Yeast Flatulence

Burnt Rubber, Rotten Cabbage, Onions, Garlic and Other Things You Don't Want to Smell in Your Wine

by Burton McClelland (AWO News # 53)

After suffering through another cool, wet summer, one of the most animated topics of discussion at a recent club meeting was who had hydrogen sulphide (H_2S) in their wines – what grape varieties were affected, what yeasts were used and what had been done to try to eliminate that characteristic rotten egg smell.

Hydrogen sulphide is a colourless, but certainly not odourless gas. Its noxious odour is perceptible at very low concentrations – the threshold concentration (the point where 50% of humans can detect the odour) is only about 5 ppb. Exposure to very high concentrations, over 700 ppm, is invariably fatal. While it is highly unlikely that home winemakers would ever be exposed to fatal concentrations, much lower concentrations of H_2S and other volatile sulphur compounds (VSC) can be fatal to your wine.

In this article, we'll look at the reasons for H_2S formation in your wines, what you can do to treat it and what can happen if you don't treat it. I won't focus on the chemistry of the processes but rather on generally how these compounds are formed and what it means to you as a winemaker.

H_2S Formation in Wine

H_2S is a natural by-product of fermentation and usually isn't a significant problem.
Most of it is gassed off with CO_2 during the most vigorous part of fermentation or during subsequent rackings. Some of it is converted to elemental sulphur and is eliminated during racking and filtering. Some of it may even be converted to other sulphur compounds, which in low concentration add complexity to your wines.

Excessive H_2S production that can become a problem can have many different causes but the following are some of the most common:

- residual sulphur on the grapes from a late spray for powdery mildew,
- some yeast strains, such as BM45, VL1 and UDC522 (Montrachet), are prone to producing higher levels of H_2S,
- some varietals, such as Merlot, Gamay and Pinot Noir, are more prone to producing higher levels of H_2S,
- wine kept too long on the gross lees,
- low nutrient levels, primarily nitrogen, in the must, and
- high temperature (over 30° C) fermentations in red wine.

If H_2S is not dealt with quickly, it can morph into other sulphide compounds, such as mercaptans and disulphides, which are more persistent and difficult to treat. I'll talk about those later in the next section.

Volatile Sulphur Compounds (VSC)

Hydrogen Sulphide (H_2S)

As discussed above, H_2S is the first sulphide compound you'll encounter in the fermentation process. It is a natural by-product of the fermentation process and generally isn't a problem, as it is quite volatile and is gassed off with the CO_2 produced in fermentation. It is only when it is produced in high quantities and is not eliminated that it becomes a problem. The problem occurs when it morphs into other noxious and more difficult to remove sulphide compounds. The most common of these are listed in Table 1 below:

Table 1 - VSC Sensory Descriptions and Thresholds

Compound	Structure	Sensory Description	Threshold Range (ppb)
Hydrogen Sulphide	H2S	rotten egg, sewage	0.9-1.5
Ethyl Mercaptan	CH3 CH2 SH	burnt match, sulfidy, garlic, onion, earthy	1.1 - 1.8
Methyl Mercaptan	CH3 SH	rotten cabbage, burnt rubber, onion , garlic	1.5
Diethyl Sulphide	CH3 CH2 SCH2 CH3	rubbery	0.9 -1.3
Dimethyl Sulphide	CH3 SCH3	canned corn, cooked cabbage, asparagus, vegetal	17 - 25
Diethyl Disulphide	CH3 CH2 SSCH2 CH3	garlic, burnt rubber	3.6 - 4.3
Dimethyl Disulphide	CH3 SSCH3	vegetal, cabbage, onion-like at high concentrations	9.8-10.2

Mercaptans (Thiols)

- ***Methyl Mercaptan*** – this is the most common sulphur problem found in wines after fermentation. In low concentrations it smells like swamp water while at higher concentrations it has odours of rotten cabbage, burnt rubber, onion or garlic.

- ***Ethyl Mercaptan*** – this has odours of rubber, burnt match, onion or garlic. At high concentrations it can have a fecal character.

These two compounds are the mercaptans most often found in wine. What complicates matters somewhat is that different people have considerably different sensitivities to mercaptans and even smell different odours from the same level of mercaptans. Even when mercaptans are below the threshold levels they can mask the fruit that you would expect in the nose. If you have a wine with no perceptible nose you may have a low concentration mercaptan problem.

To complicate things even more, there are some mercaptans, that at low level, can add complexity to your wine and are a desirable feature. If you treat your wine to get rid of the “bad” mercaptans you will also could be eliminating the “good” mercaptans. Some of these include:

- 2-furfurylthiol, the mercaptan of furfuryl alcohol, has attractive roasted coffee aromas at low concentrations.
- Mercaptohexanol, the mercaptan of hexanol, carries aromas of blackcurrant, grapefruit, and passion fruit.
- 4-mercapto-4-methyl-pentan-2-one (4MMP) is responsible for the varietal (catty, gooseberry) character of Sauvignon Blanc.

<u>Sulphides and Disulphides</u>

Development of sulphides in wine do not appear to be connected to H_2S production. There are two common sulphides that appear in wines:

- ***Diethyl Sulphide*** is usually present in wine, but below its sensory threshold. At low concentrations above the threshold it has a rubbery character. At really high concentrations it takes on onion and garlic aromas.
- ***Dimethyl Sulphide*** (DMS) is probably a product of amino acid breakdown. At low concentrations it can contribute roundness, fruitiness and complexity to a wine. As the wine ages, DMS concentration can increase. Above a certain threshold it can exhibit vegetal, canned corn or asparagus aromas.

Disulphides can form directly from mercaptans if enough oxygen is available. They generally have a much higher threshold of detection than mercaptans. You can be deceived into thinking that you have corrected a mercaptan problem through oxidation by converting the mercaptan into disulphides. The problem is that disulphides can revert back to mercaptans in the low-oxygen environment in the bottle and you can get a very nasty surprise when you open the bottle. I had that happen to me once with a batch of Landot that smelled fine when it was bottled, but was absolutely dreadful when I opened a bottle six months later. The two common disulphides are:

- ***Diethyl Disulphide*** which has a relatively low threshold (3-5 ppb) for a disulphide. It presents aromas of burnt rubber and garlic. I think this was the culprit in my Landot.
- ***Dimethyl Disulphide*** has vegetal or rotten cabbage aromas, which can become onion-like at high concentrations.

Dealing with H_2S and Other VSCs

<u>Pre-fermentation and Early Fermentation</u>

If you are concerned that you might have the potential for an H_2S problem, such as the last two cool, wet summers where growers were forced to spray often to combat potential mildew and other problems, or you are fermenting a variety, such as Merlot, which is susceptible to H_2S problems, select a yeast strain that is not prone to excessive H_2S production, such as D254 or 1118.

Do not add excessive metabisulphite to the must. For most reds and whites that you want to take through malolactic fermentation, you should keep sulphite levels under 20 ppm. For wines that you do not want to undergo malo, sulphite levels should still be less than 50 ppm.

Even the shape of your fermentation vessel can have an impact on H_2S production and retention in the wine. Tall narrow vessels with a small surface area to volume ratio tend to slow the dispersal of H_2S and other gases, especially in red wine fermentation where this shape promotes the formation of much thicker cap.

Make sure that your yeast has adequate nutrients for a clean fermentation – rehydrate your yeast with Go Ferm. Add the recommended dose of a yeast nutrient containing Diammonium Phosphate (DAP) to the must a day or so after fermentation has started. A yeast nutrient, such as Fermaid-K, with additional vitamins and other trace nutrients is preferable to straight DAP. I often split my nutrient dose for multiple applications, about half at the beginning of the fermentation and the other half when the specific gravity has dropped to about 1040-1050. Avoid adding yeast nutrient towards the end of the fermentation as additions at this stage may increase, rather than reduce, your H_2S problem.

Ferment at moderate temperatures. Red wine fermentations at over 30° C can contribute to high H_2S production, especially where other causal factors are present (low nutrients, residual sulphur, susceptible variety, etc). Some white wines fermented at very low temperatures, less than 13° C, can develop a trithiane problem which can lead to H_2S and mercaptan formation later in the bottle.

<u>Mid and Late Fermentation</u>

In the fermentation stage, the best thing you can do to combat H_2S is vigorous aeration. H_2S is very volatile and will gas off readily if allowed the chance. For red wines frequent stirring that breaks the cap and allows the gases to escape can help to dissipate H_2S quickly. One of our club members, who is retired, said that he was able to eliminate the H_2S odour in the first couple of days of fermentation by stirring his must every hour. That is a difficult regimen to follow if you are still working but it does demonstrate the effectiveness of frequent stirring. Délestage (basically draining the juice off the pulp and then reflooding) can also help deal with H_2S by aerating the must and gassing off the hydrogen sulphide.

In white wines where H_2S is detected vigorous splash racking can help to gas off the H_2S. This is one time when oxygenation is good for your wine. The racking should be really vigorous to fully aerate the wine and disperse any dissolved gases. Splash your wine through a sieve or colander in a funnel to fully aerate it as it goes into the wine. If you are concerned about potentially oxidizing your wine at this stage you could bubble CO_2 or nitrogen through instead.

One concern with vigorous aeration is the potential to convert any mercaptans present in the wine into disulphides through oxidation as discussed earlier.

<u>Post-Fermentation</u>

If you can still smell H_2S or mercaptans after the fermentation is finished, you can add SO_2 and splash rack once again. The danger here is that splash racking at this stage will introduce enough oxygen to convert the mercaptans into disulphides. Another technique that has been suggested by French researchers is to rack the wine off the lees and then re-introduce some of the lees back into the wine after about 48 hours for an extended lees contact, ensuring that the lees are stirred at least one a week. If you are worried about potential off-aromas being introduced by the lees, substitute yeast hull or yeast fining (fining with yeast that has been deactivated by rehydration in hot water) instead.

The other option is to proceed directly to treatment with copper. You need to be very careful in using copper, as it is poisonous in fairly low does. Regulations in Canada only permit 0.5 mg/l of copper. The traditional method was to pour the affected wine over a sheet of copper or insert clean copper pipes into the wine. That gives the winemaker little or no control over how much copper is introduced into the wine. A much better approach is using a measured amount of copper sulphate solution.

The first step in using copper is to determine if your odour problem is a result of mercaptans. The simple "penny test" will suffice for this. Pour a small sample of the suspect wine into a glass and then drop a penny or piece of clean copper into the glass. If the problem is indeed a mercaptan, the odour should disappear quickly. The "penny test" can also be used for wines where there no discernable odour, but no perceptible nose either and the suspicion of a low-level mercaptan problem. If there is a mercaptan problem, you should be able to pick up a nose on the suspect wine after the "penny test".

George Gibson of the BC Amateur Winemakers Association suggests a more sophisticated approach to analysing the problem. It requires three glasses of the suspect wine, a 1% solution of copper sulphate ($CuSO_4$) and an ascorbic acid solution (10 grams of ascorbic acid in 1 litre of water). Use the first glass as your control, in your second glass add 5 drops of the $CuSO_4$ solution and in the last glass add 5 drops of the ascorbic acid solution, wait a minute or so and then add 5 drops of the $CuSO_4$ solution. Table 2 outlines what this test will tell you:

Table 2 - Test for Sulphide Problems in Wine

Cases	Glass #1 Control	Glass #2 CuSO4	Glass #3 Ascorbic Acid / CuSO4	Results
1	Original smell	No change in smell	No change in smell	Not a sulfide problem
2	Original smell	No change in smell	Reduction or Elimination of smell	Disulfide
3	Original smell	Reduction of smell	Elimination of smell	H2S mercaptan & disulfide
4	Original smell	Elimination of smell	Elimination of smell	H2S and/or mercaptan

If the problem is a straight mercaptan problem, you can move directly to copper treatment. You'll need your 1% $CuSO_4$ solution, a couple of glasses and a one-litre container. Pour some of the affected wine into a glass to use as your control and one-litre into your other container. Add the

$CuSO_4$ solution to the litre of wine one drop at a time. After each drop stir the container and pour a little into your other glass. Compare with the control sample. If the smell has not disappeared, pour the wine back into the litre container and repeat the procedure adding two drops of $CuSO_4$ solution the next time. Continue repeating until the smell disappears. Each drop of $CuSO_4$ solution is 0.5 ml, so if you used six drops to eliminate the smell you would need to add 3 ml per litre to the rest of your wine. You shouldn't need to add more than 4 ml per litre to eliminate a mercaptan problem.

If the problem is the result of disulphides, you will need to treat your wine first with ascorbic acid to try to convert the disulphides back to mercaptans as disulphides can't be treated with $CuSO_4$. The amount of ascorbic acid required is fairly small, a quarter teaspoon per carboy should be adequate. Mix the ascorbic acid into the wine and leave for a couple of days before adding the $CuSO_4$.

If you are concerned about any residual copper left in the wine after treatment you can yeast fine and filter. As you can imagine you will probably lose some character and complexity from your wine if you need to go to this level of intervention, so it is preferable to treat the H_2S problem before it becomes mercaptans or disulphides.

Conclusion

Sulphide in wine is a common by-product of fermentation and can be expected. However, in some situations you can get excessive H_2S production which can lead to off odours in your wine, especially if it is not treated quickly and becomes mercaptans or disulphides. The greater the intervention required to cure the problem, the greater potential for affecting the character or complexity of the finished wine.

There is hope for a simpler solution to H_2S problems in the future. Two companies have announced yeast strains that minimize or eliminate H_2S production. The Mauri Yeast company in Australia has introduced Maurivin in Australia, while Phyterra Yeasts in B.C. announced earlier this year that they have licensed low- H_2S yeasts developed at the University of California at Davis and will be producing Napa-S, Napa-M and California Red.