# The efficiency of inert gas during racking

## Part 2: Inerting the receiving tank

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Basic Wine

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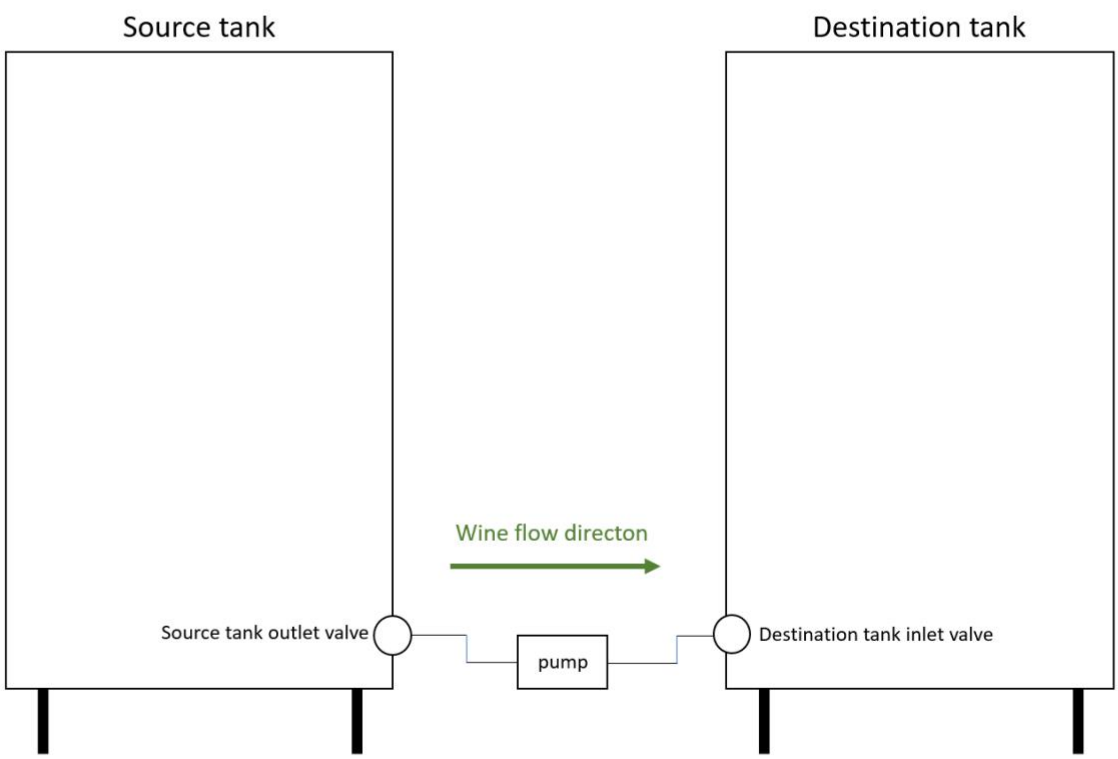
Part 1 of this inert gas series explains certain principles relating to the use of inert gas as well as outlines the main properties of typical inert gases used in the winery. Winemakers often use inert gases "blindly" due to the limited information available regarding the effectiveness of these inerting processes and gases and the volumes of each gas needed to provide sufficient protection from oxygen exposure. This results in the **overuse or underuse of inert gases** which can either have an economic impact or affect the wine's quality.

In a recent study [1], researchers from Spain investigated the **effectiveness of different inert gases during the racking process**. The aim of the work was to study the uptake of oxygen during racking by inerting the receiving tank before racking and by blanketing the wine in the source and destination tanks (hoses were also inerted). This was tested **using different types and volumes of gases**. Only some of the results reported in the study will be discussed in Part 2 and Part 3 of this blog series, for more information, please consult the original publication[1].

## Materials and Methods[1]

A model wine solution was used (from here on referred to as just "wine") which contained 12.5 %v/v hydroalcoholic solution and pH adjusted to 3.5 to assess the oxygen pickup during racking using two 1800 L tanks (height 1.7 m).

**Oxygen measurement probes were fitted at strategic locations within the tank as well as the inlet and outlet valves.** In the tank, the probes were either fitted at a **fixed location** or it were fitted at a **predetermined length from a float** that floated on top of the wine during racking (therefore at a constant height above or below the wine's surface).



## TEST 1: The impact of racking without the use of inert gas

*Receiving tank volume: 1800 L*

*Receiving tank height: 1.7 m*

*Gases tested: none*

*Total duration of racking from start to finish: ± 25 minutes*

### 1.1) Dissolved oxygen as the first wine enters the receiving tank

*Oxygen measurement probe location: In the inlet valve of the receiving tank*

- The wine arrived at the empty receiving tank **virtually free of dissolved oxygen** and remained low for the first ± 12 minutes of racking.

### 1.2) Dissolved oxygen measured in the receiving tank during the initial stages of filling

*Oxygen measurement probe location: 0.1 m below the surface of the wine in the receiving tank*

- Within two minutes of entering the tank, the wine was **saturated with oxygen** ($O_2$ > 200 hPa; dissolved oxygen roughly > 9 mg/L). This uptake is likely due to the **splashing and turbulence** of the wine as it enters the empty tank resulting in excessive oxygen exposure.

### 1.3) Dissolved oxygen measured in the receiving tank during filling

*Oxygen measurement probe location: 0.1 m below the surface of the wine in the receiving tank*

- As the volume of the wine in the receiving tank increased, the **dissolved oxygen concentration decreased**. After ten minutes of filling, the dissolved oxygen concentration in the wine was ± 1 mg/L.

This decrease in dissolved oxygen from the time of entering the empty receiving tank (see point 1.2) to around 1 mg/L after ten minutes of filling is likely due to the **continuous influx of low-oxygen wine** (from the source tank) which diluted the initial saturated wine fraction. As the tank filled from the bottom, the **turbulence and splashing subsided** and the fresh wine entering the tank was not exposed to the same oxygen exposure as the first fraction of racked wine.

### 1.4) *Dissolved oxygen as the wine enters the receiving tank during the entire racking process*

*Oxygen measurement probe location: In the inlet valve of the receiving tank*

- The dissolved oxygen concentration in the wine at the inlet valve of the receiving tank **increased slightly** as racking continued. After measuring virtually zero for the first ± 12 minutes of racking (see point 1.1), the dissolved oxygen concentration started to increase.

This slight increase is likely due to the **dissolution of oxygen in the source tank** as the wine volume decreased and the headspace volume increased. This increase was, however, marginal and after ± 25 minutes of racking, the dissolved oxygen concentration measured at the receiving tank's inlet valve was **still below 1 mg/L**.

## TEST 2: Testing the inertion of the empty receiving tank

*Receiving tank volume: 1800 L*

*Receiving tank height: 1.7 m*

*Gasses tested: $N_2$, Ar, $CO_2$, $CO_2$/Ar (20%:80%), $CO_2/N_2$ (20%:80%)*

### 2.1 *Which inert gas was most effective and how much gas was needed?*

Each inert gas was injected into the tank until full inertion was achieved. The volume of gas dispensed was monitored.

*Oxygen measurement probes locations: Height from the bottom of the tank with the percentage of vessel volume in parenthesis: 0.04m (3%), 0.4m (25%), 1m (60%), 1.7m (100%)*

- Except for nitrogen (dilution purging), all the tested gases were **capable of forming an inert gas blanket** (displacement purging) from the bottom of the tank upwards.
- The **volume of inert gas needed** to obtain inertion at 1.7 m (100%) as well as the approximate economic impact in €/$m^3$ are shown in Table 1[1].

Table 1. Volume of gas needed to obtain 100% vessel inertion and the economical impact.[1]

| Gas used | Volume of gas needed to obtain inertion (measured in vessel volume %) at 1.7 m | Approximate economincal impact €/m$^3$ vessel volume |
|---|---|---|
| $CO_2$ / Ar (20:80) | 70 | 12 |
| $CO_2$ / $N_2$ (20:80) | 100 | 14 |
| $CO_2$ | 125 | 3 |
| Ar | 125 | 17 |
| $N_2$ | 270 | 20 |

- The **mixture of $CO_2$/Ar (20:80)** was shown to be **most effective** in forming a protective inert gas blanket and only 70% of the vessel volume was needed to achieve inertion at 1.7m (100%).
- **$CO_2$ was the most economical** option with the lowest approximate €/m$^3$. **Nitrogen was the least economical** due to the large volume of gas needed to achieve inertion.

## 2.2 How effective was the inerted receiving tank in protecting the wine from oxygen dissolution?

Different volumes of inert gas were injected into the empty receiving tank. **Each inert gas blanket (different gases with different thicknesses) and its protective effect were tested** by racking the wine into the receiving tank and measuring the dissolved oxygen in the wine during the process.

*Gas blanket thicknesses: 0.04m (3%), 0.4m (25%), 1m (60%)*

*Oxygen measurement probe location: 0.1 m below the surface of the wine in the receiving tank*

*Total duration of racking from start to finish: ± 20 minutes*

**The results from nitrogen inertisation are omitted from the interpretation below due to inconsistent results*

- In general, **as the thickness of the inert gas blankets decreased**, the protection from oxygen exposure also decreased and the **dissolved oxygen concentration in the racked wine increased**. For some of the gases, a blanket thickness of 0.04m (3%) did not achieve inertness and was significantly less efficient in protecting the wine from oxygen exposure.
- When comparing the efficiency of the different blanket thicknesses, results showed that the **practical differences between a 1m (60%) blanket thickness compared to a 0.4m (25%) blanket thickness were relatively small.** It seems that a blanket thickness of 0.4m (25%) in

the receiving tank would be **sufficient to maintain low dissolved oxygen** concentrations in wine during racking.

- In general, **$CO_2$ was the gas that provided the least protection in all three blanket thicknesses**, especially during the first five minutes of racking. The remaining gases were all more or less sufficiently effective.

### 2.3 *Did the inert gas blanket on top of the wine in the receiving tank remain stable during filling?*

*Gas blanket thicknesses: 0.4m (25%), 1m (60%)*

*Oxygen measurement probe location: 0.3 m above the surface of the wine in the receiving tank*

*Total duration of racking from start to finish: ± 20 minutes*

**The results from nitrogen inertisation are omitted from the interpretation below due to inconsistent results*

- **Both blanket thicknesses, 0.4m (25%) and 1m (60%) delivered relatively stable inertisation throughout the racking process.**
- At 0.4m (25%), the efficiency can be roughly arranged from most effective to least effective: **Ar > $CO_2$ = $CO_2$/Ar (20%:80%) > $CO_2$/$N_2$ (20%:80%).** However, these differences were relatively small and **all gases can be considered efficient**.

## References


(1) del Barrio-Galán, R.; Nevares, I.; del Alamo-Sanza, M. Characterization and Control of Oxygen Uptake in the Blanketing and Purging of Tanks with Inert Gases in the Winery. *Beverages* **2023**, *9* (1), 19. https://doi.org/10.3390/beverages9010019.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