Understanding molecular SO_2

Sulfur dioxide (SO_2) is a key preservative used in winemaking, but how it works in wine is quite complicated. Concentrations of SO_2 required to prevent microbial growth are often quoted as molecular SO_2, but winemakers can be more familiar with discussing free and total SO_2. This column brings together answers to some of the more common questions about the different forms of SO_2 in wine, how much is needed and which factors can change its effectiveness.

WHAT ARE THE DIFFERENT FORMS OF SO_2 PRESENT IN WINE?

Sulfur dioxide exists as a gas but when added to wine it converts to one of three forms: molecular (SO_2), bisulfite(HSO_3^-) and sulfite (SO_3^{2-}). At wine pH, the most abundant forms of SO_2 are molecular SO_2 and bisulfite. The molecular form is responsible for the antioxidant and antimicrobial effects of SO_2 in wine.

HOW ARE THE DIFFERENT FORMS OF SO_2 MEASURED IN WINE?

In wineries, SO_2 is measured as free, bound and total forms. The free SO_2 is the unreacted components and is made up of mostly the molecular (SO_2) and bisulfite (HSO_3^-) forms. Bound SO_2 is the portion of the bisulfite form which binds with other wine components such as pigments and phenolics. Total SO_2 is the total amount of SO_2 added, or the sum of the free and bound fractions.

WHY DO I NEED TO KNOW THE PH WHEN CONSIDERING MY SO_2 ADDITIONS?

Wine pH influences the amount of SO_2 that is present in the molecular form. Molecular SO_2 is more abundant at low pH than at high pH. For example, for the same level of free SO_2, there will be twice as much molecular SO_2 at pH 3.5 than at pH 3.8 (Delfini and Formica, 2001). The effect that pH has on the equilibrium between the molecular and bisulfite forms of SO_2 is shown in Figure 1.

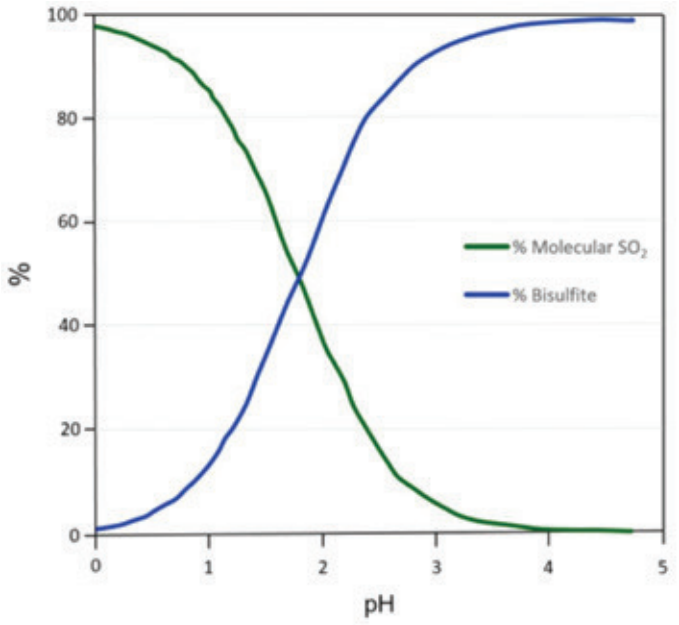

Figure 1. Distribution by percentage of the molecular and bisulfite forms of SO_2 as a function of pH (at 20°C and 0% alcohol).

WHAT CONCENTRATION OF MOLECULAR SO_2 SHOULD I AIM FOR?

The answer to this question depends on many factors, including the type of wine (red, white, sweet or dry etc.), whether you are trying to protect against oxidation or whether you are trying to inhibit a particular microorganism. However, in general, winemakers should aim to achieve more than 0.8 mg/L molecular SO_2 in white wines and more than 0.6 mg/L in reds.

HOW DO I CALCULATE THE CONCENTRATION OF MOLECULAR SO_2?

The easiest way to obtain a molecular SO_2 value is to use the AWRI's molecular SO_2 calculator, which can be found on the calculators page on the AWRI website. To calculate molecular SO_2, the concentration of free SO_2 and the wine pH must be known. The AWRI calculator uses the following formula:

$$\text{Molecular } SO_2 = \text{free } SO_2 / (1 + 10^{pH-1.8})$$

(Margalit 1997)

where the values for both the molecular and free SO_2 are in mg/L. This formula was derived using data for the SO_2 equilibrium in water at 25°C, so the influence of alcohol content is not considered.

WHICH OTHER WINE PARAMETERS AFFECT THE AMOUNT OF MOLECULAR SO_2 PRESENT IN WINE?

After pH, the main two compositional factors that influence the amount of molecular SO_2 in wine are temperature and alcohol. Increases in these two factors lead to increases in the molecular SO_2 concentration, with temperature having a greater effect than alcohol. This means that for a given pH and free SO_2 level, a lower alcohol wine will have lower molecular SO_2 than a higher alcohol wine and a wine held at a lower temperature will have lower molecular SO_2 than a wine held at a higher temperature.

For more information about SO_2 in wine, contact the AWRI helpdesk on helpdesk@awri.com.au or 08 8313 6600.

References

Delfini, C., Formica, J. V. 2001. Wine microbiology: science and technology. New York, USA: Marcel Dekker Inc.: 99–111.

Margalit, Y. 1997. Concepts in wine chemistry. The Wine Appreciation Guild Ltd: South San Francisco, CA, USA: 255–257.