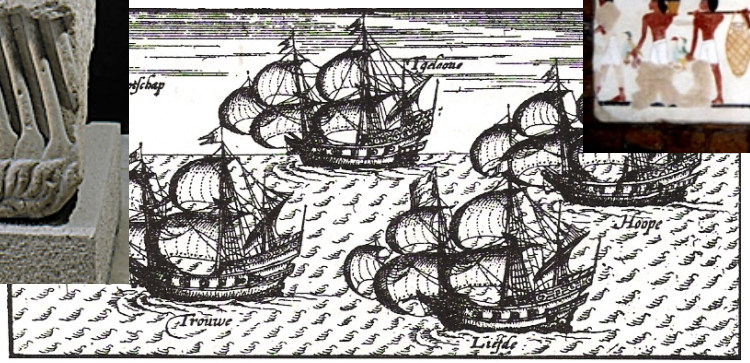
Managing Sulfur Dioxide

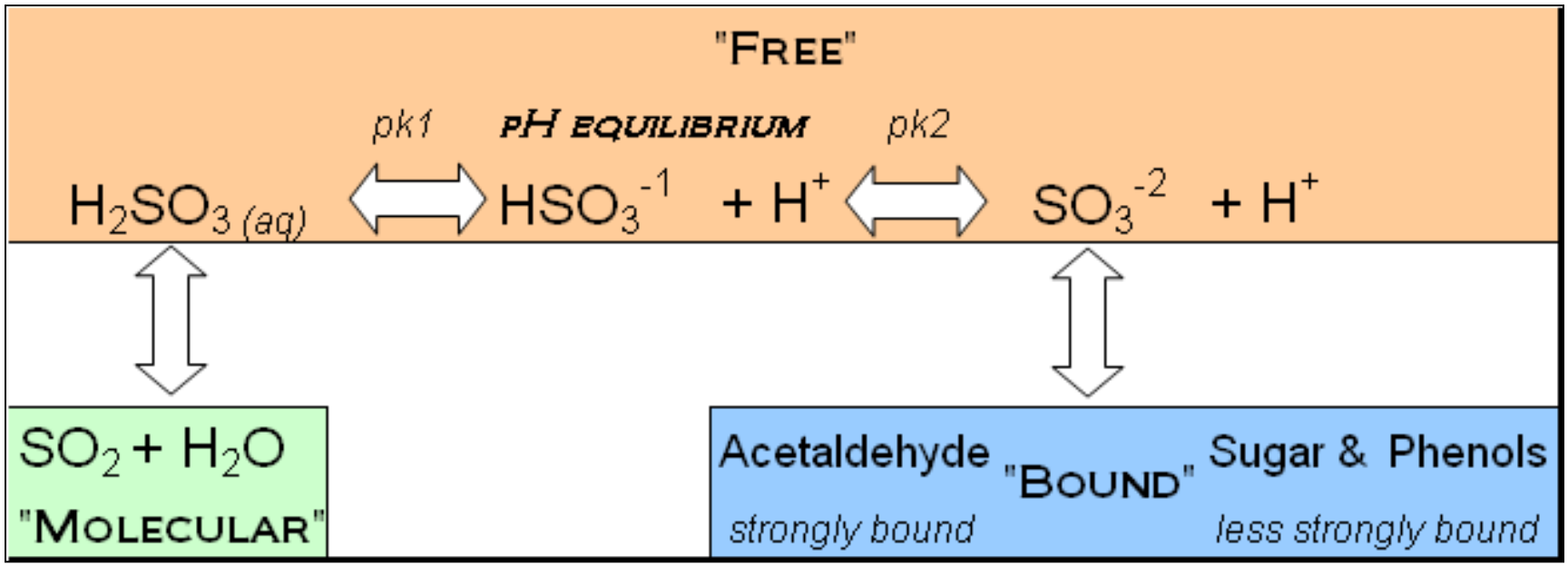
Gordon Burns
ETS Laboratories

SO2 use in winemaking

- Ancient Egyptians and Romans burned sulfur candles to preserve wines during transport.
- Medieval Dutch and English wine traders in also burned sulfur inside barrels before filling them.



Free, Bound, and Total SO_2



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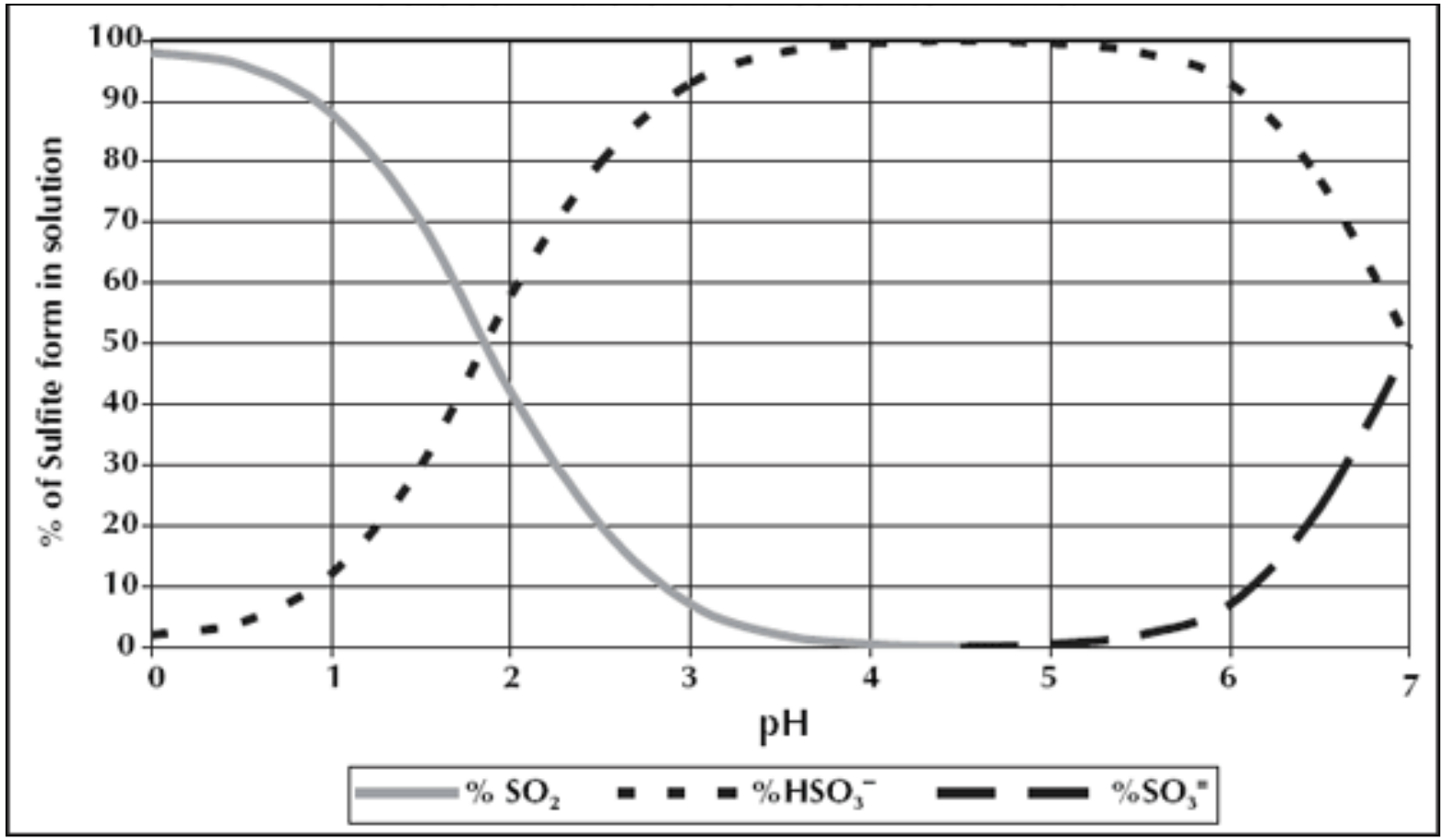
pH Effects on Free SO_2



P. Henderson, ***Practical winery and vineyard Jan/Feb 2009***

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pH Effects on Free SO_2

Table I: Table of molecular SO_2 concentrations over pH

pH	% of Free Sulfur Molecular SO_2	ppm free for 0.8 Molecular	ppm free for 0.5 Molecular
2.90	7.5	11	7
2.95	6.6	12	7
3.00	6.1	13	8
3.05	5.3	15	9
3.10	4.9	16	10
3.15	4.3	19	12
3.20	3.9	21	13
3.25	3.4	23	15
3.30	3.1	26	16
3.35	2.7	29	18
3.40	2.5	32	20
3.45	2.2	37	23
3.50	2.0	40	25
3.55	1.8	46	29
3.60	1.6	50	31
3.65	1.4	57	36
3.70	1.3	63	39
3.75	1.1	72	45
3.80	1.0	79	49
3.85	0.9	91	57
3.90	0.8	99	62
3.95	0.7	114	71
4.00	0.7	125	78

Adapted from: Enology Briefs I (#1), Feb/Mar 1982. University of California Cooperative Extension

Acetobacter & Molecular SO2

- Viability and culturability at 0, 0.35, 0.8 and 1.2 mg/L molecular SO2
- After 2 days at 0.8 and 1.2 mg/L no culturable cells remained.

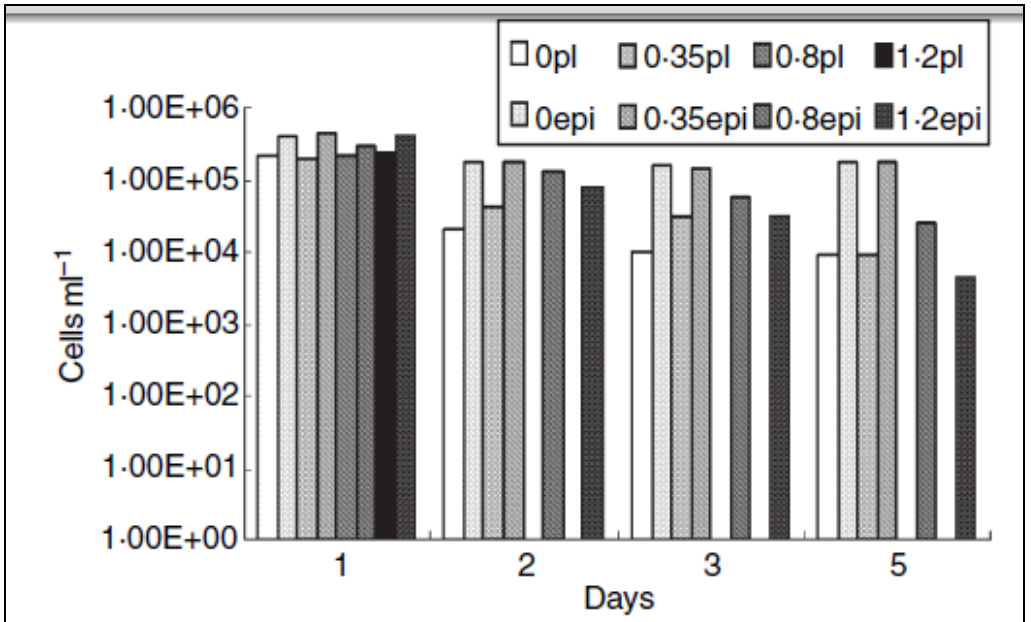

Fig. 3 Effect of different molecular SO_2 concentrations on the viability (microscopic epifluorescence enumeration) and culturability (plating on MRS agar medium) of *Acetobacter pasteurianus* A8 in fined red wine over time (epi, epifluorescence count; pl, plate count). Values are the mean of triplicate cultures

The effect of sulphur dioxide and oxygen on the viability and culturability of a strain of Acetobacter pasteurianus and a strain of Brettanomyces bruxellensis isolated from wine
W.J. du Toit, I.S. Pretorius and A. Lonvaud-Funel **Journal of Applied Microbiology 2005, 98, 862–871**

Brettanomyces & Molecular SO2

- Viability and culturability at 0, 0.1, 0.25 and 0.8 mg/L molecular SO2
- After 2 days at 0.25 and 0.8 mg/L no culturable cells remained.

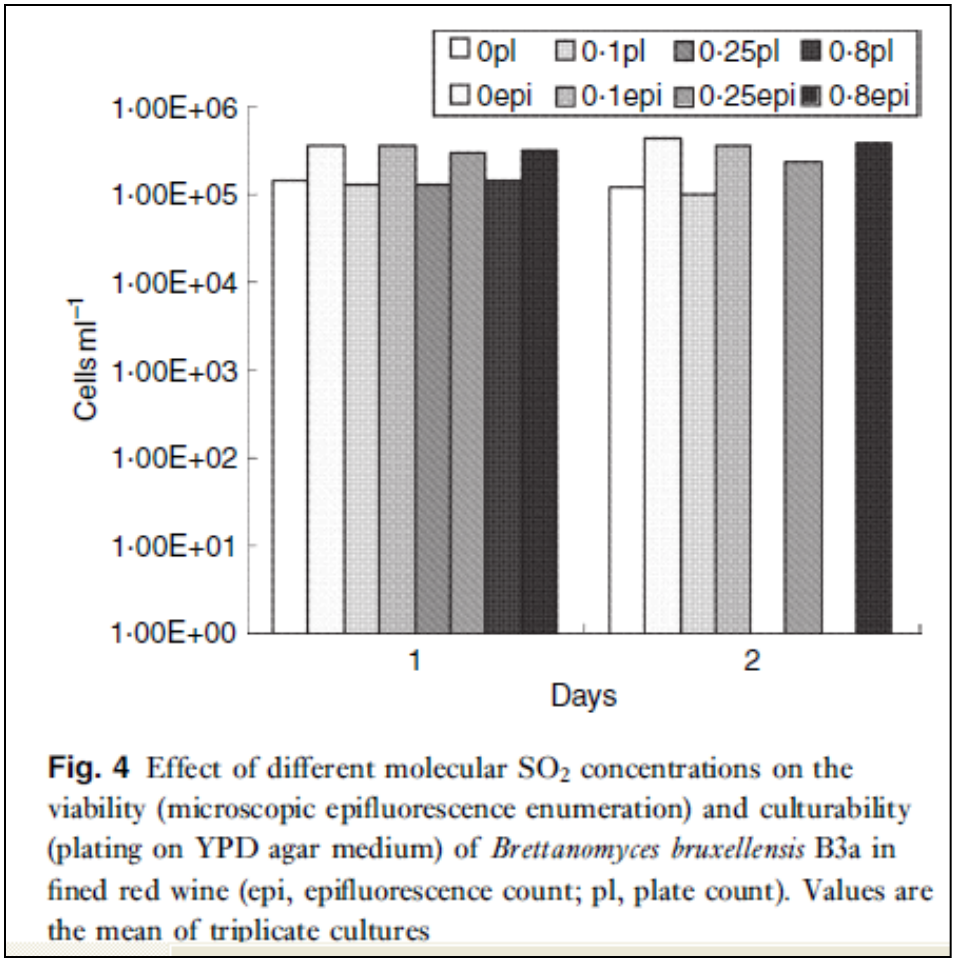

Fig. 4 Effect of different molecular SO_2 concentrations on the viability (microscopic epifluorescence enumeration) and culturability (plating on YPD agar medium) of *Brettanomyces bruxellensis* B3a in fined red wine (epi, epifluorescence count; pl, plate count). Values are the mean of triplicate cultures

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Saccharomyces & Molecular SO2

Table 12-4. The molecular sulfur dioxide requirements for control of *Saccharomyces cerevisiae*.

Author(s)	Medium	Molecular SO_2 (mg/L)
Macris and Markakis (1974)	medium	1.3
Minarik (1978)	juice	6.4
Beech et al. (1979)	model wine	0.825
King et al. (1981)	medium	1.56
Sudraud and Chauvet (1985)	wine	1.5

Source: Principles and practices of winemaking
By Roger B. Boulton, Vernon L. Singleton, Linda F. Bisson

LAB and TSO2, EtOH, pH

- Shows sensitivity to low pH, high ethanol, and SO2
- This study did not calculate molecular SO2

Table 2. Proportion (%) of strains of wine lactic acid bacteria growing[a] in MRS-TJ broth at several pH values and concentrations of ethanol and total sulfur dioxide.

Parameter	*Leuconostoc oenos* (81)[b]	*Pediococcus parvulus* (23)	*Lactobacillus* spp. (22)
pH			
3.0	30.9[c]	0	18.2
3.2	93.8	43.5	77.3
3.4	98.8	100.0	100.0
3.6	100.0	100.0	100.0
4.5	100.0	100.0	100.0
5.5	100.0	100.0	100.0
7.5	100.0	100.0	100.0
Ethanol (%)			
5	100.0	100.0	100.0
10	98.8	100.0	100.0
12.5	72.8	100.0	86.4
15	9.9	21.8	40.9
Total SO_2 (mg/L)			
32	100.0	100.0	100.0
64	100.0	100.0	100.0
96	45.7	91.3	81.8
128	11.1	73.9	59.1
160	4.9	39.1	27.3
256	1.2	0	9.1

[a] Growth assessed after incubation for 2 weeks at 30°C.
[b] Figures in parentheses denote the number of strains tested.
[c] Figures denote the proportion (%) of strains growing in each medium.

Properties of Wine Lactic Acid Bacteria: Their Potential Enological Significance
CRAIG R. DAVIS , DJOKO WIBOWO, GRAHAM H. FLEET ., and TERRY H. LEE
Am. J. Enol. Vitic., Vol. 39, No. 2, 1988

Molecular SO2 "Accepted Values"

- "SO2 is an effective germicide and concentrations of 0.8 ppm molecular SO2 will be adequate to control the growth of LAB in wine."
  - ***Lactic Acid Bacteria and Wine Spoilage**** *By Dr. Murli Dharmadhikari Iowa State Extension*
- "During storage, after all fermentations have completed, white wines can be adjusted to between 0.5 and 0.8 ppm molecular" and…
  - ***Sulfur Dioxide: Science behind this anti-microbial, anti-oxidant wine additive*** *by Patrick Henderson, Practical Winery and Vineyard Jan/Feb 2009*

Molecular SO2 "Accepted Values"

- "The levels of free SO2 generally recommended for wine before bottling is in the range of 15-40 mg free/Liter, depending on the amount required to achieve about 0.8 mg/L (ppm) molecular. The concentration in red wines is usually lower."
  - ***Wine Science: Principals and applications*** *Ronald S. Jackson Wiley Sciences 3rd Ed 2008*
- "For red wines, a level of 0.5 ppm molecular SO2 at bottling is an appropriate target …red wines usually have a higher pH than whites and often it is not possible to adjust the sulfur dioxide to a level that reached 0.8 ppm molecular SO2 without having too much total SO2.
  - ***Sulfur Dioxide: Science behind this anti-microbial, anti-oxidant wine additive*** *by Patrick Henderson, Practical Winery and Vineyard Jan/Feb 2009*

Impact of Malolactic Fermentation on Red Wine Color and Color Stability

James P. Osborne, Tresider Burns, and Charles G. Edwards
International Cool Climate Symposium Seattle, WA 2010

- All MLF+ wines had lower concentrations of acetaldehyde, pyruvic acid, and caftaric acid yet higher levels of caffeic acid.
- MLF+ wines had lower wine color, copigmentation, and polymeric pigment values compared to MLF- wines.
- MLF can affect red wine color independent of pH change and that *O. oeni* can impact the concentrations of phenolic and nonphenolic compounds involved in red wine color stability.

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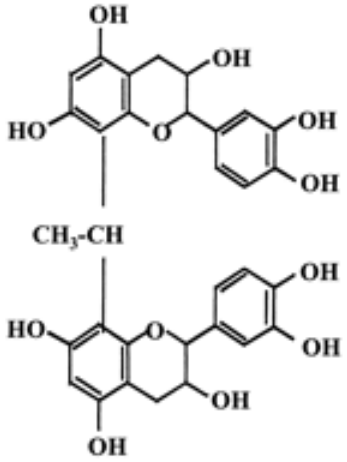
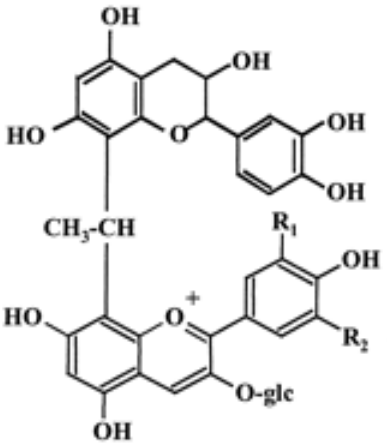
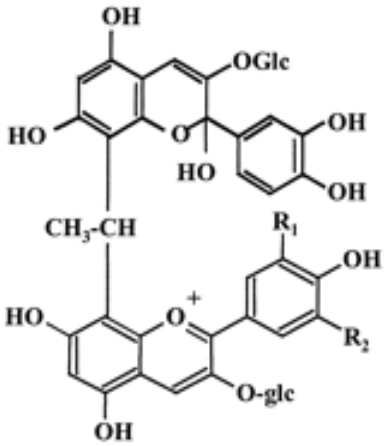
Aldehyde Bridging: Color Stability



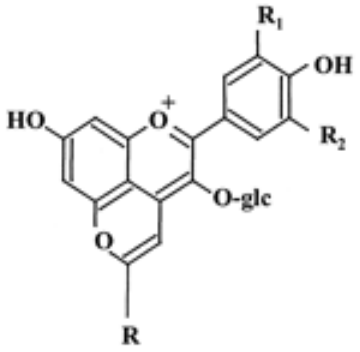
ethyl-linked flavanol dimer



ethyl-linked anthocyanin-flavanol



ethyl-linked anthocyanin dimer



R = H; HCOOH, phenyl, flavanyl

pyranoanthocyanin

Forms of Sulfite Used in Enology

- Burning elemental sulfur

  $S_0 + 0_2 = SO_2$

  1 g S_0 burns to give 2 g SO_2; actual results 30% less.

- Potassium Metabisulfite powder

  $K_2S_2O_5 + H_2O \rightarrow 2K^+ + 2\,[HSO_3]^-$

  $H^+ + [HSO_3]^- \Leftrightarrow H_2O + SO_2(aq)$

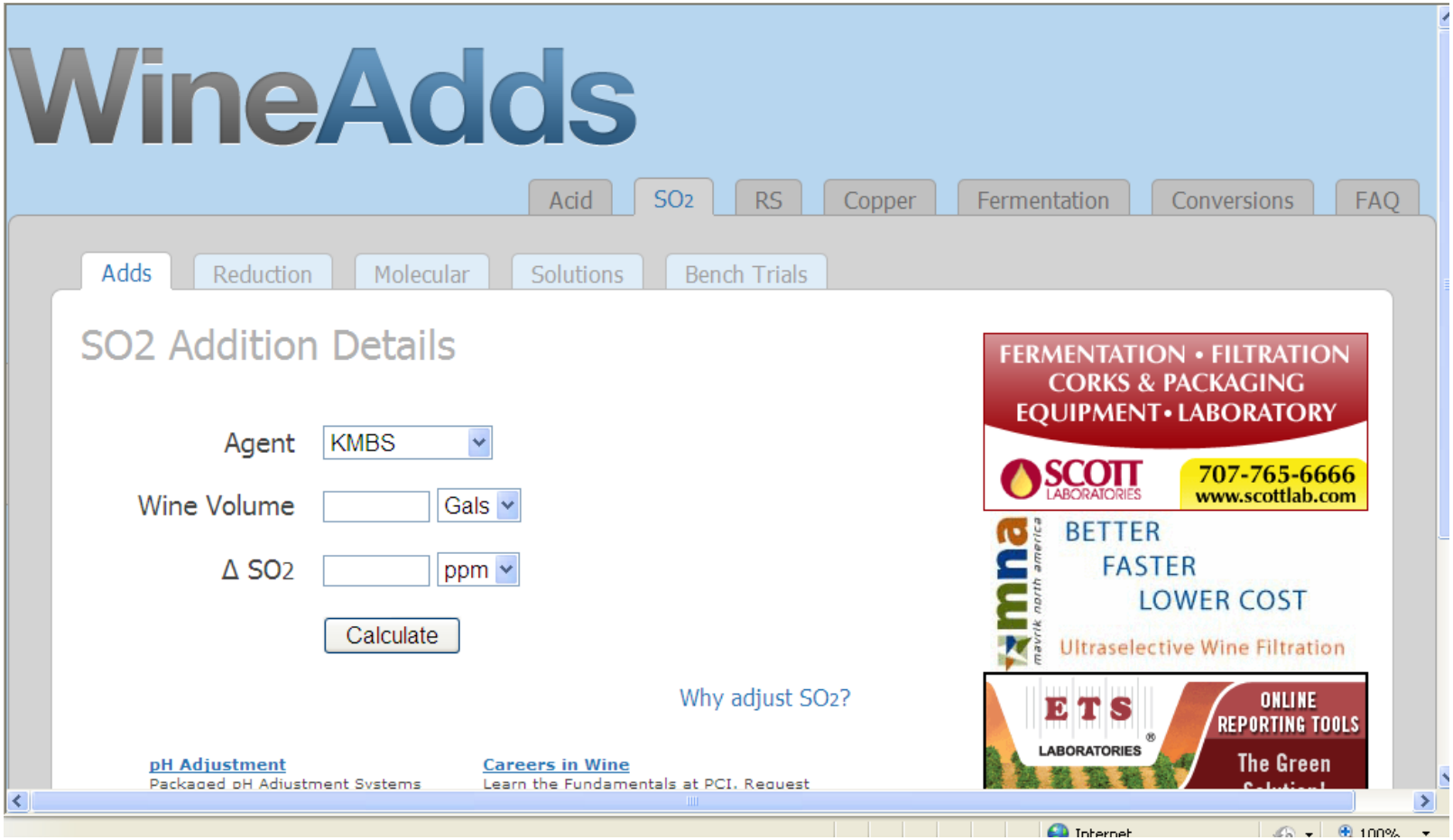
  1 g $K_2S_2O_5$ yields 0.575 g SO2

- Compressed SO2

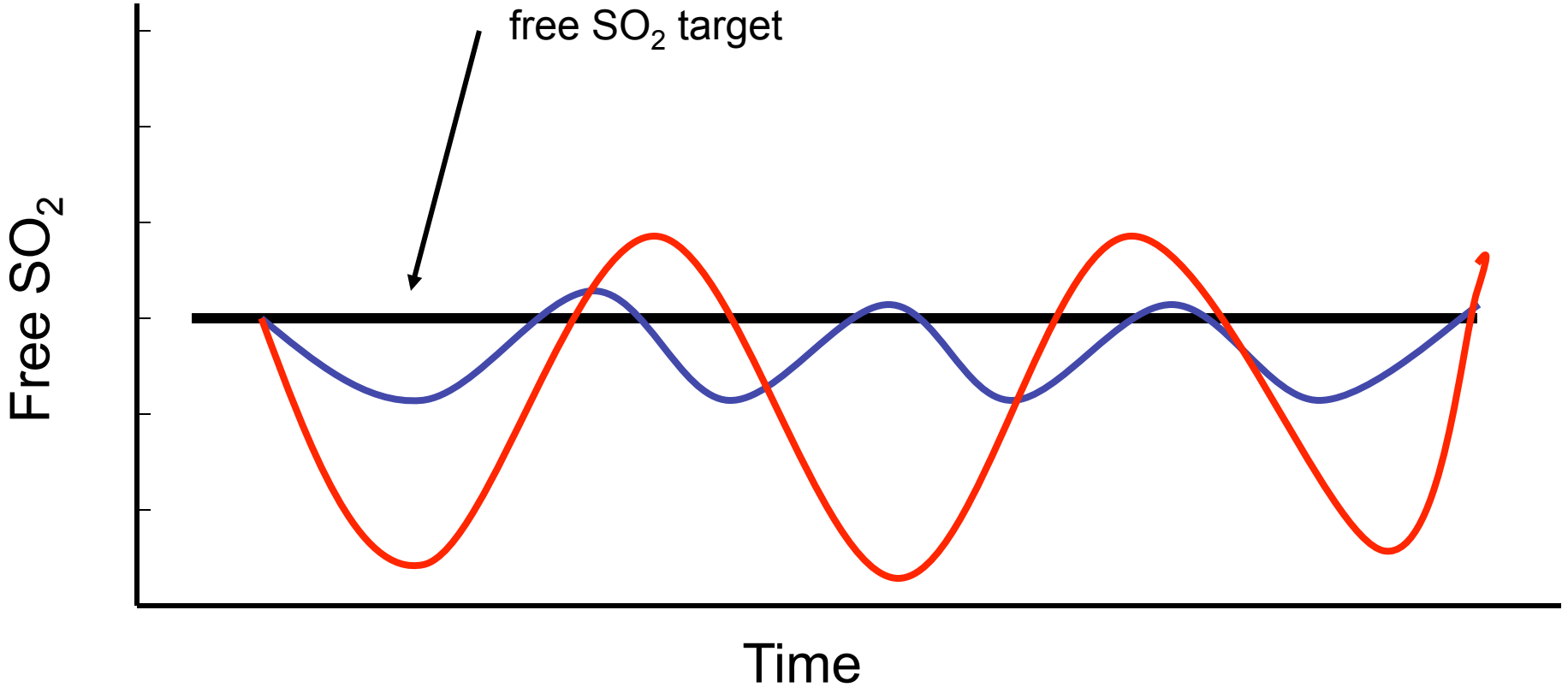
  SO_2 gas in the top of the cylinder, liquid in the bottom

- Liquid solutions, 3-6%
  - Made from $K_2S_2O_5$ or from Compressed SO2
  - Densities of these solutions will differ dependant on their source of SO2

Wine Adds Website
(www.wineadds.com)



Free SO2 Maintenance During Aging



Thank You!

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Free, Bound, and Total SO_2

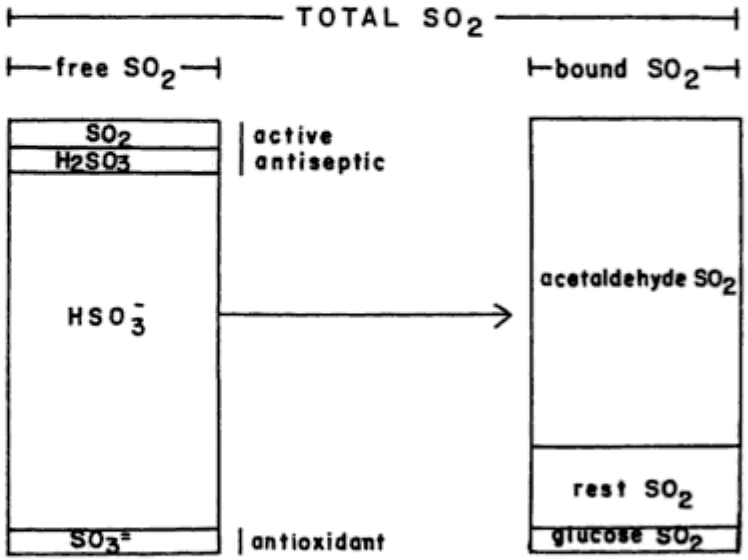

Figure 11–1 The Various Forms of SO_2 in Wine and Their Activity. *Source:* Reprinted with permission from J.M. deMan, 500 Years of Sulfite Use in Winemaking, *Am. Wine Soc. J.*, Vol. 20, pp. 44–46, © 1988, American Wine Society.

Total sulfur dioxide			
Free sulfur dioxide			Bound sulfur dioxide
Molecular SO_2	Bisulfite HSO_3^-	Sulfite $SO_3^=$	Sulfites attached to sugars, acetaldehyde, and phenolic compounds

Practical winery and vineyard jan feb 2009