Oxygen pickup is regularly seen during various winemaking processes. Some processes can even result in the wine being saturated with oxygen (especially if the wine’s temperature is very low). This dissolved oxygen is then gradually consumed by the wine and participates in reactions resulting in the oxidation of the wine.

Key aromas associated with Sauvignon Blanc are oxidation sensitive and it is therefore critical to understand how oxygen is consumed by wine and the effects thereof on various wine components and antioxidants (especially sulphur dioxide). In this blog, we look at consumption rates reported for oxygen and sulphur dioxide.
The rate at which oxygen is consumed by a wine will depend on many factors such as the inherent wine composition and storage temperature. A study titled “Oxygen and SO$_2$ consumption rates in white and rosé wines: Relationship with and effects on wine chemical composition”$^1$, investigated the oxygen consumption rate of a range of wines as well as monitoring the sulphur dioxide decrease during this process.

**MATERIALS AND METHODS**

Five white and three rosé wines were used in the study. The wines were intentionally oxidised (above 6 mg/L) and stored in the dark at 25°C. The dissolved oxygen was measured daily. As soon as the oxygen concentration of the wine reached 10% of the initial value, a sample was taken for analysis. This process was repeated five times resulting in an accumulative increase of consumed oxygen. At the end of each cycle, various wine components were analysed. For the purpose of this article, the focus will remain on the oxygen consumption rate over time and the effect on the sulphur dioxide content.

**OXYGEN CONSUMPTION RATE (OCR)**

The oxygen consumption rate (OCR) is the amount of oxygen that is consumed by a wine (and therefore participated in oxidation reactions) in a specific time period. To calculate the total amount of oxygen consumed, the dissolved oxygen at the end of the specific period can be subtracted from the initial dissolved oxygen concentration.

In the present study, the wines differed significantly in the rate at which oxygen was consumed. Looking at the five cycles of oxidation, a continuous decrease in OCR was observed from one cycle to the next. Oxygen is thus consumed faster during the initial stages of oxygenation.

For instance, for one of the white wines, the OCR after 5 days (cycle 1) was 0.8 mg O$_2$/L/day. After 20 days (cycle 3), the OCR decreased to 0.7 mg O$_2$/L/day and after 30 days (cycle 5), the OCR decreased to 0.6 mg O$_2$/L/day. Therefore, towards the end of the experiment, the lower rate of consumption resulted in a longer time needed to consume all the oxygen.

These are very high consumption rates and considering the initial amount of dissolved oxygen present, a huge amount of oxygen can be accumulatively consumed by the wine leading to oxidation. The temperature at which the wines were stored (25°C) will also have an effect on the consumption rate.
and should be considered. The lowest oxygen consumption rate reported in the study was 0.2 mg O₂/L/day.

**WHEN TO MEASURE OXYGEN**

In a practical setup, the importance of interpreting your oxygen measurements correctly is critical. As the oxygen is consumed over time, the dissolved oxygen concentration will decrease. Potentially, if a wine picked up 3 mg/L of dissolved oxygen during filtration, for instance, measuring the oxygen only 3 days later could result in a measurement of 0.6 mg/L (in the case of 0.8 mg O₂/L/day OCR). Therefore, oxygen measurements need to be done at strategic time points to determine the total oxygen pickup during the winemaking process. If the measurements are done too late, the realistic potential effects of oxygen are overlooked.

Oxygen in wine can be measured after any oenological process. Processes where the wine is moved from one location to another, often result in oxygen dissolution. This effect is amplified when the wine is cold, therefore, measurement after cold stabilization (especially after moving and/or stirring cold wine) should be done to assess the pickup. Bottling can also result in significant oxygen dissolution in wine.

**MEASURING OXYGEN IN AN OXIDIZED WINE**

There is (almost) no point in measuring the dissolved oxygen concentration of an (already) oxidized wine. If a wine is oxidized, it means that all of the dissolved oxygen (or majority thereof), has already been consumed and participated in oxidation reactions (resulting in the formation of oxidation aroma = oxidized wine). Therefore, measuring the dissolved oxygen concentration of an oxidized wine will probably give a very low measurement. The only exception is if oxygen continuously entered the wine even after the wine is considered oxidized, in this case there will still be dissolved oxygen due to recent and/or continuous dissolution. Other than that, as seen in the study, the rate of consumption decreases as the accumulative oxygen increases, thereby extending the time period in which dissolved oxygen is present in the wine.
Therefore, if you decide to measure the oxygen of an already oxidized wine, the following must be considered:

- Low dissolved oxygen value at this point means that the wine experienced an influx (or multiple influxes) of oxygen during its lifetime. However, all of this oxygen was consumed over time resulting in low dissolved oxygen at the time of measurement.

- Positive dissolved oxygen concentration (approximately >1 mg/L) means that the wine experienced an influx (or multiple influxes) of oxygen during its lifetime, the last influx being relatively recent (consumption still in progress). Or there is a continuous influx of oxygen (through the closure for instance).
CONSUMPTION OF SO₂

It is well known that oxygen pickup will result in a decrease in the wine’s sulphur dioxide concentration. It is generally assumed that 1 mg/L of dissolved oxygen will result in the loss of 4 mg/L of sulphur dioxide, however, this theoretical value seems not to ring true in a real wine environment.

Multiple studies have shown that this ratio differs significantly from one wine to the next. In the present study, the mg/L of SO₂ consumed per mg/L of oxygen consumed, varied between 1.2 mg/L and 5.4 mg/L. Therefore, for any given wine, a dissolved oxygen content of 3.0 mg/L could potentially result in an SO₂ decrease anywhere between 3.6 mg/L to 16.2 mg/L SO₂ depending on the specific wine’s chemical composition.

CONCLUSION

Oxygen consumption rates and the decrease in sulphur dioxide concentration due to the consumption of oxygen, differ from one wine to the next. There is no ideal ratio that can be applied to all wines.

The time of measuring the dissolved oxygen concentration is critical to be able to make accurate conclusions about the impact of winery processes and the state of the wine.

ABBREVIATIONS

OCR - Oxygen Consumption Rate

REFERENCES


The graphs shown in this blog post are not based on real data and was compiled for demonstration purposes only.