AWRI Australian Wine Research Institute

Fact Sheet
WINEMAKING

# Removal and addition of sulfur dioxide to must, juice and wine

## Background

Addition of hydrogen peroxide ($H_2O_2$) to juice and wine can be an effective treatment to decrease the concentration of free sulfur dioxide ($SO_2$). This fact sheet describes how to calculate $H_2O_2$ addition rates and the correct procedure for adding $H_2O_2$ to juice and wine, as well as the use of yeast cultures to decrease small amounts of free $SO_2$. It also covers the different forms of $SO_2$ that can be added to juice and wine.

## Removal of $SO_2$ from wine or juice

### *Hydrogen peroxide addition*

The removal of sulfur dioxide from wine using $H_2O_2$ is permitted in wine production in Australia. It is an effective and safe procedure when performed carefully. $H_2O_2$ reacts rapidly with free $SO_2$ in a wine or juice, oxidising it to sulfate. Following this decrease in free $SO_2$, further free $SO_2$ may be generated from the remaining bound fraction.

The $H_2O_2$ should be added in a dilute form of less than 1% w/v. The addition should be performed slowly with adequate mixing (e.g. tank recirculation, submersible pump) to avoid localised oxidation. It is necessary to wait several hours before reanalysing the concentration of free and total $SO_2$ to assess the effectiveness of the treatment. This is to allow time for the free and bound $SO_2$ to re-establish an equilibrium after the removal of a portion of free $SO_2$.

The following steps outline how to calculate a $H_2O_2$ addition. Alternatively, the calculations can also be done using the AWRI's winemaking calculators app, available for both Apple and Android devices.

1. Determine the required decrease of $SO_2$

   *Avoid attempting to decrease the free $SO_2$ to below 10 mg/L using $H_2O_2$. Situations may arise where a winemaker is attempting to decrease the free $SO_2$ down to 10 mg/L. It is recommended in these situations to allow a safety margin of 5 mg/L. Calculate an initial addition to decrease first to 15 mg/L, then analyse the $SO_2$ concentration before any further $H_2O_2$ is added.*

2. Calculate the mass of $SO_2$ to be removed

   *Multiply the concentration of free $SO_2$ (mg/L) to be removed by the volume of wine (L). This gives the mass of $SO_2$ to be removed in milligrams (mg). Next, express the mass of $SO_2$ to be removed in grams (g) by dividing by 1000.*

3. Calculate the mass of $H_2O_2$ required

   *Molar mass of $SO_2$ = 64 g/mol*

   *Molar mass of $H_2O_2$ = 34 g/mol*

   *The reaction of $SO_2$ and $H_2O_2$ occurs in a 1:1 stoichiometric ratio, meaning that one mole of $SO_2$ reacts with one mole of $H_2O_2$.*

   *Begin by expressing the amount of $SO_2$ required in moles by dividing the mass in grams of $SO_2$ to be removed (from step 2) by the molar mass of $SO_2$ (64 g/mol). Then convert this number of moles to the required mass of $H_2O_2$, by multiplying by the molar mass of $H_2O_2$ (34 g/mol).*

4. Determine the volume of $H_2O_2$ stock solution required

   *Commercial $H_2O_2$ is typically 30% w/v (300 g/L).*

   *The required volume of a $H_2O_2$ stock solution (L) is calculated by dividing the required mass of $H_2O_2$ (g) by the known concentration of the commercial $H_2O_2$ stock solution (g/L). In most instances it is practical to convert the volume from litres (L) to milliliters (mL) by multiplying by 1000.*

***Worked example***

*A 1,700 L tank of wine contains 70 mg/L of free $SO_2$. The winemaker would like to decrease the $SO_2$ concentration to 30 mg/L. Removal of 40 mg/L of free $SO_2$ is required.*

1. Determine the required $SO_2$ decrease and allow for a safety margin where needed.

   $Amount\ of\ SO_2\ to\ be\ removed = 40\ mg/L$

2. Calculate the mass in grams of $SO_2$ to be removed.

   $$Mass\ of\ SO_2\ to\ be\ removed = amount\ of\ SO_2\ \ to\ be\ removed\ (mg/L)\ \times\ wine\ volume\ (L)$$

   $$= 40\ mg/L \times 1{,}700\ L$$

   $$= 68\,000\ mg\ of\ SO_2$$

   $$= 68\ g\ of\ SO_2$$

3. Calculate corresponding amount of $H_2O_2$ required.

$$Mass\ of\ H_2O_2\ required\ in\ grams = \frac{Mass\ of\ SO_2\ to\ be\ removed\ (g)}{Molar\ mass\ of\ SO_2\ (g/mol)} \times Molar\ mass\ of\ H_2O_2\ (g/mol)$$

$$= \frac{68\ g\ of\ SO_2}{64\ g/mol}\ \times\ 34\ g/mol$$

$$= 36.13\ g\ of\ H_2O_2\ required$$

4. Determine the volume of $H_2O_2$ stock solution required.

   *Assume that 30% w/v (300 g/L) $H_2O_2$ is used*

$$Volume\ of\ H_2O_2\ stock\ solution\ required\ (L) = \frac{Mass\ of\ H_2O_2\ required\ (g)}{concentration\ of\ stock\ solution\ (g/L)}$$

$$= \frac{36.13\ g}{300\ g/L}$$

$$= 0.120\ L$$

$$= 120\ mL$$

### *Practical tips for $H_2O_2$ additions*

- Add $H_2O_2$ to juice or wine as a dilute solution of less than 1%.
- To remove large amounts of $SO_2$ add the calculated $H_2O_2$ in several steps of no more than 25 mg/L of $SO_2$ at a time.
- Make $H_2O_2$ additions during tank mixing to avoid localised oxidation.
- Use inert gas cover when appropriate.
- Analyse the $SO_2$ concentration analysis after each $H_2O_2$ addition. Wait several hours before analysing the $SO_2$ concentration to allow time for the free and bound $SO_2$ to re-establish equilibrium.
- Hydrogen peroxide degrades very quickly. Use fresh solutions and store chemicals appropriately.
- Never decrease free $SO_2$ to less than 10 mg/L using $H_2O_2$.
- Allow for a margin of safety where necessary. In situations where you wish to lower the free $SO_2$ concentration to 10 mg/L, first aim to lower it to 15 mg/L.
- Check your $H_2O_2$ addition amount with the AWRI winemaking calculator app.

Contact the AWRI helpdesk for further advice regarding the practical aspects of $H_2O_2$ additions. $H_2O_2$ is a strong, non-specific oxidising agent. Winemakers should be aware of the potential risks of a loss of wine quality associated with hydrogen peroxide additions if additions are not performed correctly.

### *Yeast culture addition*

'Sacrificial' yeast cultures have been found to be successful in removing amounts of free $SO_2$ up to 15 mg/L in juice prior to fermentation. Information on the use of 'sacrificial' yeast cultures can be found in the following article: Sacrificial yeast cultures for $SO_2$ reduction.

## The addition of $SO_2$ to wine or juice

The addition of sulfur dioxide may be made using:

- 'pure' sulfur dioxide (available as a pressurised liquid)
- an aqueous solution prepared by bubbling gaseous $SO_2$ into water
- as a solid salt, which may be dissolved in water or wine before addition.

The amount of $SO_2$ added as an aqueous solution depends on the strength of that solution, and may be calculated from its concentration, normally expressed as % weight/volume. The most commonly used salt form is potassium metabisulfite ($K_2S_2O_5$, often abbreviated colloquially to PMS and less commonly KMS).

**The proportion of $SO_2$ yielded from PMS is 57% w/w.** Note that the remaining proportion of PMS is comprised of potassium. Increasing the potassium ion concentration of a wine or juice may not always be desirable.

$SO_2$ can be added to juice before fermentation as an ammonium bisulfite ($NH_4HSO_3$) solution. This is often available in preformulated aqueous solutions, which vary in their concentrations. Ammonium bisulfite has a dual purpose of supplementing nitrogen in the form of ammonia to aid fermentation performance, as well as adding $SO_2$.

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## References and further reading

AWRI winemaking calculator – hydrogen peroxide addition. Available from: https://www.awri.com.au/industry_support/winemaking_resources/winemaking-calculators-app/

Cordingley, B. 2022 Ask the AWRI: Sacrificial yeast cultures for $SO_2$ reduction *Aust. N.Z Grapegrower Winemaker* (696): 52-53.

## Contact

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