



## Understanding Free Sulfur Dioxide (FSO<sub>2</sub>) in Wine

### EXTENSION

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Free SO<sub>2</sub> is the amount of available sulfur dioxide in wine to help protect against oxidation and microbial spoilage. Free SO<sub>2</sub> acts as a preservative to inhibit the growth of microorganisms and to protect against oxidation, as oxidation and microorganisms will spoil wine. Free SO<sub>2</sub> is often measured in parts per million (ppm) using either the aspiration-oxidation method or the ripper method. These methods require basic knowledge of chemistry that is essential for good winemaking.

Free SO<sub>2</sub> in wine will become Bound SO<sub>2</sub> in wine over time. This is because free sulfur dioxide is used up (binds) as it protects against oxidation and spoilage microbes. Bound SO<sub>2</sub> does not protect against oxidation or spoilage microbes but remains permanently present in the wine. Increasing Free SO<sub>2</sub> levels by sulfur additions, such as potassium metabisulfite (KMBS), is only a temporary fix as Bound SO<sub>2</sub> levels will only increase over time. Therefore, it is extremely important to have a sulfur dioxide management regime during winemaking and to continuously monitor sulfur dioxide levels until the wine is bottled.

The amount of free molecular SO<sub>2</sub> available to protect against oxidation and spoilage microbes is dependent upon the pH (acidity) of the wine. This is because sulfur dioxide exists in three different forms: SO<sub>2</sub> (molecular form), HSO<sub>3</sub><sup>1-</sup> (bisulfite form), and SO<sub>3</sub><sup>2-</sup> (sulfite form). The bisulfite form is more prevalent at wine pH, but as the pH is lowered, i.e., as the wine becomes more acidic, the molecular form becomes more prevalent. It is the molecular form that is best suited to offer protection in wine.

Chart 1 shows the percentage of sulfur dioxide in each form at different pH ranges. Wine mostly exists between a pH of 3.0 – 4.0 where less than 10% of free sulfur dioxide exists in the molecular form while the rest exists in the bisulfite form. The sulfite form (SO<sub>3</sub><sup>2-</sup>) is rarely, if ever, discussed for winemaking. Free SO<sub>2</sub> is almost completely in the bisulfite form at a wine pH above 4.0, and this form is far less effective in offering any type of protection. Thus, adjusting wine pH prior to an SO<sub>2</sub> addition is sometimes necessary.

Since it is most desirable to have the molecular form of Free SO<sub>2</sub> present in wine, it is also important to understand the concentration of the molecular form of Free

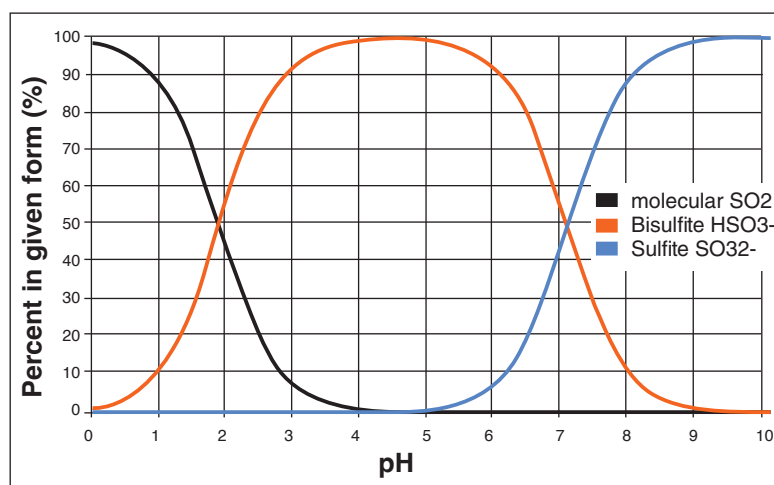
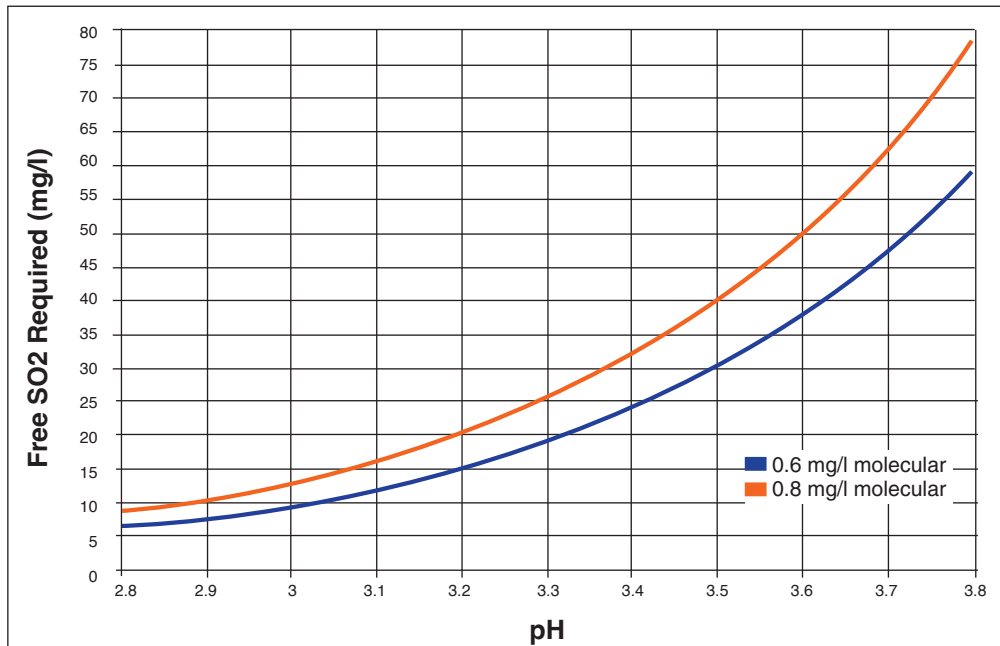


Chart 1. The three different forms of free sulfur dioxide at varying pH.

SO<sub>2</sub> obtained when making a KMBS addition to wine at a specific pH. For example, adding 50 ppm of KMBS to wine with a pH of 3.6 will only offer 0.8 ppm of molecular SO<sub>2</sub> for protection, while a wine with a pH of 3.2 will require the addition of only 20 ppm of KMBS to have that same 0.8 ppm of molecular SO<sub>2</sub> present for protection. Chart 2 and Chart 3 help to explain this phenomenon. This variable relationship among Free SO<sub>2</sub>, molecular SO<sub>2</sub> and wine pH can quickly become confusing, especially if there is already Free SO<sub>2</sub> present in wine when making a KMBS addition. Please remember to always double check KMBS calculations before making an addition, record every addition, have a Free SO<sub>2</sub> management regime, and continuously monitor Free SO<sub>2</sub> levels in wine until bottling. When making an SO<sub>2</sub> addition, it is important to thoroughly stir and mix the wine to fully incorporate the sulfur dioxide.



**Chart 2.** The concentration of molecular SO<sub>2</sub> within the concentration of Free SO<sub>2</sub> at various wine pH points. Please note that milligrams per Liter (mg/L) is interchangeable with parts per million (ppm). (1mg/L = 1ppm)

pH of Wine	% as Molecular SO <sub>2</sub>	Free SO <sub>2</sub> Concentration (ppm) for 0.8 ppm Molecular SO <sub>2</sub>
3.00	6.06	14
3.10	4.88	18
3.20	3.91	22
3.30	3.13	28
3.40	2.51	35
3.50	2.00	44
3.60	1.60	55
3.70	1.27	69
3.80	1.01	87
3.90	0.81	109
4.0	0.64	125

**Chart 3.** The numerical value as a percentage of molecular SO<sub>2</sub> within the concentration of Free SO<sub>2</sub> at a specific wine pH.

Calculations for the addition of KMBS:

- **(Desired ppm to add x Volume in Liters) / 0.57 = grams of KMBS to add**

Example:

(50 ppm x 225 Liters) / 0.57 = 19.7g of KMBS to add  
 (0.05 x 225) / 0.57 = 19.7g

Recommended FSO<sub>2</sub> Range in Wine:

15 ppm - 40 ppm

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