The efficiency of inert gas during racking

Part 3: Inerting the source tank and main conclusions

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Basic Wine

15 December 2023

Part 1 of this blog series looked at **different inert gases** used in the cellar as well as **strategies to inert** gaseous tank spaces. Part 2 summarised the main findings of a study[1] looking at inert gas effectiveness in providing an inert atmosphere in the **receiving tank** during the racking of a model wine from one tank to another (TEST 1 and TEST 2). The current blog post (Part 3) will continue reporting on the main findings of the study mentioned above, but will primarily look at the effects of inerting the **source tank** during racking (TEST 3). Only some of the results reported in the study are discussed in this blog post, for more information, please consult the original publication[1].

Materials and Methods[1]

See Part 2 for more details regarding the materials and methods used in this study.

TEST 3: Testing the inertion of the source tank during racking

3.1 Did the gas blanket on top of the wine in the source tank remain stable during racking?

In the source tank, the effectivity of the different gas blankets was tested by dispensing **50% of the vessel volume of gas** on top of the wine during racking (the volume of the wine in the tank decreased during the racking process). The injection of gases stopped after ± 10 minutes (at which point 50% of the vessel volume was dispensed) and the oxygen content in the headspace was monitored for the remaining ± 10 minutes of racking.

Inert gas dispensing: Continuous gas feeding up to 50% vessel volume (flow stopped after ± 10 minutes)
Oxygen measurement probe location: 0.3m above the surface of the wine in the source tank
Total duration of racking from start to finish: ± 20 minutes

- **All the gases tested provided inertisation during the initial ± 10 minutes during which gas was continuously dispensed.**
- After ± 10 minutes (50% vessel volume dispensed), the gas flow was terminated. An **immediate and significant increase in oxygen content in the headspace was observed for gases N_2 and CO_2/N_2 (20%:80%)**. For the remaining gases tested, some increases were observed, however, these increases were considered to be relatively small and the **headspace was still considered inert**. For these more effective gases, the rough order of effectivity ranged from most effective to least effective: **CO_2/Ar (20%:80%) > CO_2 > Ar**. The **continuous flow** of inert gas in the source tank during racking is therefore **not needed** when using these gases.

3.2 Dissolved oxygen concentration in the wine when leaving the source tank

Inert gas was dispensed on top of the wine in the source tank during the racking process. The injection of gases stopped after ± 10 minutes (at which point 50% of the vessel volume was dispensed). The dissolved oxygen concentration in the wine when leaving the source tank (outlet valve) was measured during the racking process.

Inert gas dispensing: Continuous gas feeding up to 50% vessel volume (flow stopped after ± 10 minutes)
Oxygen measurement probe location: Outlet valve of the source tank
Total duration of racking from start to finish: ± 20 minutes

- During the **initial ± 10 minutes** of racking during which inert gas was dispensed, the dissolved oxygen content in the wine **remained low**.
- After the initial ± 10 minutes, the dispensing of gas into the headspace was terminated while the racking process continued for another ± 10 minutes. During this second half of the racking process, the **dissolved oxygen content in the wine (measured at the outlet valve) remained suitably low for all gases (including N_2 and CO_2/N_2 (20%:80%))**.
- When **no inert gases** were applied (exposure to air) the dissolved oxygen content in the outlet valve remained low for the initial ± 10 minutes after which the dissolved oxygen concentration started to **increase significantly**.
- It seems that even though an increase in dissolved oxygen was seen in the **headspace** after the ceasing of gas flow for N_2 and CO_2/N_2 (20%:80%) (see point 3.1), the resultant exposure of the wine to oxygen was **not severe enough** to cause a significant increase in dissolved oxygen concentration in the wine. It might be better to er on the safe side and rather opt to use one of the more effective inert gases in the source tank, however, **a continuous flow of gas until racking is finished does not seem to be necessary**.

Main conclusions for the study[1] (Part 2-3)

No inert gas (Part 2)

- It seems that the **major source** of oxygen dissolution during racking operations is the **initial entrance of the wine into the receiving tank**. Oxygen pickup due to exposure in the source tank and transfer lines contributes relatively little when compared to the exposure experienced in the receiving tank.

Inerting effectiveness (Part 2)

- Except for nitrogen (dilution purging), all the tested gases were **capable of forming an inert gas blanket** (displacement purging).
- 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 inert the entire tank. The other gases tested needed **larger volumes** ranging from 100% to 270%.
- **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.

Receiving tank (Part 2)

- The difference in the protection provided by a **blanket thickness of 60%** vessel volume was small when compared to the protection provided by a **blanket thickness of 25%** vessel volume. A 25% vessel volume blanket thickness should, therefore be sufficient to provide protection in the receiving tank during racking.
- The inert gas **blanket of 25% vessel volume remained stable** during the racking process and all gases tested (see log post) were more or less efficient in providing protection during the racking process. However, the use of CO_2 resulted in **some increases** in dissolved oxygen in the wine during the initial stages of racking.

Source tank (Part 3)

- Gases CO_2, Ar and a mixture CO_2/Ar (20:80) were considered to be the **most effective** in providing protection for the wine in the source tank during racking.
- For the above mentioned gases, it is **not needed to maintain a continuous gas flow** for the entire duration of racking.

- The use of N_2 or a gas mixture containing N_2 were also effective, however, for these it is **advised to maintain a continuous gas flow** for the entire duration of racking.

It should be noted that **N_2 and its mixture with CO_2 showed inconsistent and unpredictable results** for many of the tests conducted. It was difficult to draw conclusions on the effectivity of N_2 in an oenological environment and based on the findings of this study, N_2 and the mixture containing N_2 **cannot be recommended** for use in the winery.

The conditions under which the study was conducted should also be considered. Factors such as the tempo of racking, the length and diameter of the transfer lines and the pump's efficiency and the effectivity of the seals can all play an important role in oxygen dissolution during racking. A relatively small tank volume (1800 L) was used to conduct the tests and the effectivity and efficiency of the different gases and blanket thicknesses might change as the vessel's shape and height/diameter ratio changes.

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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