

How much sulfur dioxide (SO₂) is needed at bottling?

The AWRI helpdesk is often asked how much SO₂ is required in bottled wine, both to inhibit microbiological growth and prevent oxidation or premature wine development. Some winemakers also ask if less or more SO₂ is required for different wine types, wines intended to be sealed with different types of closures or wines that will be aged for different amounts of time. In this column **Geoff Cowey** and **Adrian Coulter** address these questions.

How much SO₂ is needed to prevent microbiological growth?

The molecular form of SO₂ is responsible for the antimicrobial effects of SO₂ in wine and is calculated using the free SO₂ concentration and wine pH. Beech et al. (1979) found that 0.625 mg/L molecular SO₂ was required to inhibit *Saccharomyces* and *Brettanomyces* sp. yeast growth in red wine, with Rankine (1989) and other authors suggesting that up to 0.8 mg/L molecular SO₂ was required in white wines. Thus, to prevent microbiological growth in bottled wine, winemakers should aim to achieve more than 0.8 mg/L molecular SO₂ in white and sweet wines and more than 0.625 mg/L in red wines. Table 1 presents an indication of minimum free SO₂ concentrations required for microbiological control at typical pH levels in white and red wines.

How much SO₂ is needed to minimise oxidation and colour development?

AWRI helpdesk investigations have revealed that bottled wines rapidly develop oxidative aromas and exhibit colour changes when they reach a minimal critical level of SO₂. The critical value varies for different wines, but

typically is around 10-15 mg/L free SO₂ for white wines and 30 mg/L total SO₂ for red wines.

How much SO₂ is lost during the bottling process?

Closure trials at the AWRI and elsewhere have shown that the largest decrease in SO₂ concentration in bottled wine occurs within the first six months after packaging. This is mainly due to oxygen pick-up during packaging and any subsequent reactions with oxygen or oxidised phenolic matter within the wine. Under ideal packaging conditions, in both white and red wine closure trials, there has been a loss of around 5 mg/L of free SO₂ and 10 mg/L of total SO₂ in the first 24 hours after packaging. Therefore, for a true indication of the SO₂ concentration achieved in bottle it is recommended to measure SO₂ in packaged wine 24 hours after packaging. It is also best to take into account the expected SO₂ losses when adjusting the SO₂ concentration in a wine prior to bottling.

How much SO₂ is lost during bottle ageing and/or when sealed with different closures?

Free and total SO₂ losses measured in three white wines and three red wines,

sealed under a standard 'reference 2' cork closure and a screwcap closure, for periods from six months up to 10 years after bottling, are shown in Tables 2 and 3.

From an oxidation perspective, how much SO₂ is needed in wine intended for ageing?

Allowing for a 5 mg/L loss of free SO₂ in white wine and a 10 mg/L loss of total SO₂ in red wines during packaging, and to maintain a minimum critical level of 15 mg/L free SO₂ in white wines or 30 mg/L total SO₂ in red wines, then adding the average SO₂ loss for the relevant closure and storage times taken from Tables 2 and 3, you can estimate the minimal concentrations that might be required when preparing a wine for bottling. Examples are included in Table 4.

Note that these sulfur dioxide concentrations also need to be adjusted to ensure they are adequate for control of microbiological growth, which is highly dependent on the wine pH, as well as the ethanol and sugar level of the wine. These aspects change the risk level of the wine matrix and may also mean the wine could require other chemical or physical means of microbiological control.

For further information contact the AWRI helpdesk on (08) 8313 6600 or helpdesk@awri.com.au

Table 1. Minimum free SO₂ concentrations to achieve target molecular SO₂ concentrations at different wine pH values for red and white wines

White wine pH ¹	Free SO ₂ (mg/L) required to achieve 0.8 mg/L molecular SO ₂ in white wine	Red wine pH	Free SO ₂ (mg/L) required to achieve 0.625 mg/L molecular SO ₂ in red wine ²
3.1	17	3.4	25
3.2	21	3.5	32
3.3	26	3.6	40
3.4	32	3.7	49

- The molecular SO₂ calculations used do not take into consideration the impact of ionic strength, alcohol and temperature.
- The free SO₂ measured in young red wines is an overestimation as it also measures SO₂ weakly bound to anthocyanins, but for wines bottled for more than 12 months the free SO₂ more closely reflects the available free SO₂ that contributes towards molecular SO₂.

References

Beech, F.W., Burroughs, L.F., Timberlake, C.F., Whiting, G.C. 1979. Progrès récents sur l'aspect chimique et l'action antimicrobienne de l'anhydride sulfureux (SO₂) [Recent advances in the chemical appearance and antimicrobial action of sulfur dioxide (SO₂)]. *Bull. OIV* 52(586): 1001-1022.

Rankine, B.C. 1989. *Making good wine: a manual of winemaking practice for Australia and New Zealand*. South Melbourne, Vic.: Sun Books (Macmillan Australia): xvii, 374.

Table 2. Concentrations of free and total SO₂ lost after bottling in three white wines, measured at different time points from 6 months up to 10 years of bottle age

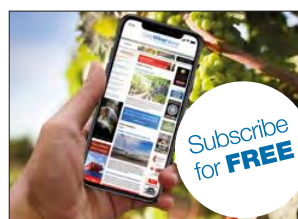
Years	1999 Semillon				2002 Semillon				2007 Semillon			
	Cork		Screw Cap		Cork		Screw Cap		Cork		Screw Cap	
	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)
0.5	11	9	7	4	13	17	13	17	16	18	14	16
1	16	18	11	10	13	14	13	13	21	24	17	18
1.5	17	-	10	-	20	24	15	19	21	25	16	16
2	18	20	12	10	17	21	15	18	23	32	15	15
3	22	28	14	11	21	27	16	18				
4	25	33	16	14								
5	24	32	18	16								
7	27	46	18	19								
10	25	43	18	20								

Table 3. Concentrations of free and total SO₂ lost after bottling in three red wines, measured at different time points from 6 months up to 7 years of bottle age

Years	1996 Cabernet Shiraz				2002 Cabernet Sauvignon				2008 Shiraz			
	Cork		Screw Cap		Cork		Screw Cap		Cork		Screw Cap	
	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)
0.5					13	18	12	18	12	15	11	12
1					12	17	13	21	17	26	13	17
1.5					16	23	16	23	15	25	12	17
2					19	32	17	26				
3	24	53	21	45					23	51	18	35
5	27	67	24	53								
7	28	72	25	62					28	62	28	50

Table 4. Estimations of SO₂ requirements at bottling to avoid oxidation during wine ageing

Years	Target shelf life	Estimated minimum SO ₂ required at bottling	Calculation
White	2 years	35-40 mg/L free	15 mg/L critical level + 5 mg/L loss at bottling + 15-20 mg/L lost during storage
White	5 years	40-45 mg/L free	15 mg/L critical + 5 mg/L loss at bottling + 20-25 mg/L lost during storage
Red	2 years	65-70 mg/L total	30 mg/L critical + 10 mg/L loss at bottling + 25-35 mg/L lost during storage
Red	3 years	85-95 mg/L total	30 mg/L critical + 10 mg/L loss at bottling + 45-55 mg/L lost during storage
Red	5 years	95-105 mg/L total	30 mg/L critical + 10 mg/L loss at bottling + 55-65 mg/L lost during storage



DailyWineNews
The wine industry's e-newsletter

www.winetitles.com.au
Wine Industry news at your fingertips
Delivered to your inbox daily*
*excludes weekends and public holidays

Wherever you go, we're with you!