Sulfur off odors during barrel aging – early detection and treatment
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As you transition from managing and finishing primary fermentation to conducting malolactic fermentation and getting wine into barrels there are a couple of issues to watch out for and be prepared to take action if necessary. One of these is the appearance of volatile sulfur compounds such as hydrogen sulfide (H\textsubscript{2}S), mercaptans and disulfides, once wine is put to barrel. Often we associate stinky sulfur issues with primary fermentation and take appropriate steps to minimize their formation such as providing adequate nutrients for the yeast. However, formation of volatile sulfur compounds can occur during aging and are not always related to sulfide issues during alcoholic fermentation. This can mean that even though you did a good job feeding your yeast and didn’t notice any sulfur off-odors during the alcoholic fermentation you can still have problems with stinky sulfur compounds during the aging of the wines in barrel. Often the problems occur soon after a wine is placed in barrel. Some of this is triggered by the wine environment becoming increasingly reductive as it ages, particularly at the bottom of the barrel and in the lees. In addition, problems with sulfur off odors can be more prevalent in one year versus another and many of the factors contributing to this are not well understood. What we do know is that the sulfur off odors often arise from degradation of sulfur-containing compounds in the yeast lees or from the re-release of chemically-entrapped sulfide during ageing. For this reason, lees management can play a role in minimizing the formation of sulfur off odors. In particular, wine should be removed from heavy lees as early as possible. Heavy lees are described as those that precipitate within 24-48 hours after the completion of the alcoholic fermentation. Wines should be separated from these lees as they can promote the production of sulfides and mercaptans. Smell and taste your wine and lees frequently to allow quick action. Formation of sulfur off odors can occur quickly and so the earlier you notice it the better. Get a sample of your lees from the bottom of the barrel and watch for the formation of sulfur off-odors. Sometimes the lees will smell bad but the wine is not yet affected. Early detection may allow you to get the wine off the stinky lees, treat the wine with copper, and minimize the impact on quality.

Treating wines with copper, in the form of copper sulfate is a common practice used to remove H\textsubscript{2}S and mercaptans. Copper ions combine with H\textsubscript{2}S and mercaptans to form complexes with no offensive smell. Bench top trials MUST be conducted to determine the appropriate dose. The following are links to copper sulfate addition trial protocols:

Concentrations of between 0.05 and 0.3 mg/L of copper are commonly added. It is important to be careful with the amount of copper added to your wine as U.S. government regulations allow additions of up to 0.5 mg/L copper while residual levels in the wine cannot exceed 0.2 mg/L (as copper). Additionally, copper should not be added to the wine until the fermentation is complete and the amount of yeast material is reduced by racking. Yeast cells can bind with the copper and reduce its effectiveness. Copper will not however remove disulfides. Disulfides can be formed...
by yeast during fermentation and they can also be formed through the oxidation of mercaptans. The oxidation of mercaptans to disulfides when exposed to air influences both their sensory attributes and their ability to bind copper. The sensory threshold of disulfides is around 30 parts per million (ppm) while mercaptans have a very low sensory threshold of approximately 1 part per billion (ppb). One concern with disulfides is that if you aerate wine to remove sulfide aromas (such as splash racking) you may oxidize mercaptans present to disulfides. Initially you will notice a loss of the offensive mercaptan aromas as disulfides have a much higher sensory threshold than mercaptans and may not be detected. However, the disulfides are still there and when conditions in the wine become more reductive (say during barrel aging or in the bottle) the disulfides may be reduced back to mercaptans resulting in a “reappearance” of sulfide aromas. It is important to determine which types of sulfides (H₂S, mercaptans, or disulfides) are present in your wine so that you can take appropriate action. For example, after fermentation, when H₂S is predominately present, aeration and splashing may dissipate the odor. However, aeration of wine that contains mercaptans may cause the formation of disulfides. Simple sulfide detection kits are available such as the following: https://www.gusmerenterprises.com/p-71-sulfide-detectiontreatment-kit.aspx. More indepth analyses can also be provided by commercial testing labs.

Overall, the best way to prevent or minimize the production of sulfides and mercaptans is to treat the wine early. Early treatment of H₂S problems can also prevent the formation of the more troublesome mercaptans and disulfides. The key points are:

- Be aware that sulfide off odors can happen in barrel even if no noticeable H₂S problems occurred during primary fermentation
- Early detection by tasting the wine and lees can help minimize impact on wine
- Rack wine off stinky lees and treat with copper sulfate to remove H₂S and mercaptans
- Perform bench-top trials to determine copper sulfate addition rate
- Copper will not remove disulfides
- Avoid aerating wines containing mercaptans as this may lead to disulfide formation