

Technical gases used in wine-making

SIAD food gases have wide-ranging application in wine fermentation processes.

Their rapid and extensive diffusion amongst wine-makers derives from the marked benefits which can be gained where these products are used: from improvements in the organoleptic characteristics of wine to the enhancement of the personality of some varietals, from the protection of the product during all the phases of the wine making process, to efficiency during the production process itself.

Solid Carbon Dioxide during the grape harvest

The use of solid carbon dioxide (CO₂), more commonly known as dry ice, plays an essential role:

- in controlling temperature so as to prevent excessive warming and, therefore, the premature fermentation of the grape, slowing down the whole intra and extra- cellular enzymatic metabolic mechanisms;
- in creating an inert atmosphere, via the process of sublimation, thereby reducing oxidation and preventing deterioration in the organoleptic characteristics of the wine.

The right “moments” for adding dry ice differ and depend on the type of grape, on the timing and production method and by the end results one wishes to achieve:

- during transportation from the vineyards to the wine making area, for both white and red grapes;
- on the crusher before the grapes are pressed, for white grapes;
- on the crusher-destemmer, for white and red grapes with different objectives.

The main effect of the treatment is to obtain wines characterised by more intense and complex aromatic notes. In the case of red wines, a more intense and stable colour is obtained, tending towards red and mauve tones, whilst the tannins appear more delicate and mature. The thermal shock, brought about by the sublimation of the CO₂ (-80°C) is able to provoke “cellular collapse” which leads to a greater extraction of phenolic substances. No less important are the benefits which they bestow, not so much on the final result, but on the production process: a reduction in the use of sulphur dioxide as an antioxidant; lower consumption of energy



when compared with using mechanical refrigeration; furthermore a quicker, higher and more homogenous temperature jump; and the combination, in one single product, of cooling and inertization properties.

By drawing on experience and combining that with the technology available today it becomes possible to make use of a diverse range of application methods, from the simplest and cheapest to the more complex and automated. Depending on the quantity of grapes that need treating and the characteristics of the wine production, one can go from simply distributing the dry ice over the grapes by hand, to using automated dry ice sprayers which can be installed on the machinery or at points in the production process where the dry-ice is needed, up to and including the adoption of “heat exchangers”, where the grapes are made to pass against the flow of a dry ice stream, for even more efficient cooling.

Dry Ice Characteristics

Solid Carbon Dioxide:	CO ₂
Temperature at ambient pressure:	-78,5°C
Heat absorbed up to 0°C:	152 kcal/kg
Specific Gravity:	1,5 kg/dm ³
Residual humidity:	0%
Appearance:	White, opaque
Odour:	Odourless

Characteristics of Carbon Dioxide

Chemical formula:	CO ₂
Titre:	99,5% (food additive specifications E290)
Temperature in liquid state:	-79°C
Density (kg/m³):	1,814
Solubility in water (cm³/cm³):	0,870
Molecular weight (g/mole):	44,0
Appearance:	Colourless gas
Odour:	Odourless gas

Nitrogen for venting and decanting

As with many other foods and beverages which are sensitive to the effects of oxygen, wine, when in contact with air, loses some of its organoleptic characteristics: colour, taste, aroma and vitamin content. Deterioration in the quality of wine can be avoided by using inert gases inside the storage containers, which inhibit the proliferation of bacteria, reduce the harmful effects of humidity and protect the conduction system from external contaminants. Gaseous nitrogen is fed into the area at the top of the wine storage container, substituting the air which would normally be present. By increasing the pressure in the headspace of the container, the gas itself becomes the safest and most secure mechanism for decanting or moving the wine on from one phase to the next in the wine-making process. Furthermore, the use of inert gases for protection and pushing the wine along means that pumps (which can leave contaminants behind from mechanical components) can be avoided, thereby reducing the possibility of contaminants being introduced from the external environment and eliminating the need for completely filling wine storage containers so as to avoid the formation of air pockets. Nitrogen can also be used in droplet form to protect bottled wine from the effects of the oxygen contained in the

headspace above the liquid. Through a dripper the correct dose of nitrogen is delivered directly into the bottle. Here, because of a temperature increase, liquid Nitrogen changes to gas creating an inert atmosphere with very low concentrations of Oxygen (between 21% to 2%). Inert gas is not only able to prevent contact between the wine and Oxygen, but also removes it from wine in which Oxygen has already become dissolved during, for example, its transfer from storage container to bottling plant.

This operation is made possible by gadgets called "in-line Strippers" via which Nitrogen is distributed throughout the liquid in the form of micro bubbles. These Nitrogen bubbles capture the oxygen which dissolves within them, thanks to the large surface contact area and to the difference in concentration of the oxygen between the liquid and the gas (Nitrogen).

The nitrogen, saturated with oxygen, is then expelled from the liquid when it exits the isobaric system.

Inertization with Argon

The ongoing quest for new solutions so as to satisfy more demanding requests and bring about further improvements in qualitative parameters, has led to experimentation in the most delicate phases of the wine making process, using another inert gas: Argon.

Argon has an even greater capacity for protecting wine than Nitrogen and is, moreover, the best gas for retaining, unaltered, the distinctive characteristics of the wine produced, without adding or taking anything away. Odourless, colourless, tasteless; it is an entirely inert gas and, indeed, a noble gas.

But the peculiar characteristics which, in essence, mainly contributed to the success of the experiments conducted with this gas, are as follows:

- Argon is heavier than Nitrogen, for which reason it stratifies over the wine, providing better protection from oxygen, even if a reduction of the pressure inside the containers should occur;
- being more soluble than Nitrogen, but less so than CO₂, the potential phenomenon of gas emulsion in the liquid (and the resulting removal of substances which determine the distinctive aromatic notes in the wine) is eliminated.

Other benefits derive from a more inhibitive effect on the oxidising enzymes tyrosinase and glucose oxydase). In summary, different from Carbon Dioxide, it does not lead to gasification of the wine and, an important fact to consider is that its use is fully permitted within the existing norms for the oenology field, without any limits whatsoever.

Characteristics of Nitrogen

Chemical formula:	N ₂
Food additive:	E941
Temperature when in a liquid state:	-196°C
Density (kg/m³):	1,147
Solubility in water (cm³/cm³):	0,0156
Molecular weight (g/mole):	28
Type:	Inert
Appearance:	Colourless gas
Odour:	Odourless gas

Characteristics of Argon

Chemical formula:	Ar
Food additive:	E938
Temperature when in a liquid state:	-186°C
Density (kg/m³):	1,636
Solubility in water (cm³/cm³):	0,0340
Molecular weight (g/mole):	39,9
Type:	Inert
Appearance:	Colourless gas
Odour:	Odourless gas

Macro and micro oxygenation

Oxygenation is a technique in which an accurately measured amount of oxygen is introduced during certain phases of the wine making process, with the aim of achieving certain results such as encouraging the multiplication of the yeast content, ageing, etc... Depending on the quantity of Oxygen and the amount of time to which it is subjected to Oxygenation, the terms Micro and Macro oxygenation are used.

Micro oxygenation consists of an Oxygen dose in the amount of 10 ml per litre, for a period of 30 days, starting sometime in the 10 to 30 day period after alcoholic fermentation. The Oxygen introduced is gradually absorbed and decreases the reduction phenomena and the formation of undesirable compounds. For white wines aged in wood, it contributes to the ageing process of the ellagitannins, improving taste and aroma. With red wines, it helps to maintain the stability of the substances which affect the wine's colour, preventing the formation of sulphur compounds and launching the polymerization and the condensation of tannins phase.

Macro oxygenation consists of an Oxygen dose in the region of 3 to 5 mg per litre, for a period of one or two days, during the final phase of fermentation. The Oxygen allows the yeasts to finish their alcohol fermentation, preventing the production of unpleasant odours and tastes. It helps to restore the phenolics, thereby maintaining the original colour.

For white wines, improving fermentation conditions impedes the production of hydrogen sulphide.

Depuration of wastewater with oxygen: The Mixflo® system

The need to treat the wastewaters, which results as a by-product of the process, has also frequently made it necessary for wine producers to adopt biological depuration systems for dealing with active sludge.

Traditional systems, which operate via the insufflation of air or oxygen into the "biological oxidation tank", have limited efficiency given the brief amount of time the oxygen remains in contact with the liquid.

The Mixflo® system, based on a liquid-liquid mixture principal, makes it possible to achieve a much more efficient depuration system thanks to a better diffusion of the oxygen. In substance, a fraction of the wastewater is removed from the tub, pressurised and enriched with oxygen to create a monophasic liquid which is then reintroduced into the tub. This process is repeated until a perfect mix of oxygen in the liquid has been obtained.

Mixflo® is an ecological system which does not leak polluting aerosols out into the atmosphere. Furthermore, it is extremely adaptable allowing absorption at times of extra demand; with Mixflo® pure oxygen can be used in the tubs only when necessary, making it possible to double the depuration capacity of the plant without having to take any further action, or it can be used to replace deficiencies in or limitations in existing plants, giving the possibility to optimise and/or limit the size of the tubs required for depuration treatment.

It is adaptable, in fact, to any type of tub and the pump can be fitted either externally or be immersed. Finally the sludge treated with pure oxygen collects more easily into a mass or forms better sediment.

Characteristics of Oxygen

Chemical formula:	O ₂
Titre:	99,5% (food additive specifications E948)
Temperature when in a liquid state:	-183°C
Density (kg/m³):	1,311
Solubility in water (cm³/cm³):	0,0310
Molecular weight (g/mole):	32,0
Type:	Oxidant
Appearance:	Colourless gas
Odour:	Odourless gas



Gases for food use

For wine production applications, as with all cases where technical gases come into contact with food products, it is extremely important to ensure that the gases are of an appropriate qualitative standard for the use to which they are being put and that they are produced in strict adherence to hygienic production rules and regulations. Gases from the Foodline® range, dedicated to food and beverage applications, comply with all these prerequisites.

First of all, they are certified as food additive gases and therefore are: Additive E290 for Carbon Dioxide, E941 for Nitrogen, E948 for Oxygen and E938 for Argon. Furthermore, materials and containers used for these gases are compatible with food use: dedicated gas cylinders, anti-contamination valves, guaranteed by a seal of integrity, and appropriately coloured and labelled for recognition as such.

Even Dry Ice, which from this point of view is one of the most delicate products, is prepared using an automated control (HACCP) system, in compliance with the hygienic production requirements.

Thanks to its SIT accredited Analysis and Research laboratory, SIAD is in a position to guarantee Foodline® products, also taking into consideration any special organoleptic or particularly stringent characteristics, which go over and beyond the safety, hygiene and toxicological requirements stipulated by law.



Cooling grapes during the harvest to avoid their premature fermentation and oxidation.

Gas used: Solid Carbon Dioxide

Carbon Grinding: Saturation of the tubs with carbon dioxide to promote fermentation.

Gas used: Carbon Dioxide

Venting and pushing the wine to prevent its contact with oxygen, avoiding any alteration.

Gas used: Nitrogen or Argon

Homogenisation: Shaking with an inert gas at controlled speed, protecting it from contact with air.

Gas used: Nitrogen

Macro and micro oxygenation: Completion of the fermentation process avoiding the formation of undesirable compounds.

Gas used: Oxygen

Decanting: removal of dissolved oxygen on the production line between the storage container and bottling.

Gas used: Nitrogen

Bottling: pushing along the production line and inertization to improve the quality of the wine, and production efficiency.

Gas used: Nitrogen or Argon

Draft wine: pressurisation of the barrels and pneumatic transportation towards the tap.

Gas used: Nitrogen or Carbon Dioxide

Wastewater treatment: removal of organic substances dissolved in water.

Gas used: Oxygen

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