75° F and have a rich source of nutrients (red wine has more nutrients than does white wine because it gets fermented on the skins). They prefer a somewhat low level of SO_2 as well. That said, each strain of ML has varying degrees of tolerance with regards to each of these factors. For example, Viniflora Oenos will work at temperatures >63° F, while Enoferm Alpha will work at temperatures >55° F. Both have comparable pH tolerances (min. pH 3.1). As far as SO_2 is concerned, Viniflora Oenos prefers to have levels under 20 ppm (total), while Enoferm Alpha can tolerate levels of 50 ppm (total). Depending on your wine's conditions (and the availability of various strains of MLB), you may be able to better match the ML to the task at hand. Good examples of this include being able to keep SO_2 levels slightly higher if you need to on a high pH wine, or not having to raise the temperature of cooler fermenting wines to help the secondary fermentation kick off (Pinot Noir, Beaujolais).

Different strains of ML bacteria each give different qualities to a finished wine. Depending on the style of wine you are making you can not only choose the correct yeast(s) that will give you these traits, but also further reinforce your stylistic goal by the choice of ML bacteria, as well.

With ML bacteria there is no danger of over inoculating, only under inoculating!

The only problems with the amount of bacteria needed to successfully finish an MLF come from not using a sufficient dosage. If the cell count is not high enough in the beginning, the ML bacteria often don't generate enough of a colony to fully complete the fermentation. In order to avoid this problem, always use the recommended dosage rates. On the opposite side of things, if you find yourself with a greater than the recommended dosage rate, don't worry and just use it all. There will be no ill effects, the MLF will only finish that much faster. The only reason why pitch rates are not always used at an elevated level is one of economics, usually only a concern for commercial-level producers. Using more bacteria than is needed just ends up adding a little bit more cost to making the wine, but no harm is done.

The best way to initiate an MLF is to add it at the end of the alcoholic fermentation (this allows the yeast to complete their fermentation without having to compete with the ML bacteria for nutrients).

Oak and ML Bacteria

If you want to have oak in the final wine, adding it during the MLF is a very good idea. The oak adds another level of complexity that will integrate more subtly into the wine, and the crevices of the wood create an environment that is excellent for microbial growth. Once the MLF has completed, if you are using cubes or stave pieces that were present during the fermentation, just rinse them until the wood is re-exposed. Sanitize the oak with SO_2 or StarSan and carry it through into the ageing vessel(s).

Chromatography

While there are visual ways to deduce whether or not the MLF has come to completion (namely twisting a carboy to see if there are any small bubbles coming up the sides, or looking for activity at the surface of the wine in a tank*), the only way to be absolutely sure that the fermentation has finished is to run a chromatography test. A completed MLF and one that has just stuck partway through the process *both look the same to the naked eye*! If you go ahead and add your SO_2 because you think the MLF has finished and it has not, you may run into potential spoilage problems if the SO_2 levels drop either during ageing or in the bottles. In addition, your wine will not be getting the full benefits of the MLF process. If you know you will be doing MLFs on a regular basis, you might want to invest in a home chromatography test (MT930).

> **Note that it is possible that if a wine has lost a lot of the CO_2 content built up during the first, alcoholic fermentation, there may not be any visible signs of fermentation during the MLF. This is because the low level of CO_2 being produced by the ML bacteria may be getting re-absorbed into the wine before it reaches the surface. This is why although a visible indicator is reassuring; it is best to monitor the progress of the MLF with chromatography.*

<u>A note about accuracy with Chromatography</u>: While Chromatography kits have a defined ability to measure the Malolactic conversion, they are still not as sensitive as they could be. Occasionally the results can show that the conversion is done when in fact there is a little residual malic acid still present. However, this is not really that big of a deal, and the workaround is pretty straightforward: once the test says you are done, just wait another week before adding your SO_2. Then rack the wine as you normally would.