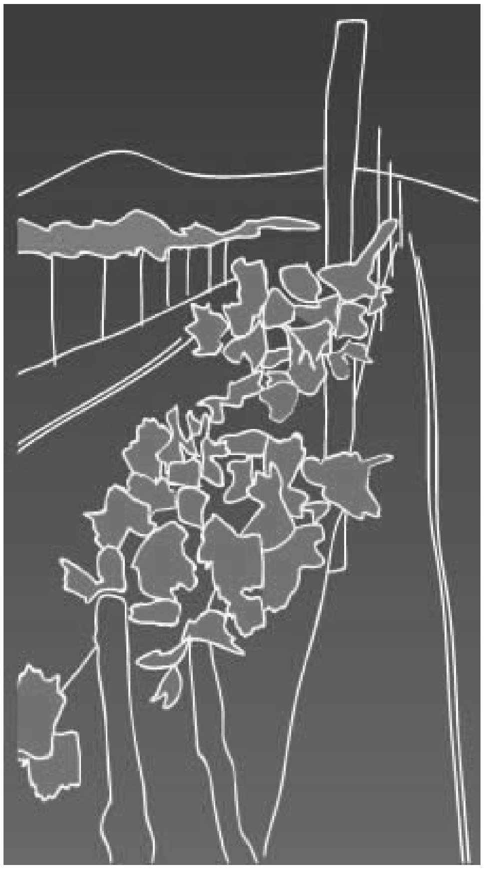
Guide to Red Winemaking



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Goal of this Manual: To make Great 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 Red 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 red wine is pretty straightforward. Fresh grapes are first crushed and separated from the stems. Next the mixture of juice and solids (called *must*) is allowed to ferment with yeast, converting the sugar from the fruit to alcohol and carbon dioxide, and extracting the color from the grape skins. As fermentation progresses, the carbon dioxide that is being created pushes the grape skins to the top of the container forming a "cap" on top of the fermenting wine, which must be re-submerged (called *punching the cap*) frequently in order to continue extracting color and to prevent the cap from spoiling. Once fermentation is completed, the wine is separated from the grape solids in a *wine press* and set aside for aging. Over about the next year the wine will be allowed to age and develop its flavors. Over the course of this year 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, the wine will be transferred to a fresh container periodically (called *racking*) in order to separate it from the sediments that naturally settle out of the wine during this time. Towards the end of the aging phase you may choose to add a clarifying agent to improve the wine's appearance. Clarifying a wine this way is called *fining* and the additives used to do it are called *fining agents*. Alternatively, you may 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 10 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 Ten 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 Ten and find the corresponding section. Our aim here is for you to have a quick reference guide that you can use to know what it is you need to do, as well as the basic theory behind it, all in an easy to navigate package that will stay within an arm's reach in the winery for years to come.

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

Chapter 1: Preparation

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.

1.1) 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. High quality frozen must and juice is also available nationwide and can be sent by air shipment to your local airport for pickup. Finally, *MoreWine!* offers 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 and also how differences from one growing season to the next can influence the fruit.

1.2) Get Your Equipment Together

If this is your first season making wine there are a few different options for you as far as getting equipment together. We suggest, if possible, that you rent the major equipment like a grape crusher and a wine press if you have a local shop that offers these for rental. Many regional winemaking clubs also 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 and so 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.

Chapter 2: The Crush (Day 1)

We Picked up the Fruit!
Ok, so you've 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 (23°-25° 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 **2.3 A** for a full explanation.)

**Note: 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 what the ºBrix are because this usually determines when they are picked.*

2.1) Crush and De-Stem the Grapes

The goal here is to remove as many of the stems as possible (at least 90%), and make sure that all of the berries have been sufficiently split open to allow the yeast to get in and work their magic. They don't need to be completely mashed, just cracked. For small amounts, this can be done by hand with a mesh bag. However, for quantities above 50 lbs, you will want to purchase or rent a Crusher-Destemmer. 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 fermenter is now called "**must**". You add yeast to the must to perform fermentation. Red wines are fermented in contact with solid materials from the grape in order to extract the compounds that give the wine its color, body, and depth of flavor and aroma.

2.2) Let's Clean the Slate – Adding SO2 (Potassium Metabisulfite)

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, sulfite 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 more sulfite-tolerant, cultured yeast strains that we recommend using. If your grapes are in good condition, free of mold etc., add 50ppm ('parts per million') of SO2 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 100ppm. However, be aware that levels of SO2 above 50 ppm will inhibit an MLF (Malolactic Fermentation) if you choose to do one. The 50ppm dosage rate at the time of the crush is usually fine.

**Note: The first sulfite addition made during the crush usually becomes entirely "bound-up" by the end of the alcoholic fermentation. During its aging and storage, only the "free" portion of the SO2 addition is actually contributing to the protection of the wine. Therefore, it is important to keep in mind that this first addition isn't part of the sulfite level needed to protect the wine during its storage and aging.*

For more comprehensive information on SO2, see sections 8.1 and 10.7.

Types of SO2

We recommend SO2 in 2 specific forms for addition to your wine, Potassium Metabisulfite (most common) and Efferbaktol (our favorite). Potassium Metabisulfite is often shortened to "meta" "SO2" "Sulfite", and comes in a white powder form. It can be dissolved into water and added to the must or finished wine. Our preferred format for sulfite is in the form of effervescent self-dissolving granules called Efferbaktol. SO2 is also available from Campden tablets, which look like aspirin. Campden tablets are made from Sodium Metabisulfite, a less desirable form of SO2. 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 SO2 for your fermenter using Efferbaktol, divide the ppm by your gallons of must to see how many ppm of SO2 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 SO2. 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 quickly use the entire contents of the package because it begins to lose its effectiveness when exposed to moisture in the ambient air.

SO2 in Powered Form:

Sizes: Available in 4oz (AD495), or 1lb (AD500) bags
0.19 grams per gallon results in 50ppm. For 10 gallons you would need 1.9 grams of powdered meta-bisulfite. If you do not have a gram scale, ½ teaspoon (level) is about 1.9 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.

Set Aside a Sample for Testing

Once you have added sulfite to the crushed grapes the must is protected. You can safely take out about a quart for testing.

2.3 Testing the Must

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 we 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.

**Note: When making corrections, consider the varietal. Seed/skin to juice ratio varies for each grape. We will only be getting around 3 (Bordeaux) to 3.5 (Zin and Rhône)* gallons of finished wine from every 5 gallons of must! This comes out to 60-70% of the must volume. Don't forget to take this into account when making corrections to the sugar levels or pH/Total Acidity (TA). In addition, most products designed to go into the must should still use the entire must volume to calculate their dosage. This compensates for the portion of the additions that physically bind to the must itself and will not make it into the final wine volume. This includes SO2, enzymes, tannins, oak, Opti-Red and Booster-Rouge).*

** Common examples of Bordeaux grapes are Cabernet Sauvignon, Cabernet Franc, and Merlot. Rhône varietals include Syrah, Grenache, Mouvèdre, and Pinot Noir.*

2.3 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.

**Note: Testing the whole must 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 68 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 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.

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”.

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:

As mentioned earlier, you want a sugar level of 22°-25° ºBrix for the start of a red wine fermentation.

- If your sugar level is lower than 22° 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 25 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 22°-25° ºBrix with water.

  For complete notes on dilution and chapitalization, see section 10.1.

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

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 6.5**g** 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 red wines is between 3.5 and 3.8.

Let's take a look at how these two parameters interact. Assume we have two red wines that each have the same TA, but different pHs, 3.2 and 4.0 respectively. The wine with a pH of 3.2 will have bright fruit flavors, but it will also be thin, acidic and aggressive on the palette. On the other hand, the wine at 4.0 will be softer and rounder than the wine at 3.2, 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 3.4-3.65 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. With red wines, it is best to get a sample of the must and lightly run it through a blender. The blender serves to open the skins and simulates the chemical make-up the juice will attain once fermentation has completed. The blended sample will need to be strained because the grape solids 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 solids out. A fine mesh bag (*Bag10)* is great for this. Next, filter the resulting liquid to obtain a clean juice free of particles. (Paper coffee filters pushed into a wine glass are great for this). The resulting clean juice is optimal for TA and pH determinations.

Steps to prepare sample:

1. Lightly blend must in a blender
2. Strain blended must through mesh bag into a bowl or jar to remove solids. Lightly squeeze bag if needed until enough sample has been collected: 50-100mL
3. 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.

2.3 B) 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 .60-.90 TA at the start of fermentation. So:

- If your acids are in the .9%-1% 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 section **6**).
- If your TA is significantly lower than .60%, 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 (remember to factor for just the juice, not the whole must). 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 10.2
For a complete example of adjusting the TA of a must, see section 10.3

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 red wine should be in the 3.4-3.6 range. A pH above 3.6 indicates and unstable wine and will not have a long shelf life. pH under 3.4 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 a must, see section 10.3

2.4 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 repackaging 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, fully-extracted wines of character and are definitely worth exploring.

**Note: All of these additions are to be calculated based on the entire volume of the must.*

Lallzyme EX (AD351)– An enzyme used to break down cell walls in the skins of grapes, freeing anthocyanins (the deep purple color compounds) and favors the release of softer well-rounded tannins. We use it on all red wines in which we want a deep, rich color with a rounded mouthfeel. Lallzyme products also eliminate the need to perform cold soaks and extended macerations – a great tool for home winemakers.

Lallzyme EX-V – A higher concentration of the enzymes used in the Lallzyme EX formulation, also used for improving the extraction of color and positive tannins. In addition, EX-V has the effect of boosting the tannic structure more than EX, and is useful for adding tannic intensity and stability to wines that are destined for long-term aging and development.

Opti-Red/Bouster Rouge– Both of these products add body and structure to a wine, as well as helping to promote color stability. Opti-Red adds a more rounded body and mouthfeel, Booster Rouge adds more structure while emphasizing the fruit character.

Enological Tannins – In addition to bonding with anthocyanins to create a stable and rich color, enological tannins are added to help structure the wine. They are used in both fermentation and during aging. 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.

VR Supra NF: A blend of grape and wood* tannins primarily used for red wine during fermentation. Added to the must, VR Supra NF helps to stabilize color and enhance a wine's structure. (* VR Supra NF contains only oak-derived wood tannins and is well-suited to producing bold Cabernet Sauvignon as well as delicate reds like Pinot Noir.)
Tan'Cor: Primarily added to red wine immediately post-fermentation. A blend of wood and grape tannins that has been formulated to help improve structure, reduce vegetal and musty aromas, reduce astringency, and help protect the wine from oxidation during aging.

Tannin Plus: Primarily used for red and white wine post-fermentation to add structure and a vanillin character. Tannin Plus contributes wood nuances that are not smoky or toasty, but a clear vanilla oak character that helps create a smooth finish. Tanin Plus can be used at low dosages along with other tannins just to add a vanilla character to a finished wine.
Galalcool SP: Can be used during fermentation to minimize reductive odors and enhance mouthfeel. It is usually used for white wines, but can be used for a subtle change in red wine fermentations, as well.
Toasted Oak (chips/cubes): 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.

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

**Note: 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.*

2.5 Rehydrating and Adding Your Yeast to the Must

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. This is essentially fermentation by Russian Roulette. 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.

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, 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.

Add the yeast to 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 10.4.

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

Chapter 3: The Ferment (Primary fermentation) (Days 2 to 14, or so)

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. Once the fermentation has begun, the yeast will proceed to consume the sugars in the must/juice, producing CO2 (bubbles) and alcohol. During this period, the skins will be carried upwards by yeast produced CO2 and compact into a large mass that will be pushed up and out of contact with the liquid in the must. This floating mass of skins is referred to as the *cap*.

3.1 Punching the Cap

This cap needs to be broken-up and re-submerged several times a day. This process is referred to as "punching down the cap". Punching the cap protects the wine, aiding with extraction of color and flavor compounds from the skins, along with the dispersal of built-up heat. If the cap is exposed to the air for too long, the surface can dry out and allow the colonization of airborne bacteria. The most common one is acetobacteria, (vinegar bacteria), though pretty much any one will ruin your wine. Since the rising alcohol levels in the fermenting must are high enough to kill airborne bacteria when it washes over them, submerging the skins helps to protect the wine from spoilage throughout the fermentation. In addition, mixing also promotes contact between the wine and the skins, aiding color and flavor extraction. The more often the cap is punched the greater the extraction of compounds coming from the skins will be. Finally, fermentation generates quite a bit of heat and the cap acts as an insulator. If not broken up, the cap does not allow the excess heat to escape, causing the fermentation to become too hot.

Try to avoid elevated fermentation temperatures because they antagonize yeast and cause fermentations to stick, as well as produce off flavors and aggressive qualities in the final wine.

**Note: 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 with every punch-down cycle. You are looking for the must to become pink 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. However, it is important to avoid mashing or grinding the seeds as much as possible during the punching as they contain harsher, more astringent tannins and their release could make the final wine more aggressive and unpleasant.*

How to Punch the Cap

MoreWine! offers several models of punches to accommodate a variety of fermenter sizes from 30 gallon plastic food-grade bins to 600 gallon stainless steel tanks. They are made of durable food-grade metal 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 skins back into solution 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.

3.2 Yeast Nutrition During Fermentation

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 we made when hydrating our yeast was only designed to get them through the hydration process. Yeast require 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 (such as Hydrogen Sulfide and VA) and have difficulty finishing fermentations. In order to avoid this scenario, we 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, hundreds of 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.**

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 (cap formation) 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. In a warm starting fermentation, an 8-10 ºBrix drop may take place in the first two days, so be sure to check your ºBrix early on Day 2. 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.

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 H2S, 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 Fermaid K, 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 10.4

3.3 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 punch down the cap (a good way to do this is to use a floating thermometer (MT400)) for future reference. The actual 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 popular red wine schedule is to start slowly at cooler temperatures, such as the low 60s. Next, gradually allow the must to warm up to the desired temperature as the fermentation gets underway. Starting cold allows water-soluble compounds in the must such as anthocyanins (color) and agreeable tannins extra time to become fully extracted improving the final wine.

During fermentation the temperature is allowed to rise, often reaching 80°-90° F for a brief period of time. Yeast create different compounds at different temperatures. How high you allow the fermentation temperature to rise or "spike" is often debated. Some winemakers allow it to go into the low 90's. However, alcohol toxicity increases as the temperatures rise, so spending too much time in the upper temperature ranges can be damaging to the yeast and they may have difficulty finishing the fermentation. We recommend limiting the spike to the mid to upper 70's for safety's sake. Most winemakers agree that a temperature range of 70°-85° F is acceptable.

Controlling Temperature

There are two main methods of temperature control, both with advantages and disadvantages. 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. The only problem with these systems is that they're relatively expensive. They provide piece of mind, but at a price. The second method only involves investing in some plastic jugs. To use, freeze the jugs, then pull them out of the freezer when the must gets too hot. Sanitize the jugs and float them in the must, stirring until the temperature drops to where you want it to be. Keep in mind that you might want two sets of jugs, one for the must and one for the next round. In general, the "hot" portion of the ferment only lasts for a few days, and life will soon return to normal. However, if you happen to live in a very warm climate or will have warm ambient temperatures when you will be fermenting, you may want to speak with us about your options for a dedicated temperature control system.

3.4 Monitoring your Sugars, Timing the Press:

In about a week, 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 not only give you an overview of how the ferment has been progressing, but also tell you when it is time to press.

Measuring the Sugar Levels

The easiest way to test your sugar levels during fermentation is to use 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. Sidestepping all of the work needed to create a suitable hydrometer sample is reason alone to upgrade to a refractometer. *MoreWine!* stocks five different styles of refractometers, as well as offering a comprehensive selection of various hydrometers.

When to Press? :

In most cases, when you reach 0° Brix, it is time to press. However, if you want to emphasize the light and fruity aspects of the wine, you may want to press before the Brix falls to 0°, maybe at 3° to 5° Brix. Or, you may want to emphasize the concentrated, “jam-like” and extracted qualities of the grape. In this case, you might choose to do an extended maceration, letting the wine stay in contact with the skins and seeds for up to two weeks after the sugars have fallen to 0° Brix (see below to understand the risks that come along with this technique). Whatever timing you choose, the press operation is carried out in the same fashion.

MoreWine!'s **Recommended Time to Press**

We suggest that most of our customers press their wine when it has fallen dry, at 0° Brix.

- 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.

Extended Macerations

Extended Maceration is an advanced technique that we get a lot of questions about. Any time spent on the seeds and skins once alcoholic fermentation has completed is known as *Extended Maceration*. Typical timing is anywhere from 1 to 2 weeks. Said to increase extraction and depth, we remain unsure after several tests. With the use of enzyme and tannin products we feel that the benefits can be achieved through alternative avenues. Overall, we recommend that new winemakers avoid the practice – leave this one to the pros.

That said, if you do decide to do an extended maceration, you will need to take steps to prevent the must from coming into contact with any oxygen. Along with covering the wine with Saran Wrap (very effective), it would be a good idea to keep a “blanket” of CO_2 (or argon) on top of the must at all times. You now only need to punch the cap once a day, until it remains just below the surface of the must. At this point, you are mainly moving the lees to avoid the formation of H_2S in the wine, along with helping the skins to break down and distribute flavors. Keep in mind that a good portion of the flavor impact gained during an extended maceration is coming from the seeds themselves, so it would be best to make sure that they are mature before you decide to give this technique a try. Mature seeds are brown and have a slight nutty taste to them when chewed. If the seeds are green and have a harsh, bitter or astringent quality, then we recommend against allowing your wine to remain in contact with them for too long once the fermentation finishes. In addition, a high level of stem solids in the must (as a result of using amateur-level processing equipment) will also create green and astringent flavors during an extended maceration. If these vegetative flaws are present at the end of fermentation, any additional time spent on the seeds and skins will only make them worse, and should definitely be avoided.

You should be tasting the wine each time you punch the cap (or stir it). The time to press is when the flavors suddenly “round” and the wine tastes more soft than it should for being so young. There is no hard and fast rule as to when an extended maceration is over, you press when the wine tastes right to you. However, determining this exact moment requires experience. If you are new to winemaking, we strongly recommend that you master the basics before experimenting with this technique.

Chapter 4: Pressing (Days 7 to 15)

At the end of the fermentation the wine will have extracted everything it needs from the seeds and skins. When this is completed, it is time to press. It is important to press in a timely fashion because a prolonged exposure to grape solids post-fermentation might cause reactions that could generate off-flavors and otherwise ruin the wine.

Pressing involves straining the liquid off and then squeezing the remaining skins and seeds (called *pommace*) to get the remaining 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) into a food-grade bucket (FE345) for smaller batches, to an actual wine press that can be purchased or rented for the day (WE110-WE160).

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

- <u>Traditional Basket Presses</u> work by pressing the pommace from the top of the holding basket down by using a heavy, cast iron, ratcheting mechanism. 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 repressed 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.

- <u>Bladder Presses</u> 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 out 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. The only downside to bladder presses is that they do cost more than basket presses.

**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 equipment. 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.*

4.1 Pressing

There are several ways to get the fermented grapes into the press. With small volumes, the most common method is to scoop them out of your fermenter with a small bucket and pour them into the press. For larger volumes, you can purchase a must pump (PMP200), which is a 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. Another method for transferring must to the press is with a Suction Tube (WE548) to remove the liquid wine from the fermenter with a pump first, making shoveling the skins into the press a much easier job.

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 often makes a better wine than the portion that is squeezed out of the skins, referred to as *press-run*. The pressed portion is not as good as the free portion because the act of pressing, while yielding more wine, also extracts some of the harsher tannins from the skins and seeds. As a result, it is a good idea to press lightly and taste the run-off frequently in order to monitor the end point for each press. The end point will be different for every must. The major signal to stop is a "thin" taste from the wine 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.

4.2 Transferring* Pressed Wine to a Storage Vessel

The wine is collected beneath the press in a shallow container and then depending on the volume, poured (often using a food-grade bucket with a handle) or pumped into a temporary storage vessel. Common storage vessels are carboys (glass or plastic) or variable volume fermenters which are topped with airlocks. If using carboys, they should be filled almost to the top in order to minimize the surface area which could be exposed to any oxygen in the headspace. You will want to leave a space 1-1.5 inches below the stopper to allow for the potential expansion of the wine as a result of temperature changes. If you are using tanks and will not be able to fill to the top, make sure that you flush the headspace with a blanket of inert gas to protect the wine from exposure to oxygen during this period (see section **10.10** for an explanation of using inert gas during winemaking).

For expanded information about transferring, see section 10.9

Chapter 5: First transfer – Rack off of the *Gross Lees* (1 to 2 Days after pressing)

5.1) Transfer clean wine in preparation for Malolactic Fermentation

Once the alcoholic fermentation is over it is time to begin the Malolactic Fermentation (the next chapter will discuss the MLF in detail). Before MLF is possible, it's important to get rid of the unwanted solids left in the wine after pressing.

A large amount of sediment will settle out of the wine in the first day or so after pressing. This layer is referred to as the *lees*. What drops out in the first 24 hours is called *gross lees*, there is nothing beneficial or helpful about them. In fact, the gross lees are often a source of harsh and bitter compounds that, if left in contact with the wine for an extended period of time, can develop negative sulfur flavors and aromas. In order to avoid potential problems, we suggest that you transfer the wine off of the gross lees between 1 to 2 days after pressing. After this transfer, the resulting wine is often quite clean and will have only a small quantity of *light* or *fine lees* (clean yeast, free of solids) that settle out to form a thin layer on the bottom of the vessel. Unlike the gross lees, the light lees are very beneficial to red wine at this stage and will serve as a nutrient source for the Malolactic Fermentation. Once off of the gross lees, the wine can safely work in a carboy, tank or barrels for the several weeks needed to complete the MLF.

**Note:* It is desirable for red wine to get exposure to oxygen during the first transfer, but only at the first racking. This serves to start rounding the flavours a little sooner. You can do this by simply lifting the transfer tubing up during the racking so that the wine runs down the side of the carboy or tank that you are transferring into. For all other subsequent transfers you will want to avoid the wine's contact with air, and to leave the transfer tubing at the bottom of the vessel so it doesn't splash while you are transferring.*

Chapter 6: Malolactic Fermentation (Secondary Fermentation) (Lasts 2-6 weeks)

After the wine is transferred you can choose whether to do a Malolactic Fermentation. The "ML" is a type of bacteria that metabolizes malic acid (the harshest of the three acids naturally found in the grape, the other two being citric and tartaric) and turns it into lactic acid (the softer-flavored acid that is in cultured milk products). 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. In general, most red wines will benefit from doing an MLF. MLF should take about 4-6 weeks to progress to completion; we have seen it complete in as little as 2 weeks in some cases.

**Note: Because CO_2 is produced during the process, the conversion of malic to lactic acid is commonly referred to as "fermentation". However, an 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**: If you will be doing an MLF on your wine, it is critical that you **NOT** add any SO_2 until after the fermentation has completed. Adding sulfur before then will only impede or possibly kill the ML bacteria.

- Unlike the primary fermentation, MLF for red wines is done in an enclosed vessel. Therefore, you will need to make sure that you use an airlock on the top of your fermenter(s) 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 aging/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 to 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 **10.6**)

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 the sake of convenience, these elements will be summed-up into a quick reference list at the end. (For complete, in-depth information on MLF, see section **10.5**)

6.1) Prepare and Add (*inoculate*) 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 type will have its method of preparation and step-by-step instructions clearly listed on the packaging itself.

**Note: 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.*

6.2) Managing 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 light 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 70°-75°F to help the bacteria do the job in a timely fashion. If it gets colder (<65°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 CO2 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 SO2 yet. Therefore, if you have access to it, it is a good idea to flush headspaces with inert gas (CO2, or Argon) each time you stir the wine.

6.3) When activity slows, begin checking with Chromatography

Once the MLF begins to slow down (around the third or fourth 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 are telling you that they are having a hard time finishing. 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. If there is only a very little malic spot left on the test, 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): press, wait 1-2 days, rack off the gross lees, then:

- 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 (66 gallons of wine) 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) is ideal for this).

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).*

- If possible, try and maintain the about 70° F. If it gets colder, (<65° F), the bacteria may slow down or even just stop altogether depending on the specific strain and the wine's conditions. *Note that different brands will have slightly different temperature tolerances, but 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.

  **Note: 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.*

- As the MLF slows, or once the signs of fermentation have stopped, check for completion with a Chromotography kit.

- Dose the wine to the correct SO2 level as soon as it has finished fermenting. With the wine protected, you can safely rack off of the lees into your carboys, tanks or barrels and begin the aging process.

For in depth information on SO2 additions see section 10.7

Chapter 7: The Second Transfer (Post MLF Completion)

Having finished MLF, the wine should be removed from any sediment at the bottom of the vessel by racking. Whenever you need to do a racking it is a good idea to test your wine for needed additions.(especially SO2) Any addition 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 container before, or in the early stages of the transfer.

7.1) Adjust SO2 Levels

Once the ML fermentation has completed (as verified with Chromotography), you need to prepare the wine for the aging/storage. Adding a specific amount of SO2* into the wine and mixing it thoroughly will achieve this. By adding sulfite, we are establishing protection for the wine that will help guard it against oxidative browning and potential spoilage organisms. From this point until bottling, we need to maintain a layer of SO2 protection in the wine at all times.

> **The precise amount of SO2 needed is based on the wine's pH. So, if you will be adjusting the TA /pH of the wine post MLF, keep this in mind when calculating your SO2 addition. A good working method is to add half of the SO2 addition into the wine, test and correct the TA/pH, then add the rest of the SO2 as needed based on the new TA/pH value.*
>
> *For a complete explanation of SO2 management, see section 10.7*

7.2) Adjust TA and pH If Needed

Once the correct SO2 levels have 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 stops you will need to test <u>and</u> taste the wine to see if the drop in acid is acceptable, or if it will need to be corrected. Red wines should end up in the 3.4-3.65 pH range, but ultimately, your palette will be your guide. You will use the same guidelines to adjust the wine's acidity as you did with the must, only now you don't need to factor out the seeds and skins when making your calculations - just use the straight volume of the wine. For a review of adding acid to adjust the TA and pH, refer back to section **2.3B**.

7.3) Transfer Wine to a Long-Term Aging /Storage Vessel

Once the TA/pH has been adjusted (if needed) and the correct SO2 level has been established in the wine, we can transfer it to our long-term aging/storage vessel(s). This transfer serves to remove the wine from the combined light and MLF lees, allowing only clean wine to go into the storage vessels. It's also important to remove nutrients that could be used by spoilage organisms during the aging/storage period. At this point, all biological activity that we have planned for the wine's existence (primary fermentation with the yeast, and then the secondary fermentation with the ML bacteria) should be finished. By removing as many nutrients as possible, any spoilage organism that does make it into the wine has a very hostile environment to survive in. Between the antagonistic effects of the free SO_2 and the absence of available food, it should be very difficult for anything to establish itself and spoil the wine. Removing the lees represents another level of good winemaking practices that we can utilize to further protect the wine.

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. In order to keep receiving their benefits, just carry the oak through to the aging/storage vessel. However, they will probably be coated with yeast, bacteria, and *tartartes* (acid deposits that naturally settle out of the wine over time). You will need to rinse them off in order to re-expose the wood.

Note:This may require hot water and a sanitized, food-grade brush. Although oak and other woods are typically naturally antibacterial, we recommend sanitizing the clean wood with a light SO_2 solution (no citric acid) or StarSan before returning the wood to the wine.

Chapter 8: Aging/Storage

The French use the term *élévage* to refer to the aging/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. Aging/storage is made up of three parts: letting the wine continue to work on its own, monitoring its progress both chemically (by testing) and sensorally (by tasting), and carrying out a series of rackings for clarification as needed. Each of these three elements works together as a complete system that allows us to help keep the wine safe as it continues its maturation. Throughout this period, winemakers will need to properly maintain the SO2 levels, hold the temperature at a constant 55-60°F, and taste the wine every 4-6 weeks to monitor its evolution.

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

Understanding Polymerization and the need to remain vigilant

Even though we are doing very little "hands-on" work, as compared to the previous steps of crushing, fermenting and pressing, remember that wine is never static. It is always moving, shifting, and alive; and it continues to develop throughout the entire aging/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 wine that has the right amount of micro-oxidative exposure will create beneficial, soft and agreeable tannin structures.

- 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, due to polymerization can cause a wine that seemed sound just after fermentation to develop problems (such as H_2S) during the aging/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 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 SO2 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 aging/storage temperatures:

Warmer wine/cellar temperatures

Pros:

- Warm temperatures of >65°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 and integrated 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. 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 SO2 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.

Note that cold temperatures will not necessarily kill these microbes; it just retards their rate of reproduction. If they are present and the SO2 is not correctly maintained, they 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 red wines this equates to maintaining a range of 55-60°F. This allows the wine to be cool enough to limit microbial growth while effectively regulating the extraction of compounds from the oak and rate of polymerization.

8.1) SO2 Management

Sulfur Dioxide, or *SO2*, 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 "SO2", "Metabisulfite", and just plain "Sulfite." In winemaking, the SO2 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 SO2 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 aging/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 exposures. In its most basic form, SO2 management simply comes down to understanding how to create and maintain a small, stable reserve of *Free SO2*. 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.

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 range from being slight to quite pronounced. 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. Because of the differences between two seemingly identical wines, they will often end up with different free SO2 levels after equal sulfur 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 SO2 has been added. Then, based on test results, additional sulfur can be added to achieve the target level. The SO2 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 SO2 level – it must be tested and corrected if we want accuracy.

Remember, it does not matter if you think you have added enough sulfur to create 35 ppm free SO2 on paper, if your test lets you know you only have 10 ppm free in the wine! Not verifying the effectiveness of your sulfur additions can cause some wines to remain unprotected. *It is always a good idea to always verify your SO2 levels after every addition.*

Aging also causes free SO2 levels to decrease, slowly but constantly. In addition, each time the wine's container is opened for tasting/testing, the oxygen that gets in interacts with some of your sulfite, further reducing the portion available to protect the wine. For this reason, each time the container is opened for tasting/monitoring the sulfite needs to be adjusted back up to the recommended level (more on this later). The exact amount of sulfur needing to be made-up each time will vary according to the wine's current state of chemical/microbial stability, temperature, and your storage vessel. Barrels and tanks with headspace tend to lose their free SO2 more quickly, due to the wine's interaction with oxygen in the environment/headspace, than fully topped inert vessels do.

These drops in free SO2 are coming from a phenomenon known as "binding" and are 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 sulfur to interact with. The binding action 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 SO2 can be viewed as an insurance policy that the winemaker takes out in case the wine has any problems during its lifetime. However, remember that protection only comes from the "free" SO2 and once the free sulfur reacts and becomes bound it is no longer available to bind with future elements. It will no longer be present to protect the wine. In order to ensure that the wine does remain protected at all times, we must be sure to always have a pool of free SO2 present.

Maintaining this reserve of free sulfur means that once a wine starts to lose its free SO2 content, we are obligated to raise it back up again, even we end up using more than we want to (choosing not to add the additional sulfur and leaving the wine unprotected is not an option). Yet, if we keep adding sulfur to the wine in an effort to maintain a pool of free SO2, we may have to add enough 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 SO2 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 sulfur management in winemaking is learning to create the required amount of free SO2 in the wine by using the lowest total amount of sulfur 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 SO2 addition (by calculating, testing the results and correcting to our desired level if necessary) we establish our starting point for free SO2 in the wine. If the wine remains completely sealed, apart from the normal and slight drop in the free SO2 levels, the starting level of free SO2 will remain fairly stable over time. However, as soon as we start to open the vessels up for tasting, testing, blending or fining (along with topping for barrels), we will begin to see a drop in the free SO2. 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 SO2 levels: aldehyde formation, spoilage organisms, and the introduction of solids into the wine.

- Example #1, Aldehydes: When a wine is exposed to oxygen the alcohols in it oxidize into aldehydes. Aldehydes are a class of chemical compound that can bind with SO_2, resulting in lower free SO_2 levels after transformation. In addition, SO_2 is consumed each time the wine is exposed to oxygen. 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, which 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.

- Example #2: Spoilage Organisms: If conditions are favorable and spoilage organisms become established, this can create a cell mass that binds with the SO2. 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 happen when depleted free SO_2 levels (due to excessive oxygen exposure) make the wine vulnerable.

- Example #3: 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 SO2.

Now that we have taken a closer look at the elements that can bind-up our free SO2 levels, we can focus on how to eliminate or at least minimize their ability to lower our free SO2 levels. For each of these three examples there is a corresponding course of action we can take to counteract its potential ill effects.

- Example #1: Aldehyde formation: Since aldehyde forms 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 contact with inert gas: i.e.; headspaces of vessels, transfer lines, pump cavities, filter housings, etc. Note that red wines do require a small amount of oxygen to develop positively, but this is on the *micro* level (1-5 mg/L/**month**, or about what a 60 gal barrel delivers). That said, any oxygen pick-up made during normal cellar operations - such as topping, transferring, or filtering - is much larger than the desired amount (1-5 Mg/L/**day**) and is considered *macro* oxygenation.

  For more information on understanding oxygen's role in winemaking, please refer to MoreWine!'s Macro-Oxygenation and Fermentation paper in the Knowledge Center on the MoreWine! website.

- <u>Example #2: Spoilage Organisms:</u> 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.

- <u>Example #3: Introduction of solids:</u> 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. Once reacted with however, the new addition should remain bound and not cause future drops in the free sulfur levels.

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 sulfur needed to maintain the recommended free levels in a wine is never a fixed, "one size fits all" amount and will be different for each of our wines. The way that individual elements in the wine interact and bind with the sulfur needs to be understood and taken into account if we are to create the stable free SO_2 level needed to protect our wines during élevage. However, remember that stable sulfur 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, we are now better to able to prevent this scenario from happening.

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 10.7

8.2) Tasting and Adjusting During Aging

We need to occasionally check in on the wine's progress by testing and tasting every 4-6 weeks throughout the entire maturation period. What we are looking for is the following:

1. <u>Is everything all right?</u> 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.

2. If the wine has no signs of spoilage, then how is it developing?

- pH/TA: How does the wine taste; is it too acidic or too flat? Check what you are tasting against the pH and TA results. If you need to raise the pH because the wine is too acidic, adding Potassium Carbonate at a rate of 3.8 grams per gallon will raise the pH by approximately 0.10 units. The wine is then chilled to as close to 33°F as possible for two weeks. When done, rack it off of the deposit, double check the SO_2 level and return to the normal aging/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)

  Refer to section 10.2 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 (for example: a delicate Riesling). 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 or enological tannins to help round things out.

- Tannin/Oak Extracts/Level of Barrel Impact: 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 10.

**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 10.8

8.3) Additional Transfers/Controlled Oxygen Exposure

Depending on how much sediment is in the wine, it may need to be racked a few times during its maturation. In addition to helping clear the wine, racking can also be used as a way to insert a small, beneficial amount of oxygen. If the wine is a little edgy when you first taste a sample, but opens up after being in the glass for a while (from being exposed to the oxygen in the air), you may want to rack it without any inert gas. However, if the wine tastes great right out of the thief or sample valve, consider taking steps to prevent it from picking up any more oxygen on the transfer preserving its original character. In this case we recommend purging the transfer lines and receiving vessel with inert gas before making the transfer.

The following basic check list should be gone over before any racking:

- Test your free SO2 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 SO2 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 it at all.

- Check the amount of oak/tannin integration. Oak compounds are continuously being released from the wood into the wine throughout the aging/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 9: Clarifying and Bottling

At some point after a year or so, the wine will have rounded and acquired enough oak character to be considered finished. This signals the end of the élevage/maturation period, and the beginning of the bottling process. Even though we have been testing the wine during the aging/storage period (along with tracking and correcting any problems), it is important to run our 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

1. If the wine tastes fine and you are happy with the level of clarity, an SO2 test is all that's left. Once this has been taken care of, we can proceed to the actual bottling of the wine.

Please see Section 8 Aging/Storage for complete information on adjusting SO_2 levels

2. More likely than not, there will be one or two elements that need our attention before we can bottle the wine:
    - Check The pH/TA: How is the wine's acidity? If the pH/TA needs to be corrected you should do it now.

    - Check the mouthfeel/tannins: Are the tannins a bit "grippy" or harsh/rough? If so, then you may want to look at some form of fining such as albumen (egg whites) or an additive solution such as enological tannins or an Opti-Red addition (see the next section). *Note that the treatment that worked for last year's wine may not work for this one. Therefore, bench trials will be needed to determine the best solution for this particular wine will be.*

      For information on running bench trials, see section 10.8.

    - Check the clarity: Is the wine's clarity satisfactory? Usually the presence of tannins along with racking during the aging/storage period is enough to clear up a red wine enough to bottle. However, if you are looking for a particular brilliance in the glass, then you may need to fine or filter the wine before it gets bottled (see the next section).

    - Check the Residual Sugar %: In general, the Residual Sugar (often just RS for short) level does not need to be adjusted for a red wine. It usually ferments dry and is left where it stopped. However, in cases where there is some RS in the wine, you may want to consider a sterile filtration in order to guarantee the microbial stability of the wine.

- Check the free SO_2: The final treatment: make sure that your free SO2 is at the correct level; adjust if needed.

  Complete information on SO_2 management can be found in section 10.7.

9.1) 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.

9.1 A) Fining

A red wine is usually fined in order to soften a harsh or astringent character and/or to improve clarification. Fining agents should be used at the lowest possible dosage needed to achieve the desired effect. Over dosage creates the risk of loss of mouthfeel, color, aroma and/or flavor. Yet, 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.

Subtractive fining treatments

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

- Egg Whites contain a protein called albumen that is used to reduce harsh/astringent tannins as well as help clear the wine out. Use at a rate of 1 to 2.5 eggs per 60 gallons (barrel): remove the yolk; mix the egg white(s) with a pinch of salt and just enough water to create a solution. Stir this into the wine for 30 seconds, then top-up/close the container. Wait three weeks then rack off of the deposit. *Note: do not let the wine sit on the settled deposit for more than two months or the egg/tannin complexes will re-dissolve back into your wine.*

- Gelatins 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. Make sure the one you use is designed to give the results you are looking for.

- Potassium Caseinate is a milk-derived protein that is used to reduce astringency and soften a red wine's tannin structure. Once added to the wine, Potassium Caseinate is quick to settle and the treated wine can usually be racked in 4 days.

Additive treatments (A.K.A.: "coating")

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 aging/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 aging/storage period. So, make sure you choose the right one for the task at hand.*

- Opti Red/Booster Rouge are specially designed, yeast-derived protein fractions that can be used to add mouthfeel and body to a wine. Normally used in the fermentation, these products can also be used to coat harsh/aggressive tannins in finished wine during aging/storage.

Note: When Opti Red/Booster Rouge additions are overdone, they can create a candied sweetness that comes across as artificial/not from the wine that should be watched for during the bench trial.

9.1 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 aging/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.

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 and pads require a "plate and frame" set-up. Both require a pump to move the wine. Cartridges are more expensive than pads because they are more intensive to produce, but they can be cleaned and reused (as well as 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, but somewhat messy – no need to clean for later use however.

<u>In 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 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. 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.

9.2) 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 and sanitized, and that your corks (W430) and corker (W405) are at hand*. Then, bottle the wine using one of the following methods:

- <u>Basic racking cane set-up:</u> 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.

- <u>3 or 5 spout siphon fillers:</u> If you are doing more than a few carboys worth of wine at a given time, you may want to look at a three (WE602) or five (WE610) spout filler to help increase the processing volume. By connecting directly to a tank or barrel, these units allow you to avoid using a pump by using a gravity siphon to bottle the wine (as long as the source is higher than the filler). The only caveat in using these types of fillers is that unless the reservoir holding the wine is being blanketed with inert gas (Argon or CO_2) the wine will be exposed to oxygen during the time it takes to make it into the bottle. Fill rate is around 30 seconds per 750mL bottle.

- <u>Enolmatic filler:</u> 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. Fill rate is around 20 seconds per 750mL bottle.

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

- Alternative, non-traditional bottling options: 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. In addition, the wine may also be kegged. Using kegs 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, so you really should wait to try it. When you finally do taste the product of your labours, 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 aging 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 10: Expanded Information Sections

10.1) Dilution and Chapitalization of Musts

-Use filtered water, not straight from the tap if you can avoid it. Chemicals found in tap water (ex: 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, process requires you to add water to the must. Dilution only requires water, chapitalization is achieved by dissolving sugar with a small amount of water. Water additions will also dilute your TA, and will need to 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. For every liter of water used for either dilution or chapitalization, you need to 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 lowering acidity by not adding acid to the water used for the 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.

Equation to calculate dilution quantities:
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:

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**.

**Remember there are only 3 (Bordeaux grapes) to 3.5 (Rhône grapes & Zin) gallons of liquid per 5 gallons of must, or 60-70% of the must volume*

Equation 1: $(L1 \times OB) / DB = L2$
Equation 2: $L2 - L1 = Y$

So, putting it together in an example: Let's say we have 8 gallons of Cabernet Sauvignon must at 27ºBrix. How much acidulated water do you need to add to dilute this to 24.5ºBrix?

OB = 27 (original starting ºBrix)
L1 = 18.2 liters (8 gallons of must x 60% (Bordeaux grapes) = 4.8 gal of juice, or 18.2 liters. (1 gal = 3.785 liters)
DB = 24.5 (desired ºBrix level)
L2 = complete equation 1 to find L2

Equation 1: (18.2 liters x 27 ºBrix) / 24.5 ºBrix = L2,
L2 = 20.1 liters

Equation 2: 20.1 L – 18.2 L = Y
Y = 1.9 liters

We need to add 1.9 liters of acidulated water to our must to lower it to 24.5ºBrix. In keeping with our practice of adding tartaric acid to the water used in the dilution, we can say that 1.9L of water x 6 g/L = 11.4g of tartaric acid should be added to the water prior to using it to dilute the must.

10.2) 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 pallets 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 aging characteristics and helps ensure that the wine will hold up well in the bottle during its years of aging/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.

<u>In Practice</u>

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, Malolactic Fermentation 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.

10.3) 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 Syrah must that is at 27.5º Brix, with a pH of 3.95 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 27.5ºBrix, let's look at dropping this to 24.5ºBrix. Using our equation (introduced in section 10.1) we come up with the following:

OB = 27.5 (starting ºBrix)

L1 = 66.3 liters (25 gal of must x 70% (Rhône grape) = 17.5 gal; 17.5 gal x 3.785 L/gal = 66 liters

DB = 24.5 (desired ºBrix)

Equation 1: (66.3 liters) x (27.5ºBrix) / (24.5ºBrix) = 74.35 liters (L2)

Equation 2: (74.35 liters) – (66.3 liters) = 8.05 liters (Y)

So, we will need to add 8.05 liters of water to the must to drop it to 24.5ºBrix.

B) Acidulate the adjustment water: In order to try and keep the must as consistent as possible when making the water addition, we will also acidulate the addition. 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 8.05 liters of water: 8.05 liters x 6 grams = 48.3 grams

So, we will need 48.3 grams of Tartaric acid to acidulate our dilution water.

2. **Looking at the pH and the TA:** With a pH of 3.95 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 pH. Our goal is a wine that finishes around 3.6 pH. Since we will also be doing an MLF (raises pH), we could add enough acid to to bring the pH to 3.5. Once MLF brought it back up to 3.6ish, we'd be in great shape.... on paper. However, in reality, adding enough acid to create a .45 pH drop is quite intense and we may find ourselves shooting even lower than our targeted range of 3.5 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, if you need to make a large adjustment, it's best to do most of it in the must, but there are limits.
With that in mind, it is probably best to compromise and target closer to around the 3.7 pH range. Calculate the amount of tartaric acid needed to raise the TA of the must by 2.5 g/L (or 0.25%). Given our original figure of 5g/L, our TA will be 7.5 g/L along with a drop in the pH to around 3.7. 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. 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 palette for the future- not only for must adjustment, but for the finished wine as well.

1. **Adjust the pH / TA:** When acidulating the must, only 60-70% of the must volume is juice. For TA and pH adjustments, we should only be using the amount of juice in the must, rather than the volume of the entire must. Since we already did our calculations for lowering the ºBrix earlier, we can use our new juice volume with the correct brix level:

   L1 = (<u>27.12 gal of must</u>) x (<u>70% (Rhône grape</u>) = ~19 gal (71.9 liters.)

   So, for our 27 gal of must, we are going to look at acidulating <u>19 gal</u> (71.9 liters) of juice 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:

<u>Gallons</u>: (19 gal) x (7.6 grams, from: 2 x 3.8 grams per gallon) = **144.4 grams**
<u>Liters</u>: (66.3 liters) x (2 grams per liter for .2% TA) = **143.8 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 27.5ºBrix with a pH of 3.95 and a TA of .5, we added 8.05 liters of water acidulated to 6.0 g/L TA (with 48.3 grams of Tartaric Acid). This brought the ºBrix to around 24.5º 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 (+4.5 g/L% TA or 0.45%), 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.

10.4) Complete Yeast Hydration and Nutrients

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.

<u>Yeast</u>: 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.

<u>*Note:</u> *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.*

<u>Recommended Yeast Hydration Procedure</u>:

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:	**<u>Up to 24.5 ºBrix</u>:** 1 gram of Yeast 1.25 grams Go-Ferm 25 mL H2O	**<u>25 ºBrix and above</u>:** 1.2 grams of Yeast 1.5 grams Go-Ferm 30 mL H2O

<u>MoreWine's recommended protocol for successfully hydrating Active Dry Wine Yeast</u>

1. **<u>The volume of H20 needed = 20 x the weight of the Go-Ferm addition</u>**

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 **<u>110º F</u> (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.*

2. **<u>The amount of Go-Ferm needed = number of grams of yeast being used x 1.25</u>**

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 **<u>104º</u>** <u>F</u> (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.

3. 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.*

4. 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.

5. 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 damaging 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.

6. 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

1. Combine water and **Go-Ferm**, wait or adjust to **104º F**
2. Add yeast. Stir gently, wait 15-20 minutes. Stir again.
3. Add 100 mLs of must to the starter. Wait 15-20 minutes until signs of activity.
4. Mix thoroughly into the must. (Make sure to be within 18º F of the temperature of the must when inoculating. If not, adjust accordingly.)
5. At first signs of fermentation, add **Fermaid-K (#1):** 1 gram per gallon of must.
6. 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!

10.5) 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 aging processes. If there is malic acid present in the wine and the SO2 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.

<u>ML bacteria and acid adjustments</u>
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/SO2 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.

<u>ML nutrients</u>
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*.

<u>Choosing an ML strain</u>
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 SO2 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 SO2 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 SO2 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 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 SO2 or StarSan and carry it through into the aging vessel(s).

Chromotography
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 SO2 because you think the MLF has finished and it has not, you may run into potential spoilage problems if the SO2 levels drop either during aging 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 CO2 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 CO2 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 Chromotography</u>: While Chromotography 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 SO2. Then rack the wine as you normally would.

10.6) 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 berry-like 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.

<u>All About Oak</u>

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.

- *Cis-oak lactone* is “woody” and “fresh oak” like,
- *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 aging 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 red wine fermentation, compounds derived from toasted oak are a highly effective, natural additive responsible for initiating the stabilization of color and cross-linking grape tannins to help 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 red 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. Therefore, the winemaker needs to make sure that the wood remains **under** the cap at all times. If loose wood is simply thrown into the must at the crush, until it becomes saturated with wine the oak will just float on the surface of the liquid and be carried up with the cap during the fermentation. The result is that the oak will become separated from the working wine and the desired components will not be transferred into the wine during this critical phase. However, it is equally important that the wood 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 under the cap. The nylon bag also makes transferring the oak into the next vessel post-press all that much easier.

Note that the ideal placement of the wood would be just under the cap since this is the zone most concentrated in the extraction of the compounds that need to be interacting with the oak.

Stavin's Recommended Oak Dosage rate for Fermentation:

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

Broken down, this works out to:

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

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

A final note on gaining complexity by blending

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.

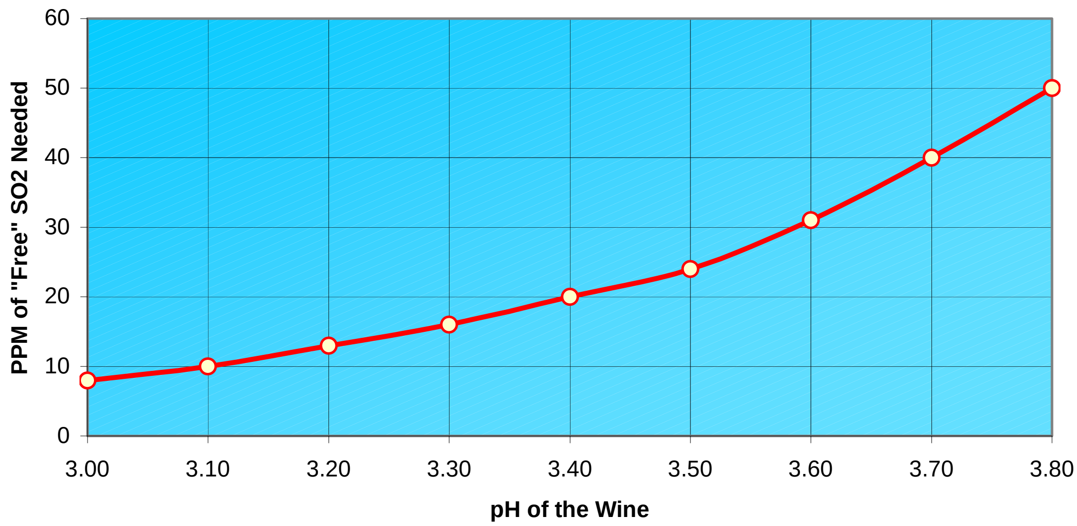
10.7) Calculating free SO2

It is important to start this section with some information. Potassium Metabisulfite ("Sulfite", "Meta", "SO2") (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 SO2-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 SO2, 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 aging 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 SO2* and *Free SO2*. When you make your SO2 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 SO2 brings you all of the previously mentioned benefits that your wine both needs and deserves.

The goal with SO2 additions is to try to use the least amount needed in order to attain a beneficial saturation level (roughly 0.5 ppm molecular SO2 for reds, and 0.8 ppm molecular SO2 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 SO2 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 SO2 will be needed, and conversely, the lower the pH the less SO2 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:

Level of "Free" SO2 Needed in a Red Wine (based on pH):



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" SO2 level. There are a few ways to do this, but 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).

Unlike for white wines, when testing red wines and musts it must be noted that the presence of tannins and colour pigments (as well as ascorbic acid) will throw the results of the "Titrets" off, resulting in a higher "free SO2" reading for the sample than there really is. In addition, depending on how deeply pigmented the sample is, it may also be difficult to see the exact endpoint of the test since it is based on a colour change- from the blue of the initial reaction back to the purplish-red of the wine's original colour.

However, with the exception of a vacuum-aspiration set-up or a Hanna Titrator, "Titrets" represent the only game in town, especially to the average home wine-maker. So, despite their flaws, it is important to point out that they are indeed still quite useful and here are some work-arounds:

With regards to the false reading aspect: it is comforting to know that while the exact ppm of "free SO2" 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 SO2 addition wound up being "free". To do this, you test your sample before you make an SO2 addition and note the endpoint. Next, you make your SO2 addition, then test again. Then, all you need to do is to subtract the first tests' ppm (pre SO2 addition) from the second (post SO2 addition), and you will get an accurate indication as to how much free SO2 remained after you made your addition.

With regards to the pigments in the red wine/must making the exact endpoint of the test difficult to be sure of: you can dilute your sample in order to thin it out, thereby making the colour change more noticeable. Just be sure to factor that dilution percentage back into your final calculation. For example, if you take a 50ml sample, and you add 50mls of distilled H20 to it, then, since you've cut it in ½, you will just need to double the end result of your test to get an accurate result.

Following the directions, test the must or wine with your sulfite test kit and find out where the "free" SO2 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" SO2 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 SO2 is 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 SO2 addition will contain the exact amount of the "free" SO2 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!:

PPM of "free" SO2 needed x 3.785 x Gallons (US) of wine you are adjusting

0.57 (the actual % of SO2 that will become "free" in your addition)

So, as an example:

If your sulfite test kit indicates that your wine has a "free" SO2 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" SO2 level of 24ppm. So,

24 (where the ppm of "free" SO2 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” SO2 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” SO2 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” SO2 needed to be added goes into the equation as .012…*

.012 x 3.785 x 5.5 (say you have 5.5 gallons) = .438 grams of meta

0.57

So, the magic number to add in order to get your 12 extra ppm of “free” SO2 (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% SO2 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 SO2 test kit ("Titrets"):

Typically, you can just add 50 ppm (1/4 tsp per 5 gallons) of SO2 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 SO2 will become bound at this stage. (However, you will want to keep the SO2 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 SO2

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 SO2, 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.

Section 10.8 – 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.

Tips and Tricks

Finally, here are a few generally 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 ± 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.

10.9) 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:

Siphoning

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.

Pumps

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 damaging 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.

10.10) 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" 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. 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 the wine, this pressure can be enough to either bow the lids of tanks outward and/or push bungs out entirely. While it may seem like an extreme result, this can and does happen. 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 aging/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 CO2. Unlike oxygen, inert gas does not react with wine to create any negative characteristics. In addition, Argon and CO2 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 aging/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. 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 CO2 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 CO2 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 CO2 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 CO2 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.

- Laminar is best: 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.

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

- 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 CO2* (D1050), Nitrogen** (D1054), or Argon (also D1054), a regulator (D1060 for CO2, and D1070 for both Argon and Nitrogen), and some tubing (D1704).

***Note:** *CO2 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. The reason for this is that CO2 will go into solution under low pressures and the other gasses will not. In other words, if you use CO2, you could inadvertently carbonate your wine! 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 aging process, and best of all, store your wine in an entirely enclosed system! Once again, no oxygen contact!