

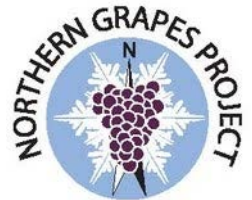


Cornell **CALS**
College of Agriculture and Life Sciences

SO₂ and You: Understanding the ‘When’, ‘Why’, and ‘How’ of SO₂ Management in Your Winery

NGP Webinar

Tuesday, May 8, 2018



Is and Is Not: Demystifying Sulfur

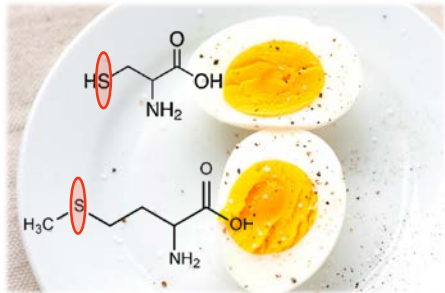
- Claim: I get headaches from drinking wine, so I know I am sensitive to sulfur. Maybe that explains why I am allergic to eggs.

Is and Is Not: Demystifying Sulfur

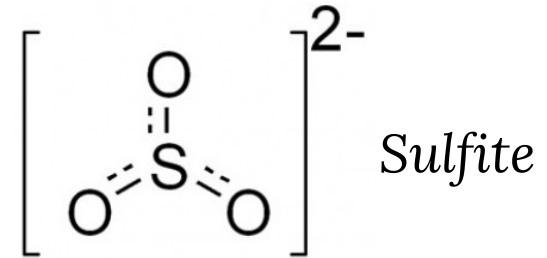
- Claim: I get headaches from drinking wine, so I know I am sensitive to sulfur. Maybe that explains why I am allergic to eggs.

Sulfur is an **element**, found in many protein-rich food sources (eggs, meat) in the form of amino acids or methylsulfonylmethane (MSM) associated with leafy greens and cruciferous vegetables.

Sulfur



vs.



Sulfite

Sulfite is a sulfur-containing **molecule**, found in dried fruit, processed foods, and alcoholic beverages like wine.

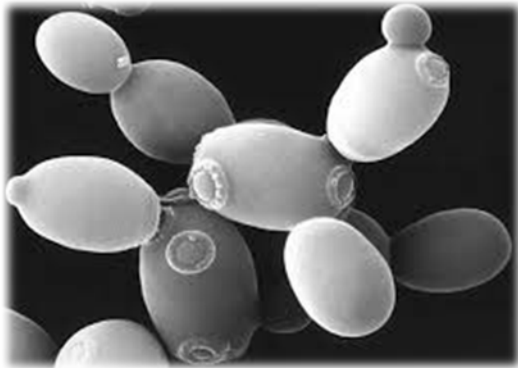
Is and Is Not: Demystifying Sulfur

- Claim: I haven't added any external sources of sulfur to my wine, so I can label my wine as "sulfite-free."

Is and Is Not: Demystifying Sulfur

- Claim: I haven't added any external sources of sulfur to my wine, so I can label my wine as "sulfite-free."

Perhaps not...

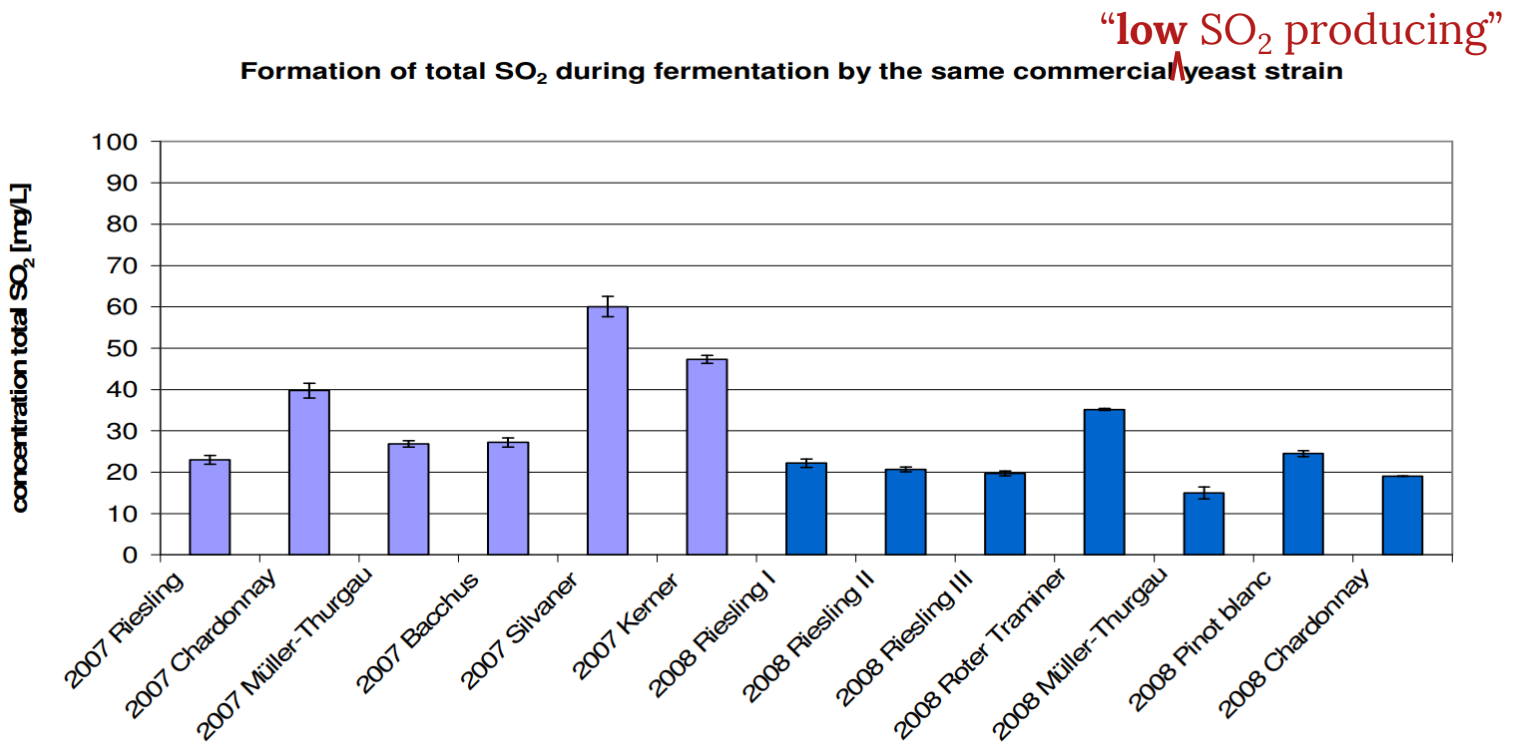


“low SO₂ producers”: (0-10, 10-20) mg/L

“high SO₂ producers”: up to **80** mg/L

Is and Is Not: Demystifying Sulfur

- Claim: I haven't added any external sources of sulfur to my wine, so I can label my wine as "sulfite-free."



Source: Werner, M. et al., InfoWine (2009)

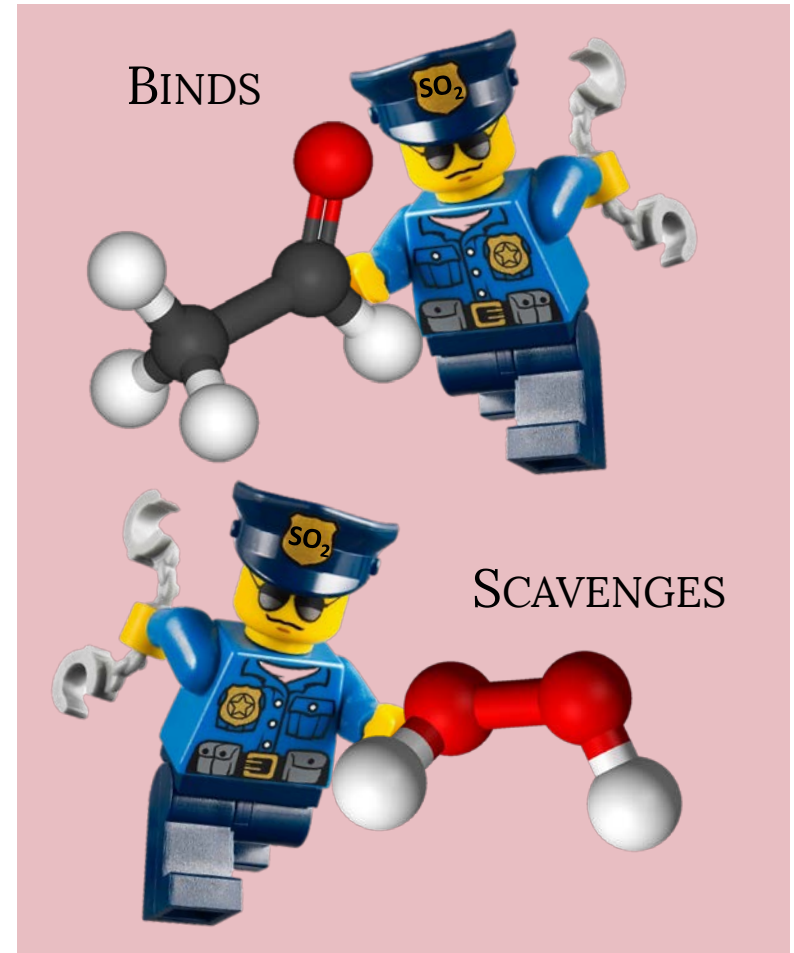
Why add sulfur dioxide?



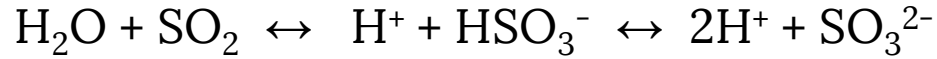
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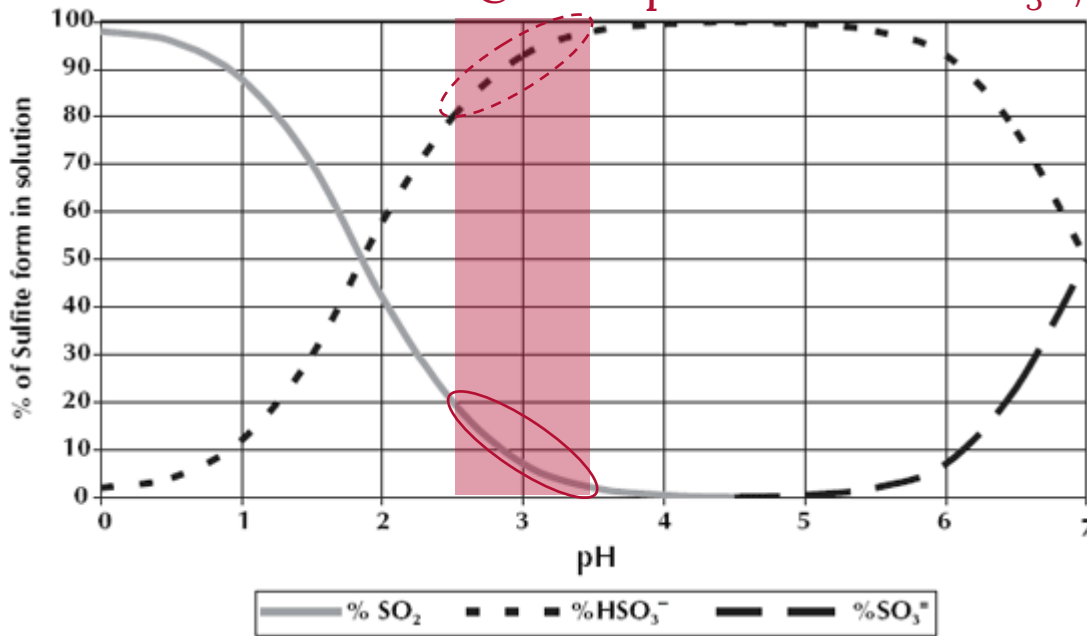
ANTIOXIDASIC



The Many Forms of Sulfur Dioxide

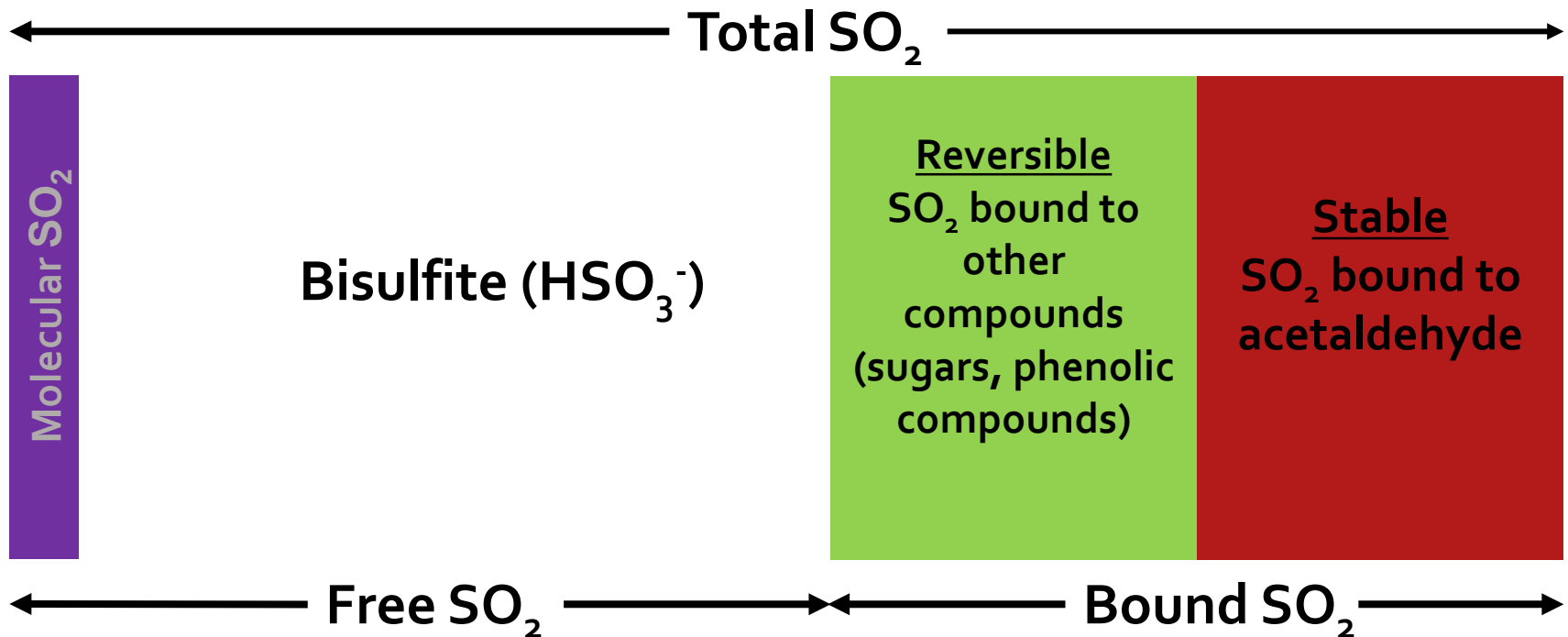


@ wine pH: 80-95% HSO_3^- , 5-20% SO_2



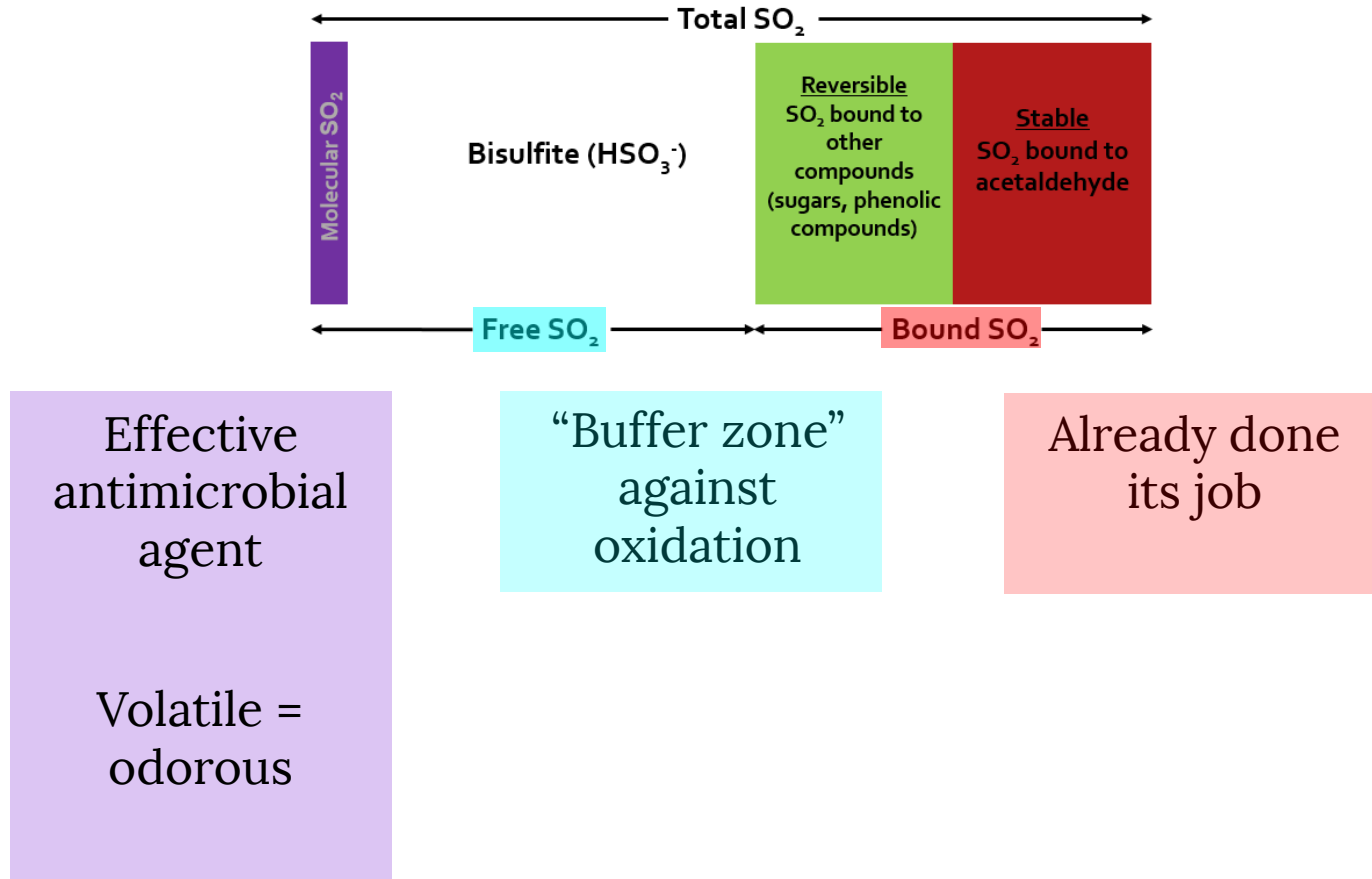
“CONTAINS **BISULFITES**”

What do you mean when you talk about “sulfur”?

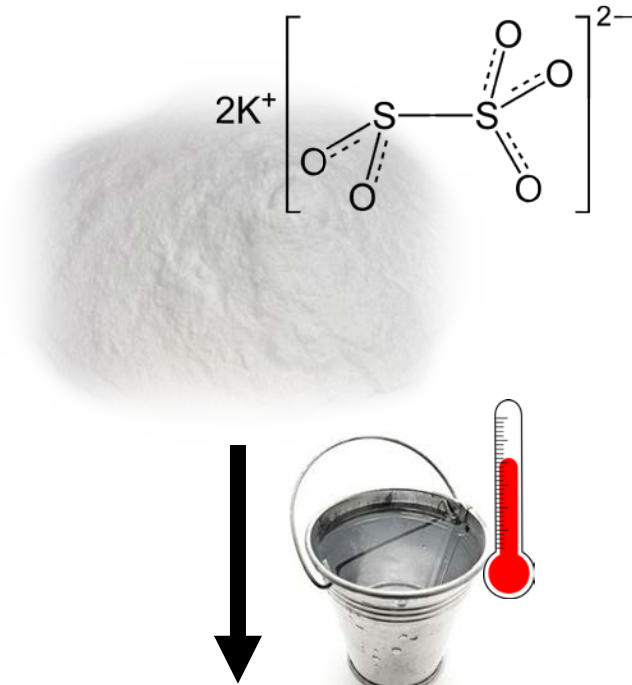


Adapted from A.K. Mansfield

What do you mean when you talk about “sulfur”?



How is sulfur added to wine?



57.6% KMBS converts to SO_2
3.785 gallons in a liter

So, after some math...

$$\begin{aligned} & \text{Volume of Wine (gallons)} \\ & \quad \times \\ & \text{Desired } \text{SO}_2 \text{ addition (ppm)} \\ & \quad \times \\ & \quad 0.0066 \\ & = \text{Mass of KMBS (g) to add to wine} \end{aligned}$$

~57% available SO_2

How else is sulfur added to wine?

- Liquid SO₂ solution made from bubbling gaseous sulfur dioxide into the water
 - Drawbacks: gaseous SO₂ is rather volatile and dangerous to inhale, so it imposes a considerable safety risk
- Sodium metabisulfite (67.4% conversion instead of 57.6%!)...alas, health implications for sodium intake, so this is used more often as a sanitizing agent
- Barrels often cleaned with 5 g elemental sulfur tablets
 - Must be VERY careful not to leave un-burned sulfur or ashes behind in the barrel, as it will reduce to form hydrogen sulfide (rotten egg smelling H₂S)
 - Can contribute up to additional 10 ppm total SO₂ for 225 L barrel



“More is better-dump it on in!”

NO! Not advised.

Too much will lead to:



While too little can lead to:

- Oxidation (acetaldehyde production, oxidative browning)
- Spoilage microorganisms

Legal Limits: The Upper End

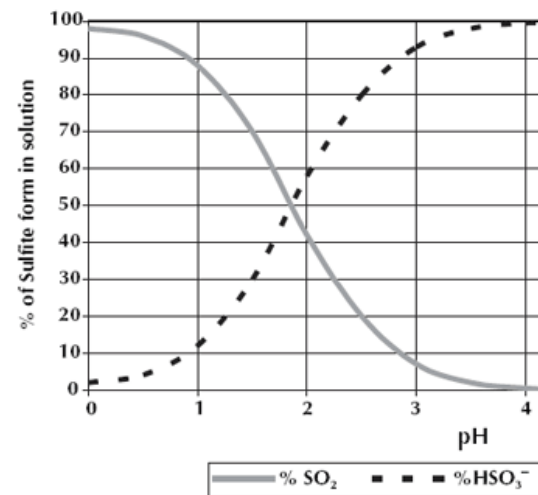
Country	Wine Type, RS	Limit (ppm)	Legal Reference
USA	All	350	27 CFR 4.22(b)(1)
Canada	All	350	Canadian Food & Drug Reg. B.02.100
Australia	< 35 g/L (3.5% RS)	250	ANZFSC 4.5.1: Clause 5(5)(a)
	> 35 g/L	300	
European Union	White, < 5 g/L	200	EC No 606/2009, Annex I B
	Red, < 5 g/L	150	
	White, > 5 g/L	250	
	Red, > 5 g/L	200	

Adapted from Appellation Cornell 2011-3

Eliminating Excess SO₂: A Fool's Errand

- Bubble wine with excess nitrogen gas to try to volatilize molecular SO₂
 - Remember molecular SO₂ and free bisulfite is in dynamic equilibrium
- Add hydrogen peroxide to bind with the molecular SO₂ to form sulfuric acid
 - NOT advised as this is often illegal in many winemaking regions, as well as from federally regulated food and beverage laws
- Best advice: don't add too much SO₂ to begin with

Know Your pH!

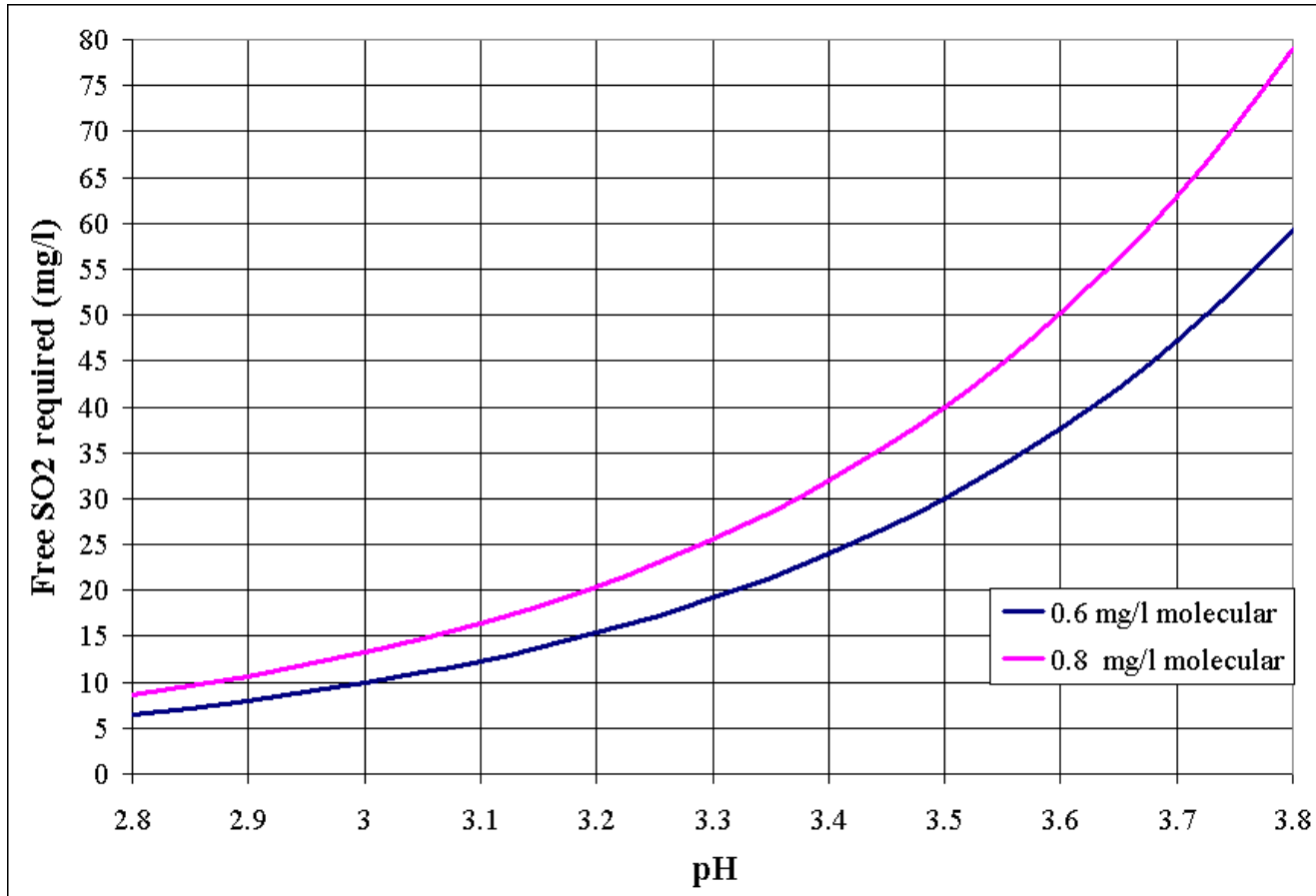


Remember: Free SO₂ is a function of pH.

What exactly is their relation? I am glad you asked!

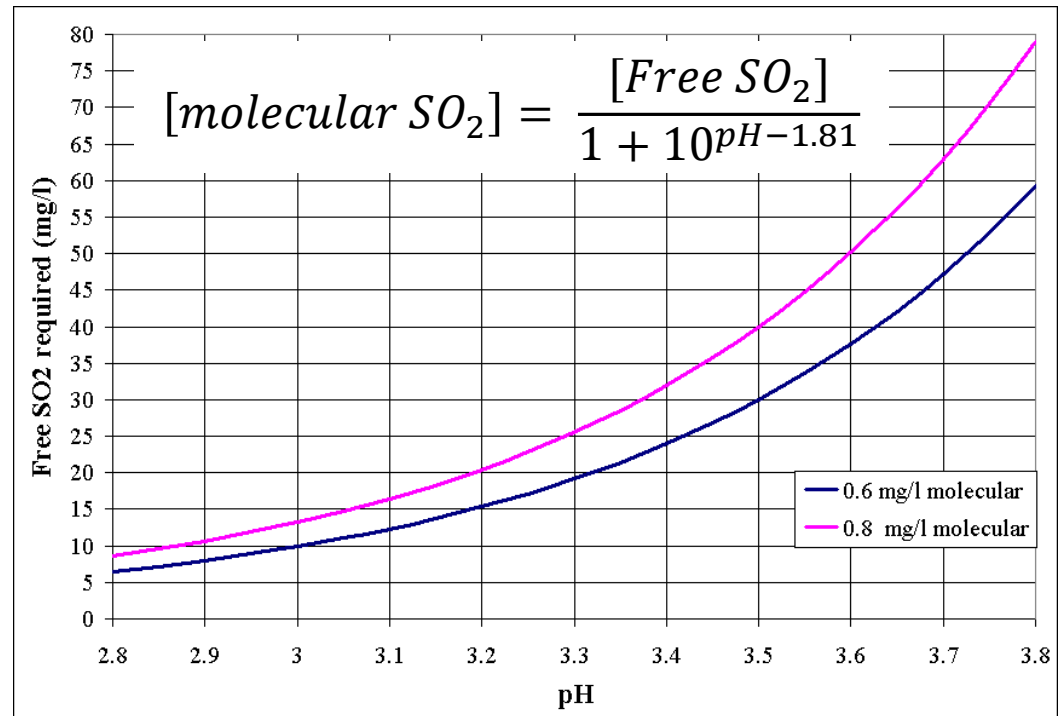
$$[\text{molecular } SO_2] = \frac{[\text{Free } SO_2]}{1 + 10^{pH-1.81}}$$

Know Your Wine



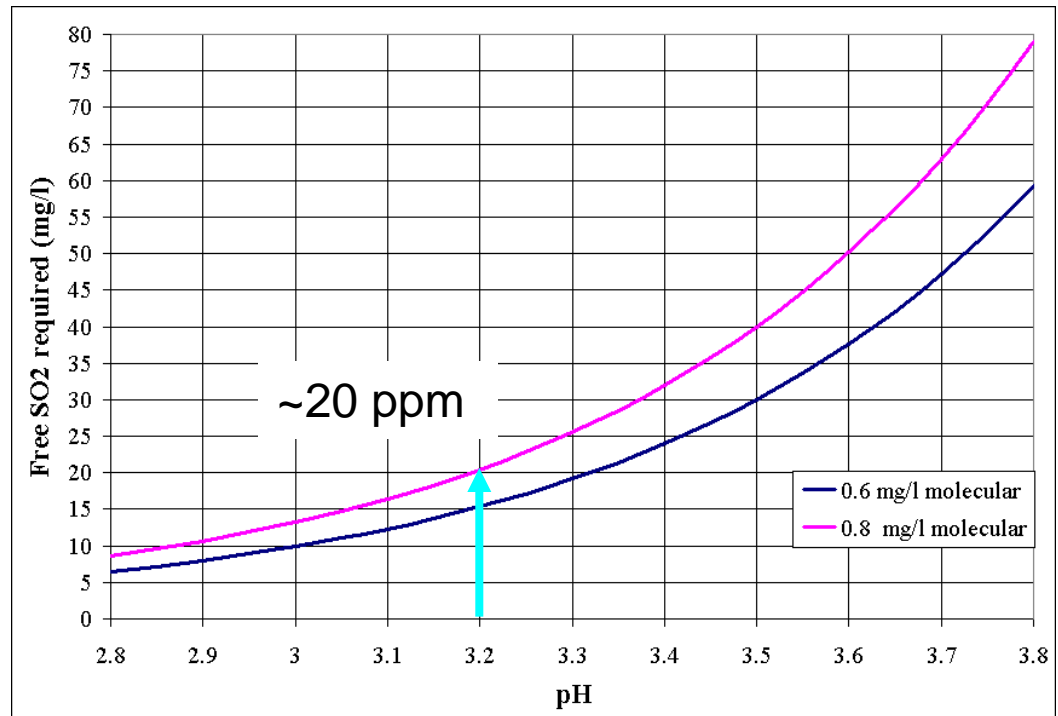
Practice Problem 1

A white wine with pH 3.2 is soon to be bottled. How much free SO₂ is required for a [molecular SO₂] of 0.8 ppm?



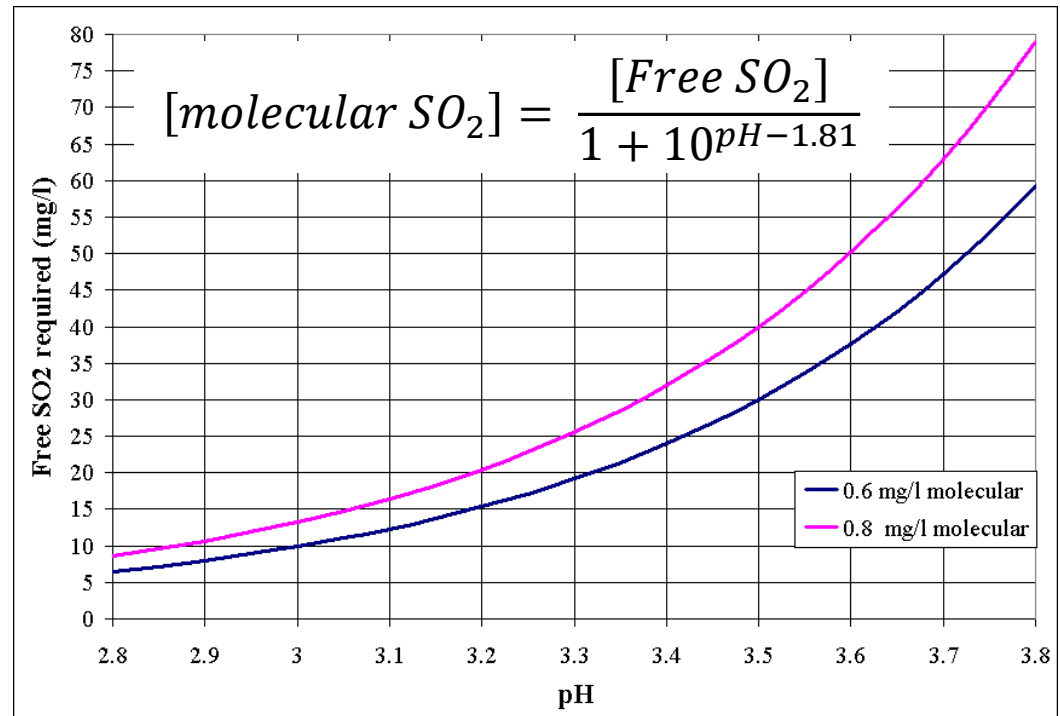
Practice Problem 1: Solution

A white wine with pH 3.2 is soon to be bottled. How much free SO_2 is required for a [molecular SO_2] of 0.8 ppm?



Practice Problem 2

A dry red wine with pH 3.60 is soon to be bottled. How much free SO₂ is required for a [molecular SO₂] of 0.5 ppm?



Practice Problem 2: Solution

A dry red wine with pH 3.60 is soon to be bottled. How much free SO₂ is required for a [molecular SO₂] of 0.5 ppm?

$$[\text{molecular } SO_2] = \frac{[\text{Free } SO_2]}{1 + 10^{pH-1.81}}$$

$$[0.5] = \frac{[x]}{1 + 10^{3.6-1.81}}$$

$$(0.5) \times 62.66 = [x]$$

$$[\text{free } SO_2] = 31.3 \text{ ppm}$$

Questions so far?



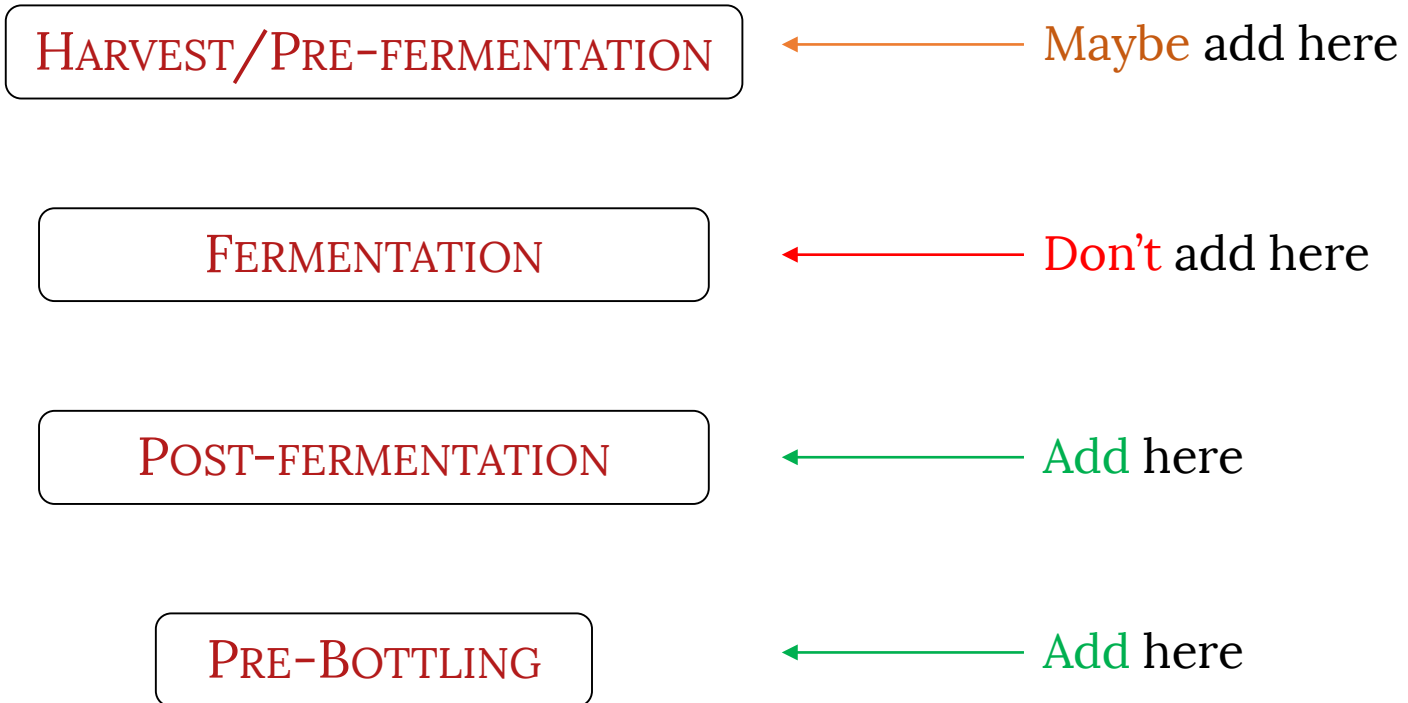
“Any questions?”

Free SO₂ Requirements: Less Math

Minimum Free SO₂ Required (ppm)

<u>Wine pH</u>	<u>Target: 0.5 ppm molecular SO₂</u>	<u>Target: 0.8 ppm molecular SO₂</u>
2.90	6.7	10.6
3.00	8.2	13.2
3.10	10.2	16.4
3.20	12.8	20.4
3.30	16.0	25.5
3.40	20.0	31.9
3.50	25.0	40.0
3.60	31.3	50.1

SO₂ Production Walk-Through



SO₂ Production Walk-Through

HARVEST/PRE-FERMENTATION

← Maybe add here

Factors to Consider:

- How clean is the fruit?
- Do you want to prevent any spontaneous or wild fermentations?
- Do you want to prevent oxidative browning?
- Do you want to prevent MLF?

RULE OF THUMB: 30-50 PPM AFTER CRUSH FOR WHITES
25-50 PPM AFTER CRUSH FOR REDS

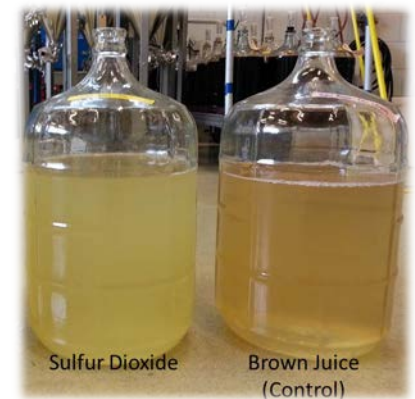


Photo credit: Denise Gardner

SO₂ Production Walk-Through

HARVEST/PRE-FERMENTATION

← Maybe add here

FERMENTATION

← Don't add here

POST-FERMENTATION

← Add here

PRE-BOTTLING

← Add here

SO₂ Production Walk-Through

POST-FERMENTATION

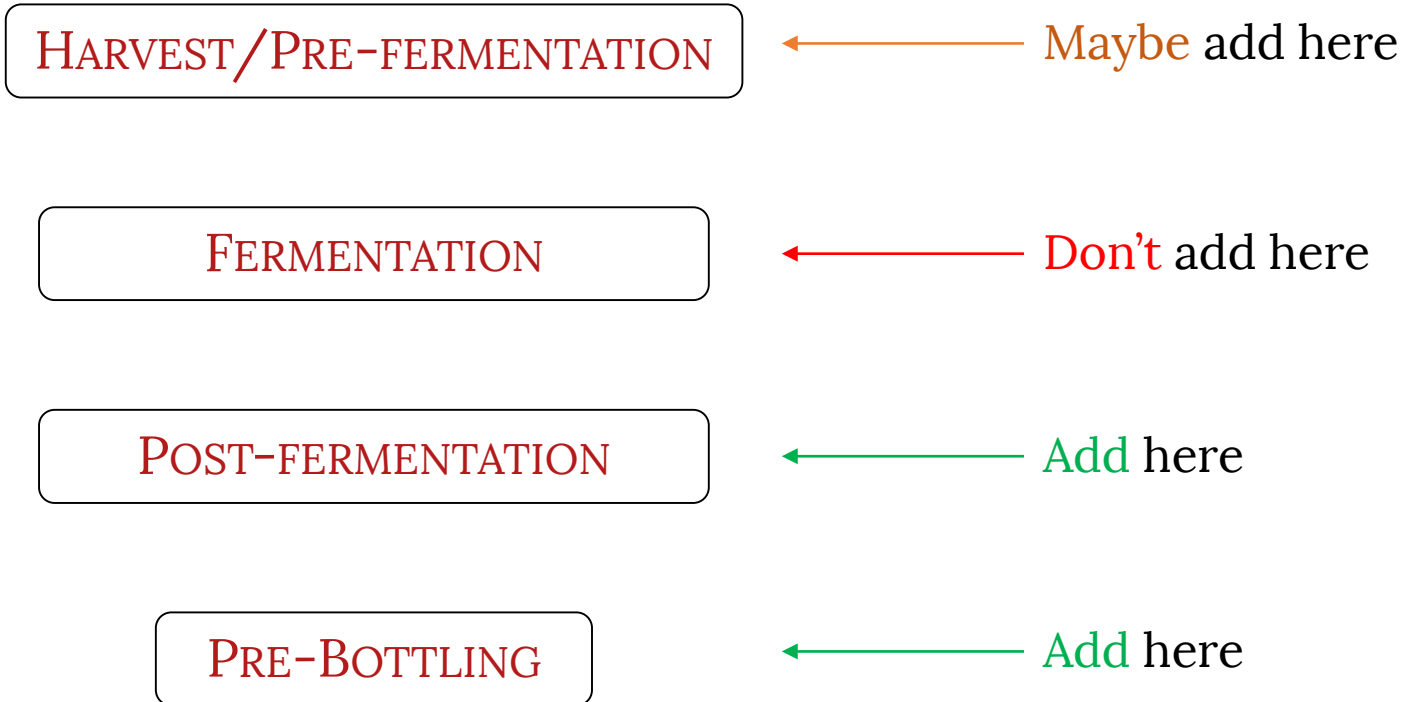
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Factors to Consider:

- Will the wine undergo MLF? Do you want it to?
- Whites: generally you want to prevent microbial issues and oxidation/browning at this point
- Reds: less oxidation protection generally needed

RULE OF THUMB: 0.8 PPM MOL. SO₂ WHITES
0.5 PPM MOL. SO₂ REDS

SO₂ Production Walk-Through



SO₂ Production Walk-Through

PRE-BOTTLING



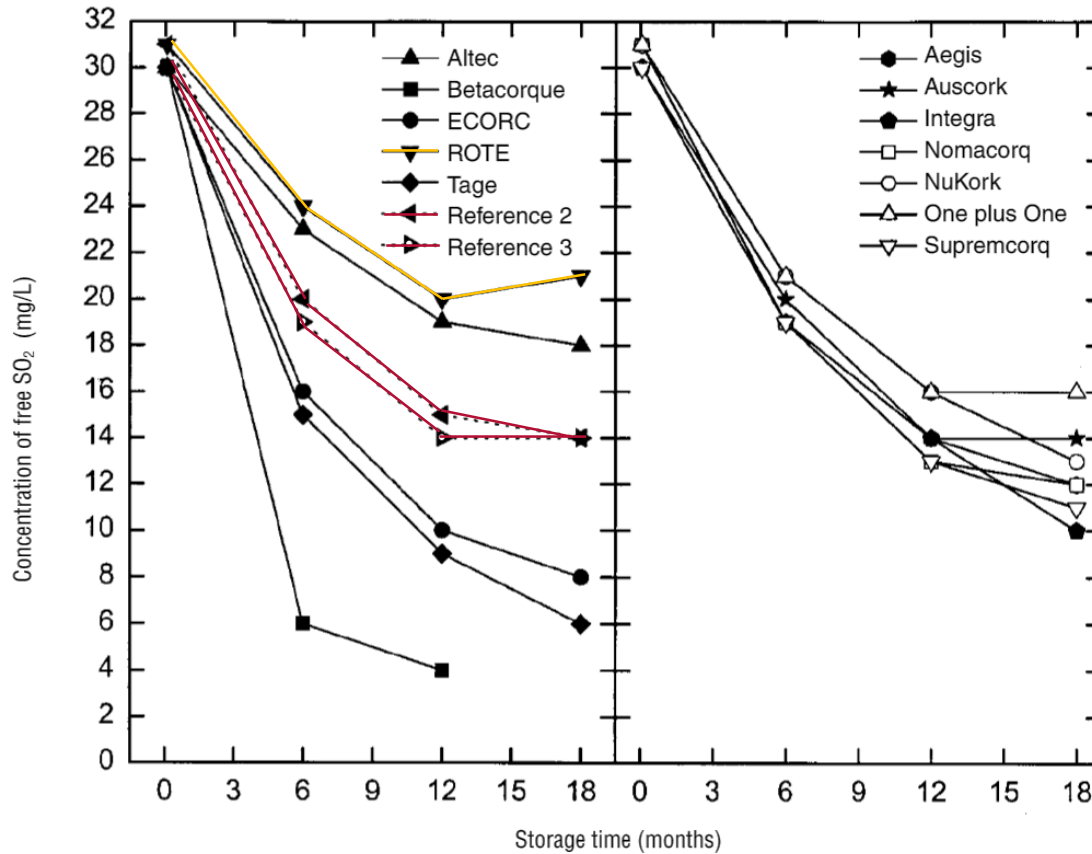
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Factors to Consider:

- Does your wine have significant residual sugar?
- What kind of bottle enclosure are you using?
- How long will this be in the bottle before release?
- What is the final pH of the wine?
- How much oxygen exposure will the wine have during bottling?

RULE OF THUMB: MEASURE FREE SO₂ LEVELS PRE-BOTTLING; ADD ENOUGH FOR ~30 PPM FREE SO₂

Post-Bottling [SO₂] Decay



— Natural cork
— Screw cap

Source: Godden, P., et al. (2001)

Methods of Analysis

- Ripper Method-iodine titration to endpoint (color change subjective)
- Titrets (simplified and portable Ripper method)
- Aeration-Oxidation (AO)
- Segmented Flow Analysis (Foss FiaStar)



Comparing Methods: Which is right for you?

METHOD	PROS	CONS
RIPPER	<ol style="list-style-type: none"> 1) Simple titration setup 2) Quick 3) Measures free and total SO₂ 	<ol style="list-style-type: none"> 1) Red wine endpoint difficult to determine 2) Time sensitive- easy to underestimate of total SO₂ 3) Non-selective titration (i.e. ascorbic acid)
TITRETS	<ol style="list-style-type: none"> 1) No setup 2) Quick 3) No cleanup - disposable 	<ol style="list-style-type: none"> 1) Relatively expensive (\$1/sample) 2) Only measures free SO₂ 3) Same caveats as Ripper Method but even less accurate
A-O	<ol style="list-style-type: none"> 1) Most accurate and precise 2) Measures free and bound SO₂ 	<ol style="list-style-type: none"> 1) Interference from volatile acids or bases 2) Initial investment of specialized equipment 3) Time-intensive distillation step

Calculation Resources

- <https://vinoenology.com/calculators/SO2-addition/>

Volume of wine, must, juice:

Target SO₂ addition:

Amount of KMBS to add:

INPUT

OUTPUT

Content Resources

- <https://grapesandwine.cals.cornell.edu/sites/grapesandwine.cals.cornell.edu/files/shared/documents/Research-Focus-2011-3.pdf>
- Godden, P., Francis, L, et al. (2001). Wine bottle closures: physical characteristics and effect on composition and sensory properties of a Semillon wine. *Australian Journal of Grape and Wine Research*, 7, 64-105.
- Werner, M., Rauhut, D., Cottereau, P. (2009). Yeasts and Natural Production of Sulphites. *Internet Journal of Enology and Viticulture*, N 12/3.

Many thanks to Anna K. Mansfield for allowing me to adapt some of the information and slides from Cornell Enology Extension.

If you remember anything about this talk:

- Molecular SO₂ at 0.5-0.8 ppm is going to act as antimicrobial agent
- Free SO₂ is pH dependent but aim for 20-40 ppm additions during crush/harvest, post-fermentation, storage
- Wine style (pH, sugar) will affect free:bound SO₂ ratio—only free SO₂ is available to help as an antioxidant
- Know your wine! pH, free SO₂ levels—measure and calculate carefully
- Aim to get SO₂ levels just right—too much or too little can lead to serious wine defects

You Be the Judge

“Sulphur dioxide contributes significantly to hangovers. Heavy drinkers who also have to get up in the morning would be advised to stick to natural wine.”

-a random online blogger

Questions?

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