Inert Gas & Winemaking

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The Importance of Inert Gas

During aging, if a wine is not protected from both microbial spoilage and oxygen at all times it is likely to spoil. Protecting wine usually involves maintaining proper SO_2 levels and keeping containers full. Additionally, purging your headspaces with inert gas to effectively remove the oxygen greatly increases the amount of protection. When it comes to using SO_2, the benefits are widely understood and in-depth information describing its usage is readily available in most winemaking literature. Yet, often when these texts refer to purging with inert gas they fail to explain the actual, step-by-step techniques needed to do so. It is important be aware that creating an effective blanket of gas to protect your wine requires more than just shooting some Argon into the headspace of your vessel until it feels right. In fact there is a bit more to it! The goal of this manual is to help you understand the techniques needed to successfully purge headspaces with inert gas, so that your wine will actually be protected. Let's start by first looking at the importance of protecting your wine from oxygen exposure, and then we will take a look at the specific gas purging techniques needed to do so.

The Need to Control Oxygen Exposure:

Any space in a carboy, tank or barrel that is not occupied by liquid is filled with gas. The air around us is actually a mixture of gases, roughly 20% of which is oxygen.

A continuous exposure to oxygen is great for people, but not for storing most wines! This is because when wine is exposed to oxygen a series of chemical changes takes place. If oxygen exposure is not controlled and extends over time, then the resulting changes often result in undesirable flaws such as: browning, loss of freshness, sherry-like aromas and flavors, and volatile acidity production ("VA" or vinegar). Since these unwanted reactions happen as a result of oxygen exposure, wines which exhibit these defects are described as oxidized. One of the key points to properly aging/storing wine is learning how to limit a wine's exposure to oxygen so that it won't become oxidized. This could easily be achieved by filling the storage vessel with the wine to the rim and therefore eliminating any headspace (as is the case when filling/topping-up barrels), but as we shall see in the next section this may not always be practical.

Expansion & Contraction — The Need For Headspaces:

Unless you are in a situation with a guarantee of temperature stability, as with a glycol-jacketed tank, or a temperature-controlled storage area, tanks and carboys should have a small headspace kept at the top (note that barrels should not have any space in them when filled/topped). This headspace is needed because it helps to compensate for the 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 if a little space is maintained at the top. 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.

> ***Note:*** *The opposite happens when the wine cools; bung/lids are pulled inward as the liquid contracts.*

While it may seem like an extreme result, this can and does happen! And if it does, besides creating a loss of wine and a mess, your wine has now become exposed to the elements and potential spoilage. Therefore, if the wine will be exposed to any temperature variances during its aging/storage it is best to leave headspace at the top of your vessels to prevent this scenario from happening.

Making Headspaces Safe:

Thinking back to the first section of this paper, we can see that this poses a problem: how do you create a space for expansion and contraction while avoiding any negative

oxidative reactions? The answer lies in being able to replace the oxygen-containing air in the headspace with an inert gas, such as Nitrogen, Argon or CO_2. Unlike oxygen, these three gases do not react with wine to create any negative characteristics. Of the three gasses, Argon and CO_2 are actually heavier than air* and winemakers can use this property to their advantage. When done correctly, purging headspaces (also referred to as flushing or sparging) with either Argon or CO_2 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 period 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 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.*

The 3 Recommended Steps For Creating A Protective Blanket Of Inert Gas:

- Avoid turbulence to maintain purity: The key to creating an effective blanket with CO_2 or Argon lies in understanding a basic physical property of gases: they readily mix with each other when agitated. 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. Higher flow rates create a churning effect that actually causes the inert gas to mix with the ambient air (which contains oxygen). When this happens the purity of the inert gas becomes diluted, and its ability to protect your wine is decreased. 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 (the coffee being a stand-in for the air in a headspace). Pouring at a high flow-rate causes a lot of turbulence and as the cream and coffee roll and swirl around in the cup they quickly mix themselves together. On the other hand, if we gently pour the cream into the coffee at a slow enough rate to keep the turbulence to a minimum, we can see that the cream will form a layer in the coffee that remains there until we stir it. Dispensed CO_2 and Argon gases behave just like the cream does. In order to create that pure, unmixed layer of inert gas that is devoid of oxygen, 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 without our thumb over the opening of the hose.
- We can see from the these two 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 it flow 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 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 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.) ***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 risk contaminating the wine.*
- Turn on the gas and begin sparging
- Using a lighter or BBQ match, 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.

Some Final Notes on Using Inert Gas

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

***Note:** CO_2 is only to be used for a non-pressurized headspace. If you will be using gas to push the wine, such as in filtration, serving from a keg, etc., you will want to use Nitrogen or Argon. The reason for this is that CO_2 will go into solution under low pressures and the other gasses will not. In other words, if you use CO_2, you could inadvertently carbonate your wine! 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 (KEG400). 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!