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Sulfur Dioxide Measurement and Management

The following is a recap of the talk given by Chik Brenneman, UC Davis' Student Winery's lead winemaker.

AT A GLANCE

Sulfite (SO^2) has different purposes at different wine pHs.

Above a pH of 3.6, sulfite loses almost all of its "bad bugs" protection that comes from the "molecular" form.

Consider the use of Lysozyme, at crush, if needed to kill gram-positive bacteria (not acetobacter), when working at a pH of 3.6 and up.

The "Bi-Sulfite" form still has some anti-oxidative protection at a pH of 3.6 and a bit above.

For sensory reasons, do not maintain more than 50ppm Free SO^2.

After MLF, adjust acidity by taste, not by just pH or TA.

Chik reminded us that there are three forms of "SULFITE".

"MOLECULAR" (SO^2) / "BISULFITE" (HSO_3^-) / "SULFITE" (SO_3^{2-})

"MOLECULAR" (SO^2)

Only the Molecular form reduces microbial spoilage.

In your juice, SO^2 levels that inhibit browning enzymes, also are sufficient for inhibition and/or a significant reduction in native flora. In general, Bacteria are more sensitive to SO^2, than Yeast are. Varies with the organism.

H_2O_2 (hydrogen peroxide) is generated from the oxidation of phenols (mostly tannins).

Only the Molecular form scavanges this peroxide. Less peroxide = less acetaldehydes formed.

The Molecular form is quite volatile, being lost into the headspace, lowering free SO^2.

"BISULFITE" (HSO_3^-)

Peroxides oxidize ethanol, forming stale smelling acetaldeydes.

Additionally, acetaldeyde is formed from microbial oxidation of ethanol under aerobic storage conditions.

It is only the BiSulfite form that binds with acetaldehydes, forming a less noticeable hydroxy-sulfonate.

"SULFITE" (SO_3^{2-})

The Sulfite ion is the only form that combines directly with oxygen (O^2).

At wine pH (3.0-4.0) there is almost no Sulfite form to act as a direct anti-oxidant.

Now that you are clear on what each of the three forms of Sulfite do, it is absolutely essential that you also know the pH of your wine at all times.

Why? Look at the chart below, and you can see that the form and thus the desired effectiveness of Sulfite is totally pH dependent.

The higher the pH = the less Molecular form of Sulfite = the less biological stability in your wine.

At a pH of 3.6 and above, you would have to add above 50 mg/L (ppms) to get the .825 Molecular needed for the desired biological stability.

This is above the negative sensory limit (smell/taste) of SO^2.

The percentage of SO2 forms in solution at specific pH values*				
pH	Molecular SO2	Bisulfite	Sulfite	Free SO2 for 0.825 mg/L molecular
2.7	10.50	89.5	0.00283	7.9
2.8	8.54	91.5	0.00364	9.7
2.9	6.90	93.1	0.00467	12.0
3.0	5.56	94.4	0.00596	14.8
3.1	4.47	95.5	0.00759	18.5
3.2	3.58	96.4	0.00964	23.1
3.3	2.87	97.1	0.0122	28.8
3.4	2.29	97.7	0.0155	36.0
3.5	1.83	98.2	0.0196	45.1
3.6	1.46	98.5	0.0248	56.5
3.7	1.16	98.8	0.0312	71.1
3.8	0.924	99.0	0.0394	89.3
3.9	0.736	99.2	0.0497	112.0
4.0	0.585	99.4	0.0627	141.0

*Boulton, et.al. Principles and Practices of Winemaking, 1985

SO^2 Addition Strategy

- At Crush: Adjust acidity down to 3.6. Add 50 mg/L for whites, 30 mg/L for reds of Sulfite for minimum bio-stability. (If you are co-inoculating with M-L bugs during ferment, note that the upper limit for MLF is 30 mg/L Total SO^2) (With "bio-suspicious" grapes, add 50 – 75 mg/L plus 150 mg/l Lysozyme and do M-L addition after dryness)

  (Total SO^2 minus Bound SO^2 = Free SO^2. Your post fermentation goal is to add SO^2 and stabilize this dynamic equilibrium between these three forms)

- Post Fermentation: At 2 -3 weeks after dryness, adjust the acidity to taste (not to some pH/acidity value) and then test for free SO2, as the Free/Total/Bound SO^2 equilibrium is being established.
- This first SO^2 addition gets bound quickly, necessitating adding 10 – 20 mg/L (ppms) higher than the chart, to establish equilibrium at the chart's recommended value.
- Additional SO^2 additions (every 1 – 3 months. Certainly when racking) are based on the results of testing for free SO^2. Check the chart. Do not go over 50 mg/L free SO^2)
- Chart free SO^2 values are maintenance values. Go into your bottles with 5 – 10 mg/L SO^2 above chart value to account for loss during the rigors of bottling.

In conclusion, we all know that at higher pHs (3.6 and up) our wines taste more accessible, fuller, more forward, yummy.

However -

- **At wine pH (3.0-4.0) there is only a little Molecular SO^2 to provide bacterial protection. Assuming that most people can smell/taste free SO^2 at 50ppm (mg/L), this is your upper limiting factor for SO^2 additions (see the chart, above).**
- **Unfortunately, At pH 3.6 and above, to achieve bacterial protection (.825 mg/L Molecular), you would have to exceed this 50ppm upper limit of Free SO^2.**
- **Fortunately, at pH 3.6 and a bit above, you do still have some anti-oxidative protection from the Bi-Sulfite form.**
- **If you have crushed "bio-suspicious" grapes (other than picture perfect, mold, critter damage, over 10% raisins), consider using "Lysozyme" to dramatically reduce the population of gram-positive, spoilage bacteria like lactobacillus, etc..**
- **Consult the several computer programs to figure how much Total SO^2, as per your pH, to add to achieve the desired Free SO^2 maintenance level.**
- **Under all circumstances, you must constantly maintain sound, clean and consistent winery sanitation; proper SO^2 maintenance relative to pH and the above free SO^2 chart; bio-free barrels; topped barrels; no sweet/stuck wines that are a perfect media for spoilage bacteria.** 1/29/2014 **www.homebeerwinecheese.com**