A SELECTION OF OENOLOGICAL GASES

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INTRODUCTION

There are several economical and efficient options to control the levels of oxygen and carbon dioxide. They are offered and can be used as pure gases or mixed with each other, as dry-gels, pellets or dry powder in different forms and as associated materials.
This article intends to answer frequently asked questions about the gases mostly used in oenology, and also gives some details for their application.

CARBON DIOXIDE (X 2)

Its properties

- Solubility: 1.01 v/v
- Relative density: 1.53 (Air = 1)
- Available in different containers: Bottles (large 37 kg and small 10 kg), rangers (170 kg) or permanent tanks (variable capacities)

Carbon dioxide is still the most heavily used gas in oenology and produces good results if properly applied. Its main property is its solubility in wine (1.01 v/v).

Because of its density (53% heavier than air) and in spite of being very soluble in wine, it tends to blanket the surface of wines in tanks. In the production of dry-gels/dry-ice the conversion ratio from liquid to solid never exceeds 40%, even if the reservoir holding the carbon dioxide is cooled below 0°C. If bottles are used, the yield will hardly exceed 25%.

Theoretical yield of dry-gels as a function of bottle temperature:

Bottle temperature in º C	***Theoretical yield of dry-gel in %***
4	35
10	32
15	30
25	25
35	21

N.B.: The true yield is approximately 80% of the theoretical yield.

Equipment needed?

In order to operate a simple carbon dioxide installation, the following is needed: a pressure regulator and/or flowmeter as well as a reheater, a suitable flexible pipe, a gaz diffuser or a French “Purgal” – a diffuser which can be fitted to the top of the tank.
The reheater is not essential if the various bottles are connected to each other (the maximum flow per bottle is 1.8 kg per hour – 960 litres per hour, or 16 litres per minute).

In order to bring the residual oxygen level in the headspace below 2%, the volume of carbon dioxide needed will have to be approximately 1.5 times the volume of the headspace.

NITROGEN (X 1)

Properties?

- Solubility: 0.017 v/v
- Relative density: 0.9667 (Air = 1)
- Available in: bottles (large and small), rangers, permanent tanks “Floxal” units (on-site nitrogen generators)

Nitrogen is still very popular and frequently used, partly because of its low solubility (0.017 v/v). The disadvantage of this gas is its relative density (0.9667), which means that it is lighter than air. Consequently, the headspace has to be be purged with 3 to 7 times its volume. It is also essential to reflush the headspace regularly. A critical factor for this will be the impermeability of the tank.
In some countries, such as France and Italy, nitrogen is heavily used in oenology with good results.

Equipment required?

A simple installation will require the same equipment as listed above for carbon dioxide, except for the reheater which is not necessary for nitrogen.
The use of a regulated diffuser is less efficient since nitrogen, because of its low density, tends to rise to the top of the tank/headspace.
As for carbon dioxide, it is recommended to use a good flowmeter if the total gas consumption is to be determined.

Carbon dioxide/nitrogen mixtures (X 13, X 15)

Properties?

	X 12	**X 13**	**X 15**
Solubility:	0.2156	0.3149	0.5135
Relative Density:	1.0796	1.1356	1.2483
Available in:	pre-mixed bottles	as for Aligal 12	as for Aligal 12

Experiments have shown that the level of dissolved oxygen can be controlled using a balanced mixture of carbon dioxide and nitrogen. Carbon dioxide/nitrogen bottles are offered, where a specific mixing ratio has already been adjusted.
Every mixture contains a different percentage of carbon dioxide and nitrogen and thus, a different solubility and relative density.

The list below shows the percentage of carbon dioxide in the mixtures:
- **X 12** – 20% of carbon dioxide in nitrogen
- **X 13** – 30% of carbon dioxide in nitrogen
- **X 15** – 50% of carbon dioxide in nitrogen

Because of the physical properties of the different mixtures, we realized that these could be used to respond to various requirements. All the Aligal mixtures have a higher relative density than air and thus blanket the wine in the tank.
Preliminary studies could establish a correlation between the percentage of carbon dioxide (in the mixture) with the level of carbon dioxide dissolved in the wine.

Wine at 20° C
- **X 12** – 0.4 g/l of dissolved CO_2

- **X 13** – 0.5 g/l of dissolved CO_2
- **X 15** – 0.8 g/l of dissolved CO_2

Equipment required?
Regarding the equipment or systems required, a reheater may be necessary for mixtures with high percentages of carbon dioxide. Other than this, the same equipment than for nitrogen applications is needed (see above).

ARGON (X 6)

- Solubility**:** 0.038 v/v
- Relative density: 1.38
- Available in: bottles (large), rangers or permanent tanks

Considering experience gained in the U.S.A., Australia, New Zealand and France, argon certainly has a great future as inert gas in the wine industry.
Its physical properties offer interesting perspectives. It has a very low solubility (0.038 v/v), which is equivalent to nitrogen, but its relative density (1.38) is significantly higher. Thus argon, such as carbon dioxide, blankets the wine. Moreover, experimental results indicate that using argon offers advantages in terms of flavour, colour and aroma retention.
The argon volumes required for purging vary between 0.6 and 1 x the headspace, and the experiments confirm that residual oxygen levels inferior to 2% can be maintained for almost one week. This can be a very important decision factor for small wineries.

Are there only advantages?
No, because we have to consider that the initial cost is higher than for nitrogen or carbon dioxide. The expected gas consumption will have to be weighed against the argon price.

Equipment required?
Argon gas system requirements are identical to those for nitrogen, but the regulated diffuser and “Purgal” will work very efficiently.

ARGON / CARBON DIOXIDE MIXTURES (X 62 et X 63)

These recently developed mixtures resulted from experiences and studies carried out in the U.S.A. and Australia. They are a compromise between the advantages of argon and the cost of carbon dioxide. Their market introduction enables small producers (wherever they are) to benefit from a mixture containing argon and obtain significant results.

X 62 – 20% of carbon dioxide in argon
X 63 – 30% of carbon dioxide in argon

In France, the Aligal 62 mixture is widely used in combination with the “Purgal” system, while the Aligal 63 mixture is particularly used in Australia.

Equipment required?
No specific equipment is required for these mixtures - the standard system is fully adequate.
The average application rates are slightly higher than for pure argon, but still lower than those for carbon dioxide.

	X 62	**X 63**
Solubility:	0.2324	0.3296
Relative density:	1.41	1.425
Available in:	pre-mixed bottles	as for Aligal 62

DRY-GEL (DRY-ICE)

- Available as pellets or powder, or locally produced from permanent carbon dioxide tanks.

Dry-gel, which is economically viable and easy to use, remains a popular choice with many winemakers for tank inerting.
If used in this form, it remains in suspension at the wine surface.
The very cold gas is liberated rapidly from the dry-gel leading to low oxygen levels above the wine surface within few minutes.
Nevertheless, this effect diminishes very rapidly over a period of two to three hours because the dry-gel will lead to the formation of a thin ice layer.
If dry-gel addition is the only protective measure, it has to be reapplied approximately every 12 hours, in any case before 24 hours have elapsed.
Regarding the quantities required, the addition will have to be proportional to the headspace and not just a "handful" two or three times a week.
In theory, for every 1,000 litres headspace, 2 kg/day are required. In practice, it will be necessary to almost double this quantity since the product only lasts around 12 hours. This means a de facto consumption of twice the volume of the headspace (considering 500 l/kg) for long-term inerting. In spite of this, the process can be simple and inexpensive. However, it is recommended rather for short-term and punctual applications.

OXYGEN (X 3)

- Available in: bottles (large and small), rangers or permanent tanks.

Aligal 3 or food-grade oxygen is required for all microoxygenation or even hyperoxydation applications.

Equipment required?

The systems, equipment and procedures will depend on the particular needs, but it is important to note that all equipment has to be clean and tested for oxygen use.

The Future

With new studies and experimental work underway, and considering the demand for quality of the industry, the future is interesting. In America, mixtures of the three compounds (argon, carbon dioxide, nitrogen) are being used. Various examples of gas mixtures used in Australia - specifically for premium wine production - could be cited.

The percentage of carbon dioxide in the gas mixture determines its dissolution in the wine. Nitrogen contributes to cost reduction.
The best way to balance this mixture of three gases still has to be studied in order to respond to the needs of a larger number of winemakers.
Certainly, the distribution system and equipment will be adapted to allow every winemaker to use the new mixtures.

In the future, systems and equipment may be developed, that would enable us to infinitely vary gases or mixtures, in order to reach set objectives and efficiently contribute to wine quality control.