COOPER

A TRADE, A PASSION

MARIAUD
Consulting

MARIAUD MICKAEL

MY NAME IS MICKAËL MARIAUD, AND I AM A COOPERAGE CONSULTANT WITH MORE THAN TEN YEARS OF EXPERIENCE. I HAD THE OPPORTUNITY TO LEARN THE TRADE IN FIFTEEN DIFFERENT COMPANIES BEFORE PUTTING MY KNOWLEDGE AND EXPERTISE AT THE SERVICE OF OTHERS THROUGH CONSULTING.

Overview

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FOREST MANAGEMENT

There are two categories of trees: **hardwoods** and **softwoods**. In cooperage, we mainly use oak, which is a hardwood tree.

Hardwoods

Softwoods

We also use black **locust** (acacia) and occasionally chestnut on a more limited basis.

Deciduous hardwoods are trees that lose their leaves every year.

ONF: NATIONAL FOREST OFFICE

Silviculture is the set of practices used to manage and maintain forests for commercial exploitation. This activity includes various operations, from cultivation to reforestation, as well as the harvesting of forest resources.

*Chifres moyens qui peuvent différer d'une forta Tautre.

ONF MARKETS MORE THAN

35%

structural timber placed on the market in France

=

50%

Marketed **OAK**

80%

BEECH

35%

FIR & SPRUCE

A high forest is a woodland or forest composed of large mature trees grown from seedlings. In contrast, there is what is known as **coppice management,** where trees originate from vegetative regrowth.

The management of **uneven-aged** high forest allows the maintenance of a varied mix of trees at different stages of development. However, the balance of this mix may vary depending on the ages, heights, or diameters of the trees.

This approach ensures continuous renewal through **regular regeneration**. However, it does not guarantee the development of large, defect-free trees.

What is an even-aged high forest?

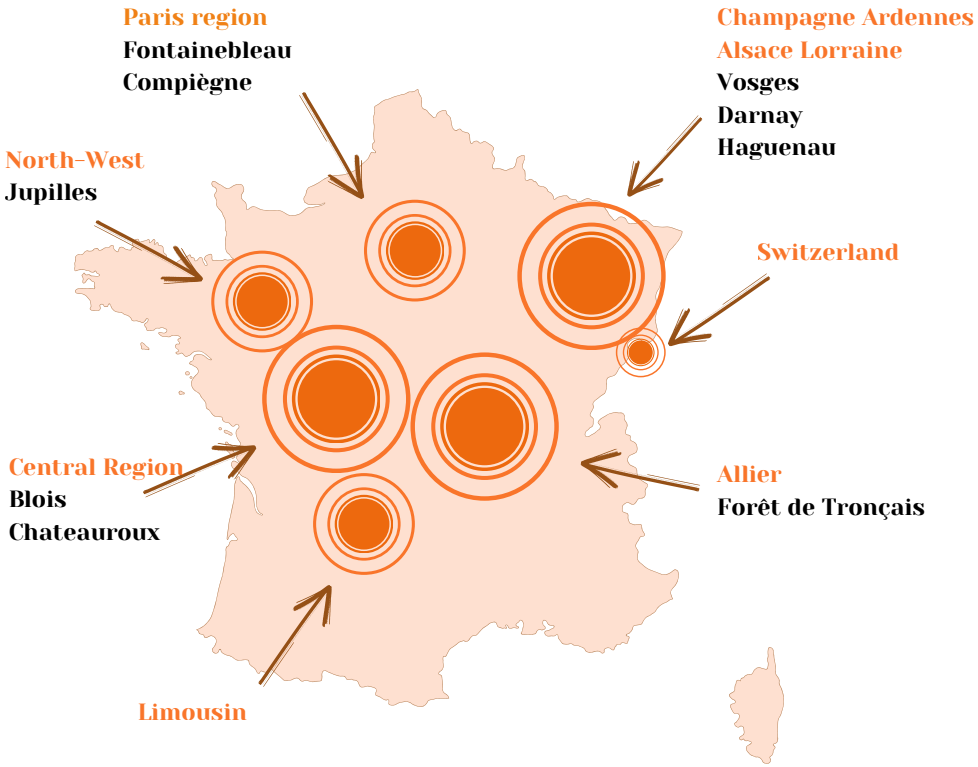
An even-aged high forest is a silvicultural method consisting of maintaining trees of similar age within a defined forest area.

This practice requires "improvement cuttings" every 6 to 12 years in order to bring in light and promote the growth of the finest trees. It allows the cultivation of trees with homogeneous diameters and heights, as well as tall and balanced trunks.

This technique meets society's needs for timber used in the manufacture of flooring, structural frameworks, barrels, etc.

It is possible to carry out an "elite selection" of forests through silviculture.

PRODUCING REGIONS



LE SAVIEZ-VOUS?

In cooperage, two types of French oak are commonly used: sessile oak, also known as durmast oak, and pedunculate oak.

Sessile oak is better suited for wine aging because its **slower growth** produces a finer grain and, consequently, a **more subtle aromatic profile.**

Pedunculate oak, on the other hand, **grows more quickly,** resulting in a **coarser grain.** Consequently, it is richer in tannins and other **woody compounds, making it particularly well suited for the production of spirits such as Cognac.**

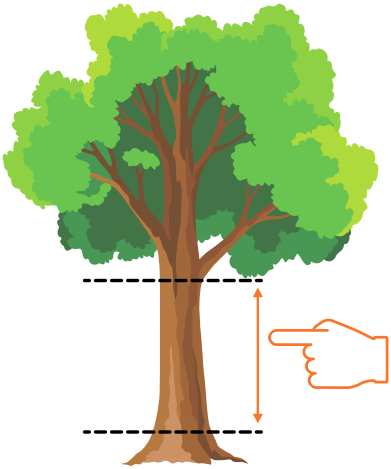
The choice of wood is often based on 3 criteria:

The wood species
The origin of the wood
The grain of the wood

What is wood grain?

"**Wood grain**" corresponds to the annual growth ring of a tree. Thus, the notion of **coarse grain** or **fine grain** refers to the size of each growth ring.

These growth rings correspond to the growth produced by the tree each year.



This section, called the trunk or bole, is the only part of the oak used in cooperage.

It is the section between the base of the tree and the first branches.

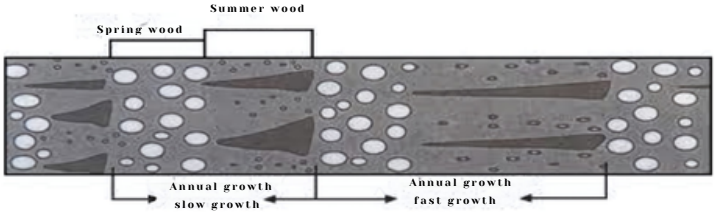
The estimated loss is between 70% and 75%.

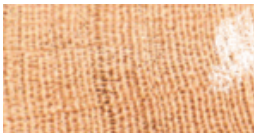
The remaining parts will be allocated to other sectors of the wood industry.

Today, cooperages pay particular attention to optimizing oak, their raw material, both through waste recovery and machining precision.

1 GROWTH RING = 1 YEAR

A growth ring is composed of two distinct elements: **spring wood** and **summer wood**. Spring wood is made up of **large vessels**, while summer wood consists of **denser fibers.**





Fine grain generally corresponds to **sessile oak**.

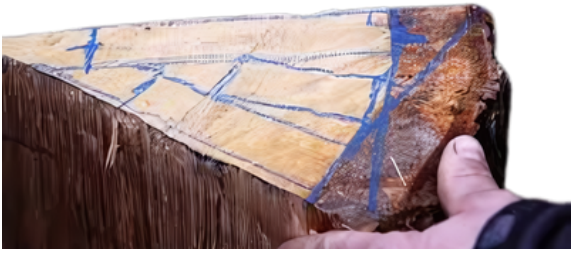
Coarse grain is generally associated with **pedunculate oak**.

Note that this is a generalization. Sessile oaks can also have coarser grain, and pedunculate oaks can sometimes have finer grain. It all depends on their growth and environment.

PRODUCTION OF STAVE WOOD

The log section is split into quarters using a splitting machine.

Splitting is a crucial step to ensure cutting along the wood grain and to facilitate later bending. In addition, this cutting method has a significant impact on the future watertightness of the barrel.



After marking out the different staves while removing the sapwood and the heartwood, they are cut parallel to the medullary rays and perpendicular to the growth rings.

Once the quarters have been split, they are sawn in order to obtain stave wood that is as uniform as possible.

DRYING

The stave wood is transported and stacked in a seasoning yard where it is naturally dried for a period of 24 to 36 month.

Coopers may extend this drying period in order to produce specific barrel ranges.

The stave stacks are arranged with specific spacing to allow proper air circulation.

There are different methods for stacking stave wood.

Wood drying provides several advantages:

It allows the barrel to swell properly once filled with wine.

Although it dries slightly, the wood maintains a moisture level balanced with the surrounding humidity.

The drying process helps develop organoleptic complexity, thereby improving the quality of the wine or spirit.

It also helps prevent deformation, especially in the barrel head pieces.

Stave wood must be worked at a moisture content between 14% and 16%.

WOOD DEFECTS

« Good-quality stave wood must have the following characteristics: a clean and characteristic smell; no sapwood; and it must be neither rotten, worm-eaten, red-stained, heat-damaged, pierced by worm holes, streaked with veins of different colors, nor greasy (as it would warp), nor ring-shaken, meaning formed of non-adherent concentric layers, which is a sign of very poor quality. »

excerpt from the "Cooperage Manual" by R. Brunet

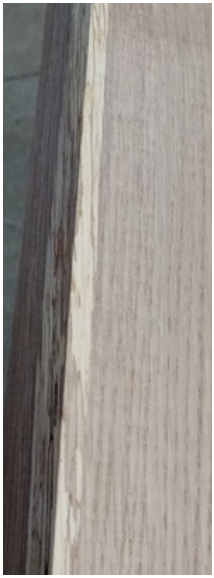
THE COMMON DEFECTS ARE AS FOLLOWS:

CUBIC ROT

WORM-EATEN WOOD

FIBROUS ROT

SAPWOOD



The soft and whitish layer that forms each year between the hardwood and the bark of a tree. This peripheral area is **living wood**, more porous, softer, lighter in color and weight, and more hydrated than heartwood, with conductive vessels that transport raw sap.

« Let it be neither streaked nor worm-eaten, nor red-stained. In certain forest areas, oak boards display veins of different colors on their surface. When the wood takes on a marbled red color, it is a sign of poor quality. Such wood does not last as long as other wood. It absorbs moisture and rots quickly. »

New Complete Manual of the COOPER and GAUGING by W. MAIGNE

HEAT-DAMAGED WOOD

Ring shake

separation along the medullary rays.

STAR SHAKE

WORM HOLE

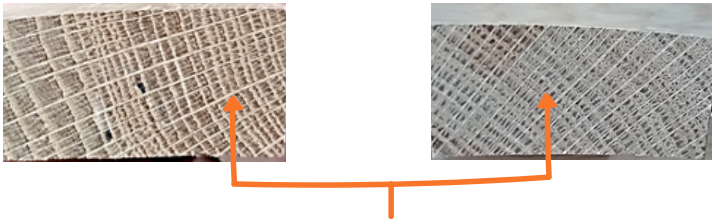
CRACKS

CROSS GRAIN

the grain running from one side of the stave to the other.

Knots present on stave wood result from the intersection of branches.
Not all knots need to be discarded, as they are aligned with the medullary rays.

Medullary rays connect the heartwood and the bark.



MEDULLARY RAYS

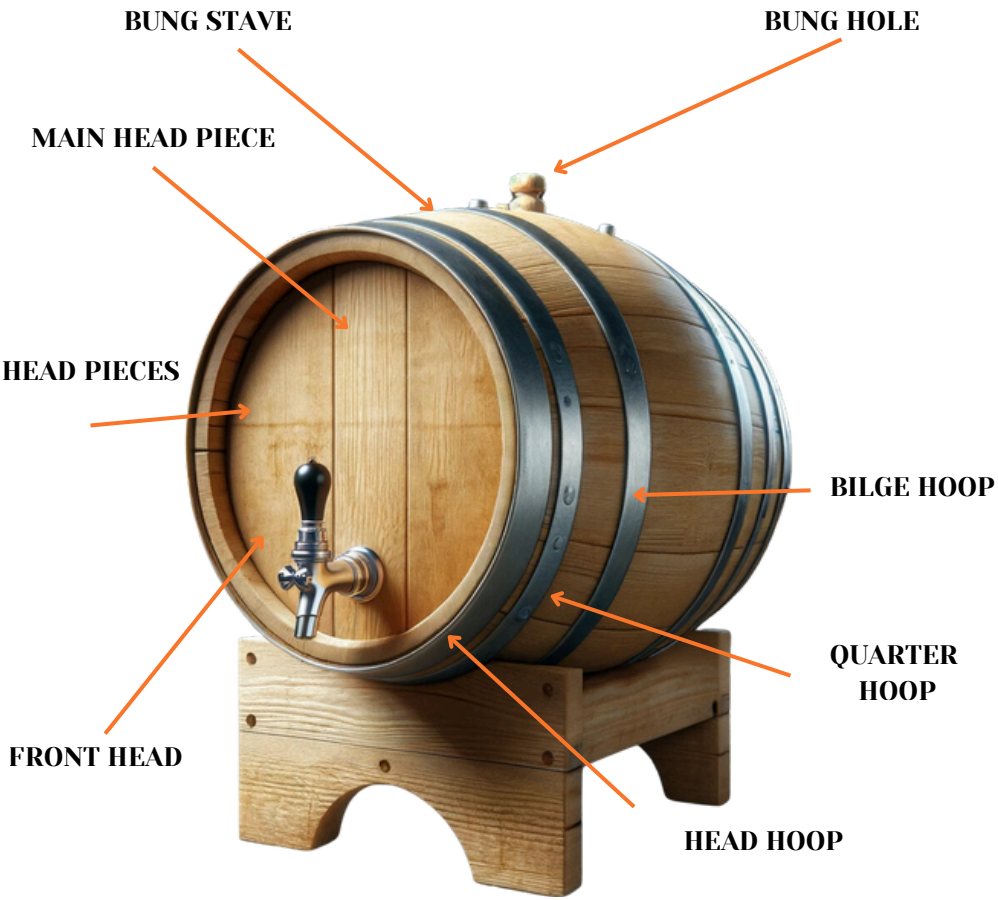
When the medullary rays are **properly parallel** to the wood surface, **knots do not present any leakage risk.**

When the medullary rays **are not perfectly parallel** to the wood surface, **stricter inspection** is required because they may sometimes pass through from one side of the stave to the other. In general, knots are tolerated **as long as they do not exceed half the thickness** of the stave.

Cooperages are increasingly working with PEFC-certified wood.

- PEFC certification ensures that wood and wood-based products come from **sustainably managed forests.**
- It guarantees **the application of sustainable forest management practices** by forest owners and operators, as well as compliance with **traceability rules** by all companies involved in the processing and marketing of wood.
- **There are four types of PEFC labels**, differentiated by the composition of the product, notably with or without recycled materials.
- This certification contributes to forest management that takes **environmental, social, and economic aspects into account**.

THE BARREL


BUNG STAVE
BUNG HOLE
MAIN HEAD PIECE
HEAD PIECES
BILGE HOOP
QUARTER HOOP
FRONT HEAD
HEAD HOOP

MACHINING

Hollowing is the shaping of the outer side of the stave. A slightly rounded form is given in order to obtain a circular and uniform surface when assembling the barrel.

Hollowing out consists of removing all the rough wood from the inside of the stave in order to obtain a smooth and uniform surface.

Jointing is carried out in two stages.

The first stage consists of determining the angle corresponding to the correct barrel diameter, which will give the barrel its rounded shape during assembly.

The angle is radial according to the barrel diameter.

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The second part is what gives the barrel its proportions, meaning the shape that creates its “bulged” profile.

Each stave follows the **proportional dimension ratio** of the barrel.

If I divide the head diameter by the bilge diameter, I obtain a result around **0.80 / 0.83** for standard barrels.
And when I divide the width of a stave at the head by its width at the bilge, the result should be similar.

$$\frac{\varnothing}{2} = \text{RADIUS}$$

$$\varnothing = \text{RADIUS} \times 2$$

$$\text{DEVELOP} = \varnothing \times \pi$$

ASSEMBLY

This is the stage where the required amount of wood is selected to assemble the barrel. It is also the final inspection of wood defects before the barrel takes shape.

Assembly consists of placing the staves side by side to form a circle.

Next, the hoops must be positioned and the barrel tightened. The cooper will also make sure to eliminate all misalignments in order to obtain a uniform result.

TOASTING
THE COOPER'S SIGNATURE

Toasting is an essential step in the production of high-quality barrels. Its mastery is a fundamental factor in the expression of the wood's organoleptic qualities.

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Toasting is a crucial stage in barrel manufacturing, carried out in three distinct phases:

Preheating: to make the wood more flexible before bending, it is important to heat it in order to soften it.

This step can be carried out in several ways: by heating the wood over a wood fire, soaking it in hot water, or using steam.

Bending: the cooper bends the staves to give the barrel its final shape.

LE SAVIEZ-VOUS?

COOPERS USE A CLOVE HITCH KNOT WHEN BENDING WITH A CABLE.

ÉCooking or Toasting Stage:
To create unique aromas, it is important to heat the wood deeply.
This stage breaks down certain oak compounds, resulting in a variety of flavors. Each toasting method produces a different barrel flavor profile, which is essential for the development of various recipes.

- Light Toast: The subtle aromatic impact highlights freshness and fruit, allowing the wine's original aromas to remain dominant.
- Medium Toast: Aroma synthesis is intense and at its peak, bringing notes of soft vanilla, smoothness, roundness, and balanced tannins.
- Medium Plus Toast: Toasted and roasted notes, hints of spices and coffee, with a soft tannic structure.
- Heavy Toast: Burnt and caramel notes are very pronounced, although the complexity is lower than with a medium toast.
  It brings roasted and smoky aromas, with increased notes of clove and spices.

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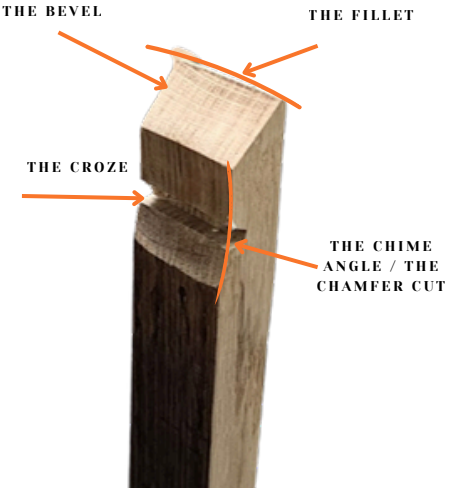
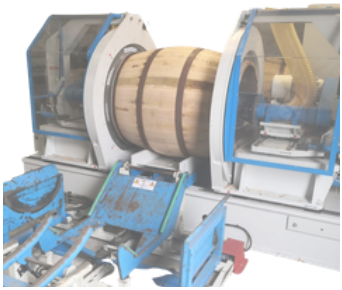
CROZING

After the barrel has been toasted according to the client's requirements, the cooper machines a bevel and a groove for fitting the barrel head.

This stage must be carried out with great precision, as the slightest defect can lead to watertightness problems.





Nowadays, these operations are carried out using machines in order to ensure precise repeatability and efficient wood consumption management.

THE HEADS

The heads are made from wooden pieces that are jointed and planed before being assembled together.

The heads are then planed again in order to remove all irregularities.

THE 3 MOST COMMON ASSEMBLY TYPES:

Stainless steel nails

Wooden dowels

Tongue-and-groove assembly

Coopers use reed to fill any imperfections on the edges of the head pieces. It is placed between each piece.

The heads are cut to the correct diameter and then beveled around the entire circumference.

Different head bevel profiles exist, but the objective is always to create sealing contact points between the head and the croze.

LE SAVIEZ-VOUS?

Some coopers innovate by using heads made from a different wood species than the barrel itself, or by choosing materials such as glass or polymer.

THE SEALING PASTE

Ensuring watertightness with a natural paste.

Coopers use a paste to ensure the watertightness of their barrels.
This paste, which acts as a “natural glue,” is made from flour and water. It ensures watertightness between the heads and the shell, and also seals the wood pores around the croze when it is sufficiently fluid.

There are different ways of making this paste. Some people add ingredients to modify its color so that it matches the wood more closely, or to improve its sanitizing properties.

WHEAT FLOUR

BUCKWHEAT FLOUR

WHEAT BRAN

ASH

Other options include food-grade sealant and gluten-free paste.

HEADING

In cooperage, to fit the head into a barrel, sealing paste (water + flour) must first be applied into the groove. The cooper then loosens half of the barrel while keeping the hoops in place.

The cooper inserts the head into the barrel, ensuring that it fits perfectly into the croze and remains straight. He then tightens the hoops to close the barrel around the head.

He will then tighten the hoops evenly in order to avoid watertightness problems.

HOT WATER TREATMENT

The barrel watertightness test is very important because it guarantees the quality of the product.

DIFFERENT METHODS ARE POSSIBLE:

- Heat approximately 10 L of water to 70–90°C, then roll the barrel.
- Mix approximately 10 L of cold water with about 0.3 bar of air pressure, then roll the barrel.
- Mix approximately 10 L of hot water with 0.3 bar of air pressure, then roll the barrel.

FINISHING

The barrel will be completely sanded before being fitted with new galvanized or colored hoops.

The heads and bevels will also be sanded.

The brand identification plate will be placed on the barrel head, along with laser customization according to the client's preferences.

LE SAVIEZ-VOUS ?

The hoops are drilled and riveted to size. Afterwards, the hoops are nailed into their final position to prevent them from loosening if the barrel dries out.

SEALING A BARREL

Cutting methods and raw material selection play a crucial role in the manufacture of watertight barrels. Indeed, the wood must **be split along the grain** to avoid defects that can cause leaks and deformation.

Furthermore, **the medullary rays** form a natural barrier against liquids.

The term "**silver grain**" is used to describe a cut through the medullary ray.

Working with dry wood allows it to swell when exposed to liquid, ensuring **optimal watertightness** between each joint.

When a leak occurs in a cellar, it is important to clean the area, locate the leak precisely, and identify its source before carrying out any repair.

THERE ARE TWO TYPES OF LEAKS:

Manufacturing-related leaks

Leaks can occur due to a production issue during barrel manufacturing. This may result from improper machining, unsuitable wood selection, or even incorrect hoop tightening.

Raw material-related leaks

Raw material leaks can be caused by different factors, particularly issues with the wood itself. The wood may be porous, or contain veins or knots that begin to leak over time due to constant pressure being applied.

If you notice porosities of around 5 mm in diameter near the inner edge of the bevel, and they are present around most of the barrel, it is likely that the croze was not sufficiently filled with sealing paste. When filling the barrel with water, allow it to swell and check whether the porosities disappear. If this does not work, it will be necessary to remove the head and add enough paste.

When liquid leaks are observed at the head joints, this may indicate two possible causes. The most likely is that the head is weak, meaning the pieces are not compressed enough and allow the liquid to escape. The second possibility is a machining defect.

It appears that the issue comes from the high moisture content of the wood during barrel manufacturing, which caused abnormal drying before filling.

In this case, there are **two areas** to check for leaks: the barrel shell and the bevel.

For the leak located on the shell, it is likely caused by **stave porosity**, since the leak appears in the middle of the piece rather than at a joint. Regarding the bevel, it is possible that the same stave is **porous** at its end and that the liquid runs along the bevel by gravity down to the base of the barrel.

In the case of porosity, it is important to **clean** the area carefully before intervening, in order to **locate the leak and determine the type of porosity**. If the entire stave is porous, it may be difficult to make it watertight. In this case, the last solution would be **to apply paraffin** to help temporarily seal the leak during aging, before sending the barrel back to the cooper for repair as soon as possible.
On the other hand, if it is only a **small porosity**, it is possible to **use a wedge or a sealing pin to pinch the leaking vein**.

Leaks in knots can be stopped using a **sealing pin**. Simply make a hole with a nail at the leak location and insert a wooden pin into the hole. If this does not work, it will be necessary to call the cooper.

It is possible to control **porosities** located at **the end of the stave** using a wedge or a sealing pin. Another solution is to apply liquid **paraffin to block** the pores of the wood.

If you notice that certain parts of your barrel are porous as shown in the photos, it is essential to contact your cooper to replace the porous components.

SEALING PINS

When you notice worm holes and they are not too numerous, you can use a sealing pin to prevent or stop the leak.

EQUIPMENT FOR SEALING A LEAKING VEIN

HAMMER / CHISEL / WEDGES

HAMMER / PUNCH / SEALING PINS

WOOD CHISEL / SCRAPER / SANDPAPER

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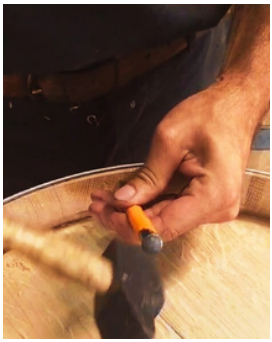
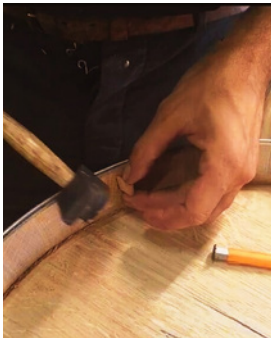


Place the punch on the leak to create a hole for inserting a sealing pin or a wedge. The angle of the punch should be almost perpendicular to the chime. Avoid placing a sealing pin or wedge less than one centimeter from the edge of the chime, as this could damage the wood.



Gently tap the wedge or the pin with a hammer.

Drive the punch / chisel in using a hammer to create the hole.

Using a wood chisel, cut off the part of the wedge or sealing pin that protrudes.

Lightly scrape the chime and finish with sandpaper.

EQUIPMENT FOR PARAFFINING A STAVE

PARAFFIN

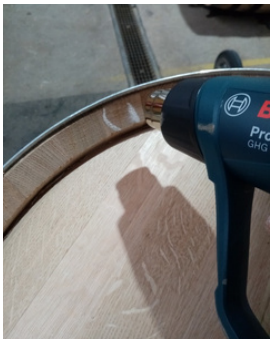
HEAT GUN

VACUUM PUMP

SUITABLE BUNG

Locate the leak at the end of the stave.

Place the barrel under vacuum using a pump.



Heat the leak area

Melt the paraffin onto the leak.

Scrape off the excess paraffin, remove the vacuum pump, and test the watertightness again.

ENTRETENIR UNE BARRIQUE

BARREL HYGIENE PRINCIPLES:

- FERMENTED PRODUCTS ARE FOOD PRODUCTS SUBJECT TO STRICT HYGIENE STANDARDS IMPOSED BY LEGISLATION.
- GOOD CELLAR HYGIENE IS ESSENTIAL FOR THE MICROBIOLOGICAL STABILITY OF THESE PRODUCTS AND FOR PRESERVING THEIR ORGANOLEPTIC QUALITIES.
- THE ENTIRE ENVIRONMENT SURROUNDING FERMENTED PRODUCTS MUST COMPLY WITH A HYGIENE PLAN.
- IT IS RECOMMENDED TO CLEAN WINEMAKING EQUIPMENT BEFORE HARVEST AND DURING AGING AFTER EACH USE.

Precautions and Warnings:

- Wear gloves and safety goggles, as some cleaning products may be aggressive to the skin.
- Follow the manufacturer's instructions regarding product concentration, temperature, and application method.
- Use only food-grade cleaning products.
- Always clean from the cleanest area to the dirtiest area and from top to bottom.
- Avoid using sponges; maintain cloths or mops through pre-washing, cleaning, disinfection, and wringing.
- Store cleaning equipment and products in a dedicated, ventilated, and clean area protected from moisture and heat. Use containment trays if necessary to prevent accidental pollution.

Recommended Volumes for Cleaning/Disinfection Solution:

10 liters of cleaning/disinfection solution for every 1000 liters of winemaking equipment.

Implementation Steps:

1.**Empty Storage:** For short-term storage (less than 2–4 months), sulfur the barrels every 2 months. For long-term storage, fill the barrel with sulfited and acidified water a few days before use.

2.**Cleaning and Disinfection:** Prefer high-pressure hot water (65–85°C) over cold water for cleaning.

Use steam or ozone for disinfection.

In the event of specific issues such as suspicious odors, use a sodium carbonate solution.

3.**Rinsing:** Rinse with cold water until the water runs clear.

4.**Residue Control:** When using sodium carbonate, check the rinse water with a strip test or pH paper.

5.**Sulfuring:** Sulfur the barrels at the specified concentrations after draining and every two months thereafter.

The recommended quantity is considered to be **5 g per hectoliter.**

What Should Not Be Done:

- **Do not store barrels** in direct sunlight, strong wind, or near a heat source.
- Avoid purchasing and storing barrels for use far in the future.
- Do not leave the barrel empty for too long.

Good Practices:

- **Immediate Use:** Use your barrels as soon as possible.
- **Ventilation:** If stored for a long period, do not place barrels directly on the ground in order to avoid mold. Use a support or place them on wooden battens.
- **Monitoring and Watering:** During dry periods, sprinkle the barrels with water from time to time.
- **Storage When Not in Use:** Store in a humid place and keep the barrels laid horizontally to prevent hoop loosening in the event of excessive drying.
-

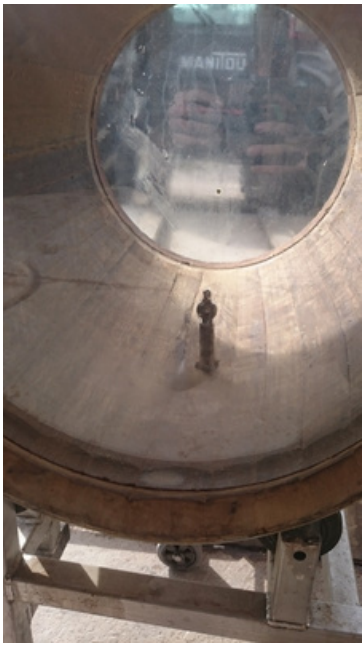
Useful Information:

- The complete combustion of a sulfur wick of:
  - 10 g corresponds to a quantity of 5 to 7 g/hl of SO_2
  - 5 g corresponds to a quantity of 3 to 3.5 g/hl of SO_2
  - 3 g corresponds to a quantity of 1.5 to 2 g/hl of SO_2

It is recommended not to store empty barrels that previously contained wine in order to avoid the risk of microbial spoilage.

The burning of sulfur to protect wine in barrels is a Dutch invention that first appeared in Bordeaux in 1765. This technique makes it possible to sanitize the barrel and contributes to the sulfiting of the wine aged inside it. Today, the quantities of sulfur used have decreased thanks to technical alternatives such as the use of dry ice or sterile filtration. Natural wines without added sulfites are also rapidly developing.

This discovery contributed to the evolution of the barrel from a simple transport container into a true winemaking tool.



Easily clean the inside of barrels and remove tartar deposits.

The washing lance is a tool that allows you to easily clean the inside of barrels. Thanks to its rotating head, it sprays pressurized water for optimal cleaning.

Steam is an effective method for eliminating contaminants and removing tartar deposits inside barrels. This technique consists of creating a thermal shock by alternating hot and cold water.

The washing lance is also used with cold pressurized water for more thorough cleaning.

The use of sulfur dioxide (SO_2) as a preservative and antioxidant is common in fruit and vegetable products, dried fruits, snacks, and wine. In addition, SO_2 is an effective antimicrobial agent that protects foods against harmful microorganisms.

Principle of Negative Oxygen: Negative oxygen is an active biocide that suppresses the biological activity of microorganisms. The production of negative ions (O-) naturally and effectively eliminates fungal elements and odors. These ions neutralize yeasts such as Brettanomyces, which are responsible for cross-contamination in cellars.

Applications: This technology has several applications, including **the cleaning, disinfection, and rehabilitation of wine containers** (stainless steel tanks, barrels, etc.) contaminated by microorganisms such as Brettanomyces.

Importance of Hygiene: Hygiene is a crucial factor in preventing cross-contamination. Barrel maintenance requires specific cleaning procedures to avoid contamination by Brettanomyces.

Barrel Inspection:

Using a small flashlight, check for the presence of blisters or tartar deposits. Blisters are manufacturing defects and can become breeding grounds for bacteria. Tartar gives the wood a dull and opaque appearance and can block wood-liquid and gas-liquid exchanges while potentially hiding bacteria.

Olfactory Inspection:

The second inspection point is smell. Common defects must be identified, such as vinegar odors (acetic acid), adhesive tape glue or solvent odors (ethyl acetate), animal odors (Brettanomyces), reduction odors (sulfur compounds), and other unpleasant smells such as dust, cheese, mold, dirty mop, or vegetal notes.

Microbiological Analysis:

If defects cannot be detected visually or by smell, microbiological analyses may be carried out.

Pre-use Recommendations:

Before using a barrel, it is advisable to rinse it to remove residues and fill it with water in order to swell the wood and identify possible leaks.

Storage and Maintenance:

To store an empty barrel, it is recommended to burn a sulfur disc inside. The correct dosage depends on the barrel size and the storage duration.

HOW TO REPAIR A DAMAGED BARREL?

When leaks or damage make the barrel unusable, it is sometimes necessary to replace certain parts in order to repair it. Here are the different steps to carry out this repair:

- Replace the damaged staves
- Replace the head pieces if necessary
- Ensure that all parts are properly fitted
- Check that there are no remaining leaks

Follow these steps to repair a barrel and restore it to working condition.

TOOLS

The hammer and **the driver** are the two essential tools of the cooper.
The hammer **provides the force** used to tighten the hoops, while the driver transmits this force onto the hoop.

The head puller is a small pulling tool used to hold the head in the croze while the barrel is being closed again.

The paste applicator is a small tool, often made by the cooper himself, used to apply the sealing paste into the croze.

Head or bevel scrapers (straight or curved) are finishing tools which, when properly sharpened, are used to remove misalignments between staves or head pieces.

Pincers are pliers used to remove the nails that hold galvanized hoops or wooden hoops in place.

A knife is used to scrape away the old dried paste and obtain a clean croze before refitting the barrel head.

It is crucial to correctly identify **leaks** or **damage**.

It is important to clearly **identify both sides** of the barrel in order to avoid confusing the position of the heads and to **correctly locate the hoops**.

MISE EN ROSE :

Opening the barrel allows us to access the inside in order to replace the defective stave.

Thanks to a hoop, also called the support hoop, placed on one end of the barrel, we are able to completely loosen the shell.

While keeping a bilge hoop on the opposite side from the support hoop.

REMOVING THE STAVES

Before removing the staves, it is essential to select a replacement stave with the appropriate dimensions. It must also be adjusted to obtain a proper joint without deformation. The joints of the two adjacent staves must also be reworked.

Simply lift the bilge hoop to slide the three staves outward so they can be removed.

Then remove the staves carefully.

REFITTING THE STAVES

Reinstalling the staves
After jointing the staves, it is time to reassemble them onto the barrel. Use the croze and the head to reposition the two staves.

It is essential to reposition the staves in their original location.

Retighten the bilge hoop.

Turn the barrel over to check whether the staves are properly aligned.
Make sure that the staves are correctly positioned.

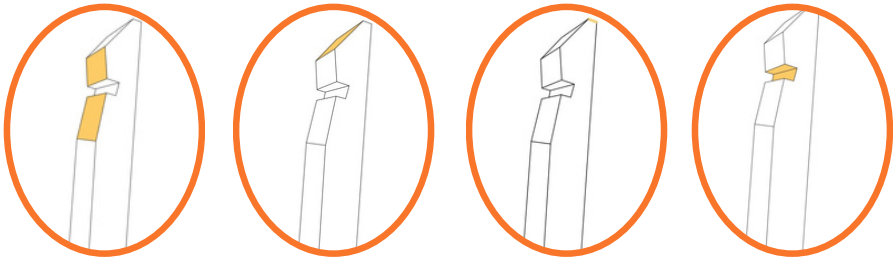
Once the staves are properly aligned, we can tighten the entire side (bilge hoop / quarter hoop / head hoop).

Then we will turn the barrel over and perform the crozing operation.

CROZING:

A slight chamfer cut must be made at the bottom of the bevel and the chime angle in order to avoid splintering during crozing.

We begin with the chime angle, then the bevel, the fillet, and finally the croze.



The chime angle | The bevel | The fillet | The croze

Inside the croze, it is important to scrape away the old paste with a knife in order to obtain a clean surface.

You can also scrape off the remaining paste from the bevels of the head.

Instructions for Refitting a Barrel Head

1. Using a paste applicator, apply the sealing paste into the croze.
2. Loosen the head hoop first, the bilge hoop second, and the quarter hoop third. Leave the bilge and quarter hoops on the barrel.
3. Slide the head into the barrel and position it into the croze at the bung stave.
4. Use the head puller to lift the head into the groove and hold it in position.
5. With the other hand, tighten the bilge and quarter hoops using a hammer.
6. Remove the head puller and tighten all the hoops of the barrel.
7. Before replacing the head hoop, make sure the staves are properly seated by lightly tapping each stave with a hammer to correctly fit the head into the croze.
8. The only step remaining is to test the barrel's watertightness.

CAPACITIES

Capacity in liters	Length in cm	Ø HEAD	Ø BILGE
1	20,5	11	15
5	28	18	22,2
10	37	21	26,1
15	41	23	29,6
20	40	27,5	34,3
25	48	29	36,6
28	50	30	37
30	52	30	38,2
35	52	31,5	38,5
40	57	31	40,1
50	60	34,5	44,2
57	56	39	47
60	65	35	45,5
70	68	36	46,1
75	69	37	47,7
105	73	43,5	55
114	70	49	58
140	85	46	59,2
150	87	47	60,8
200	90	54	68,1
210	85	57,5	68,1
225	95	56	69
228	88	60	73
250	90	61	74,8
265	95	60	73
300	103	62	77
350	103	66,5	81
400	106	70	86,5
500	109	76,5	94,7
600	117	86,5	102,5

I WOULD LIKE TO WARMLY THANK EVERYONE WHO CONTRIBUTED TO THE CREATION OF THIS BOOK.

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