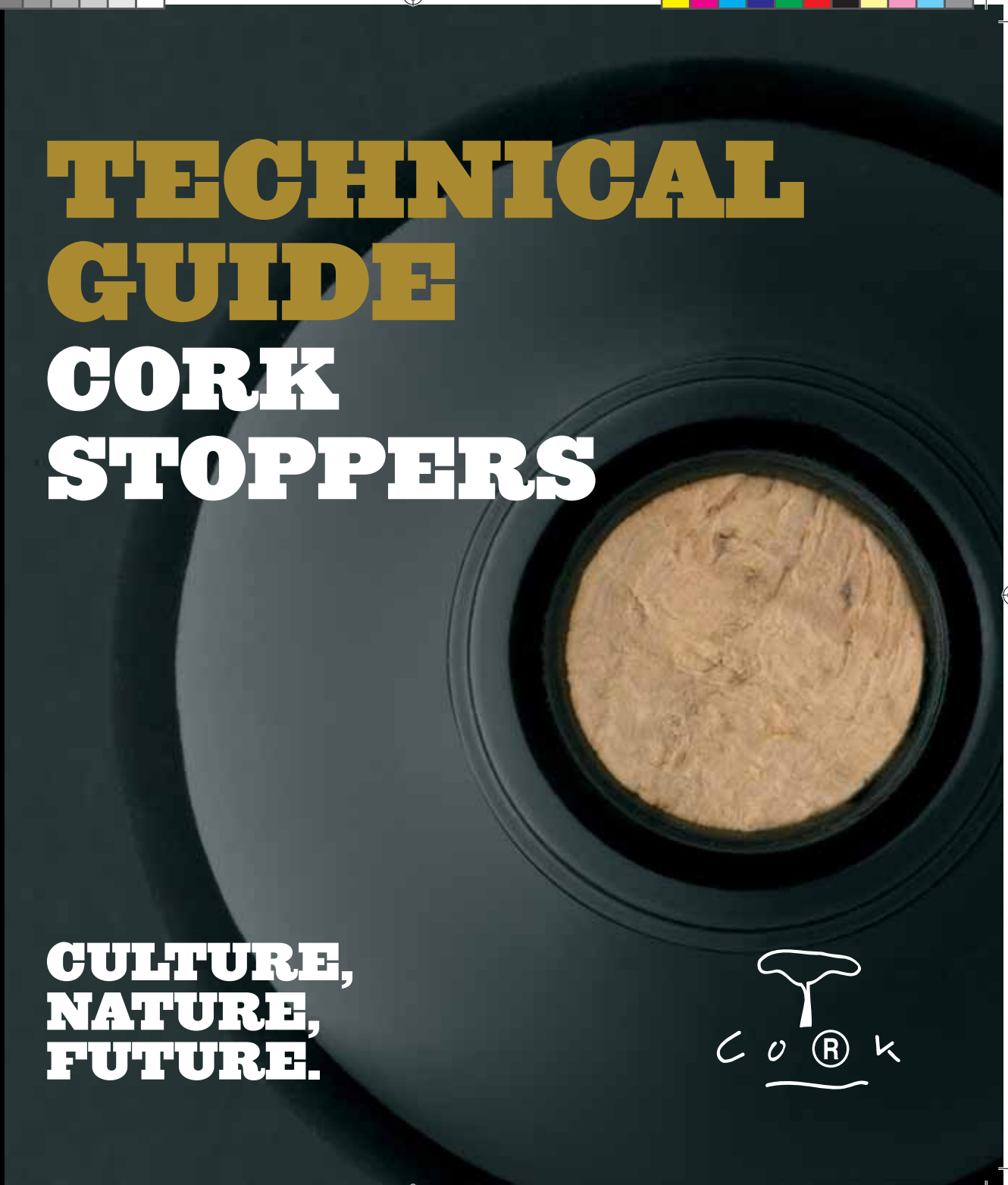
TECHNICAL GUIDE

CORK STOPPERS



CULTURE, NATURE, FUTURE.

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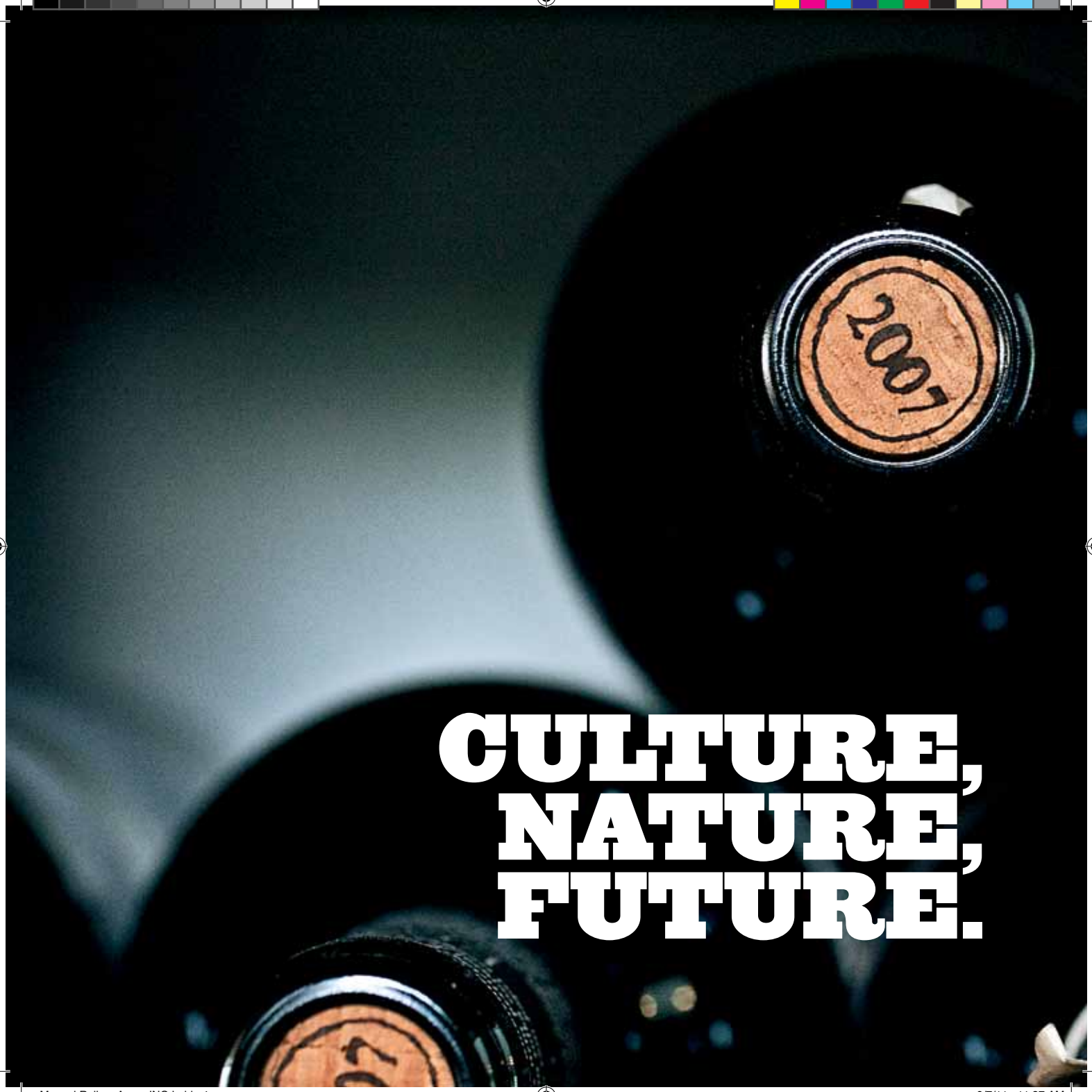


Knowledge passed from Generation to Generation

Cork has protected, inspired and fascinated mankind for thousands of years. The discovery of cork's potential and excellence has led to various industries passing this knowledge on from generation to generation, without cutting down a single tree.

Synonymous with Good Wine

Cork has been the preferred wine closure for centuries and is chosen by over 70% of winemakers worldwide, for approximately 12 billion bottles produced annually.

100% Environmentally Friendly

Cork is a 100% natural, sustainable and recyclable material. Cork oaks have a unique ability to absorb CO_2 from the atmosphere. It is estimated that the cork oak forests can absorb up to 14 million tons of CO_2 per year.

Biodiversity Hotspot

The cork oak forest is one of the 35 global biodiversity hotspots and a habitat for some of the most endangered species on the planet. It helps to control erosion, regulates the hydrological cycle and contributes to fighting desertification and global warming.

Innovation, Technology and Quality

High-tech materials for the aerospace industry, polymer compounds for the transport sector, top-level sports equipment, benchmark architecture and design works are just a few examples of how cork is used which demonstrates the versatility of this complex material.

Added Value

Since there is no future without people, the cork industry is a truly social, environmental and economic pillar for the millions of inhabitants of the western Mediterranean basin. Thanks to the cork oak forest and products made from cork, it is possible to show that sustainable development may not be a utopia.

The Montado is an intensively cultivated landscape in Portugal, representing about 21% of Portugal's national forest area and more than 50% of the world's production of cork.

Although it is found throughout the country, the cork oak is characteristically associated with the landscape of Alentejo where there are large concentrations of cork.

Throughout the world, the Montado occupies a total area of about two million hectares, mostly in the Mediterranean basin, and especially in Portugal, which accounts for 30% of the world's total.

Cork is the name given to the bark of the cork oak (Quercus Suber L.), a tree that is found principally in the western Mediterranean region, where a manmade environment known as Montados (or Dehesas, in Spain) has formed. Among the various unique characteristics that distinguish it from other trees of its species, it has the particular trait of naturally regenerating its bark, the cork, after each harvest. The act of harvesting the cork from the cork oak tree is a very delicate operation which follows the legal rules of the season, frequency, intensity and form.

01. CORK, A NATURAL PRODUCT WITH UNIQUE QUALITIES

Harvesting is only carried out by experienced professionals at minimum intervals of nine years and causing no harm to the tree. The cork oak tree is neither cut nor damaged in extracting the cork bark. The first extraction of cork is only done when the tree reaches a perimeter of 0.70 cm measured at a height of 1.30 meters. However, the cork used to manufacture stoppers is only collected after the third harvest, which in general happens when the cork oak has reached about 45 years of age. Cork is thus said to be "cultivated." The average lifespan of a cork oak tree varies between 170 and 200 years, which means that a cork oak can generate cork for fabrication of stoppers about thirteen times.

Light, impermeable to liquids and gases, compressible, elastic, a good thermal and acoustic insulator, practically rot-resistant and highly resistant to friction, cork is a material that has been highly appreciated since early times in mankind's history.

The first references to cork date to 3000 BC in Egypt and Persia, where it was used in fishing gear. Yet its unique properties were also known to the Babylonians, the Assyrians, and the Phoenicians. During the classical Greek-Roman period, it was widely used in the construction of floats of various types, honeycombs, soles for shoes, and stoppers.

However it has been with wine that cork has had the strongest and most significant relationship: ever since man came to produce and consume wine, cork has been the best material to seal it in barrels, bottles and pitchers for conservation. However, the industrial use of cork on a large scale only began to take shape towards the end of the eighteenth century, stimulated by the increasing use of glass vessels to package wine.

Cork is one of the most appreciated natural products. Its three-century old association with wine guarantees it a top place as a cultural reference.

02.

CORK STOPPER - AN INCOMPARABLE PRODUCT.

02.1 - Cork, preferred by consumers and winemakers

According to studies, consumers continue to prefer the cork stopper for their wine as it is associated with quality, tradition, and the ritual of enjoying wine. Yet winemakers are also of the same opinion, as found by other studies (Note 2). In addition, cork stoppers add value for their users in comparison with other stoppers. In a study published by AC Nielsen in 2010 in the USA, it was found that bottles of wine sealed with a cork sell at higher prices (one to two Euros) than those sealed with alternatives. The same study showed that the brands of wine that use cork stoppers showed higher annual growth in sales and more stable prices than those that opt for alternative closures, such as aluminum capsules and synthetic stoppers.

Note 2
In a study carried out in 2009 by Texas Tech University (Twisting Tradition: Consumers' Behavior Toward Alternative Closures):

71% of those interviewed prefer cork stoppers to other stoppers

82% choose to serve bottles of wine sealed with aa cork stopper

58% make the same association when consuming wine at home

The packaging thus has considerable value as a strategic marketing tool, as this type of stopper influences the perception the consumer has of the quality of the wine; consumers continue to relate aluminum capsules with cheap wine and cork stoppers with quality wine.

Wine Business Monthly magazine also released its "Closure Report" in 2009, surveying United States winemakers. Its main conclusions were:

- The cork stopper obtained the best positions in terms of perception and in the categories of consumer acceptance, performance in the bottling line, and product performance;
- On a scale from 0 to 5, in terms of 'general' perception, the cork stopper was awarded the highest marks with 4.0; it was given 4.5 in terms of consumer acceptance ; 4.0 in terms of performance on the bottling line; and 3.8 in terms of product performance;
- In terms of environmental impact, cork was once again awarded the highest mark with 3.9.
- In France, a study was carried out by Ipsos* in 2010 to assess the preference of French consumers for stoppers. Its main results were:

89,3% prefer natural cork to other stoppers

96,3% believe the cork stopper carries on tradition

89,8% said that the cork stopper preserves all the aromas of the wine

84,7% stated that wine could be kept longer if stored using a cork stopper

83,3% believe the cork stopper is a sign of the wine's quality

71,5% said that cork has less impact on the environment

*The study interviewed 955 French nationals aged 18 and over.

02.2 - The unique characteristics of the cork stopper

The natural properties of the cork stopper give the wine industry a stopper with incomparable characteristics.

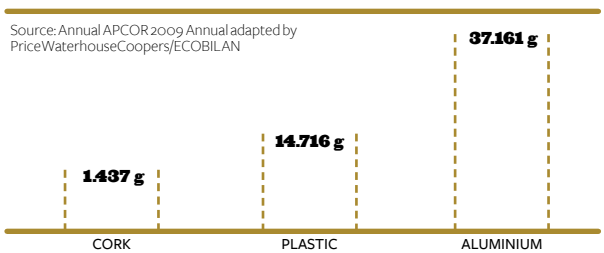
- **LIGHTNESS.**
  It weighs just 0.16 grams per cubic centimeter. A stopper contains about 89.7% air or similar gas;
- **FLEXIBILITY, ELASTICITY AND COMPRESSIBILITY.**
  These properties come from the approximately 750,000,000 cells (40,000,000 cells/cm3) that make up a cork stopper. These cells are waterproof and have a gaseous mixture inside them that is similar to air which enables a stopper to be easily compressed (to be fully inserted into the neck) and to recover its initial shape when decompressed, guaranteeing perfect adaptation to the neck of the bottle. This adaptation is also dynamic over time, accommodating the expansions and contractions that the glass undergoes due to variations in the temperature of the environment, ensuring that the bottle remains sealed;
- **IMPERMEABILITY.**
  to liquids and practically impermeable to gases, thanks to the suberin and cerin present in the composition of cork cells;
- **NON-PERISHABILITY.**
  Because of its chemical makeup and specific structure, it is highly resistant to the action of humidity and thus to the oxidation humidity causes;
- **RECYCLABLE, REUSABLE AND RENEWABLE.**
  Cork stoppers can be recycled and, when ground up, the resulting granulate is used in other products, such as for wall and floor coverings, shoe soles, fishing buoys, etc. Recycled cork is not reused in the fabrication of stoppers. The industrial use of cork guarantees the sustainability of the Montados, contributing to a balanced relationship with nature and the maintenance of the ecosystems associated with them.

02.3 - Environmentally friendly cork

In a study carried out by PriceWaterhouseCoopers/Ecobilan [1] on the life cycle of cork stoppers versus aluminum capsules and plastic stoppers, the cork stopper showed environmental advantages in comparison with alternative stoppers across different indicators.

In regards to the emission of greenhouse effect gases, the study showed that each plastic stopper emits 10 times more CO_2 than a cork stopper and the emissions of CO_2 by aluminum capsules are 26 times more than that of the cork stopper (Chart 1).

Chart 1 - CO_2 Emissions (g)/1000 stoppers



The environmental benefits of cork have been scientifically proven.

These results consider that each 45x24 cork stopper retains 6.4g of CO_2, corresponding to the carbon incorporated in each stopper by the photosynthesis process, and the impact by life cycle stage is summarized in table 1..

[1] PricewaterhouseCoopers/ECOBILAN, "Evaluation of the environmental impacts of Cork Stoppers versus Aluminium and Plastic Closures" (2008)

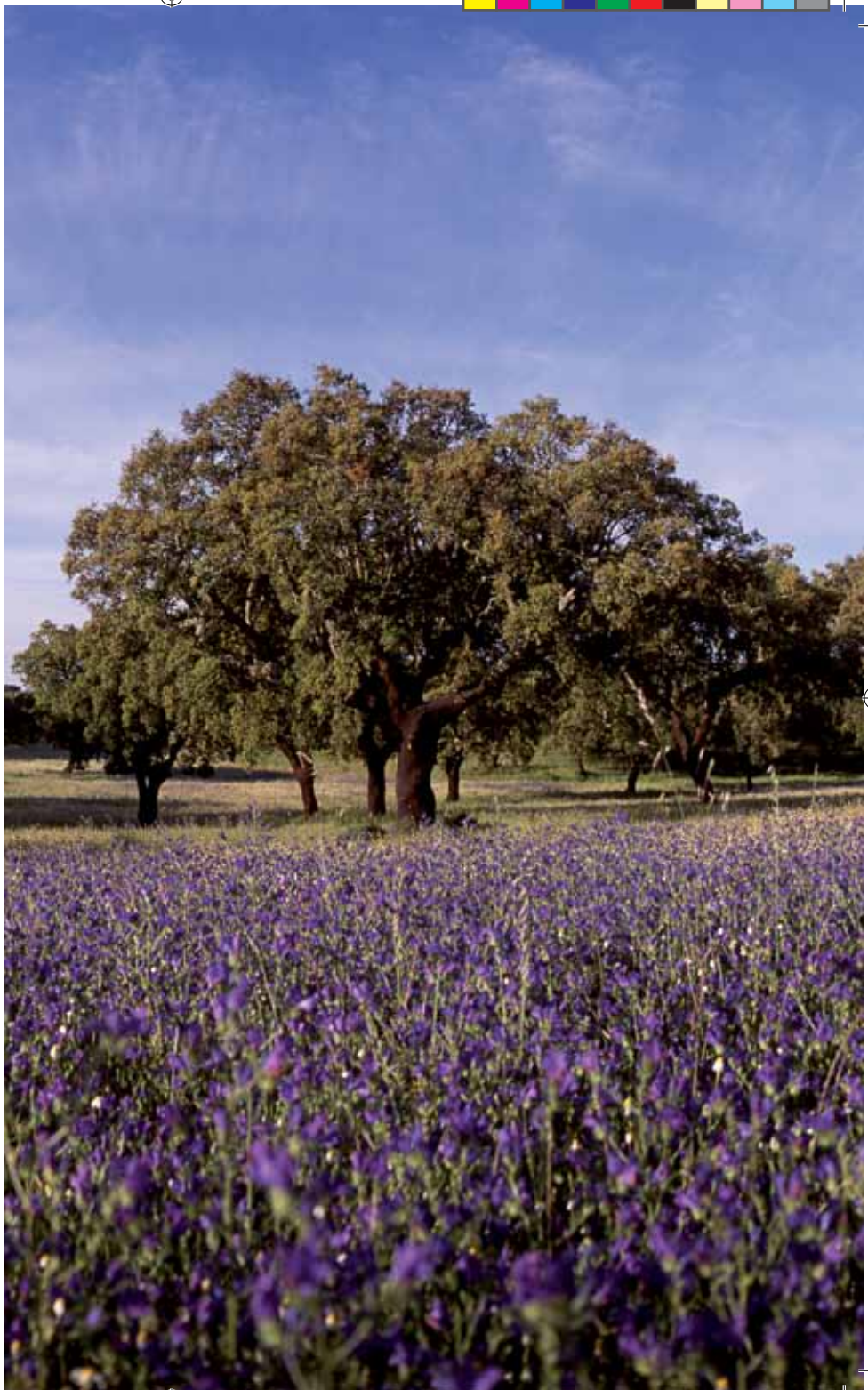


Table 1 – CO_2 emissions by life cycle stage

	CORK	PLASTIC	ALUMINIUM
Production	-3 280.5	12 618.3	36 701.0
Transport	920.9	323.1	439.4
Bottling	3 272.3	3 272.3	0.0
End of Life	524.0	1 497.5	20.3
Total CO_2 Emissions (g/1000 Stoppers)	1 436.7	14 716.2	37 160.7

Source: Annual APCOR 2009 Annual adapted by PriceWaterhouseCoopers/ECOBILAN

02.4 - Stopper permeability to oxygen

In understanding the impact of oxygen on the various phases of preparing and storing wine, it is crucial to guarantee the quality standards defined by wine producers. Oxygen is a factor which influences the aging of wine in a bottle. Its transmission is intimately related to the stopper.

The management of oxygen in the wine begins with the pressing of grapes, continues in the bottling and goes through to storage in the bottle through factors such as: head space between the wine and stopper, volume, pressure, and gaseous composition of the head space, and lastly entry of oxygen through the stopper.[2]

Stoppers play a significant role in the oxygen transmission levels in the period when the wine is stored. In a three year study carried out by the University of Bordeaux (France), the entry of oxygen was quantified for natural cork stoppers, technical cork stoppers, synthetic stoppers and different aluminum capsules using a non-destructive colorimetric method.

The results obtained showed that the different types of stoppers have significantly different permeability to oxygen. Aluminum capsules (Saran-tin Liner) act as a hermetic seal and do not allow oxygen to pass into the bottle over time. On the other hand, synthetic stoppers allow for a significant and constant entry of oxygen from the time they are placed into the bottle. Between these two extremes of behavior in relation to oxygen, cork stoppers provide a different dynamic, depending on their type: technical cork stoppers allow a small amount of oxygen to enter during the first month after bottling, and a negligible amount thereafter; natural cork stoppers allow for a significant increase in the amount of oxygen in the bottle in the first months, followed by a period of decreasing entry until about one year later, after which the entry of oxygen becomes negligible.

This same study also concluded that storing in the vertical or in the horizontal position has little impact on the entry of oxygen for the various stoppers. These results are in line with data published in 2005

by Skouroumounis et al.[3] Which demonstrate that there is no effect on the composition or on the sensorial properties of white wines during a period of five years whilst they are stored.

OXIDATION AND REDUCTION

The capacity of a stopper to contribute to the oxidation and/or reduction of wine in a bottle is very much linked to its oxygen transmission rate (OTR). The majority of wine producers recognise that some transmission of oxygen through the stopper is favorable to wine making.

In a recent study, the performance of different stoppers in producing a Sauvignon Blanc over two years in bottle showed that from a sensorial point of view, the evolution of the wine was balanced with the cork stoppers. The wine was proved to be more highly evolved using the synthetic stoppers and showed some reduction with the aluminum Saran-tin capsule, showing better evolution with Saranex.[4]

The results of the chemical analysis (ascorbic and sulfuric acid, color, 4MMP, 3MH, H2S) correlated with the sensorial evolution observed for the different stoppers.

02.5 - Cork and health

In recent years, various studies have been carried out to analyze the intrinsic properties of the Quercus Suber L. species, (particularly at the bark of the cork oak, the cork and its leaves,) and its advantages to health. Cork has physical, mechanical and chemical properties which not only have great potential for new applications, but could also play an important role in the well-being of mankind. This raw material consists of suberin, lignin, polysaccharides, ceroids, tannins and other components. The tannins have anti-oxidant and anti-carcinogenic properties and can be used in various applications after extraction of the cork. The tannins and flavonoids in the family of phenolic compounds have increasingly raised interest in the scientific community because of their high antioxidant capacity. Antioxidants are intimately involved in the prevention of cell damage and may help prevent cancer, aging, and a range of other illnesses.[5]

The notable anticarcinogenic, anti-inflammatory, antibacterial and anti-viral characteristics of the polyphenols in cork led Gali-Muhtasib et al. to conclude that these compounds are universal anti-tumoral agents.[6]

[2] Non-destructive Colorimetric Method To Determine the Oxygen Diffusion Rate through Closures Used in Winemaking – LOPES, Paulo; SAUCIER, Cédric; and GLORIES, Yves - In, Journal of Agricultural and Food Chemistry, 2005.

[3] The impact of closure type and storage conditions on the composition, colour and flavour properties of a Riesling and a wooded Chardonnay wine during five years'storage. – SKOUROUMOUNIS, G.K.; KWIATKOWSKI, M.J.; FRANCIS, I.L.; OAKEY, H.; CAPONE, D.; DUNCAN, B.; SEFTON, M.A.; WATERS, E.J. – Aust. J. GRAPE and Wine Res. 2005, 11, 369-384.

[4] Impact of Oxygen Dissolved at Bottling and Transmitted through Closures on the Composition and Sensory Properties of a Sauvignon Blanc Wine during Bottle Storage – LOPES, Paulo; SILVA,MARIA A.; PONS, Alexandre; TOMINAGA, Takatoshi; LAVIGNE, Valerie ; SAUCIER, Cedric; DARRIET, Philippe ; TEISSEDRE, Pierre-Louis and DUBOURDIEU, Denis – In, Journal of Agricultural and Food Chemistry, 2009..

[5] Antioxidant and Biological Properties of Bioactive Phenolic Compounds from Quercus suber L. – FERNANDES, Ana; FERNANDES, Iva, CRUZ, Luís, MATEUS, Nuno; CABRAL, Miguel; and FREITAS, Victor de – In, Journal of Agricultural and Food Chemistry, 2009.tural and Food Chemistry, 2009.

[6] Plant tannins as inhibitors of hydroperoxide production and tumor promotion induced by ultraviolet b radiation in mouse skin in vivo - GALI-MUHTASIB, H. U.; YAMOUT, S. Z.; SIDANI, M. M. Oncol.Rep. 1999.

Combining ancestral knowledge with its modern technological equivalent, the cork industry is now one of the most advanced and innovative industrial sectors.

03. THE LATEST GREAT ADVANCES OF THE CORK INDUSTRY

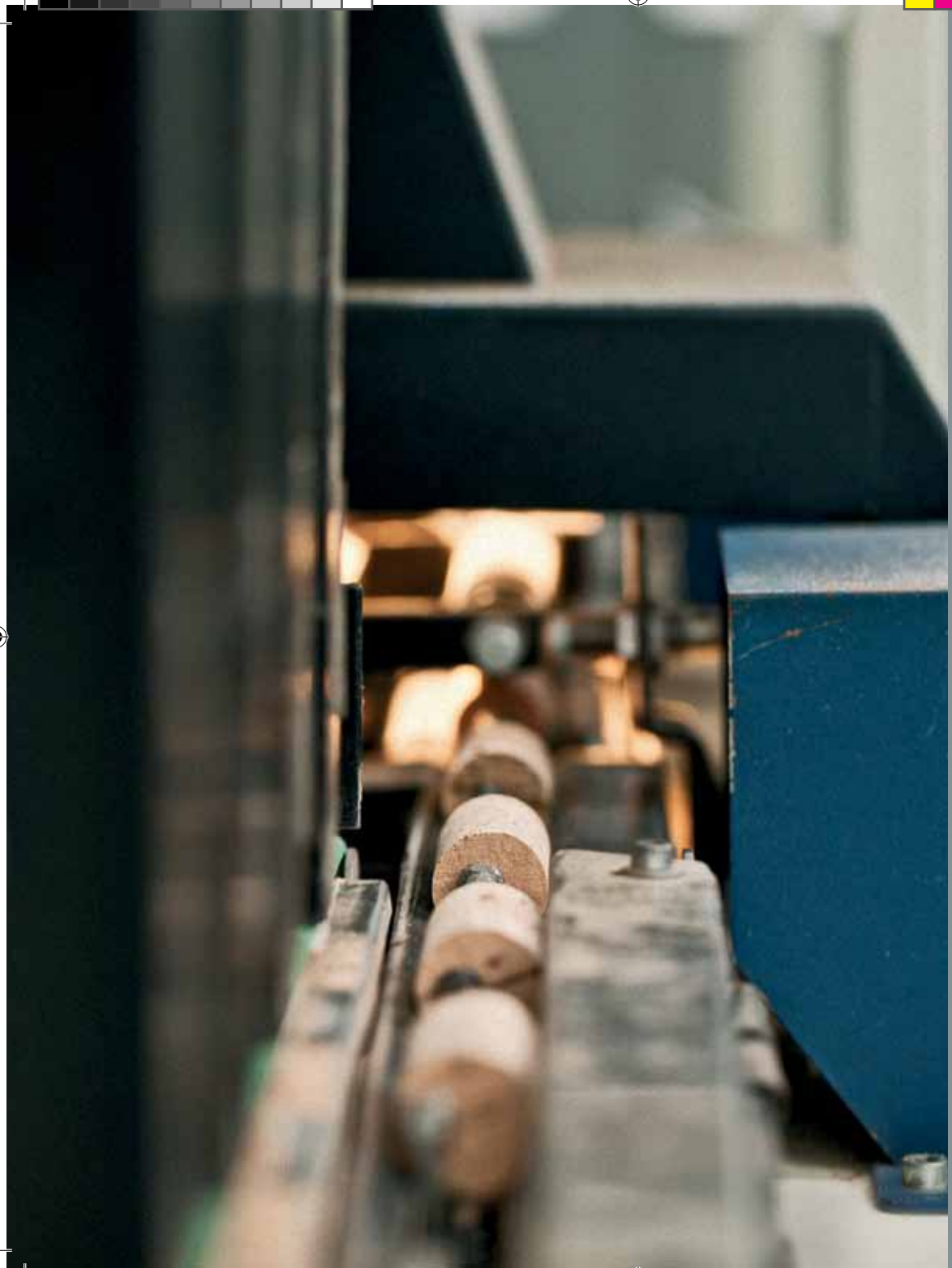
The Portuguese cork industry has invested heavily in research and development. As a result, the National Engineering and Industrial Technology Institute (INETI) found in its latest study in 2004 that there were 691 patents registered throughout the world related to cork, its applications and processes, broken down as follows:

363	115	114	99
Specific applications	Cork stoppers	Cork agglomerate	Technologies, processes and equipment

In terms of the individual investment by each one of the companies, it was also calculated that, in recent years, more than 400 million Euros (460 million dollars) has been provided for modernization, new factories, and new technologies.

The Portuguese cork industry has inaugurated a new paradigm of industrial management, becoming vertically integrated to guarantee control of the whole chain of value and, at the same time, coming closer to forestry production and end users. The cork industry is now totally committed to quality and to the satisfaction of its clients.

The cork industry has built new factories at a considerable rate in the last ten years, and these are the most up to date in the world in this sector. There is also increasing investment in research and development in quality. The industry is carrying out projects in different areas, such as diversification policies, personnel qualification and training, while continuing renovation of production processes. This impacts upon the entire management and organization of production as well as looking to guarantee the best occupational health and safety conditions; in the integration of process and environmental protection and improvement; in the intensification of internationalization; in the concern for the level of human resource management with a particular emphasis on skill



The Portuguese cork industry has launched a new paradigm of industrial management through verticalization to guarantee the control of the whole value chain and allowing for closer proximity to the forest and final consumer.

03.

development and qualifications; and also a serious effort regarding all aspects of quality, especially in relation to the implementation of the International Code of Cork Stoppers Manufacturing Practices (CODE) and of the accreditation system, Systecode.

The latter was a huge step taken by the cork industry in eradicating 2,4,6 - Trichloroanisole (TCA). The Quercus project was begun (1992-1996) as an initiative of the Confederation Europeenne du Liège (CELiège), which involved seven countries and various public and private laboratories which studied the sensorial problems related to the aroma/smell of mold in wine in greater depth.

Using suggestions from earlier studies and the discoveries of this wide-ranging project, it was possible to enhance knowledge about the compounds responsible for this type of problem, such as TCA, Tetrachloroanisole (TeCA) and Pentachloroanisole (PeCA) (see chapter 4).

Through Quercus, it was possible to gain a clearer understanding about the formation and contamination of TCA, and to formulate the basic rules to avoid them. It was from this initiative that the CODE was created, which is a set of standards and good practices for the production of cork stoppers, whose adoption by the cork industry allowed a quality level to be established for the entire sector.

The CODE became an international benchmark as of 1997. It is a dynamic code which always takes into account the most recent discoveries and ongoing technological advances and it is currently in its sixth version.

Continuing this movement towards quality, the international 'Systecode certification system' was established in 1999. The objective is to certify cork stopper companies that comply with the rules stipulated in the CODE.

In the first edition of Systecode in 2000, 87 Portuguese companies and 198 international companies were certified. In 2010, this number grew to 270 companies in Portugal and 377 at the international level. About 90% of these companies are members of the Portuguese Cork Association (APCOR).

The CODE and the consequent Systecode certification are two of the most important factors in the modernization of the heart of the cork stopper industry. These have resulted in companies adhering to the most advanced production techniques, while also requiring a broad and deep knowledge of the materials as well as absolute compliance with rules on hygiene, occupational health and the environment.

Systecode is a guarantee of quality and reliability that the market has begun to see the effects of in bottled wines as of 2001.

OTHER CERTIFICATION SYSTEMS

Cork companies have also adhered to other quality benchmarks, including:

48 certified with ISO 9001 (Quality), 8 certified with ISO 22000 (Food and safety), 4 certified with ISO 14001 (Environment) and 1 with NP 4397/OHSAS 18001 (occupational Health & Safety Systems)

Some companies have also signed on to Hazard Analysis Critical Control Points (HACCP), which became obligatory in the production and packaging of foods in 1998. This is a preventive food safety system which, when implemented, ensures the hygiene and chemical and microbiological safety of the foods. Because cork stoppers are in direct contact with food, namely wine, the mandatory use of the HACCP system in the wine sector has greatly increased the level of hygiene during the bottling process.

At the level of forestry certification and the respective chain of custody by the Forest Stewardship Council (FSC), there are around 50,000 hectares of Montado that have been certified and 20 Chain of Custody entity certifications, for companies in the sector (March 2011). In addition, the PEFC – Programme for the Endorsement of Forest Certification Schemes has currently certified 3 cork companies pertaining to the Chain of Custody.

TCA (2,4,6 - Trichloroanisole) is a chemical compound naturally present in nature. It can be present in wood, wine, water, soil, vegetables, fruit, and also in cork.

This compound is one of the chief factors responsible for the problem associated with mold liable to be found in cork. Very small amounts of this compound, on the order of nanograms, can be responsible for this defect.

04. COMBATING 2,4,6 - TRICHLOROANISOLE (TCA)

The limit of perception of TCA is variable depending on the consumer, the type of wine, the occasion at which it is consumed, amongst other factors.

Frequently the consumer will use the term "cork taint" to describe the sensory deviations associated with the taste/aroma of mold. However, this expression is incorrect because, although the cork stopper may be one possible vehicle for the transference of TCA to bottled wines, it is not the only one. In fact, its presence can also be associated with barrels where the wine was fermented, the equipment used in its bottling, the wooden pallets used in its transport, etc.

TCA is a compound that poses absolutely no problems to human health.

The practical advice referred to in this manual will be useful in preventing the contamination of your stoppers and of your wine by TCA and other chemically related compounds, for example, such as Tetrachloroanisole or Pentachloroanisole.

04.1 - TCA formation and contamination mechanisms

TCA is an exogenous product to wine, wood and cork stopper. If it is present in the atmosphere and comes into contact with the barrels, cork stoppers or even the wine, it may easily be absorbed. If it is present in the water, this absorption will also take place if this liquid comes into contact with the aforementioned products.

However, TCA may form directly in some of these products if they are contaminated with chlorophenols, which are the principal precursors of TCA. For formation of chlorophenols, a substance which contains phenol has to come into contact with a source of chlorine. If, for example, a wooden barrel is washed with a cleaning product that contains chlorine, there is an increased possibility that this will happen. Similarly, when a cork stopper is washed with chlorine, the possibility of chlorophenols developing increases. The cork industry banned the practice washing cork stoppers more than 15 years ago. The International Code of Cork Stopper Manufacturing Practices prohibits the use of chlorine and also any materials containing this compound at any stage of stopper production. Stoppers are currently washed with hydrogen peroxide as means of disinfecting and whitening.

Chloroanisoles are formed from chlorophenols by the action of enzymes present in most if not all fungi, with varying degrees of activity. These fungi are found in nature and potentially in cork. The good manufacturing practices of stoppers, namely short periods of stabilization of the raw material after boiling and the correct management of all of the materials which come into contact with stoppers, reduce the probability of these compounds forming.

04.2 - Methods of extraction, prevention, and control of TCA

In addition to the recognized standards in the International Code of Cork Stopper Manufacturing Practices, other processes to eradicate TCA have been implemented by companies in the sector, as follows:

04.2.1. - METHODS FOR EXTRACTION/NEUTRALIZATION OF TCA

A. New boiling systems

B. Controlled steam distillation

C. Volatilization by dragging a controlled temperature and humidity

D. Volatilization by dragging in the gaseous phase of adjusted polarity, under controlled temperature and humidity

E. Super-critical extraction with CO_2

04.

A

These processes are dynamic systems where the water is constantly circulated and at the same time being decontaminated before re-entering the boiling system. These systems allow for uniform boiling of all of the cork planks at high temperatures increasing the removal of the soluble compounds and the extraction of organic compounds that are volatile such as TCA, thus simultaneously avoiding the possibility of cross contamination.

B

The steam distillation of cork products, in particular cork granulates often used in Champagne and technical stoppers, is a highly effective process in the extraction of TCA from these products. In fact, the volatility of TCA allows it to be dragged in a current of steam. This process is patented by a company in the sector.

C

This process takes advantage of the fact that TCA has a volatility temperature of 60°C. In an environment where the relative humidity is permanently kept high and the temperature is maintained at 60°C, there is significant extraction of TCA from the cork stoppers. This process, patented by a company in the sector, used in natural stoppers is not only highly effective at reducing TCA levels, but also does not cause deformation of these stoppers.

D

Based on the principles of distillation and steam dragging, and seeking a polarity adjusted to the extraction of molecules such as TCA, this process patented by a company in the sector introduces the use of ethanol in the dragging phase.

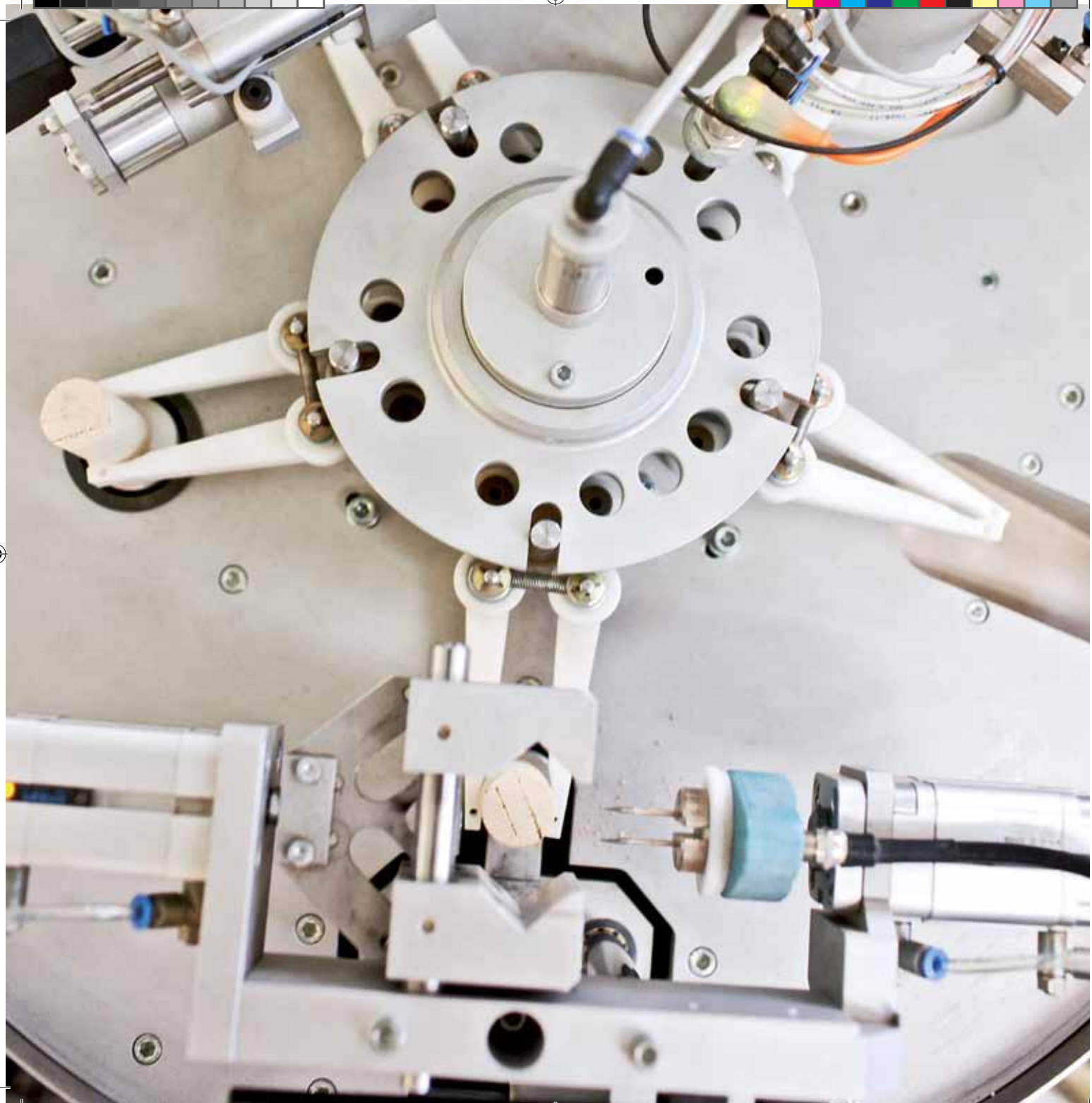
The process allows for the effective treatment of natural cork stoppers, preserving all of their physical and mechanical properties through the optimised combination of temperatures close to 60°C, concentration of ethanol in the steam phase, and continuous introduction of hot air.

The process simulates the ceding of cork molecules to bottled wine using the dissolving effect of the ethanol. Thus, the early migration of undesired aromas is achieved, dragged by a continuous extraction current during the treatment cycle.

The technology developed is inspired on the concept of migratable TCA, which became apparent at the end of the 1990s, also opened the doors to new quality control practices applicable to stoppers.

E

This process submits granulated cork to a current of CO_2 in a super-critical state to drag TCA and other volatile compounds of cork products. This process was patented by a company in the sector.



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04.2.2. - PREVENTION OF TCA FORMATION METHODS

IONIZATION

The significant reduction in the microbial load contributes to the prevention of TCA formation. A sterilising process of different materials called ionization can be used with cork products, contributing to their microbial decontamination.

MICRO-WAVES

The system works by vibrating the intramolecular connections using electromagnetic waves, which causes internal generation of heat. This rise in the internal temperature brings about evaporation of the water present in the material, enabling co-volatilization of metabolites by the action of steam.

SYMBIOS

Symbios is a process developed by the Cork Technological Center (CTCOR) which hinders the formation of chloroanisoles in cork, notably TCA. This is a preventive biological process, which brings about the development of benign microorganisms, which occur naturally in cork, to the detriment of microbiological species with potential formation of undesirable metabolites and the inhibition of biosynthesis of chloroanisoles during the transformation stages of cork.

As an additional advantage, during the boiling phase of the cork, this process brings about extraction of water soluble materials in the cork, such as soil and polyphenols (with potential negative impact on contact with drinks).

ENZYMATIC ACTIONS

Trichlorophenol is the principal precursor of TCA by fungal metoxilation of its OH group. Some enzymes are able to polymerize the phenolic compounds and chlorophenols in particular, making them unavailable for the aforementioned metoxilation.

CHROMATOGRAPHY IN GASEOUS PHASE

(SPME-GC/MS, SPME-GC/ECD) (ISO 20752)

The Cork Quality Council in the USA developed a research project using SPME-GC/MS analysis which allows technologically complex and very sensitive equipment to be used in the quantification of TCA in cork lots. This uses the application of Solid Phase Micro Extraction (SPMW) with Gas Chromotography (GC) adopting preferential detection by Mass Spectometer Detector (MS) and is also feasible to use other detection systems such as highly sensitive electron capture (ECD) (more information www.corkqc.com).

During the first research phase, new analytical tools were identified to replace the sensorial method using a chemical analysis process. The researchers said "the objective was to develop a qualitative and non-destructive test, while at the same time allowing for improvement in the level of sensitivity and reliability."

The second and third research phase culminated in the definition of the concept of TCA migration, which was the result of laboratory analysis of TCA levels in cork stoppers and the correlation with their performance in wine bottles.

Knowledge of the dynamic nature of the transfer of the TCA was needed to find out which conditions were necessary for a representative analysis.

The fourth phase sought to apply the laboratory methodology to a commercially viable quality control tool, and this gave rise to the current ISO 20752.

CQC carried out more than 24,000 analyses based on this methodology in 2010. The results compared with nine years of data show a drastic reduction in the levels of TCA: around 84 percent. In the most recent period of analysis, 93 percent of samples from loads of natural cork stoppers showed levels of less than 1.0 ng/l, and just 5 percent showed results between 1.0-2.0 ng/l.

Technical cork stoppers began to be tested after 2007. The results showed reduction of TCA similar to that of natural stoppers (chart 2).

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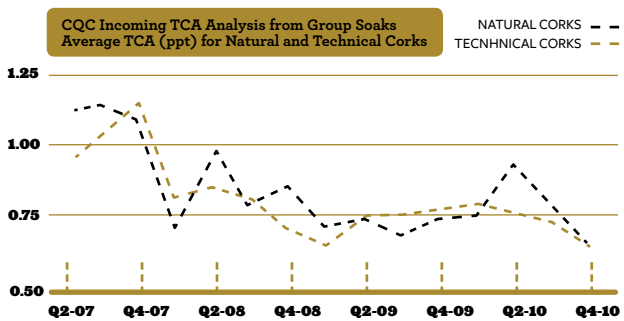
Chart 2 - Average TCA (ng/l) for samples of natural and technical stoppers



The method of quantifying TCA, developed by CQC, is now used by the large majority of companies in the sector and also by winemakers who carry out quality control on stoppers. This method is described in the ISO 20752 standard, as mentioned above.

SENSORIAL ANALISYS

(ISO/PRF 22308)

For many years sensorial analysis has contributed to quality control for cork stoppers. The analytical procedure is expressed in the ISO/PRF 22308 standard and has the advantage of not only describing the methodology to identify the aromas of mold, but also other aromas which may be present in the cork stoppers.

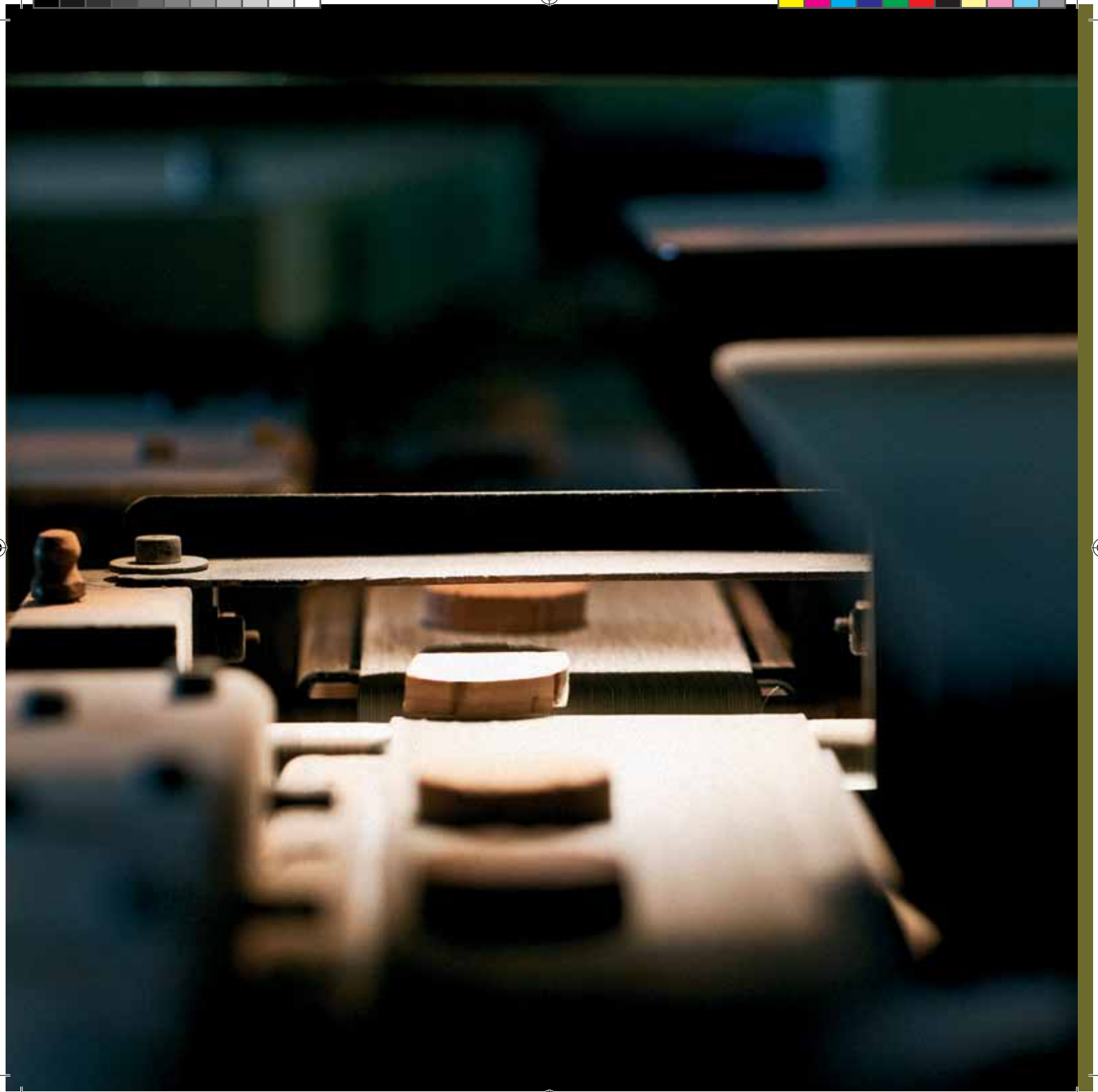
The curative, preventive, and control processes of TCA in cork products have contributed significantly to the qualitative improvement of these products and to improving their image with users, consumers and wine critics.

Some examples of this are given in the following testimonies:

Christian Butzke, Ph.D., Associate Professor of Food Science, Purdue University said: "TCA is no longer a problem..." His analyses at the Indy Wine Competition showed levels of TCA of less than 1 percent. (May/June 2009 Edition of Vineyard & Winery Management)

Robert Parker, at the end of The Grand Garnacha Tasting at the WineFuture Conference in November 2009, said: "A great success and triumph for Spain....my tasting had more than 650 people and about 200 on the waiting list... of the 600 bottles of wine opened... less than 1 percent had "cork taint"..."

Jancis Robinson, after a tasting of 200 bottles of 2006 vintage Bordeaux, said: "Perhaps the best news is that we had practically no bottles contaminated by TCA, which means that the cork industry took the TCA problem seriously." The article is entitled 'A mean, green streak in the crimson' and was published on January 30, 2010.



05. TYPES OF CORK STOPPERS

The cork industry has a full range of stoppers, available in countless shapes and sizes to adapt to the enormous diversity of bottles and every type of wine. Cork stoppers can be grouped into the following categories:

05.1 - Natural stoppers

Cork stoppers ensure the sealing of wine in a glass container. If this sealing is prolonged over time, the wine matures, which is to say there is an evolution by means of numerous physical and chemical processes between the components or between these and the substances in the bottle.

This gradual evolution of the bottled wine occurs in an environment with very low oxygen content, but which is necessary and sufficient for the correct aging of the wine. Until now, only the natural cork stopper has been able to provide this perfect balance, allowing for the correct evolution of the wine and the formation of the much appreciated "bouquet."

Bouquet consists of a set of aromas that characterize the wine in question and which in part develop during maturing of the wine in the bottle. This is the element that gives the wine personality and which is related to its intrinsic quality and to the conditions of its maturation or conservation.

The hermetic quality ensured by the cork stopper is not only indispensable to maturing wines, but is also necessary for wines which will be consumed more quickly. Natural stoppers enable the excellent conservation of wines while preventing interference in the harmony of their components, conferring a sign of quality to the wine.

Because of its characteristics of elasticity, compressibility, cellular makeup and innocuity, the stopper is the only sealant able to ensure this type of preservation in any style of wine.

In addition, only this natural material is able to adapt correctly to the internal irregularities of the neck, guaranteeing a perfect seal, even if the glass expands or contracts, which can happen when the ambient temperature changes during shipping or storage.

This perfect seal can last for decades and prolonged with high-quality cork stoppers and under correct wine storage conditions (suitable temperature, pressure and humidity and without great variations in temperature during the day or seasons of the year).

Formats: natural cork stoppers are fabricated by milling using a single piece of cork. There are cylindrical or conical shapes and various sizes. The most common measurements are those indicated in table 2 (length x diameter), and these measurements can be adjusted depending on the intended specifications..

Table 2 – Measurements of natural stoppers

	54X24 to 26mm	49X24 to 26mm	45X24 to 26mm	38X24 to 26mm	38X22	33X21 to 22mm
Bordeaux, Bourgogne or Rhine type bottle (75 cl)	OK	OK	OK	OK	OK	-
Bottle (50cl)	-	-	OK	OK	OK	OK
Half bottle (37,5cl)	-	-		OK	OK	OK
Prolonged aging	OK	OK	OK	OK	-	-
Average aging	-	-	-	-	OK	OK

NOTE: detailed consultation of the internal section of the neck of the bottle to be used is recommended (data supplied by the manufacturer), in order to be able to choose the size of stopper best suited to fulfilling its function as a closure.

05.

The use of longer stoppers is common in wines associated with longer bottled maturing. However, it should be said that the quality of the sealing over time depends more on the appropriate choice of the diameter of the stopper than on its length. Ideally, a stopper should be used that is at least 6 mm wider than the smallest diameter of the neck of the bottle, taking care that it should not be compressed by more than 33% of its diameter when inserted into the bottle, which may damage its cellular structure. On the other side of the equation, lengths should be chosen that guarantee expansion of volume in order to compensate for the internal pressures generated by any thermal fluctuations during storage and especially in shipping (which can have significant effects on the consequent variation in volume of liquid).

CLASSIFICATION OF NATURAL STOPPERS

In the commercial classification of natural cork stoppers, categories can frequently be found that are defined with the following names, according to visual criteria: Flor; Extra; Superior; 1st; 2nd; 3rd; 4th; 5th.

Classification is done based on a sample of stoppers agreed between the producer and the user, which serves as a reference standard for the fulfillment of orders (see "Visual Standard").

Checking the quality of the cork:

Density – The density of the cork is associated with the elasticity of the stopper. Cork for natural stoppers has a mass by volume of between 160 kg/m3 and 220 kg/m3, although it is possible to find stoppers with lower or higher densities from this interval range.

Humidity – The humidity in the cork stoppers should be between 4% and 9% in order to maintain the suitable elasticity and to reduce the possible risk of microbial development.

Surface Treatment – There are different large groups of products used in the treatment of the surface, but the use of paraffin and silicon is significant. Treatments with paraffin are used for sealing and also provide some lubrication. Treatments with silicon are principally for lubrication of the stopper, which facilitates use at the time of bottling and when opening the bottle. There are also other options available on the market which use lubricating and sealant polymers compatible with the foods industry.

The type of treatment to apply and its dosage depend on the type of wine, the type of bottle, aging time, and the type of bottling machine. For wines that need to be aged in the bottle (more than 18 months), a paraffin surface treatment must be done first followed by silicone treatment. Whatever the treatment used, it must be of the highest quality, as there is no use in having an esthetically attractive stopper with deficient finishing that may harm the final performance of the stopper.

Force of extraction – The force of extraction required for the stopper tends to lessen with time in the bottle. The recommended values are between 20 and 40 kg (24 hours after bottling), with the specifications varying according to the market. Nowadays, stopper producers have the means to develop surface treatments to meet required specifications..

Visual Standard – The visual class of the stoppers is established on the basis of the quantity and size of holes (lenticels) the surface has.

Sampling – In sampling, the size of the lots should always be taken into account and the standardised sampling tables - NP (Portuguese Standard), NP 2922 or ISO 3951 or ISO 2859, should be followed depending on the applicable mode of quality control.

05.2- Multipiece natural stoppers

Multipiece natural stoppers are manufactured from two or more pieces of natural cork glued together with an adhesive approved for use with food. These are stoppers made from thinner cork that would be insufficient to make natural stoppers in a single piece. These stoppers are of higher density.

Whether in more common sizes or in the existing classes, they are basically the same as single piece natural stoppers. The multipiece stoppers are used more in larger bottle sizes, as these require larger stoppers, and as such are harder to fabricate from a single piece.

05.3 - Colmated natural stoppers

Colmated stoppers are natural cork stoppers with pores (lenticels) that are only filled with the cork powder resulting from the finishing of natural stoppers. To set the powder in the lenticels, a natural resin base is used with natural rubber. This process is largely conducted using water based products to withdraw the organic colmating solvents that were frequent some years ago. Operational concerns (protection of the operator and the installations) and environmental considerations were present in this option.

Colmating essentially serves two purposes:

1 **To improve the visual aspect of the stopper**

2 **To improve its performance**

These stoppers are of quite homogenous appearance and have good mechanical characteristics. They are fabricated in the widest range of shapes and sizes. In the cylindrical shape, the most widely used sizes (length x diameter) are given in table 3. As with natural stoppers, sizes can be adjusted during production to ensure performance for a given model of bottle, although detailed consultation of specifications may determine needs for options other than those given in the following table.

Table 3 – Measurements of colmated natural stoppers

	49X24mm	38X24mm	38X22mm	33X21mm
Bordeaux, Bourgogne or Rhine type bottle (75 cl)	OK	OK	OK	-
Half bottle (37,5cl)	-	-	OK	OK
Average aging	OK	OK	OK	-

NOTE: detailed consultation of the internal section of the neck of the bottle to be used is recommended (data supplied by the manufacturer), in order to be able to choose the size of stopper best suited to fulfilling its function as a closure.

As for quality:

All the variables previously referred to in the "checking the quality of the cork" section should be noted. Furthermore, there is generally a classification which is divided into 3 classes, almost always associated with the visual aspect of the original product (before colmating). Irrespective of this classification, each manufacturer has specific products which may not fall under any of these classes.

05.4- Technical stoppers

Technical stoppers were designed for bottling of wines to be consumed, in general, within two or three years.

These consist of a dense agglomerated cork body with discs of natural cork glued to its top or both ends.

1+1
with a disc at each end

2+2
With two discs of natural cork

2+0
with two discs at just one end

To glue the discs of cork to the ends of the cylinder of agglomerated cork, agglutinins approved for use in products that will come into contact with foods are used.

This type of stopper is chemically very stable and mechanically highly resistant. They behave very well under the torsion to which they are submitted when bottling and uncorking. Furthermore, they have proven to be excellent stoppers over time (Australian Wine Research Institute, Wine Bottle Closure Trial [6]), managing to maintain the necessary concentration of free SO_2 in the bottle, preventing premature oxidation of the wine while not developing unpleasant reduction aromas.

The most common formats on the market are given in table 4, and these can be adjusted in fabrication to ensure performance for a given model of bottle, although detailed consultation of specifications may determine needs for options other than those given in the following table.

Table 4 – Measurements of technical stoppers

	44X23,5mm	40 or 39X23,5mm
Bordeaux, Bourgogne or Rhine type bottle (75 cl)	OK	OK
Half bottle (37,5cl)	-	OK
Short aging	OK	OK

NOTE: detailed consultation of the internal section of the neck of the bottle to be used is recommended (data supplied by the manufacturer), in order to be able to choose the size of stopper best suited to fulfilling its function as a closure.

As the body of these stoppers is agglomerated, the quality of the technical stopper is quite homogenous. However, the visual standard of the natural cork discs used at their ends varies. This standard is generally classified into three groups, and presupposes an agreement by the producer and the user on the basis of a sample to be used as a benchmark.

[6] Australian Journal of Grape and Wine Research – Godden et al. 2001

05.5 - Champagne stoppers

As the name suggests, these are stoppers especially designed to cork Champagne, sparkling wines and ciders. The Champagne stoppers are considered to be part of the family of technical stoppers, as these are produced from a body formed by agglomerated granules of cork, to which one, two or three discs of selected natural cork are attached to one of the ends.

Champagne stoppers are always of larger diameter in order to support the high pressure in bottles of wines with gas. To obtain the best chemical and physical performance, Champagne stoppers are subject to careful fabrication and a tight quality control.

The following alternative formats can also be found:

0+2

when the agglomerated body has two discs of natural cork at one of the ends

0+1

when just one disc is used

Simple agglomerate or microagglomerate, without discs

Champagne corks on which discs are used basically fall into the following classes: Extra, Superior, 1st and 2nd, and are associated with the quality of the disc.

05.6 - Agglomerated stoppers

Agglomerated stoppers are manufactured entirely from cork granulates derived from sub-products resulting from the production of natural stoppers. Agglomerated stoppers can be made by individual molding or by extrusion, and in both of these methods, the agglutinating substance used to bind the cork granulate, as with all other products adopted in the transformation of cork, are approved for use in materials that come into contact with foods.

Agglomerated stoppers are cost-effective solution that ensures a perfect seal for a period that should not, in general, exceed 12 to 24 months. In addition to the economic advantage of lower priced wines and high turnover on the market, these stoppers also have the advantage of being completely homogenous within a lot. This product is the result of a highly industrialized process, and the categories are defined on the basis of the size of the cork granule and final density of the product, whose characteristics are later adjusted with the surface treatment used.

These are essentially made in the measures (length x diameter) given in table 5; once again, these can be adjusted in production to ensure performance for a given model of bottle, although detailed consultation of specifications may determine needs for options other than those given in table 5.

Table 5 – Measurements of agglomerated stoppers

	44X23,5mm	38X23,5mm	33X23,5mm
Bordeaux, Bourgogne or Rhine type bottle (75 cl)	OK	OK	-
Half bottle (37,5cl)	-	-	OK
Aging	-	-	-

NOTE: detailed consultation of the internal section of the neck of the bottle to be used is recommended (data supplied by the manufacturer), in order to be able to choose the size of stopper best suited to fulfilling its function as a closure.

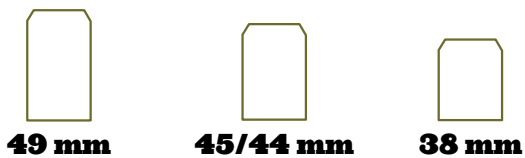
As for quality, all the variables previously mentioned in the "checking the quality of the cork" found in the section on natural stoppers should be noted. Regarding their classification, these stoppers are categorised depending on the specific weight and granulometry of the raw materials used.

05.7 - Microgranulated stoppers

Microgranulated stoppers have a body made from fine agglomerated cork granules, of an approximate average size of 1 mm. These granules are glued together using an adhesive approved for contact with foods. They are made using a procedure which aims to improve their sensorial neutrality and may contain expanded synthetic materials.

This stopper's main characteristic is its high structural stability. It is recommended for wines which will be quickly consumed, but which have some complexity.

These stoppers are essentially made in the following lengths:



Source: International Guide for Buying Cork Stoppers for Still Wines – CELiège.

05.8 - Capsule stoppers

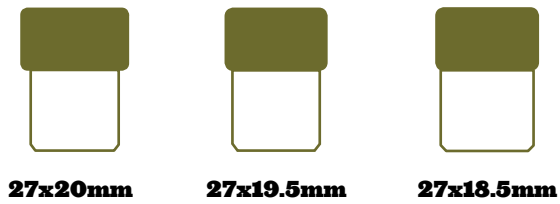
A capsule stopper is a cork stopper where the end is placed in a capsule of wood, PVC, porcelain, metal, glass or other materials.

The capsule stopper is generally used with liqueur/fortified wines or spirits which are ready to drink when they are sold. Examples are port wines, Madeira Sherry, Calvados, Muscatel from Setubal, and also whisky, vodka, cognac, armagnac, brandy, liqueurs, and clear spirits.

This stopper is very practical for bartenders and consumers, as it allows for easy reuse, an important factor for bottles whose content is not consumed immediately.

The most common formats on the market have the dimensions for the most commonly used sizes of bottles. Note that with this type of stopper, it is not necessary for it to have a diameter of 6 mm more than the internal diameter of the bottle neck. In fact, 2 mm is sufficient without compromising good sealing to allow for easy reuse of the bottle.

The most common measures (length x diameter) are::



27x20mm **27x19.5mm** **27x18.5mm**

24x17mm
20cl bottles

18x13,5mm
miniature bottles

Bottling fundamentally serves two purposes:

To divide up the wine thus making it able to be shipped and stored more easily, and in good condition of conservation;

To allow the wine in the bottle to age, improving it.

06. BOTTLING, SHIPPING AND STORAGE OF WINE.

Bottling, shipping and storage of wines are crucial stages in the life of the wine, and some basic rules should be followed to obtain the most from the properties of the cork stoppers, which are:

- In the selection of stoppers appropriate for the bottles used and for the type of wine to be;
- In the correct storage of the cork stoppers before bottling;
- In bottling (with special care in the correct use of stoppers in the filling line, especially in regard to the suitable conditions of the clamps), shipping and storing of wine.

Compliance with these rules is decisive in ensuring quality when the wine is consumed..

06.1 - Selection of cork stoppers

- As stoppers to be used must be chosen while accounting for the bottling machine, the type of bottle and the size of the neck, as well as the type of wine to be bottled and the circuit expected for the wine on the market (shipping and turnover time).
- For most wines, and keeping in mind the internal size of the neck, the diameter of the natural stopper should be at least 6 mm larger than the smallest diameter of the neck. For longer aging in the bottle, a diameter of more than 6 mm is recommended, but no more than 8 mm.
- Due to their higher density, if using technical or agglomerated stoppers, the size should be 1 mm less in selecting the diameter.
- The stopper should be both longer and larger in diameter when the aging time scheduled for the wine in the bottle is longer. However, in relation to the length of the stopper, the space required between the lower end and the surface of the wine should always be observed (a minimum of around 15 mm) so as to have an expansion chamber to compensate for any expansion of the wine due to thermal effects.
- For wines with some gas (internal pressure above normal), stoppers should be chosen with a larger diameter than those recommended for still wines. In general, and as an example, for wines with about 1 bar internal pressure, a diameter of 8mm larger than the smallest internal of the neck is recommended (Figure 1).

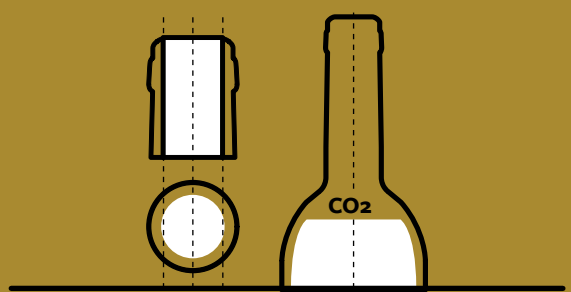


Figure 1

06.2 - Storage of cork stoppers

- Whenever possible, cork stoppers must be used soon after being received. Long periods of storage should be avoided. The maximum advisable period is up to 6 months, in the appropriate storage conditions.
- Stopper packaging should only be opened when stoppers are to be used. In general, stoppers are packaged in bags containing SO_2. This gas acts both as an anti-septic and antioxidant, protecting the stoppers.
- Unused stoppers should be returned to packaging in bags with SO_2 (between 0.5 g and 4 g of SO_2 per bag of 1000 stoppers).
- **Storage of the stoppers should be:**
  - In a cool dry place at a stable temperature of between 15 °C (59F) and 20 °C (68F) and at a relative humidity of between 50% and 70% (Figure 2);
  - In places free of smells and without mold, away from any type of fuel, or products containing chemicals, such as cleaning products or paints, for example;
  - In places where there is no wood treated with chloride products (for example in structures with recently built roofs, or on shipping pallets).

Compliance with all these recommendations is essential so that when bottling, the stoppers continue to have the same physical and chemical characteristics and are not subject to any kind of outside contamination.

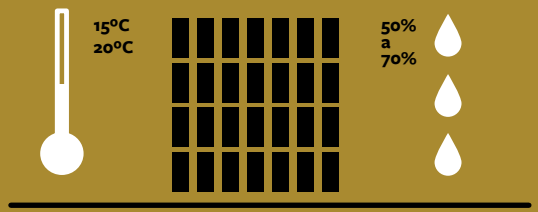


Figure 2

06.3 - Bottling

- Making use of the compressibility of cork, the bottling machine compresses the stopper so that it can be inserted into the neck of the bottle..
- Suitable compression is carried out when the stopper is 2mm smaller than the smallest diameter of the neck and when greater compression of the diameter of the stopper of more than 33% is avoided. Thus, a stopper of 24mm in diameter should be compressed to 16.5 mm for insertion into a neck of 18.5mm in diameter (Figure 3).
- Compression must never be more than 33% of the diameter of the stopper, as there is a risk that this could compromise its elasticity, with loss of part of the memory and consequent difficulty in correct sealing of the wine in the bottle. Thus, for a stopper of 24mm in diameter, the recommended compression is of about 8mm (which is equivalent to the 16.5mm as mentioned previously).
- Making use of its elasticity, the stopper recovers its volume in the first 5 to 10 minutes after being corked, adapting itself to all the irregularities of the neck; and, after just one hour, a uniform force is exercised over the whole surface of the glass. To this end, it is advisable that the bottle not be placed in the horizontal position soon after being corked (Figure 4).

06.

- In the case of bottling lines where corking comes immediately before the bottles are laid horizontally in their boxes, the risks can be minimized by prolonging the time that the bottle remains on the conveyor belt from the corking machine to the labeling machine. All that is needed is to add some sections of track, making a tight "S" bend so that space is not wasted.

During shipping and also when in storage at the distributors, with rare exceptions, the bottled wine is not immune to variations in the ambient temperature. These variations in temperature are responsible for the:

- Variation in the diameter of the neck of the bottle due to the natural effects of contraction or expansion of the glass;
- Variations in the volume of the wine. As a guide, wine expands on average about 0.2ml for each degree centigrade (33.8F) of rise in temperature, increasing the internal pressure in direct proportion.

Although the variations in diameter of the neck can naturally be compensated by the excellent elastic properties of the cork, the same cannot be said in relation to the variation in volume of the wine and consequent variation in internal pressure. To avoid this problem, the following recommendations should be followed at the time of bottling:

- Bottling the wine at an ambient temperature of between 15° and 20° Celsius (59F to 68F) to obtain an appropriate volume of the wine (Figure 5);
- The bottling machine, with the correct selection of the length of the stopper, should be calibrated to allow at least a space of 15mm between the surface of the wine and the stopper (values for 750 ml bottles). This free space is essential to allow the expansion of the wine if the temperature rises during shipping or storage (Figure 6);

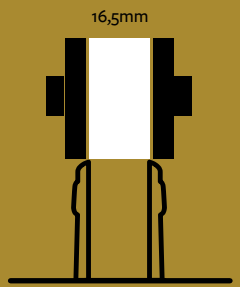


Figure 3

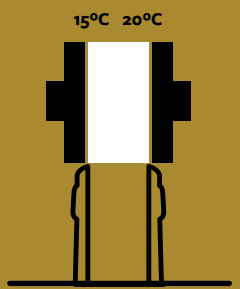


Figure 5

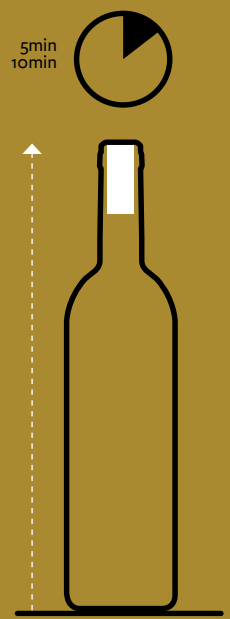


Figure 4

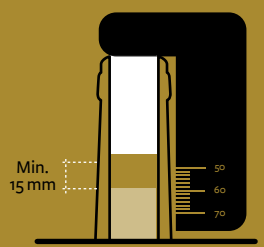


Figure 6

- In sparkling wines, this spacing should be greater;
- To minimize the effects of alteration of the internal pressure which may lead to leakage of the wine, it is recommended that it be done in a vacuum or by injecting CO_2. The CO_2 is gradually absorbed by the wine, and ends up creating a small amount of depressurization inside the bottle. Bottling in a vacuum or by injecting CO_2 protects the wine better against premature oxidation and may assist in the prevention of microbial multiplication **(Figure 7)**;
- The internal pressure of bottles that have just left the bottling line must be checked frequently to confirm that the vacuum or injection of CO_2 system is functioning correctly. The internal pressures, in the case of still wines, should be as close as possible to zero **(Figure 8)**;
- At limit conditions, high internal pressures hinder the perfect adaptation of the stopper to the neck after bottling and tend to force the discharge of wine in order for the internal pressure to come into balance. In these cases, the wine does not leak continually, but a few milliliters are expelled until the internal pressure is re-established. This is not a problem with the stopper, but rather with the internal pressure of the bottle.

Further care to be taken at the time of bottling:

1. Regarding the place of bottling, care should be taken that:

- It is free of insects, especially wine moths **(Figure 9)**;
- It is correctly ventilated using a ventilation/forced exhaust system;
- That it is at a constant ambient temperature of between 15 ºC and 20 ºC **(Figure 10)**.

2. The bottles should be taken from the pallets only at the time of bottling. Before bottling, the bottles must be well washed and thoroughly dried (almost all bottling machines do this automatically).

3. Pallets with bottles should be kept in a warehouse at moderate temperatures and in a dry place, free of mold and free of chloride compound treated woods. The pallets should have planks, which are not made of cardboard or wooden composite material, to separate the bottles from other materials.

4. Never pass the stoppers in water or wine before bottling. In the past this technique was used to clean the stoppers or to facilitate their insertion into the neck, but this meant that these liquids accumulated in the pores of the stopper, and developed tastes and aromas that could slowly migrate to the wine. Currently, stoppers come fully ready to be used, and need no treatment or additional operation. If the stoppers must be cleaned for any other reason, then it is recommended that a solution of sulfite be used, releasing SO_2.

5. The interior of the neck of the bottle must be clean and dry. A damp neck has a thin incompressible liquid film which hinders the expansion of the stopper, as well as reducing its adherence to the glass **(Figure 11)**.

6. In standard bottles, the top of the stopper should not be more than 1 mm below the top of the neck. Ideally, the stopper should be +/- 0.5mm from the top of the neck. If the stopper is too far in, this may cause a rise in the internal pressure (if not using bottling by vacuum or CO_2) and create a space between the stopper and the capsule which will only serve to promote the formation of fungus. If the stopper is too far out, there will certainly be problems when it comes to placing the capsule.

7. Stoppers with humidity of less than 4% should undergo a process of rehydration at the supplier's premises and stoppers with humidity of more than 9% should undergo a process of drying at the supplier's premises.

06.

06.4- Maintenance of the bottling equipment

The maintenance of bottling equipment is fundamental to obtain good performance from the stoppers and consequently to prolong the life of a wine. Here are some measures to be taken in relation to the equipment:

- Maintain the feeder channels of the stoppers very clean, as well as all the mechanisms of the machine;
- Ensure the alignment of the piston and the upkeep and alignment of the centralizing cone. This is essential for the correct introduction of the stopper in the neck (Figure 12);
- Check the level of wear in the compression jaws frequently, as the least wear or defect can make lateral grooves in the stopper which may lead to leakage of the wine or infiltration of air (Figure 13);
- The bottling machine should work smoothly, especially during compression of the stopper, but also quickly, above all, at the time of introduction of the stopper into the neck (Figure 14);
- Keep all surfaces where the cork stopper passes clean, using chlorine free products (Figure 15);
- Before starting to bottle, the machine should be sanitized. Washing with a jet of a solution of water with metabisulfite at 80 degrees centigrade is recommended (176F) followed by drying any water condensation.

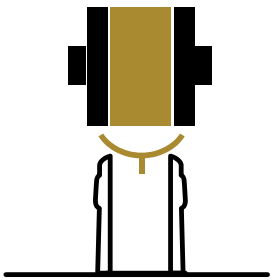
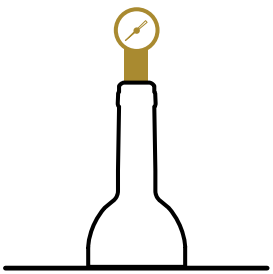


Figure 7



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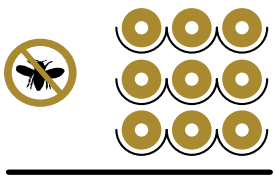

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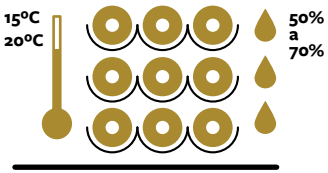

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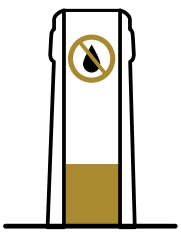

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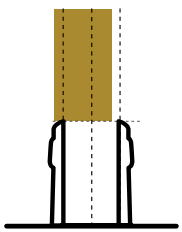

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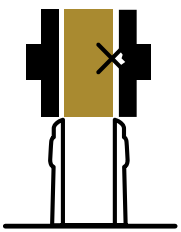


Figure 13

06.5- Continual flow or leakage

The flow or "Couleuse" is a defect in which the wine passes between the neck and the stopper. This problem may have various causes and can be avoided by following the rules already mentioned. This problem almost always is the result of a combination of various factors and is never easy to identify systematically and in a clear manner.

The causes of this problem are::

- Excessive internal pressure. An excessive internal pressure does not give rise to a continual leaking of the wine, but rather to a temporary loss of a few milliliters of wine. This leaking occurs only until the internal pressure of the bottle is re-established;
- Defects in the compression jaws. These defects may result from wear of the jaws and result in grooves on the surface of the stoppers;
- Unsuitable diameter of the stopper, resulting in an insufficient force against the neck, compromising its impermeability;
- "Green spot." This is a problem that may arise in a stopper produced from cork which has not been properly dried. Only when green spot is present in a stopper in large amounts will this cause flow. A stopper that has "green spot" will reduce its volume inside the neck, very probably becoming creased at the sides, allowing the wine to pass. This is a completely random problem and very rarely appears in finished stoppers, since the various stages of production are rigorously controlled, from inspection of the planks to visual control of the finished stoppers;

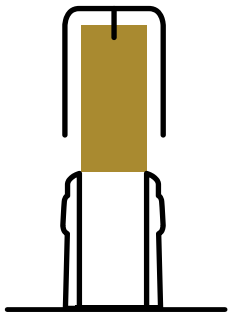


Figure 14

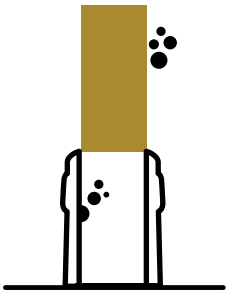


Figure 15

- Channels – worm and ant holes. Caused by insects when the cork is on the tree. This defect is easily detectable after the cork has been harvested and as such is extremely rare in a finished stopper;
- Fabrication defects. These are problems that may arise during the production process, but which are in general easily detectable, as there is a rigorous quality control during the various stages of the manufacturing process.

06.6 - Shipping bottled wine

Because of the adverse conditions that bottled wine is subject to during the long journeys to be made to arrive at its destination, it is recommended that bottles always be transported in the vertical position (Figure 16).

The use of thermally insulated containers is recommended and the cooler seasons of the year should always be chosen to ship wines, especially for wines which have to be shipped between continents.

If the wine is to be shipped in maritime containers, the last type of cargo used in the container should be informed. If the container is not clean, free of smells and completely dry, it must be rejected. If this is not possible, it should be cleaned with a solution of metabisulfite and then properly dried, for example. Humidity due to condensation during shipping leads to the appearance of fungi which may later lead to the formation of chloroanisoles or other compounds responsible for undesirable odors.

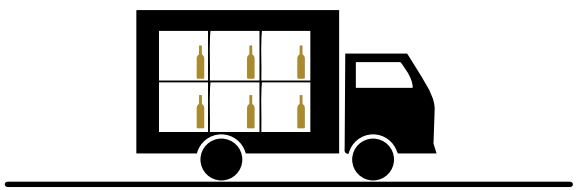
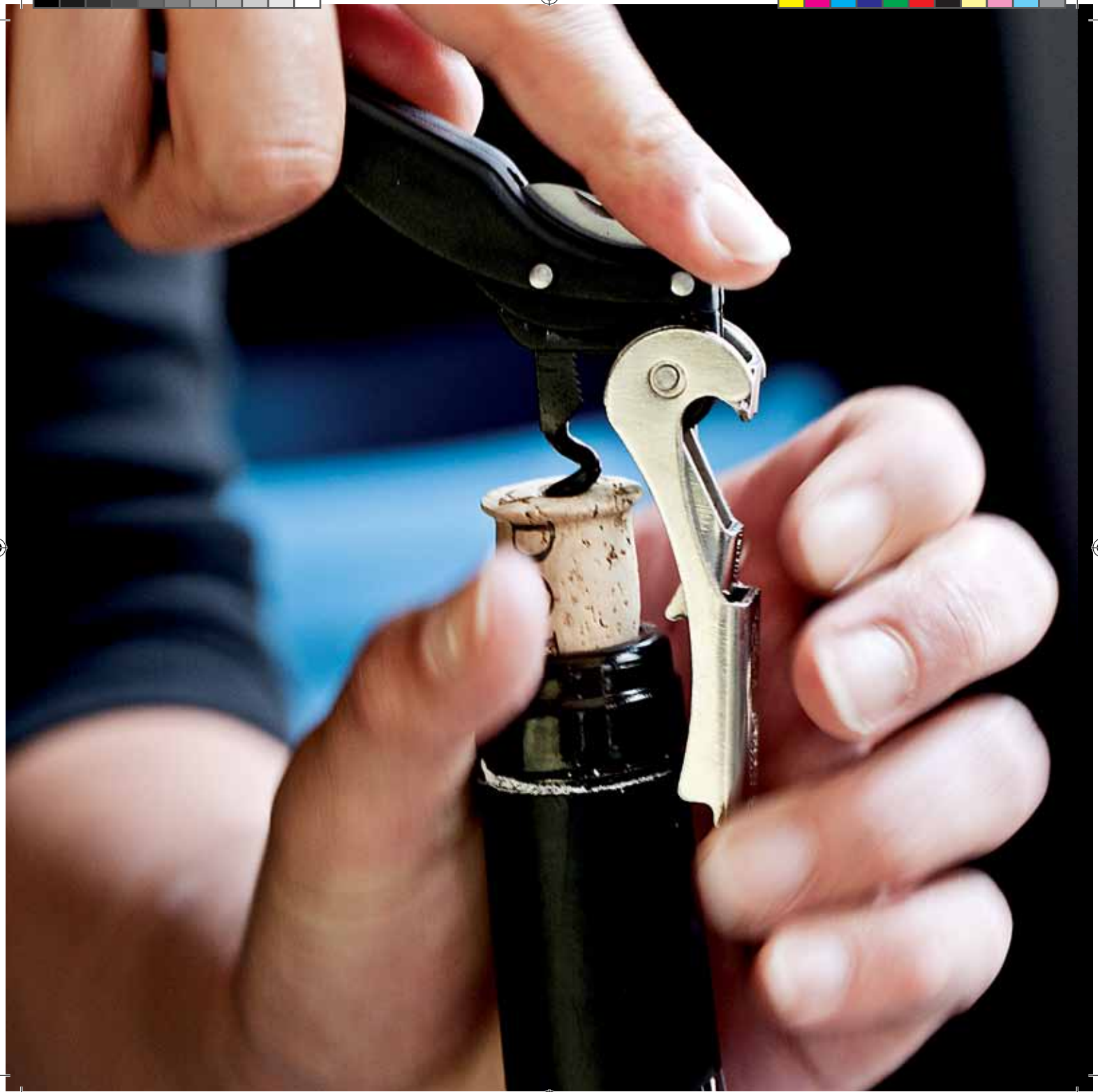


Figure 16

06.7- Storing bottled wine

The expression "the cellar makes the wine" is as old as it is true. The temperature, humidity and hygiene of a cellar contribute to the final quality of the wine. The cellar should have the following characteristics::

- Ambient temperature of between 15° C (59F) and 20° C (68F), with no great variation either during the day or throughout the year;
- Humidity of between 50% and 70%;
- The cellar should be free of insects and rodents. This does not include spiders, as these are excellent predators of undesirable insects;
- The cellar must not have chemically treated wood;
- The cellar must be free of odors;
- Chemical products, such as paints or cleaning products must not be stored in the cellar;
- The bottles must be kept in a horizontal position so that the wine is in contact with the stopper and so that it keeps its excellent elastic properties.



The ceremony of extracting a cork stopper marks the beginning of a ritual - that of drinking a good bottle of wine.

However, wine becomes increasingly precious if drinking it becomes simultaneously a cultural act. This act commences when the cork is withdrawn.

07. WITHDRAWING A CORK - A RITUAL WITH RULES.

Depending on the age of the bottle, there will be stoppers in the widest range of states. Thus, in new wines, we will find the most robust stoppers. In older wines, stoppers will have some loss of elasticity; and lastly, in very old wines, generally over 35 years old, we will find weakened stoppers due to their already fragile internal structure. These stoppers are the hardest to remove because they may break when pulled out. In these oldest wines, instead of using a corkscrew, heated tongs can be used to cut the neck, without having to withdraw the stopper (see Figure 18).

Whatever the case, when using a corkscrew and with new or old wines, care should be taken to always pull the cork in the vertical.

"Sommelier" corkscrews are quite common and allow the stopper to be withdrawn easily and always vertically. There are other models that use an impulse, but which always work in the vertical (Figure 17). The blade corkscrew, which extracts the cork from the sides without damaging its internal structure, can be used with wines of any age, but especially when opening older wines.

One of the main parts of a corkscrew is its spiral. This has to be at least 7 cm in length to be able to deal with longer corks, and should have a sharp point. In terms of the material, the spiral must be a single-piece, completely smooth and without sharp edges. Spirals with a Teflon™ surface or surface with a similar material are recommended as they pierce the cork with ease, without damaging its internal structure.

The bottle should be opened carefully and calmly. First, the capsule that protects the neck of the bottle must be removed, at about one centimeter below the top rim of the bottle. Then, especially if the bottle is old, the neck of the bottle and the top of the cork stopper must be wiped with a clean cloth.

The point of the corkscrew is then placed in the center of the cork stopper taking care to insert the spiral of the corkscrew far enough but not so deep so that it perforates the bottom of the cork. This operation is hard to do with some designs of corkscrews, especially those that do not work by pushing, and the corkscrew must be inserted fully. In this case, particles of cork may fall into the wine, especially with older stoppers. However, this is not a serious problem and it is good to remember these small particles are organically harmless, even if consumed. If this were to happen, they are normally poured into the first glass, which is then generally served to the host.

In the case of sparkling wine, the bottle must be opened with care and without agitation so as to enjoy all the qualities of the wine. After removing the muselet, the cork stopper must be held firmly. Then, the bottle and not the cork must be turned, in order to prevent too much twisting of the cork stopper. On removal, the cork will give that unique 'pop,' a cause for joy and enrichment of our senses - something only a cork can do.

Blade Corkscrew

"Sommelier" Double Impulse Corkscrew

Rabbit

Velvet

Figure 17 Types of corkscrew

Demonstration:

1- heat the tongs in a gas burner until red and apply to the neck for 30 seconds..

2- immediately withdraw the tongs from the neck, and apply a brush with cold water to the surface of the glass that was in contact with the tongs. Alternatively, ice can be applied directly or cold water can be run over the neck. The glass will immediately crack and the cut will be clean, without any shards. The wine will then be ready to be decanted.

Figure 18 Illustration on the use of heated tongs

Cork is one of the most appreciated natural products by man throughout the ages and the world.

The relationship that became established with wine guaranteed it a top place in our cultural references, and this is the main reason why the cork stopper is the natural preference of wine consumers.

08.
THE CORK SYMBOL, A GUARANTEE OF QUALITY

The cork stopper is the only stopper that is natural, renewable and totally recyclable, and the only one whose physical, mechanical and chemical properties afford a quality sealing compatible with the rigorous requirements of the modern winemaking industry. For this reason, it is the most preferred stopper by consumers, constituting the best indicator of the quality of a wine. In fact, any connoisseur of good wine will demand a cork stopper.

However, most consumers have no guarantee whatsoever as to the type of stopper used in the wines they buy.

For this reason, the Confederation Europeene du Liège (CELiège), in partnership with the European Forestry Commission of the Food and Agriculture Organization (FAO), created the Cork Mark – the international symbol which identifies products made of cork or using cork. This means that bottles carrying the Cork Mark were bottled with genuine cork stoppers produced in accordance with the most rigorous quality standards. So this symbol also contributes to ennobling and giving prestige to good wines, as well as allowing the consumer to make a conscious choice - a choice in favor of culture, nature and the future.

In the case of the bottles, different symbol application alternatives were developed. The objective is to offer producers the possibility of choosing the application which best attends to their interests. The use of the symbol is free to the winemaking industry, although written authorization must be requested from CELiège. Further information at www.celiege.com.

09.

THE CORK INDUSTRY - MODERN AND ENVIRONMENTALLY FRIENDLY

As we have seen in the foregoing chapters, there are various characteristics that make the modern cork industry something special: its investment in research and development, its very high investment in new factories closer to the source of the raw material, its efforts in implementing quality systems, and its persistent modernization of the manufacturing processes.

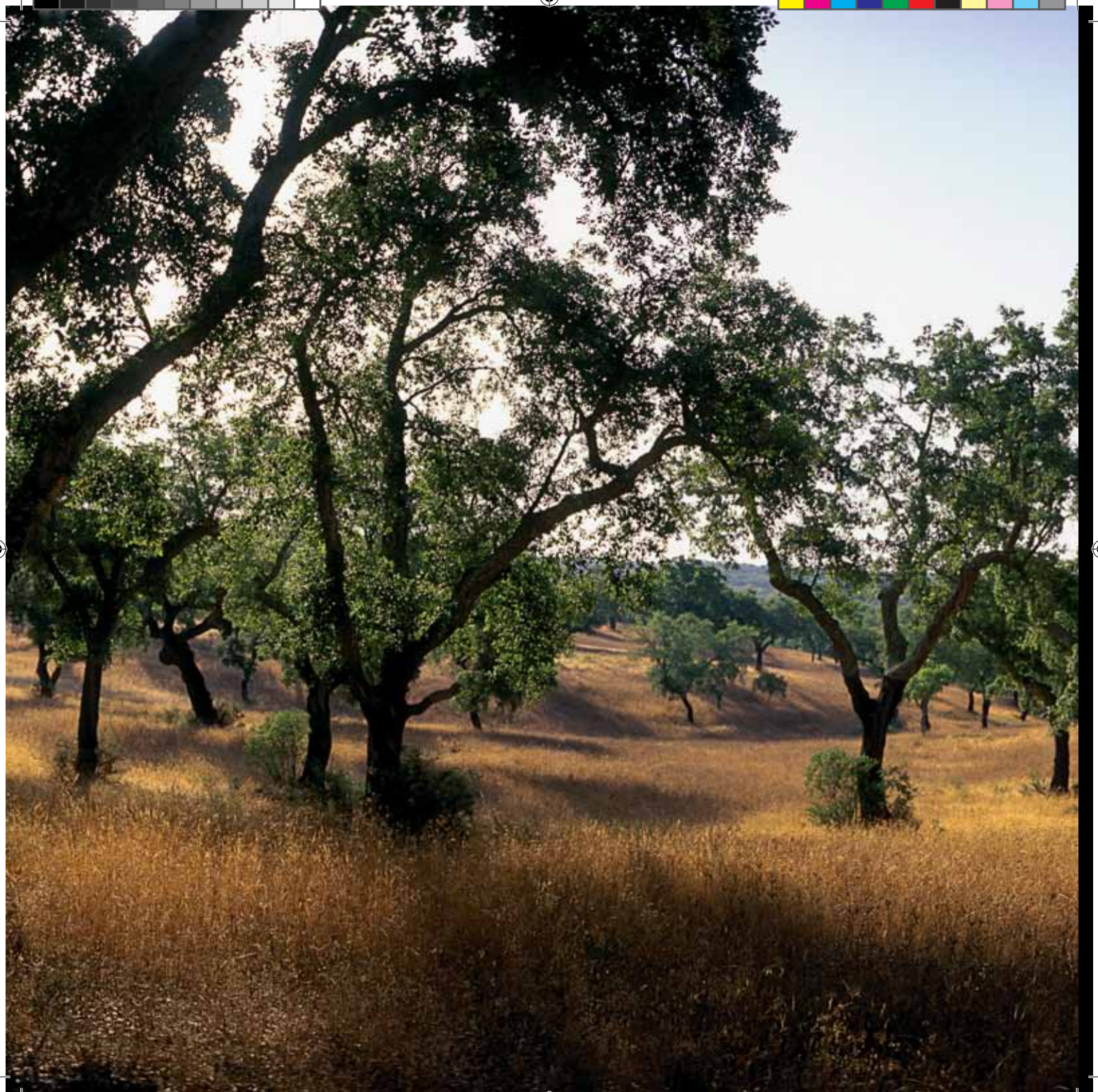
Furthermore, through the fabrication of stoppers, the cork industry guarantees the sustainability of the Montado and thus the preservation of the species of fauna and flora that live there, as well as guaranteeing the maintenance of the local populations.

The remaining Montado and the agricultural, forestry and pasturing ecosystem that coexists in its surroundings is of crucial importance, as it contributes to the preservation of the environment, sustaining the existing fauna and flora and also ensuring the way of life of the populations in areas with a hostile climate with poor soils.

In fact, although one quarter of the production of cork is used for the manufacture of stoppers, it is this part that guarantees around 70% of the added value generated by the sector.

Yet there is another reason that makes this industry really unique: its remarkable ecological efficiency. Throughout the whole of the production process, all of the waste from the fabrication of stoppers is transformed into useful products of excellent quality. Stoppers, panels for flooring and coverings, all kinds of decorative items for the home and office, works of art and design, soles for shoes, applications in the automotive industry, applications in the military and aerospace industries, and chemical products for pharmaceutical purposes, among many others, are produced from the granulates obtained by the grinding of waste (by products). In other words, during the whole cork production process not one gram of the raw material is lost. Even the cork powder is used in the co-generation of electricity.

At the other end, the recycling of used cork stoppers is in full expansion. Although they are not reused in the wine industry, used stoppers are ground up and used in the making of many other products for the widest range of uses, keeping the same characteristics as natural cork. This means that the cork stopper is the only completely natural, renewable and recyclable stopper.



10. CONTACTS

The mission of the Portuguese Cork Association is to represent and promote the Portuguese Cork Industry and products made using cork. It has 250 member companies that are responsible for approximately 80% of the nation's total production and 85 per cent of Portuguese cork exports.

APCOR works to ensure that its members adopt the best internationally recognized production practices to produce high quality cork stoppers for the wine industry and its consumers.

APCOR is responsible for developing promotional and value-adding activities for cork by carrying out initiatives that are domestic and international in character, moreover providing an information center as well as consulting services to its members.

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Property: APCOR
Year of Publication: 2011
Nº of Copies: 2.000





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Portuguese Cork Association

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QREN
QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL
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