New Procedure for Handling Headspaces in Wine Containers

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An important step forward for Kentucky winemaking this year is the development of the theory and protocols to safely maintain wine in partially filled wine tanks. The finding of numerous examples of spoiled wine in partially filled wine tanks prompted the work to find and present a true understanding of the problem and its correction, for the first time in winemaking history.

1) Oxygen uptake by wine must be limited. Wine can generally absorb and dissolve approximately 6 ppm of Oxygen at a time, in the range of what is picked up during racking.[1] This Oxygen is consumed over 8 to 10 days.[2] Oxygen already in the headspace will move into the wine in a period of approximately 8 hours, drawing in some outside air which contains more Oxygen. Oxygen from whatever source will do the dirty work of starting to spoil the wine, and the wine will be ready to accept more dissolved oxygen to continue the spoiling. Reaching approximately 80 ppm of total absorbed Oxygen will ruin most wines, whites faster than reds. Exclusion of ambient air is essential, and so is the removal of Oxygen from the headspace, either before or after moving the wine into the container.

2) The correct choice of inert gas to replace the Oxygen-containing air is, thanks to the "ideal Gas Law" and its attendant axioms, simply the least expensive inert gas available, which is generally Nitrogen. Argon has been espoused by many with the erroneous belief that the heavy gas could form a "blanket" to protect the wine from Oxygen. That is a complete misconception. No gas can form a protection from another gas. This does fly in the face of numerous "authorities" who say: "Argon is the only gas to use." Well, they are wrong. If you need further convincing, familiarize yourself with the "Ideal Gas Law", especially the contribution made by Mr. Dalton.

CO_2, Carbon Dioxide, does NOT qualify as an inert gas, AND it dissolves in wine, up to 107.2 mL/L[3], causing the container to "inhale" some make-up ambient air which contains more Oxygen. Since some CO_2 in a wine can be good, CO_2 may be added to the headspace to maintain a beneficial level.

3) The standard procedure used by many wineries to flush the oxygen from the headspace, or non-wine volume of a tank has been "5 minutes with the nitrogen hose running into the tank" or so. In fact, the correct flushing procedure was developed in 1977 by an insurance company[4] serving a different industry, and requires flushing with an amount of gas equal to **5 times** the volume of the headspace, to go from 21% Oxygen to 0.21% Oxygen. The contents of gas cylinders are measured in cubic feet of gas. One cubic foot of gas is equal in volume to 7.48 gallons or 28.3 Liters. So, if the headspace is 1 cubic ft., 7.48 gallons, then **5 times** 1 cubic foot, or 5 cubic feet (37.4 gallons or 141.5 Liters), of gas should be flushed through the system to reduce Oxygen levels below 1%

4) The manner in which many wine makers test for oxygen absence is to see if a match or butane lighter flame is extinguished when entering the tank atmosphere. While handy, the dousing of such a flame occurs while there is still 14.5% Oxygen in the volume, still way too high for wine, and a little too low for humans. This was examined and published by a Spelunker group in 1993.[5]

5) Once the headspace has been "inerted" the regular practice has been to "seal" the container; a 5-gallon jug, or a 5,000 gallon tank, with an "air-lock", a small plastic u-tube with liquid in it which will allow gas to pass through, either in or out when the pressure differential corresponds to 1.2 inches of water, or 0.04 psi (pounds per square inch). Changes in temperature large enough to push gas through such a gas gate at 0.05 psi, are as small as 1 ^{O}C or 2 ^{O}F, and are often seen even in well-controlled cellars. In addition, beyond the control of winemakers, the diurnal barometric pressure changes can be greater than 0.15 psi or 4 inches of water. That makes the u-tube or "bubbler", or what should be called an "air-passage", allow air passage.

With only an "air-passage", falsely called an air-lock, in place, the wine in a half full container (of any size) will pick up about 2.8 ppm of oxygen per day. A container 90% full will only get about 0.28 ppm per day.[6] Since 80 ppm of oxygen pretty well kills a wine, there is some motivation to stop those oxygen inhalations. Stainless steel tanks and glass jugs can handle 3 psi positive pressure, so it is better to bung these things tightly if no further fermentation is possible. If a downward temperature change is expected, inert gas may be admitted to the container up to 1 to 2 psi positive pressure[7], and then the container may be bunged tightly. Plastic containers and VCT's with a flat floating head can swell and contract with temperature and pressure changes, and are best kept tightly sealed at all times.

Dr. Tom Cottrell, 7/16/2014

References:

1. Riberéau-Gayon, P., Glories, Y., Maujean, A. and Dubourdieu, D. (2000) Handbook of Enology, Vol.2, *The Chemistry of Wine Stabilization Treatments*, John Wiley & Sons, New York, page 274 section 10.3.1
2. IBID. page 360 section 13.3.3
3. Riberéau-Gayon, P., Dubourdieu, D. Donéche, B. and Lonvard, A. (2000) Handbook of Enology, Vol.1, *The Microbiology of Wine and Vinifications,* John Wiley & Sons, New York, page 216, section 9.6.1
4. Factory Mutual Insurance Co., FM Global Property Loss Prevention Data Sheets 7-59, September 1977, revised 2000
5. Smith, G. K., Australian Caver No. 133 (1993) pp 20-23.
6. Cottrell, T.H.E., Presented at the Fruit and Vegetable Growers Conference, Wine Short Course, Lexington, KY, 2014.
7. Riberéau-Gayon, P., Dubourdieu, D. Donéche, B. and Lonvard, A. (2000) Handbook of Enology, Vol.1, *The Microbiology of Wine and Vinifications,* John Wiley & Sons, New York, page 216, section 9.6.1

Vol 2 P 274 Racking allows pick up of 2 to 5mL/L of O_2

p 360:

at 5 deg C, O_2 saturation in wine is 10.75 ml/L Sec 13.3.2

5mL/L will be consumed in 8-10 days Sec 13.3.3

P 370 “It has been observed the bottle aging corresponds to a gradual stripping of the wine.”

P 371 “A wine that tastes hard and astringent at the time of bottling will generally retain that character even after several years.”