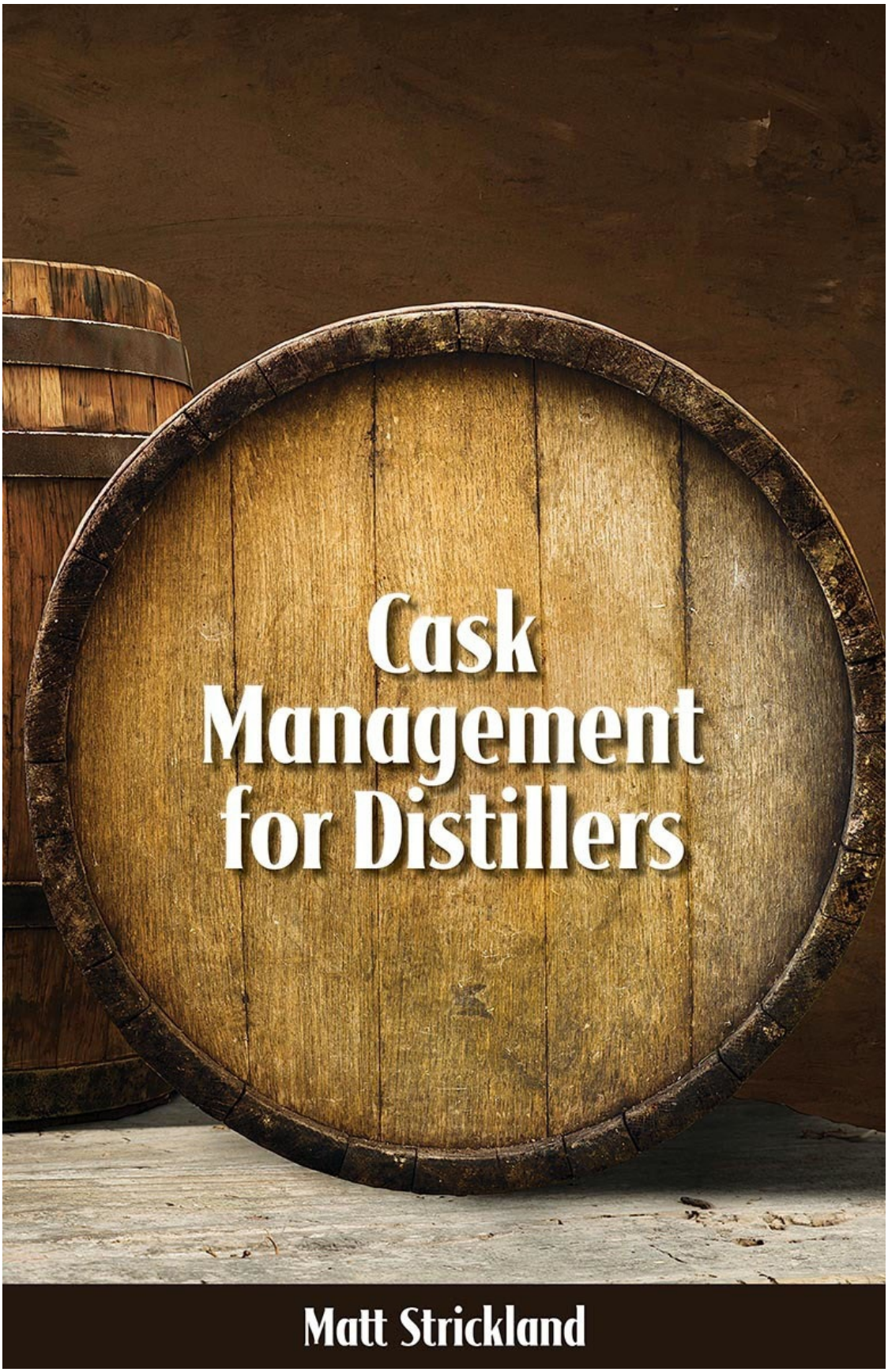
Cask
Management
for Distillers
Matt Strickland

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Introduction

When I was interviewed for a job heading up a new malt whisky-focused farm distillery in rural Quebec, I was asked by the owners what I thought was the most important production factor for making the best whisky possible. Without hesitation I began talking about the need for a diverse and innovative cask program. Within my answer I even went so far as to put forth a template plan for cask types, future blend percentages, and line extensions. I found out later that answer was what got me the job.

The owners were not distillers themselves, but they were attentive and avid fans of the profession, paying close attention to the production and flavors coming from their favorite drams. Eventually they began to see what many of us in the industry see every day: the cask is integral to quality spirit production.

I've lost track of the number of times I've heard the phrase, "barrels make up 70-90% of a whisky's flavor". Setting aside that I'm not entirely sure what metrics are being used to quantify "flavor", I think that for many spirit types, these words largely ring true. There is something alchemical and almost magical about cask maturation. The white spirit enters the barrel as a brash and rude liquid neophyte and emerges (hopefully) smoothed, matured, and coifed for the real world.

It's hard not be taken in by the wonder and aroma of a properly maintained maturation warehouse. Whether it be the cool dunnage systems throughout Scotland or the hot and dry rick houses dotting the Kentucky landscape, you can't help but fall in love with their spartan design and primitive allure. These are altars to the idea that time and patience are the perfect finishing ingredients for spirits and can't easily be improved upon.

Casks are the sporks of the distilling industry. That is to say, a game changer. This can't be overstated. Prior to the use of casks for the maturation of spirit, they were merely viewed as containers; a transient vessel to hold spiritous liquid for the purposes of transportation or easy serving. Wooden casks became the CD's to the clay amphora's cassette tapes of the day. They were more efficient, robust, and easier to move. However, until the advent of toasted and charred

barrels, they were considered little more than holding tanks.

Eventually fire entered the mix and the cask evolved into something more than a vessel. It became part of the recipe, an ingredient. And it has forever altered the spirits we consume today. Through various physical and chemical reactions between cask and spirit we see rough-hewn white liquors transformed into bolder and haute impressions of their former selves. Would Jack Daniels or Jim Beam taste the same were it not for the use of newly charred American oak? The Macallan sherry bomb would not exist were it not for careful cask selection and management. The famous cognacs of southern France would likely remain fiery and rustic without the addition of state-run old growth oak forests.

So, to make many of the world class spirits we know and love, a cask must enter the picture at some point. Several of these spirits require either through tradition or law a specific type or class of cask. Most American whiskeys must legally be aged in new charred oak barrels. Caribbean rums are typically aged in used bourbon casks while cognac and its older brother Armagnac are almost exclusively aged in toasted French oak. If you know what you're producing, then choosing a barrel is seemingly the easiest decision to make.

Sometimes it really is that simple. Buy barrel. Put liquid in barrel. Wait and then bottle. However, like most things in life there's a difference between simply doing something and doing it well. This is where the principles of cask management come into play.

In my view cask management begins with the selection of the standing tree to be converted into stave wood and ends with the final blend. All along the middle there are roads, routes, and rivulets that we can meander down to further alter the character and effects of the maturation process. In the end I believe most distillers want to make a high-quality product. This becomes much easier and more consistent when we fully grasp the potential of the tools of our trade, casks included.

And that my friends is the raison d'etre for this book. Like much else in the distilling industry finding reliable information and learning materials to better your craft can often feel like a daunting task. In the kingdom of alcoholic beverages, distilled spirits come off as arcane witchcraft and sorcery. Far more research and time has been spent learning and explaining the scientific minutiae of wine and beer. Spirits have typically received the short end of the information

shaft.

Distillers are usually a convivial folk, and most don't mind sharing information but that's still far from ideal with regards to raising the technical level of the industry as a whole. We need to move beyond the anecdotal and apocryphal into the realm of fastidious research. Sure, the internet is your friend, but it's not your only friend.

The story of cask management is just like any other story. First it requires a beginning. For us, that beginning is in the forests where our cask wood grows. To understand how to better manage our barrels and maximize their potential for our products, we need to understand where this particular ingredient comes from. There is understandably a sort of terroir with regards to oak and differences in location and growth factors can have pronounced effects on the sensory character of the finished barrel. This ignores the obvious differences that can arise from the different species of oak or even different types of wood apart from oak. We will explore what makes American oak different from French oak, Oregon oak, and Japanese Oak. And for the sake of cat killing curiosity we will look at a few woods making minor headway into the spirits industry such as chestnut and acacia.

Tree felling and stave cutting are not insignificant tasks. Neither is the crucial time of stave drying whether it is in a field of stave ricks or through forced air drying. We will discuss the benefits and disadvantages of both and how they affect the final barrel.

Moving into the cooper's workshop we discuss the basic techniques for shaping the cask from stave selection to heading. This is also when fire is introduced to the stave wood and we toast or char the barrel to the desired specifications. How this is done has a profound impact on the wood chemistry and subsequent sensory characters that our casks contribute.

In Chapter 2 we get down to the molecular level of the cask to explore some of the important chemical changes that casks can contribute to immature spirits. These reactions are roughly grouped into four major classes: reductive, additive, subtractive and productive. We will explore them all and how they can be manipulated in subtle ways to give us more control over the maturation process.

Chapter 3 is where we begin the process of selecting our cask. Barrels should be

selected for the express purpose of modifying our spirit in ways that we find desirable. Certainly, what may be desirable for one person may be anathema to the next. This chapter deals with that disparity by tackling the many factors that go into cask selection and how they may alter the spirit maturation process. This includes barrel sizing considerations, char and toast levels, and the use of used barrels.

Chapter 4 is interesting in that here we step away from the cask to look at the warehouse itself. The warehouse is effectively the cask that contains the cask, and its materials of construction and environment are every bit as important as the casks themselves. This section deals with the common warehouse designs, their construction, advantages/disadvantages of each as well as safety and work-flow considerations. Next, we talk about the warehouse micro-climate and macro-climate and how these affect the maturation of the casks contained therein. Finally, this chapter goes into more detail about the common aging and physical placement systems currently in use and how they affect the maturation process.

Chapter 5 for some people may seem like the crux of this book and it some ways it is, though this comes with the caveat that nothing in chapter 5 will mean much if we don't pay heed to chapters 1-4. This chapter is all about maturation techniques. This section is front-loaded with traditional aging techniques for the world's best-known spirits including American whiskey, Scotch whisky, French brandy, rum, and tequila. Of course, I am a big proponent of studying as many distilling traditions as possible so this chapter contains information on what some might call "alternative" maturation techniques which includes such concepts as stave additions, alcohol adjustments and oak extract additions.

Chapter 6 in the book deals with blending and the myriad bits of minutiae that go into the blender's art. As such blending is not something that can necessarily be taught but must be experienced first-hand for the practitioner to hone their skills. All the same, there are quite a few standards and techniques practiced throughout the industry that we will treat as suggested practices for the would-be blender.

Chapter 7 takes a shallow dive into the world of sensory analysis. Every distillery should consider implementing a formalized sensory program to ensure consistency and better understand their products. This chapter includes building and training a sensory panel for simple discriminatory tests as well as basic

statistical approaches for their assessment.

Chapter 8 is all about physical cask maintenance. Wood is a porous and organic material, meaning it is structurally prone to problems if not well attended to. Barrels can leak. They can dry out during storage. Mold can grow on them. These and many other issues can occur if the distiller is not paying attention or properly maintaining their casks. This chapter speaks to the handyman living in all of us and attempts to set out a simple set of techniques that can be used to assess barrels upon receipt from the cooper or broker, proper storage conditions, repair techniques and basic coopering concepts. Barrels may serve as ingredients, but they are also tools and we must be diligent about keeping our tools in top condition.

When I teach classes and workshops, I have always had a simple view on sharing information with students. I believe that with rare exception there is no one correct way to do something in the spirits industry. That is probably why I find this industry so freeing when compared to brewing or winemaking. The motto that a friend and I coined at a conference one year discussing this very thing is, “tools not rules”. I believe the contents of my courses and by extension this very book should be treated not as dictums for how something must be done, but rather how it can be done. If you line up 100 bourbon distillers and ask them how to make bourbon, you will likely wind up with close to 100 different answers and most of those answers would produce some delicious liquor. I cannot tell you how to run your cask program. I can only show you techniques and hopefully give you some ideas and inspiration on how to improve your processes.

So, we begin our journey down the rabbit hole of spirit cask management. Cheers to your journey. I hope to someday share a dram with you on the other side.

Chapter 1

How Casks Are Made

Anatomy of a Cask

Barrels are truly magnificent feats of human engineering. Take a close look at one the next time you are strolling through a warehouse. The curves are perfectly balanced for rolling a full cask with relative ease. Metal hoops supply support and the all-important bung implanted for a perfect liquid-tight seal. We could go on contemplating the coopers craft and waxing poetic about…well, barrel wax, but perhaps it would be best to simply show you the ins and outs of a barrel. We must start somewhere, and a little barrel anatomy seems as good a place as any.

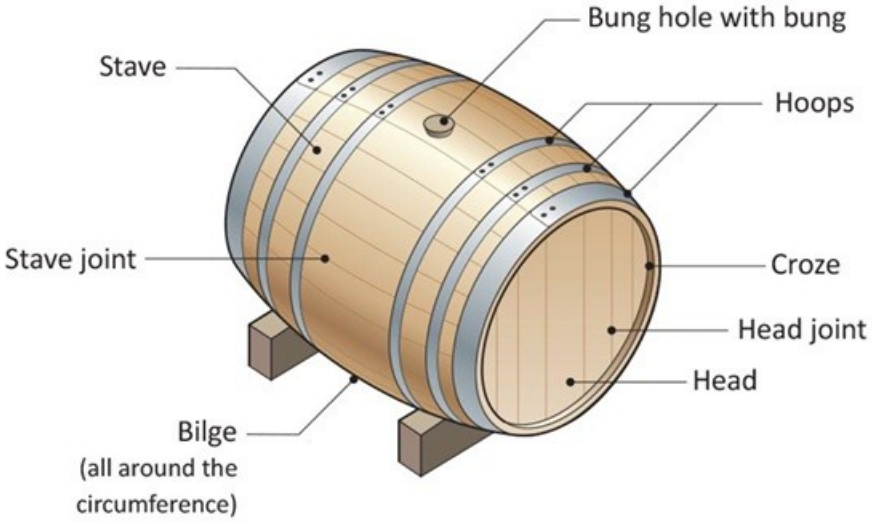


Figure 1 Anatomy of a Barrel

A barrel is simply a series of curved wooden staves bound together by hoops and closed at both ends by heading materials (usually specially cut stave wood). However, there are some specific anatomical points worth noting.

Bilge: This is the bowed center section of the barrel. It is the point on the cask with the largest diameter. This is the circular plane that makes rolling the barrel quite easy when it is on its side. The bung hole is typically drilled somewhere in the plane of the bilge.

Bilge Hoop: These are the widest diameter hoops that fit closes to the center of the barrel around the bilge.

Bung Hole/Bung: The bung hole is where the bung fits to seal off the barrel. This is the point where the barrel is filled and often sampled from. The bung is often (but not always) made of a different wood than the rest of the cask. In U.S. whiskey barrel production, it is commonly made of poplar which is a softer wood than oak. The bung hole is typically drilled into the bilge section of the barrel though some coopers and distillers prefer to place it on one of the barrel heads.

Cant: The cant is a section of the barrel head that has one straight side and one curved side that fits neatly into the croze.

Chime: The chime is the extended section of stave wood that comes out beyond the head sections. It provides the cooper and distiller a convenient place to grab the barrel for rolling and leverage. The barrel can also be “edge rolled” using the chime.

Croze: The croze is simply a crease cut into the longer stave sections that allows for the fitting of the head pieces. It is also a notorious place for barrel leaks to occur. More on that later in the book.

Head/End: The head refers to the end sections that perpendicularly close of the barrel at the stave ends. The head fits neatly into the croze seam.

Head Hoop: This is simply the hoop that tightens and holds the heads against the stave wood at the ends of the barrel.

Quarter Hoop: This is the hoop that fits in between the head hoop and the bilge hoop.

Stave: These are the long pieces of wood that make the length of the barrel. They are fit together at the stave joint.

Stave Joint: Joint formed by the intersection of two staves. Can be a source for leaks if the barrel is not formed properly or is too dry.

Structure of Oak

When it comes to casks, oak is undoubtedly king. To understand why, we need to look a little deeper under the hood or in this case, bark.

Imagine that you have just cut down a large oak tree a few feet up from its base and you're looking down at the freshly cut trunk. A few things will immediately stand out to you. First, is that there are a series of concentric rings that radiate out from the perfect center of the trunk getting large in circumference towards the bark. You will also see a set of rays that run perpendicular to those rings as they extend from the center out to the bark. Next you may notice that the wood nearer the center of the trunk is darker compared to the lighter colored outer circumference bands right next to the bark. All the things you are looking at make up important pieces of wood anatomy and hence are important to the character of the cask that we can potentially build from it.

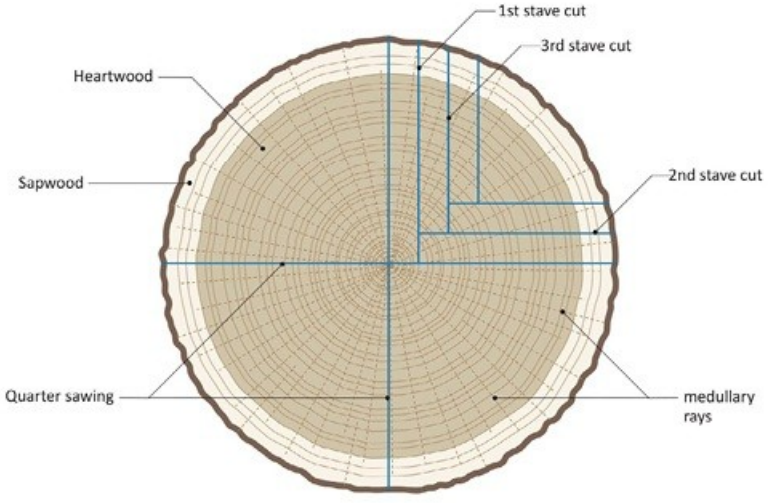


Figure 2 Cross section of white oak

(Image courtesy of the Institute of Brewing & Distilling)

Look at the above figure. In the cross section of the oak trunk you can see the light-colored wood layer just beneath the bark. This layer is called the "sapwood". The role of sapwood is to conduct water, nutrients, and food throughout the tree using a series of pores that can transport these materials. As the tree grows in height and diameter, the innermost cells of the sapwood become non-functional and become part of the darker inner layer of wood called heartwood. The functional pores of the sapwood become blocked by structural growths called tyloses. Tyloses effectively block liquid flow through the heart wood. Different wood types have differing amounts of tyloses with American white oak having them in abundance. It is partly because of the high amounts of tyloses that American white oak casks retain liquid so well.

Now let's look at the concentric rings that radiate from the center of the trunk out to the bark. Look close enough and you should see an alternating pattern of dark and lighter colored rings. These rings are called "growth rings" and in the case of oak, they generally (though not always) represent one year's worth of growth. The lighter colored bands are called "earlywood" and are formed in the spring at the start of the growing season. Earlywood is composed of large cells with thin cell walls. As the growing season continues towards summer and fall, earlywood gives way to a darker band composed of smaller cells with thick cell walls. This is referred to as "latewood".

Put all this together and it should make sense that counting one light ring and one dark ring equals one growing season or year of the tree's life. Aside from age, other things can be gleamed from the growth rings. Wide rings indicate periods of ample growth while narrower rings indicate tough years for the tree. There is an art to reading growth rings for sure. But what we really want to understand here is that ring size also indicates the "grain" of the wood. Wide rings from good growing seasons amount to wide grained wood while narrow rings tend to give a tight grain wood.

Now imagine the log that was cut from our stump. On the cut end you will see

the same growth rings. If we cut that log lengthwise into quarters, we can then look on the inside of the wood. What we will see are a series of lines that come from the growth rings. This is what most people think of when they consider the grain of the wood and its orientation. Most importantly for us in the production of casks, we want a relatively straight grain, with little in the way of wave patterns and no knots.

Some distilling traditions prefer differing levels of grain tightness for their spirits. For most major spirit categories, wide grains are preferred because some distillers feel they offer faster extraction of oak compounds. This like so many "absolutes" in distilling is heavily up for debate. The counterargument goes like this: latewood has fewer pores than earlywood. Earlywood growth is somewhat constant whereas latewood growth is a bit more variable. So, a tighter grained wood should have a smaller band of latewood than in wide grained wood. The pores are where much of the aromatic compounds are contained. Therefore, an oak that has a tighter grain from slow growth conditions has more potential extractives per unit area than a wide grained oak because there is proportionally more earlywood with pores in proportion to the amount of total wood. So, counterintuitively it is the tight grained wood that has greater extraction potential.

I know. The logic is a bit dizzying. Personally, grain width is not something that I invest much thought in. I merely bring it up because some folks have strong opinions on it. Most of the wood that I use for my own barrel program is wide grained, but that is more about the types of characters I am trying to extract and not about the speed of the extraction. I suspect that the extraction speed differential between tight and wide grains is not large enough to matter for most maturation programs of high-end spirits. Tellingly much of the fuss over grain width is made in wine-making circles where aging time is most often much less than that of aged spirits. Regardless, my suggestion is to focus on wood character rather than extraction speed. Speed is a quantitative issue and not a qualitative one. Quality is what we are after, here.

Types of Wood

There is a variety of wood types currently used in the production of casks. Acacia, chestnut, and mulberry woods all make their appearances, but it is the

various species of oak that have dominated the cooper’s trade for centuries.

Oak is desirable for cask production for several reasons. It is strong. It maintains a good level of porosity without being so porous that it leaks. It can be shaped relatively easily. It is resistant to various pests that could otherwise damage the quality of the wood. Oak also has a desirable balance of volatile and non-volatile compounds that provide flavor, aroma, and mouthfeel to spirits.

The oaks of the Quercus genus number roughly 600 species. Of these, only a few are truly suitable for cask production. The primary oak species used in spirits production are:

Quercus alba (American WhiteOak)

Quercus robur(French/English Oak, LimousinOak)

Quercus petraea(SessileOak)

There are other species and different common names abound. It can get rather confusing at times. Quercus petraeaand Quercus robur are sometimes both referred to as “French Oak”. You will see things such as Hungarian Oak, “European Oak”, and Russian Oak. Of course, there is the recently famous Japanese Oak and the curiosity that is OregonOak.

We must remember though: all these woods fall into the same genus, which means they share similar traits. Most of these similarities are in the form of structural characteristics, but as we will begin to see, there are a host of organoleptic properties that these oaks share. However, there are enough differences between them that we should consider each on its ownmerits.

American Oak

Quercus alba is arguably the most important oak in the spirits industry. It forms the basis for nearly all-American whiskey production and when the casks are emptied of their initial contents, they are most often sold off to the Scotch whisky industry. These casks also regularly find their way into the warehouses of rum,

tequila, and brandy producers all over the world. In short, American oak iseverywhere.

American oak grows throughout the Midwest and Eastern U.S. from Maine to northern areas of Florida and Alabama while extending into eastern Kansas and Oklahoma. It reaches north of the U.S. border into parts of Ontario and Quebec as well. It is typically a lowland tree but grows comfortably in higher elevations in the Appalachian Mountains. It generally grows to a height of 100 ft (30m) and may reach diameters of more than five feet (1.5 m). These are long lived trees with some specimens reaching over 600 years of age (Tirmenstein, 1991). American oak grows straight and tall with little in the way of lower branches. This makes for fewer knots in the final staves which can be difficult to work with in the cooperage and may be points of potential leaks in thewarehouse.

Q. alba is a hardy tree. It grows on a variety of soil types, though it seems to prefer well drained loamy soils. Temperate climates are its preference though it can withstand a wide range of temperatures and rainfalls. Even though American oak is adaptable, different growing conditions will affect the usability of the oak in the distillery. Trees that grow in more stressful conditions such as high altitudes with short growing seasons, will tend to have a tighter grain wood. This situation might be desirable or not depending on what kind of maturation regimen you are aimingfor.

Harvest typically happens when the tree is at least 80 years of age (Barrels,2020).

French Oak

Here we are talking about Quercus robur or Limousin oak. There are other oaks such as Q. petraea that are occasionally referred to as French oak as well, since multiple oak species grow well in France. However, Q. robur forms an important basis for a certain French spirit, cognac, so that is why we’re associating the country with thisoak.

French oak is generally wider grained than other European oaks; however, this is somewhat dependent on growing conditions. Growth factors that allow for the tree to obtain larger diameters promote wider grains and viceversa.

French oak grows throughout many areas of France but much of what is harvested comes from the Limousin forests in western France. These forests lie just a bit east of Cognac, making them the logical choice for wood sourcing for theirindustry.

Unlike oak harvests in the U.S., France strictly regulates the harvesting of all oak species throughout the country via the Office National de Forets (ONF) (Office National des Forets,n.d.).

In the search for sherry casks, you may come across the term “Spanish Oak”. Spanish oak is generally Q. robur but grown in Spain. The growing conditions for oak in Spain are quite different than those in the forests of France. Spain is considerably hotter and drier. This set of conditions tends to produce wood that is more porous and prone toleaks.

Figure 3 Major oak growing regions in France and related spirit and wine regions (Image courtesy of The Institute of Brewing & Distilling)

Sessile Oak

Quercus petraea is the so-called "other" French oak. It grows in roughly equal proportions to its sibling, Q. robur throughout France. However, it typically grows taller with a narrower diameter which yields a tighter grained wood. This is due to tighter spacing between trees that causes these plants to fight each other for light quite a bit. As such, Sessile oak typically requires longer times to reach maturity for harvesting, up to 150 years or more (Robin H.-G. , 2016). This species is popular with the wine industry for partly thisreason.

This species grows in several forests throughout France including Allier, Vosges, and Tronçais. It also grows well throughout eastern Europe which is why it is sometimes called "Europeanoak".

Japanese Oak

Quercus mongolica is a species of oak that grows throughout Japan, certain parts of China, Korea, Mongolia, and Siberia. Also known as Mongolian oak and "Mizunara" it has become a hot topic of conversation within the whisky world over the past few years. Specifically, it is used in sparing quantities to produce some highly sought Japanese whiskies. Fresh Mizunara barrels contribute interesting incense and sandalwood aromas towhisky.

There are two primary drawbacks to using Mizunara. First, is that it tends to leak. This type of oak has fewer tyloses (heartwood compounds that prevent liquid movement) than many other barrel-ready oaks and an abundance of knots (Yushi Noguchi, 2002). The wood grain is also quite curved making coopering rather difficult. Trees are typically not ready for harvest until they're nearly 200 years old making this oak rare (Mizunara Oak,2017).

All this brings us to the second issue with mizunara oak: it is expensive. Stave wood does not make it outside of Japan very often and when it does you have to

make sure that you use a cooper who understands how to work with it. Expect to pay up to 10-15 times more per barrel for brand new mizunara oak casks when compared to other new American bourbon oakcasks.

Oregon Oak

Quercus garryana is perhaps the newest member of the cask oak family. Interest in the tree started in the wine industry many years ago and it has recently made inroads into the distilling community, albeit in limitedquantities.

Oregon oak has a small range growing from Northwest California, through Oregon and Washington states up into southwest British Columbia. Like most other cask oaks, it is tolerant to drought and typically grows at low to moderate elevations throughout much of its range (up to 6000 ft in Northern California, but typically much lower in Oregon and Washington). It grows well on its own but often grows ingroves.

Oregon oak is one of the smaller oaks typically only reaching a height of 30-100 ft (9-30 m) at maturity (Gucker,2007).

This is not a common oak as the forests are small and finding a suitable tree with a straight trunk for staves is difficult. However, for some people the effort is worth it. Oregon oak tends to have “darker” flavors such as molasses, coffee, smoke, and cloves. Most often it is used as part of a blending program though it would be interesting to see more single cask releases from it (Hoffman,2020).

In a study that looked at the possible use of Oregon oak as a maturation material, the extractives from the heartwood were assessed. Provided in the table below are extractives from American oak seasoned 1-2 month with minimum moisture drop for comparison (Hewlett, Oregon Oak: Quercus garryana,n.d.).

Table 1 Comparison of Extractives from Oregon and American

Oaks (Hewlett, Oregon Oak: Quercus garryana, n.d.)

Wood Extractives	Q. garryana	Q. alba
Gallicacid	94.3	679.68
Vescalagin	13.1	0.84
Castalagin	6.3	0.54
Hmf	16.7	126.88
Furfural	25.6	107.56
Vanillicacid	20.6	68.85
Syringicacid	21.2	35.14
Vanillin	16.1	15.2
Syringaldehyde	16.4	5.43
Scopoletin	0	27.62
Ellagicacid	936.5	428.88
Coniferaldehyde	0	10.77
Sinapaldehyde	11.7	6.78

We will get into more chemistry in the next chapter but for now you can see that Oregon oak is very different from American oak with regards to extractives. It is lacking in many things that we find important in American oak such as tannin (gallic acid and equivalents but the story is more complicated than this…), but there do seem to be higher levels of some lignin degradation by-products such as a few of the importantaldehydes.

Other Woods

There are several other types of wood that are occasionally used in the alcohol industry for maturation. Enterprising distillers should look beyond the comfortable confines of their chosen spirit traditions to arenas such as winemaking, eastern European brandy, or even cachaça. It is not realistic to cover every single wood currently in use in alcohol production, but I will provide a few examples to get your mind thinking about the different possibilities that may be available toyou.

It should be noted that many regulations regarding spirits production around the world require the use of oak as the primary maturation wood. Depending on what you are producing, you should research the pertinent rules prior to committing a new make spirit to one of these woods. Even finishing the spirit in some of these casks may not be permitted in your region. Do yourhomework.

Acacia

Acacia wood has been popping up in American white wine circles for some years now. Compared to oak it is a relatively soft wood and is somewhat more porous. This makes evaporative losses a constant concern. Currently its primary use as cask wood is in some experimental white wines such as chardonnay, viognier, and Semillon. The casks are generally not toasted beyond a light toast, thus minimizing heavy barrel contributions. Acacia does not contribute much in the way of tannins so these casks could be quite useful in certain blending

programs where there may be a need to reduce tannin influence from other barrel types. Winemakers feel these barrels are more for adding body and mouthfeel rather than intense wood flavors (Theron, 2013). That being said, spirit producers would likely purchase one of these barrels from a winemaker who has already used it so you would need to consider the flavors contributed by the previous barrel contents in addition to any potential benefits to mouthfeel. You may come across something called Black Locust wood. This is essentially Frenchacacia.

Amburana

Amburana is a wood that falls into the Fabaceae family which also contains peas and beans. Amburana grows throughout south America including countries such as Bolivia, Peru, Argentina, and notably Brazil. In fact, it is within Brazil that we see the most use of this wood for cask production. It is used to mature some high-end cachaças. The flavors produced by this wood lean towards dark stone fruit and spice notes. This is not an easy wood to source for cask production as the trees are considered endangered in some regions. However, it may be possible to contact current users in the cachaça industry to see if they would be willing to part with the occasionalcask.

Cherry

Cherry wood is found throughout the eastern United States sharing a similar geographic range to American oak. These large trees are a common source for furniture lumber, because it is relatively easy to work with and to bend. Sounds like a good cask material, doesn’tit?

We can thank the wine community for being intrepid enough to experiment with cherry wood casks. One study found that total phenolic content of wine aged in cherry wood was like that of the same wine aged in French oak. Perhaps not surprisingly winemakers have found that cherry wood adds nice cherry and fruit notes to the wine (Yeamans-Irwin, Examining the Influence of Cherry Wood Barrel Aging on Red Wine Color, 2012). This is certainly an interesting wood to consider experimentingwith.

Chestnut

Chestnut is a hardwood that does not get made into barrels that often. It is occasionally used in some wine production, notably the occasional port. Considering that it is an abundant source of wood in some areas of Europe, people have been rightly curious about its potential as a caskmaterial.

One informal study analyzing volatile compounds from extracted samples of Spanish chestnut, French oak, and American oak found that chestnut exhibited a lot of similar aromatic qualities to the oak species. Of course, things are not exactly the same, and chestnut is missing some kinds of lactones which are often important to distillers. However, it does have ample volatile phenols and good tannin content making it an interesting choice for a blending program. However, be warned: like acacia, chestnut is fairly porous which may result in greater evaporative losses over time (Yeamans-Irwin, Chestnut Wood as an Alternative to Oak Wood: Differences in Aromatic Potential, 2012). High levels of porosity do have their benefits. For sherry production it allows for high levels of oxidative maturation to occur while the wine is in cask. This characteristic can be beneficial for spirits as we will see later in thebook.

Mulberry

Mulberry is a family of trees that grows throughout temperate regions in the northern hemisphere. These trees are used for a variety of things including their fruit, as well as providing a food source for silkworms (apparently white mulberry is their favorite, making these trees indispensable to the silk industry). However, these trees also regularly get turned into barrels, primarily for the aging of eastern European plum brandies such asslivovitz.

Reportedly these barrels can be problem leakers, so it is best to use caution and diligence with this wood. However, many cooperages and distillers report that mulberry is one of the more aromatic woods available for cask production so it may be worth the time and money to experiment withthem.

Rauli

Rauli wood is the final “alternative” wood we will discuss in this chapter. This wood comes from a type of beech tree that grows in Chile and Argentina. These trees are rather large, growing 50 m (160 ft) and can reach diameters of up to two meters (6.5 ft). Like many of the other woods on this list, its primary uses are well outside the realm of cask production, most often being used for furniture and flooring. However, some of the wood does get turned into casks for Chilean wines and Chilean pisco. While smaller format casks exist, most often in pisco production this wood is used to make 1000 liter plus sized “tuns” for long-term mellowing andstorage.

This is not going to be an easy wood to find for the adventurous distiller. However, it might be worth contacting Chilean pisco distillers and wine makers to see if they have any spent casks they are willing to partwith.

There are several other woods that we could add to this list and possibly by the time this book goes to print we may even see a few new woody additions to the arena of cask production. Certainly, woods such as juniper, ash, hickory, maple, red oak…well the list could go on for a while. I have merely given a primer on the woods that I feel are most important to spirit production today. Of course, these things change all the time and experimentation is often the seed for evolution, so I look forward to seeing what types of casks come onto the market in the comingyears.

Selection of Materials and Coopering

Now that we’ve taken a cursory glance at the various oaks and alternative woods that are used in barrel production, let’s refocus our discussion on oak cask production since oak, particularly American oak, makes up most casks used in the spirits industry. In this section we want to discuss the beginnings of the barrel making process, which just like the beginnings of a great spirit, starts with the rawmaterials.

American oak is a hardy plant. It can withstand a wide range of temperatures, soils, and water availabilities. It’s an abundant natural resource and estimates suggest that even with all the new distilleries and spirits production in the world

that rely on American oak (we must remember that winemakers, use quite a bit of it as well), that the species isn't really threatened. So far, the industry has done a good job of responsibly harvesting and replanting. According to the American Hardwood Export Council there are just over two billion cubic meters of white oak stock growing in the U.S. Each year a total of about 21 million cubic meters is harvested but the amount of oak that grows during the year is roughly twice that. In fact, one cubic meter of white oak is grown and added to the current tree stock every 0.8 seconds (American White Oak,2020).

Choosing American oak that is good for turning into casks is no easy task. It requires knowledge and a good eye. The selection process starts with the logger. Loggers will survey an area of trees to decide as to the worth of the timber and the cost of harvesting it. This is called "cruising". Generally, a logger only cuts the trees worth harvesting, leaving young trees to grow. This also avoids the harvesting of damaged timber (From Forest to Barrel: Harvesting,2018).

The ideal trees are tall and straight with a large section of trunk wood without branches. We do not want any knots, or fungal diseases on the wood. We also want the wood to have a straight grain, avoiding curvy grain selections whenever possible. The logger fells the tree, loads it onto a truck with its recently felled siblings, and heads off to the stavemill.

First, the logs are debarked and run through a large metal detector to ensure that they are free from things such as nails or embedded barbed wire. The logs are then cut into smaller segments so that they are more easily worked. The smaller sections are then cut intoquarters.

At this point the cooper begins to mark out how the individual staves will be cut out of the quarter sawn segments. We only want the inner heartwood of the tree, leaving the sapwood as scrap. The mapping and cutting of staves is a time and labor-intensiveprocess.

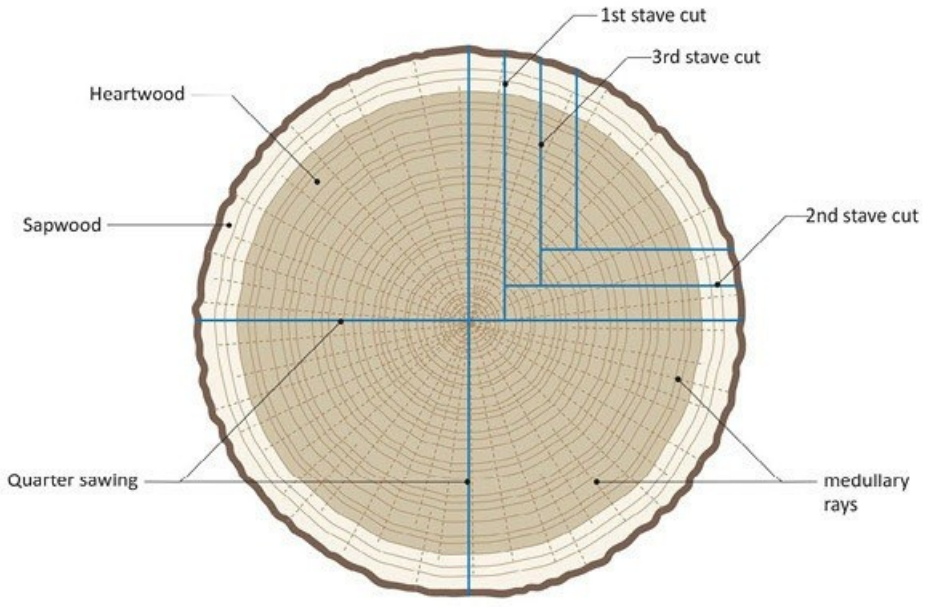


Figure 4 Stave cuts on a bolt of oak (Image courtesy of the Institute of Brewing & Distilling)

Interestingly in French cooperages using French oak, the log bolts are usually split by hand instead of quarter sawn. This is considerably more time consuming and less efficient in terms of stave wood yield. These cooperages feel that sawn wood opens the grain to release more tannin, and that cutting with the grain produces superior flavors. (This is somewhat debatable but does help explain some of the pricing differentials between American and French oak.) Some cooperages say they can only use about 20% of the wood for stave production. However, the remaining 80% can be used for other things including fuel for the cooperage (Barrel Making,2017).

Once the staves are cut, they must be seasoned. The staves are carefully stacked into columns and left outside. Every stave mill has their own method for stacking the staves. The end goal is to ensure that as much of the stave wood throughout the stacks is exposed to airflow and that little wood overlaps. This helps to reduce the chances of unwanted mold growth attacking the wood and weakening it. How long they stay outside is left up to the individual cooperage and the barrel buyer. This is a topic that has a lot of debate and baggage. In the wine industry, particularly for French cooperages, staves are exposed to the elements for two to three years. In the bourbon industry however, it is common to see staves seasoned for only three to six months before being air dried in industrial kilns and moving on to the next cooperingstages.

There are two primary reasons for seasoning the staves. First and somewhat counterintuitively is the reduction of moisture in the wood. Exposing the stave stacks to the elements including rain, sleet, and snow, might cause you to think that the overall wood moisture would go up, but that is not actually the case. The moisture levels go down to 12-14% over a period of two to three years. This helps prepare the wood for final cooperingsteps.

Second, is the promotion of fungal growth on the stave material (Swan, 2008). The growth of microorganisms on the wood coupled with rain and snow has shown to break down and remove unwanted “green” and tannic characters from

the wood, bringing about a better aromatic and flavor profile. This is partly why some people are willing to pay more for casks that have had their staves seasoned for three or moreyears.

However, not everyone believes in the practice of air seasoning. As you can imagine, this is an expensive process. It essentially ties up the cooper's working materials for extended periods of time and puts them in unpredictable elements. As we have already mentioned, in the American whiskey industry, it is common to have the stave wood air kilned after only a few months. Why would American whiskey do this when the French wine industry claims it does not make a good barrel? Let's unpack this abit.

If we work under the assumption that air seasoning provides a way to remove unwanted tannins and green wood character from the staves, then we can certainly understand the appeal of the process. However, French barrels just prior to completion are typically "toasted" on the inside whereas American whiskey barrel oak is "charred" on the inside after an initial toasting, by literally setting the inside of the barrel on fire. The toasting process is considered quite a bit gentler on the wood than the charring process. The charring process is thought to be another way to remove or at least lessen the amount of tannin material in the stave wood. So the question for some coopers of American whiskey barrels is "why would you go through the time and expense of air seasoning staves when the charring process coupled with air kilning gives the staves the right moisture and tannin content in a fraction of thetime?"

It is not as easy a question to answer as you might think. I have spoken to several distillers about this topic and some swear there's a major difference between charred air seasoned casks versus charred kilned casks. Even Independent Stave Company offers casks from staves that have been air seasoned for over two years. You will pay a higher premium for these barrels as opposed to the air kilnedversions.

Also consider this: during the maturation of a spirit in the cask the liquid penetrates the wood, moving slowly in and out of the pores over the aging period. The level of penetration in many American oak casks is 7-8 mm deep into the stave wood. However, the char level only reaches about 5 mm into the stave. That extra 2-3 mm can have a huge impact on flavor. Therefore, in my opinion it is best to pony up for the air seasoned wood with 18-24 months producing great results for most spirits. That is not to say that air kilned casks

will produce inferior spirits, just that you are starting yourself out on a better foot with a longer seasoningperiod.

The cut staves that have been drying in the stave yard for two plus years are not ready to be formed into a barrel. There is still some woodworking that needs to be done to have staves that will form the proper shape when coopered into the final caskform.

First, the staves need to be properly shaped. That means shaving the back or outside of the stave into a convex bow. This will help keep the casks final round shape. Conversely the inside of the stave needs to be concave so this will be worked and shaved out aswell.

Next the side edges of the stave need to be tapered at both ends. This can be hard to mentally envision, but this process aids in forming the bilge of the finalcask.

The sides then need to be shaved down and in from the outside of the stave to the inside. This will allow other staves to be jointed next to it. The process requires a lot of experience on the part of the cooper. Try as they might, stave mills just do not produce perfectly uniform staves every single time. They are working with an organic material that comes with its own imperfections and structural quirks. So, it is not uncommon for some staves to be wider than others. This means that to maintain a good leak-proof exterior to the cask, the staves must be jointed according to the sizes of the other staves in the same cask. Remember, the cooper is also trying to make uniform barrels of a particular size, so this step cannot be taken lightly. Putting too many of one size of stave in the cask may result in odd sizing, which is no good for distillers that demand consistency in theircasks.

The final touches are making the croze seam that the heading pieces will fit into and beveling the ends of the staves to form the chime. One of the wider staves will be chosen for drilling thebung.

Now the barrel needs to be raised. The freshly formed staves are placed inside a truss hoop which is a reusable hoop the cooper uses to aid in shaping the barrel. The truss hoop and barrel staves are placed onto a flame source. At this point the staves are straight and need to be bent into the typical cask curvature. This is accomplished with a little bit of heat. The flame is turned on and over a period of several minutes a metal cable called a windlass is used to gently pull the staves

closer together. This is another stage where the cooper must have a trained eye. If the fire gets too hot too quickly, stress from the cable can crack the staves, so this step must be done carefully. Once the splayed staves are in place the cooper will place another truss hoop over that end to keep everythingtight.

Firing the barrel is also important as it provides flavor to the stave wood. Once the initial bending firing is done a secondary firing is undertaken. Depending on the type of cask being made, it might be a long gentle low heat firing so that the barrel is toasted, or it might be a quick and violent firing so that the staves are charred. Temperatures and times can be hard to come by because different combinations of these two factors can yield similar results. Toasting times are generally 40-60 minutes with barrel wood temperatures between 45-65°C (Tiessedre, 2014). However, it should be noted that this varies greatly between cooperages. Some research suggests that certain oak components do not generate flavor compounds until the temperature reaches about 200°C.

The process of charring a barrel essentially sets the inside of the cask on fire for a brief time. The cask will be set on top a propane fueled flame and ignited. The barrel will be flamed for a predetermined amount of time depending on the requirements of the customer. In industry parlance there are four primary levels of charring, Char #1, Char #2, Char #3, and Char #4 which is sometimes referred to as “Alligator” char due to the rough scale appearance of the blackened wood on the inside of the cask. To obtain these levels, a close monitoring of flame time is crucial. Char #1 is the lowest char level and is generally only flamed for 15 s. Char #2 is flamed for 30 s. Char #3 is flamed for 35 s and is the most popular char level found in the industry. Char #4 is flamed for up to 55 s. Once again, the times and temperatures will vary from cooperage to cooperage. Once the time is reached the flames are extinguished withwater.

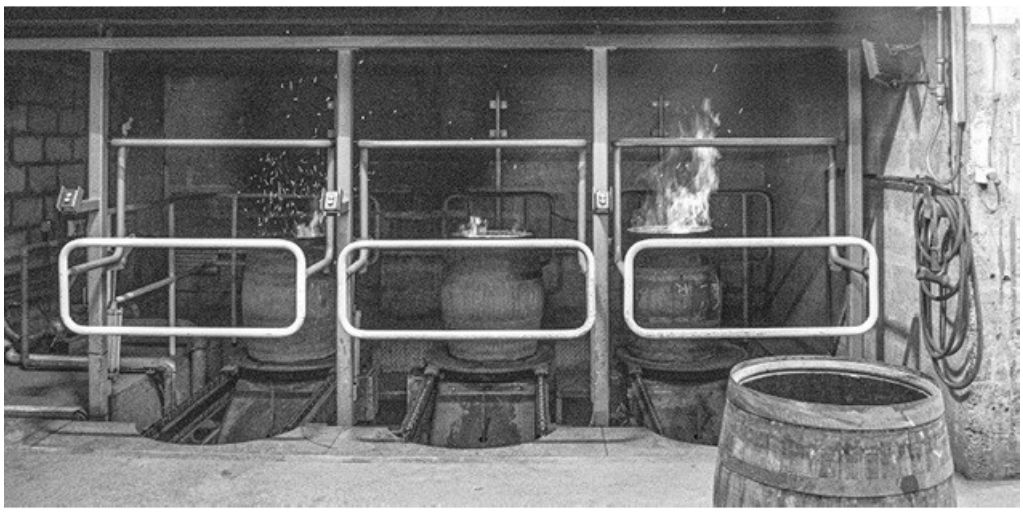


Figure 5 Cask charring at Speyside Cooperage

The charring process has a few interesting effects on the barrel. First is the formation of what is essentially a layer of activated carbon on the inside of the barrel. This aids in the eventual reduction of some unwanted new make spirit compounds. Second, the toasting and charring processes caramelize the hemicellulose wood sugars of the oak. This caramelization provides color and sweetness to the cask. It also increases the body of the spirit contributing to the overall mouthfeel. It has also been found that the char level serves as an easier entry point for spirit to penetrate the toasted wood beneath. Charred and toasted casks seem to have faster levels of extraction than toasted casks (Burgess, 2020). Finally, there is the direct contribution of the char layer to the flavor of the spirit in the form of burnt wood aromas and flavors. These are increased or decreased depending on the overall char level. Char levels are integral to the characters of many famous brands. Wild Turkey for instance, matures much of their whiskey in Char #4 casks which adds to the big character of theirwhiskey.

But what about the head pieces? The heads of the barrels are usually formed from scrap stave wood to save costs. The head pieces are measured and cut to fit the ends of the cask. The individual pieces of the heads are held together by small wooden dowels similar in effect and appearance to what holds most Ikea furniture together. Some cooperages forgo the dowels for a “tongue and groove” system which makes repairs easier in case the dowels break. Once formed the heads are beveled along their edge so that they can fit snuggly into the croze of the cask. As the cooper inserts the heads into the croze, he or she will often tamp in a small piece of water reed called flagging to line the seam of croze and head wood. This provides extra leakage protection as heads are perhaps the most common sources of leaks in thewarehouse.

Figure 6a Unfinished heading pieces

Figure 6b Finished heading

The final step in cask assembly is to assess its quality. To the cooper this means ensuring that no leaks are present, and that the cask can hold a certain amount of pressure. This is generally done with a small amount of water quickly jetted into the cask. If there is a problem, then the cask goes back to the coopering station to see if adjustments can bemade.

After checking for leaks, various types of finishing work may be undertaken. This all depends on the cooper and the needs of the customer. The cooper may shave and sand down the outside of the cask to remove splinters. The customer's distillery name and other information may be laser etched onto the heads aswell.

Re-coopering

In many distilling regions of the world, the use of used casks is the norm and virgin oak is rarely employed. Used casks, most often from American whiskey producers, require their own inspections and coopering to ensure consistent quality for thecustomer.

Speyside Cooperage in Craigellachie, Scotland is managed by Andrew Russell. He and his team of 11 people repair between 70,000-80,000 casks per year in addition to the production of new casks. It is a busy operation to besure.

The company travels to the U.S. to purchase groups of casks. Russell oversees the selection of which casks to purchase. He tries to avoid cask lots with too many broken staves and rusted or warped hoops. Cracked staves can indicate poor initial coopering and are structural weaknesses in the finished barrel. Rusted or warped hoops indicate the barrel may have been stored in poor conditions in thewarehouse.

Once purchased the casks are shipped whole to Scotland for any repairs or re-coopering. This is different from times past when casks were broken down prior to shipping and recoopered at the cooperage. Russell says that due to labor costs

and efficiency it no longer makes sense to do this, hence the switch to shipping wholecasks.

Once the casks reach the cooperage, they are given inspections. Cracked staves require the cask to be disassembled and new staves replaced. Hoops may be replaced. If the customer requires hogsheads (250 L size) then the barrels will be taken apart and reassembled with additional staves to increase the volume. The barrels go through the same types of inspection processes that new casks gothrough.

Figure 7 Cooper's workstation at Speyside Cooperage

Sometimes a customer wants to extend the life of a barrel that they have already used. Perhaps the cask has gone through several fillings and is no longer contributing the right amount of flavor. In this instance the customer may ask the cooperage to do a re-char. Re-charring the cask requires that the initial 5 mm of original charred wood be scraped and removed, revealing fresher wood underneath. At this point the barrel will be placed on top a flame and charred again. This process has its proponents and critics. Obviously, there is a cost savings to doing this as it is generally cheaper to re-char than to purchase a replacement barrel. However, there is only so much wood you can safely remove before weakening the stave structure. With bottom lines teetering lower and lower for more companies, it is certainly an attractive option forsome.

Chapter 2

Cask Chemistry

Now that we have seen how casks are made and the wood species that they are typically made from, we can justifiably begin to explore the important chemical reactions that occur during the maturation process.

First, let's start with the word "maturation". While I often use the terms "age" and "maturity" throughout this book (and in my conversations with other distillers), honestly, I have never been completely comfortable with the term "age". To "age" a spirit implies that the primary goal is to reach a predetermined age statement on the bottle. In some instances, this may be at least partly the case. In much of the whisky world a spirit needs to sit in cask for at least three years before the word whisky can even be associated with it. Even in the United States you may want to release a "straight" whiskey or a bottled in bond product. In either case a requisite amount of time must be met to place those words on the label. And as much as many folks, myself included, wish that age statements were a thing of the past, a large proportion of consumers put immense stock in them.

So, for me age is just a number on the bottle. It does not mean much to me as a sum total of a spirit's quality. Rather it is just another piece of the maturation puzzle that helps me to see a spirit in its totality. Much like the raw materials, the distiller's hand, and the type of wood (among dozens of other things), age is simply another factor that can play into a spirit's final character. It is not a direct indicator of quality on its own as too many people assume. I have tasted beautiful spirits of all types that have been aged for decades but have also tasted some that probably should have been bottled long before that. Likewise, I have had incredible drams of whiskey as young as three months, but also a glut of glasses that should have stayed in the barrel. Age is only a part of a spirit's story and nothing more. I can no more judge a spirit based solely on its age than I can judge a book by its word count.

“Maturation” on the other hand is what the cask is doing to the maturing spirit. We must first understand some basic chemistry surrounding the wood itself. Oak wood is made up of several important components that affect how a spirit matures. The primary cask components that we are concerned with are:

Carbohydrates

Lignin and Lignin degradationproducts

Tannins

Char layer (ifpresent)

Lactones

Acids

Carbohydrates

First, let’s discuss the carbohydrates. For ease we can divide this category into cellulose and hemicellulose. Cellulose is a long chain of glucose units. (You might be thinking that sounds a lot like starch and you’d be right…to a point. The bonds linking glucose units in cellulose are a different breed than the ones that hold starch together.) By weight, cellulose is the most abundant biological polymer on the entire planet. It is found in plant cell walls and serves as an important structural component. It isn’t very digestible to us humans (though ruminants such as cows love the stuff) so it serves as dietaryfiber.

In the barrel cellulose has shown itself to not be that important with regards to spirit flavor development. However, seeing as how it is an essential structural component of plants, including oak, we can argue that part of the reason the barrel can even hold liquid is due to the cellulosecontent.

Hemicellulose on the other hand is incredibly important to spirit flavor and maturationcharacter.

Hemicellulose is a family of polymers and even though you might think otherwise, it doesn't share too many similarities with cellulose. Hemicellulose doesn't have the rigid structural buffs that cellulose adds to oak. In fact, it's importance for spirit maturation doesn't become apparent until after the barrel has been toasted orcharred.

During the heating process, the hemicellulose fractions in oak are essentially broken down and caramelized. The by-products of this breakdown are free wood sugars that go on to add body and possibly some sweetness to the maturing spirit though the amounts of resulting sugars are comparatively low and may not truly factor into the sweetness equation as many people have traditionally assumed (Conner, Reid, & Frances, 2003). The caramelization reactions theoretically contribute some of the color to the spirit aswell.

Lignin

Lignin is another important structural polymer found in plants. Its exact composition varies between species, but generally it is composed of phenolic alcohol precursors that go onto form more complicated rigid structures. This is a hard family of compounds to parse out because of itsheterogeneity.

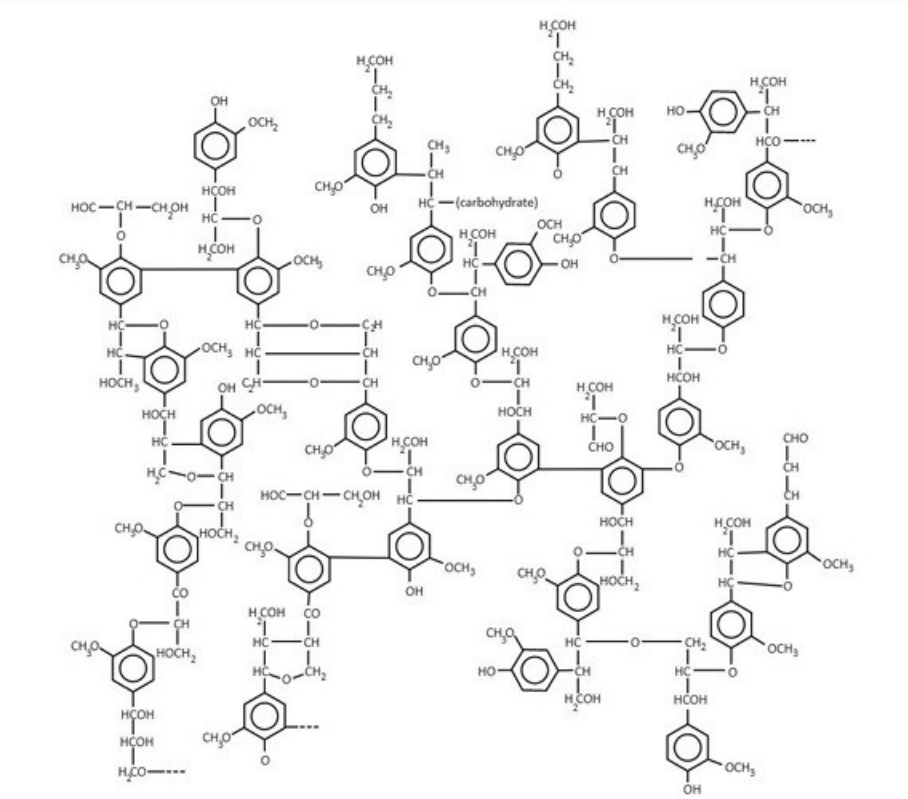


Figure 8 Structure of lignin

(Image courtesy of The Institute of Brewing & Distilling)

Now, lignin on its own is not very interesting to the character of maturing spirit. However, due to its heterogeneous nature, it breaks down into a variety of aromatic and extractive compounds that go on to improve the character of the maturing spirit. Oak lignin is composed of guaiacyl and syringyl units and when the larger lignin structure is broken down by pyrolysis there are all sorts of potential compounds that can form down the line. For instance, vanillin starts with lignin and is a downstream lignin degradation product. Lignin also produces guaiacol which gives subtle smoke aromas to spirits. Other lignin-derived aromas found in spirits may include certain floral aromatics as well as notes ofclove.

During the maturation process, lignin is slowly solubilized by ethanol and may undergo ethanolysis. This further increases the number of lignin degradation products and potential precursors for other aromatics (Mosedale,1995).

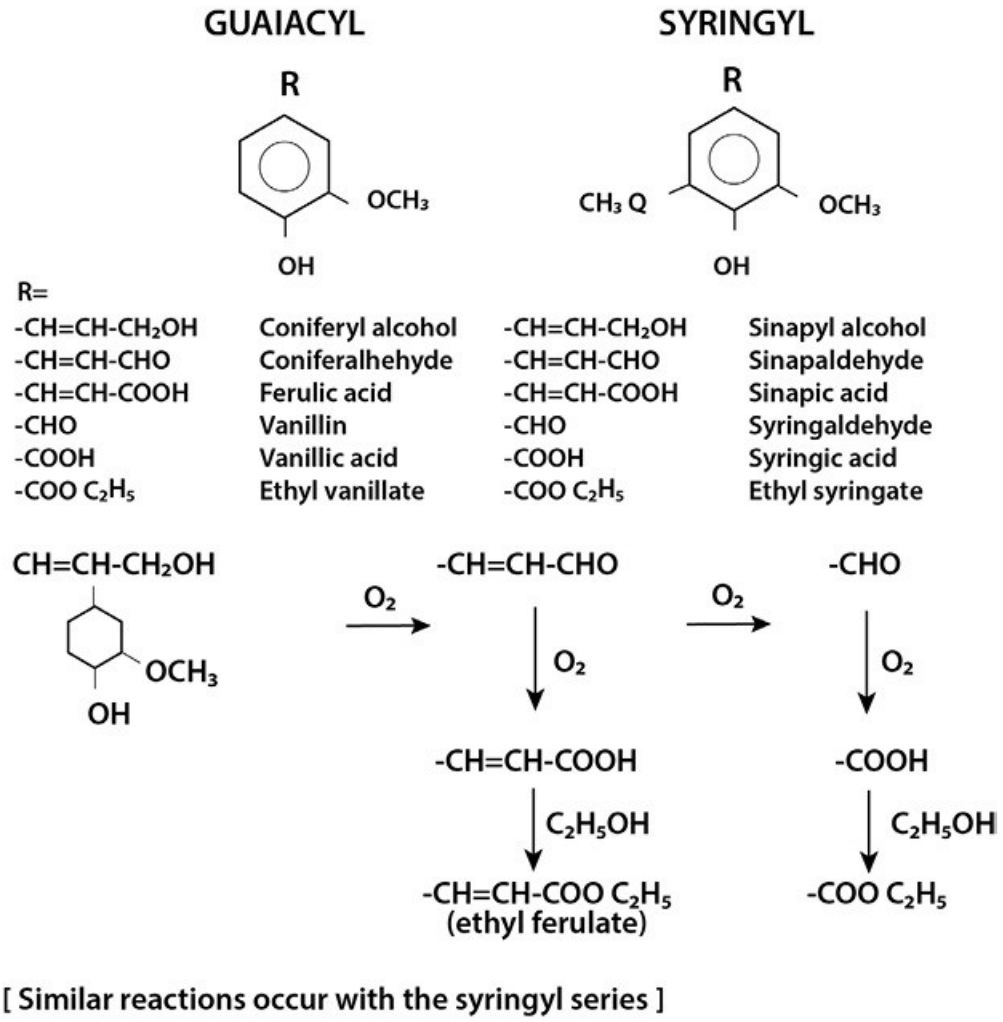


Figure 9 Oxidation and esterification reactions of lignin degradation products

(Image courtesy of The Institute of Brewing & Distilling)

Tannins

Tannins are part of a large group of compounds that are often generically labeled simply as “phenolics”. To make matters worse, tannins are generally part of the “mouthfeel” character of a spirit, which is even murkier water. I’ll do my best here to get us through theweeds.

Tannins and mouthfeel are not the best understood subjects in the world of alcohol production. Even in wine where reviewers will pontificate endlessly about supple, silky, and even serrated tannins, few people (including the reviewers) really understand what it all means. Tannins affect mouthfeel. That much we can say. They are the primary compounds responsible for astringency in spirits. Astringency is often confused for bitterness, but the two are most definitely not the same as bitterness is a taste while astringency is a tactile sensation. The best way I can describe astringency is as a sand-papery, drying quality on thetongue.

Tannins in mature spirits are an important, if often overlooked, character worth considering. Immature spirits in new oak are often excessively tannic with incredibly drying palates. Tannin levels greatly increase in the spirit within the first few months of maturation. After about six months, the tannin uptake slows down quite a bit. This is especially important when working with virgin oak casks. However, as the spirit ages, it takes up other extractives from the cask such as wood sugars that can help to balance out the astringent qualities contributed by thetannins.

Don’t take all this talk of astringency to mean that tannins are bad. Like everything else in a spirit, astringency needs to be balanced. A little astringency provides a nice foil to sweeter components in the spirit and adds complexity to the overall drinkingexperience.

Tannins have also been shown to affect color in the final spirit. The mechanisms are not fully understood but it is believed that various condensation reactions

between tannins may contribute to an increase in spirit color increasing color saturation, red and yellow hues (Canas,2017).

This is not the last word we'll have on tannins because they are heavily affected by oxygen, but more on thatlater…

Char Layer

Not every barrel has a char layer. If you're working in the traditional brandy space and want to only use toasted Limousin oak, then you won't have to consider the effects of barrel char on your spirit. However, in the U.S., new charred oak casks are de rigor for much of the spirit producing industry so it's worthexamining.

When the cask is charred, it is quite literally set on fire from the inside. The charring process produces a layer of burnt wood that extends a few millimeters into the staves. This char layer is essentially activated carbon. We use activated carbon for all sorts of things, but the use that's most familiar to folks is to remove unwanted aromas and taints from drinking water in household water filters. The char layer on the inside of a new cask does something similar by helping to absorb and remove off notes from the young spirit. Now, don't go thinking that using heavy char new casks can make up for poor production techniques. If you put in a bad spirit, you're not likely to get anything much better on the other end. There's only so much a barrel can do. However, residual sulfur notes and immature character can be polished by the char layer and this is beneficial to some distilling traditions. In bourbon, the cuts are not very narrow, (more of the heads and tails fractions are typically accepted into the hearts fraction than many other spirit traditions), and so in this case heavy char layers can be a boon to the young spirit. Taste the rough new make off a large bourbon still and compare it to the mature version if you don't believeme.

Lactones

The final group of oak-derived compounds we'll discuss in this section are the lactones. There are two molecules that we'll consider here. The first is cis-oak lactone. This molecule has aromas of coconut and fresh wood. Trans-oak lactone

takes on more spicy notes like cloves but also smells of coconut as well. Virgin bourbon casks have about 10 times more lactone available than a first fill ex-bourbon cask used for Scotch whisky. Much of the lactone content is found beneath the char layer deeper into the wood (Lee, Paterson, & Piggott,2001).

These compounds are considered desirable in many spirit styles. In general, American oak has higher amounts of whisky lactones than Q. petraea which in turn has higher amounts of lactones than Q. robur (Masson, Guichard, & Puech, 1995)(Prida, Ducousso, Petit, Nepveu, & Puech,2007).

There is no shortage of other chemistry-related avenues we could drive down inside the barrel, but the categories listed above are perhaps the most important to the overall “barrel character”. Now, let’s move onto the spirit itself and what new-make parameters are important to the chemical changes that occur throughmaturation.

The New Make Spirit

As I previously intimated, don’t make the mistake of thinking a barrel will correct a bad spirit. Much like the raw materials used to make whisky, brandy, and rum, if you put garbage in, you’re going to get garbage out. A barrel is simply another ingredient and in some respects a tool, but it is not a magic wand. If your spirit is flawed going in, it won’t get much better (and may get worse) from being in thebarrel.

So, thinking about the quality of the new make spirit is paramount to producing a quality matured spirit. This line of thought should start with your raw materials, through processing, fermentation, and on to distillation. In this section we’ll parse each of these out one by one to identify some key parameters that you can control to set up the best conditions for spiritmaturation.

Raw Materials

Tragically this is going to be a few thoughts that I wish I didn’t have to say. But humans are big dumb apes and sometimes we don’t think things all the way

through. Most distillers select their ingredients with great care. They're talking with the vineyard owners, or the grain suppliers, or working with the sugar refineries to convey what quality they expect in their rawmaterials.

Unfortunately, I've also known quite a few distillers that have on occasion come across the random batch of untested grain from the unknown farmer or the unwanted wine from the local winery and said, "What's the harm in distilling it to see what happens?" (I will admit to my fair share of quixotic failures in this department aswell.)

The results of these endeavors while occasionally edifying, are far too often less than stellar. So, the old saying goes, "Garbage in equals concentrated garbage out." It's just as true for maturation as it is fordistillation.

At the same time, I'm not here to tell you how to run your business. There are so many conceptual entanglements that go along with raw ingredients selection these days such as marketing and brand imaging, that most folks are not likely to change anything, least of all from reading this book. In other words, you know what works best for you. However, I will still go on record to say a few things on thistopic.

Grain should be free of mold and pests. And it should be fairly "fresh", meaning not sitting in a storeroom for years prior to use. While freshness isn't something that we tend to think about all the time when it comes to distillery grain, in some instances the effects can be profound. I know of one distillery that purchases smoked malt from Germany for one of their whiskeys. The grain comes in standard grain bags with a thin plastic layer in the inside to limit oxygen exposure and deter pests. This kind of bag is fine for most grain and for smoked grain sold in Germany it's probably adequate. However, since the grain is traveling halfway around the world in relatively uncontrolled conditions this kind of bag just doesn't cut it. By the time the grain gets to the distillery, much of its smoke character isdiminished.

Interestingly something else that seems to affect spirit maturation is the base grain. I've not seen any hard research done on this subject, but in my own experience and in speaking with other distillers, a predictive pattern has emerged with regards to the "ageability" of some grains. Corn (maize) seems to produce a new make spirit that is often quite harsh, more so than spicy rye. Meanwhile barley is a bit softer and wheat even more so. It does seem that wheat reaches an

acceptable mature character faster than that of rye or corn. Of course, countless other factors affect maturation speed, and this just adds another piece to thepuzzle.

Fruits should be harvested and processed as quickly as possible to avoid contamination. Avoid picking fruit with obvious issues such as mold and pest infestation. And stay away from any fruit that has been recently sprayed with sulfur to deter field molds. The same goes for molasses and sugar sources. Sulfured molasses is out there, and I've known people to distil it to less than satisfactoryresults.

All ingredients should be tested for ethyl carbamate precursors. Ethyl carbamate is a potential human carcinogen and it can occasionally be found in most spirit categories. This isn't really the place to get into EC chemistry and avoidance, but we can say a few things about it. Grains should be selected that have a minimal level of cyanogenic glycosides. The same can be said for sugar cane crops. With fruits, be wary of breaking any pits from stone fruits such as apricots, peaches, or cherries as the pits contain compounds that can also step into the EC formation pathway. And even though it is a rare practice in modern winemaking, do not use urea as a nitrogen source for fermentations as urea can also lead to ECformation.

Your yeast should be fresh and pitched at the appropriate cell count at the appropriate temperature using good hygiene. Avoid dry yeast that is more than one year old as the viability has likely dropped to an unsatisfactorylevel.

Water should generally be soft (lower than 50 ppm hardness) and should have any chlorine or chloramine removed prior to use in the distillery. A pH hovering around 7 is good though extreme swings in either direction (say, about 0.5 of a pH change) may be problematic depending on the solids content of the water and your processingtechniques.

Raw Materials Processing and Fermentation

How the materials are processed also indirectly affects the success of a maturation program. The philosophies and lines of thought that I previously brought up with regards to raw materials carry over here. The goal is to cause as little qualitative damage to the ingredients as possible while at the same time

encouraging positive flavor development all the way throughfermentation.

For grains this means using quality water during the mash, being careful to hit the required temperature targets for the starch(es) that you are working with and ensuring full starch conversion. For fermentation, find a yeast that can consume maltotriose for optimum fermentation performance. Beyond that the choice of yeast depends on what your final goal is. For matured spirits, I personally think it's wise to use yeasts that express a lot of esters and other volatiles in the final wash. At the same time, I'm more prone to using "neutral" yeasts for non-matured spirits. As this and subsequent chapters move along, my reasoning for this will become more obvious. For now, it's fine to say that a well-developed ester character provides fodder for a more complex maturation character with some esters declining over time and others increasing inamounts.

Fruit should be processed quickly, and the juice expressed in a hygienic manner. Avoid too much oxygen contact during processing, though admittedly we don't have to be quite as careful about this as some high-end winemakers. Avoid the use of any sulfur additions during the processing. In traditional winemaking circles that might seem like a scary concept but as we distillers know all too well, sulfur is not a nice thing to have in the still. And as I mentioned above, be careful with the processing of stone fruits like apricots or cherries. The occasional cracked pit is not the end of the world, but high amounts are detrimental to the spirit and possibly consumer safety. In general, not more than 5% of the stones should be crushed (Berglund,2004).

During red wine production for brandy, make sure that skin caps are punched down on a regular basis throughout the day. This is not necessarily for maximum extraction but rather to help reduce the risk of oxidative bacteria and yeast taking upresidence.

Other issues with fruit processing include pH and acid adjustments. Fruits such as pears can be notoriously low acid, which makes them incredibly susceptible to attack by spoilage organisms. Laws and regulations permitting, you may need to make the occasional acid adjustment with food grade acids such as lactic, phosphoric, tartaric, or malicacid.

Fermentations of fruit may go in several directions depending on the goals and desires of the winemaker. It's common to use a commercial yeast strain with a good aromatic profile to ferment the wines. However, some folks prefer the

traditional approach of allowing native yeast cultures to take hold at various points in the fermentation for added aromatic depth. If you are familiar with the effects of your native yeast populations and know how to manage the subsequent fermentations, then this is an attractive route to go. However, some of the so-called “native” yeasts can prove to be quite troublesome by producing high amounts of volatile acidity in the form of ethyl acetate and acetic acid. These compounds don’t make for the best spirits and maturation will not likely correct them very much. This is therefore not a recommended route for people who have never worked with native yeast fermentationsbefore.

Sugar and molasses washes come with their own set of issues as well. First, for those willing and able to source and work with fresh press cane juice, be wary of how quickly fermentation will kick off. I know of one distiller who attempted to work with the stuff and found the tank top had blown off from rapid fermentation starting within 20 minutes of moving the cane juice to the distillery. In other words, pitch your desired yeast as soon as possible. Molasses, on the other hand, is a bit more forgiving. The high osmotic pressure that is associated with molasses in storage keeps spoilage organisms at bay. However, contrary to popular belief, this osmotic pressure does not make molasses “sterile”. “Biologically inert” would be a better phrase. There are often dormant microorganisms living in the molasses and they can wreak havoc in the fermentation vessel if given theopportunity.

Distillation

Our distillation practices heavily affect how maturation proceeds. Are we doing a single distillation or multiple passes? Are we using some kind of column with internal plates? How are our cuts performed? Do we take a large heads cut or a small one? What about tails? How fast are we running the distillation? How much copper contact do we have? How much have we filled the still? Are we recycling heads/tails/feints fractions? How are we recyclingthem?

So many questions and I’ve only listed some of the most obvious ones. The sheer range of options when it comes to distillation techniques is massive and in turn produces a massive variety of spirit styles. We don’t have time to delve into the answers and effects of all these techniques and questions (maybe in another book…). However, as before, we’ll make a few general statements that are worth

considering when producing your new makespirit.

The primary themes we must think about here are the levels of esters and higher alcohols in our new make spirit. The esters (especially ethyl acetate) tend to come earlier in the distillation (though by no means all of them do this), while higher alcohols are generally relegated to the late hearts and tailsfractions.

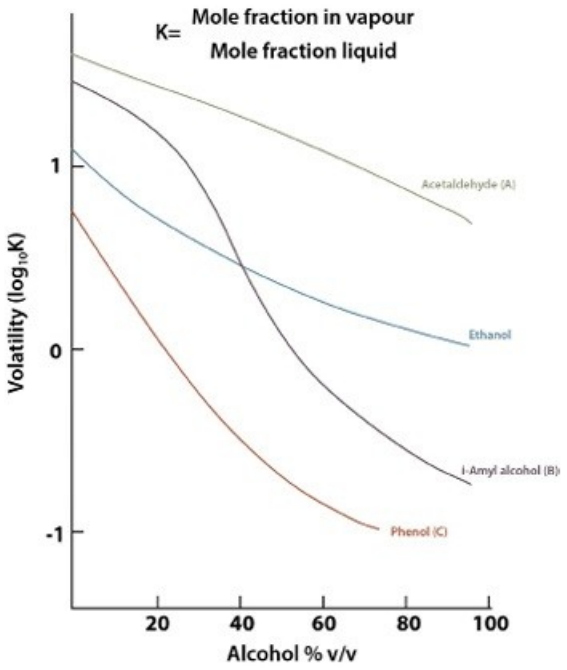
I cannot stress this enough: these levels are all heavily dependent on countless other factors and therefore can easily be altered in all sorts of ways. But I said we're speaking in general terms here so that's what we're going todo.

Much of the data in the charts above pertains to pot distillation but can also be attributed to some styles of column distillation as well. The second plot takes information from the first and puts it into a useful format. Notice that in the second plot some of our high volatility congeners such as ethyl acetate (and even acetaldehyde to an extent) persist into the spirit or "hearts" fraction. Also, some of the low volatility congeners that we associate with our tails cut actually begin in the heads fraction (figure 10a). I think this is important to point out because too many folks believe that cut fractions are concrete and definite with regards to their contents, which is simply not the case. What I mean by that is, low boiling point compounds will persist throughout the distillation run and high boiling point compounds will start coming over through the still at the beginning ofdistillation.

What does this all have to do with maturation? Well, what are we doing when we distill our fermented wash? We're producing our new make spirit. Our new make spirit's character is heavily impacted by decisions we make during the distillation process (as well as everything we've done up to this point). Looking at the plots (figure 10b) you can see how something as simple as when to cut your heads and/or tails can have a huge impact on the level of various congeners in the new makespirit.

When we say the term "new make spirit" what we're really talking about is "immature character". Immature character is a tough thing to define, but let's give it a shotanyway.

Immature character is simply the character of the new make spirit before it enters the cask. Hmm, I guess that wasn't so hard after all. But perhaps more clarification isneeded.



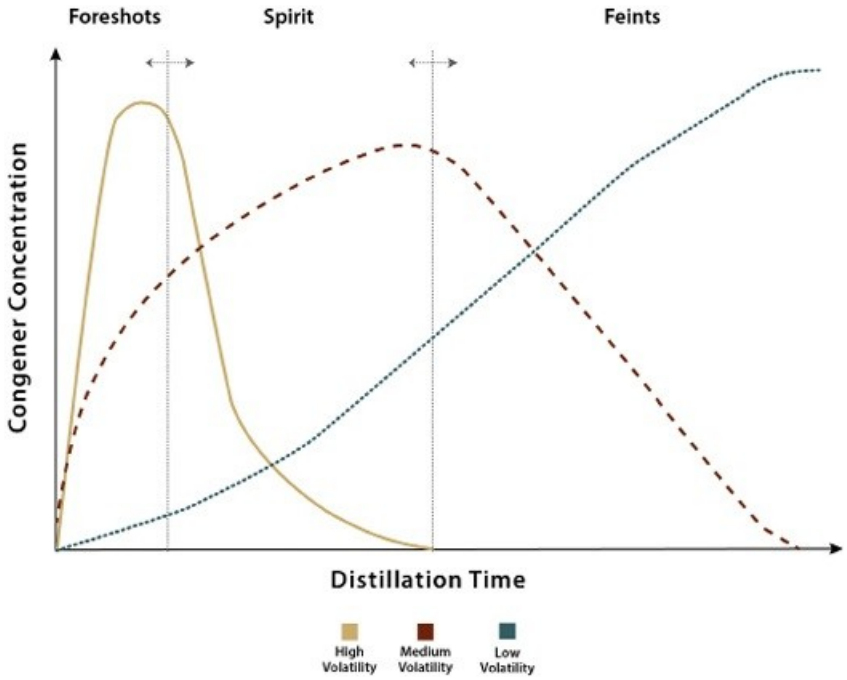


Figure 10a (Top) Volatility curves of some important distillation compounds relative to alcohol content; Figure 10b (Bottom) Congener concentration versus distillation time in a simple pot distillation (Image courtesy of the Institute of Brewing & Distilling)

Generally speaking, immature spirits are often fiery (hot), feinty, estery, solventy (ethereal is a term that sometimes gets used), and occasionally sulfur-y. Of course, by from reading all that, new make spirit doesn't sound like something we'd really want to drink does it? Well drinkability is in the glass of the beholder I suppose, but the point is that immature spirit has some rough edges to it. These rough edges can be smoothed and polished over by a proper maturationprogram.

The idea of immature character when compared to final spirit matured character is an important one. Ideally, we want to balance immature character depletion with mature character but not at the expense of your distillery's housecharacter.

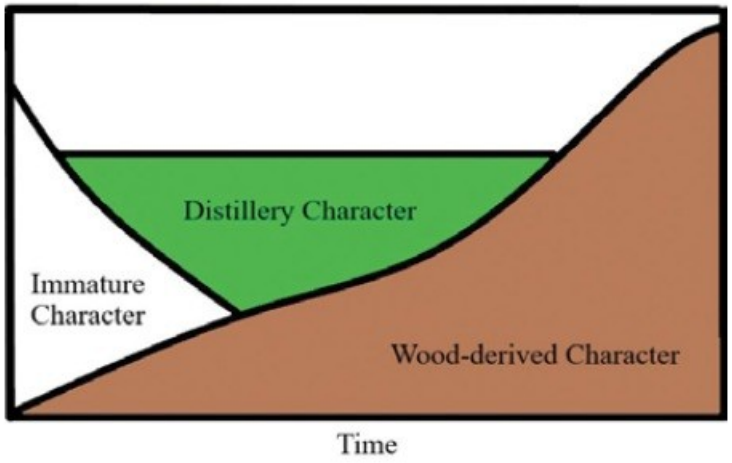


Figure 11 Immature vs. mature character over time

(adapted from figures by D Murray, Diageo PLC)

In the above chart we see how spirit character in a maturation program plays out over time. Immature character goes down as wood-derived character from the cask steadily gains ground. Note that it is theoretically possible for our mature character to rise above our distillery character, masking a bit of our spirit'sidentity.

It's a simple plot, but it illustrates an important point on attaining balance in the final product. If we allow our maturing spirit to go too long in the cask then eventually the wood-derived character will overpower our distillery character. Conversely if we don't allow for enough time in the cask then we will have too much residual immature spiritcharacter.

Effect of Fill Strength

After the distillation is done, we have our new make spirit, crystal clear and ready for the cask. But not so fast! There's one more major consideration we need to make before dumping everything into a barrel and that's the fillstrength.

Fill strength is the alcohol level of the spirit when it enters the cask. The choice of fill strength may be based on things such as legal requirements, tradition, cask climate, and desired finished spiritquality.

In the United States, most whiskey production has a maximum allowable fill strength of 125 proof (62.5% abv) (TTB, 2007). Many large bourbon distilleries opt to go in the cask at this strength. This has as much to do with conserving warehouse space as it does for quality. (For the rest of the spirits in the U.S. the regulations are quite a bit laxer, and usually do not have fill strength restrictions.) However, there is historical precedent for considerably lower fill

strengths in U.S. whiskey production. Prior to prohibition it was common for distilleries to enter whiskey into the cask at lower strengths, some opting for fill strengths less than 100 proof (50%abv).

In Scotland, the decision of fill strength is also based on quality and warehouse spacing, (but for slightly different reasons as we'll see in a later chapter). However, the Scots really don't have much in the way of legal restrictions regarding fill strength. Fill strength for single malt Scotch Whisky is generally around 64% abv while grain whisky enters the cask at 65-70%abv.

Rum has a wide array of fill strengths. This is largely due to the sheer enormity of the category. Some countries may have specific rules regarding rum fill strength while others will have no rules at all, so it can be hard to even talk about rum in generalities. Even within the same region or country you may see rum enter the cask as low as 55% or as high as80%.

Tequila (mezcal is not usually matured in cask except for a few "experimental" offerings) is matured in a hot and arid region. Most tequilas are not matured for "long" periods of time. The most recent category of "extra anejo" only has a three-year minimum maturation requirement. The entry strength of a lot of tequila is around 55%, but this varies somewhat betweenproducers.

Cognac, Armagnac, and calvados share quite a bit of production DNA. This is certainly the case when it comes to maturation. Common fill strengths for these spirits are between 65-70% abv. As we'll see in a moment, however, the story of French brandy fill strength is a bit morecomplicated.

So, why is all this talk about fill strength important? Well, let's just forget all the talk about regulations, tradition, and warehouse space for just a moment. The reason fill strength is important is that it has a huge impact on maturation and hence final spiritquality.

This is an easy concept to understand if we think in terms of barrel extractives, which is something we'll dive deeper into in just a moment. For now, we just need to recognize that some compounds are more water soluble and others are more ethanol soluble. Lower fill strengths favor extraction of more water-soluble compounds (a lower alcohol level means we've got more water in our maturation system) such as wood sugars, color compounds, hydrolysable tannins and glycerol. At higher fill strengths compounds such as whisky lactones are

more readily extracted (Conner, Reid, & Frances,2003).

If your definition of “mature spirit character” is more about barrel character, then a lower fill strength would seem to speed things up quite a bit. In fact, many U.S. bourbon distilleries are playing with lower fill strengths to better understand the effects on maturation character and speed. Conversely, higher fill strengths seemingly “slow” the maturation speeddown.

However, the quality of the wood plays a role here. If you’re going into the cask at a low fill strength with the hopes of “quickening” the maturation process, you need to understand the characters that your casks will confer onto the spirit. (You should always strive to understand this regardless.) For instance, if you’re cask comes from wood that was air kilned as opposed to being seasoned outside for 18-24 months, then the quality of tannins you would be preferentially extracting into the spirit at a faster rate may not be very pleasant. If I were using a cask with air kilned wood, I would likely opt to go into the cask at a higher fill strength to avoid the harsher astringency. This is just one example of the many considerations that come into play when selecting a fill strength. Like the rest of the decisions you have to make as a distiller, the effects of fill strength on maturation don’t happen in the proverbial vacuum and are affected by quite a few other things that you should give serious considerationto.

There is much more to the story than this but to understand what comes next, we need to talk about the chemical changes that happen duringmaturation.

Types of Maturation Changes

Maturation character is the sum of countless chemical reactions that occur throughout the spirit’s life inside the cask. It would be silly (and doubtlessly boring) to go through every single known reaction that occurs. Besides there are quite a few reactions that we don’t know much about yet. Research is lacking but at least it’s ongoing. Regardless, the reactions that occur during maturation can be broken down into fourcategories.

Additive

Productive

Subtractive

Reductive

In this section we'll walk through each of these so that you have a better understanding of what's happening throughout the maturationprocess.

Additive Reactions

Additive reactions are probably the easiest maturations to understand conceptually. These reactions are simply the extraction of components that naturally reside inside the cask from both the wood and compounds formed during cask production. This includes things such as wood sugars, aromatic aldehydes, lactones, color compounds (often part of the wood sugar fraction) and tannins (also color contributors). As our spirit sits inside the cask, the water/alcohol matrix extracts these compounds and adds them to the spirit, hence the term"additive".

Most of these compounds are extracted into the spirit in fairly predictable patterns. For instance, if we're using a brand new American oak cask with a heavy char (such as we would do for a bourbon), then we expect wood sugars and color to increase in the spirit rapidly during the early part of maturation only to slow down later on due to lesser amounts of these compounds being available in the cask for extraction. The same can be said for the lactones as well, though remember that in both scenarios, things are heavily affected by alcohol

concentration and that can throw a slight wrench into things, but more on that in abit.

Tannins, which we've already discussed a bit in this chapter, reveal themselves to be a bit more complicated. Tannins increase during the first part of maturation but tend to hit a maximum point and then decrease. However, during the entire maturation period phenolic acids generally increase. This is likely due to hydrolysis of hydrolysable tannins such as the ellagitannins. The tannin hydrolysis also produces small amounts of glucose which increases our sugar fraction (but only slightly) (Vivas, Vivas de Gaulejac, Bourden-Nonier, Mouche, & Rossy,2020).

(On a personal note, this is one of the more obvious gauges I use when assessing maturation character in a spirit. For me poorly structured tannins stick out like a sore tongue-scraping thumb and they are incredibly common in many "young" spirits, especially coming from virgin American oak casks. Mouthfeel and astringency are such immediately obvious and uncomplicated things, and they can quickly make or break aspirit.)

Acids that naturally occur in the wood are another important addition to the maturing spirit. Acetic acid is especially important; not so much directly, but for its indirect effects on the spirit as it gets used in esterificationreactions.

Finally, some of the most important extractives that are added to the spirit are the lignin degradation products. Lignin degradation generally happens two ways in spirits production. The first is degradation from heat treatment in the cask. The second is through ethanolysis, a process whereby ethanol is the catalyst for lignin breakdown. Regardless of the method we wind up with a wide array of important products and potentialprecursors.

In figure 12 we see how these reactions may cascade into some interesting aromatic components. If lignin undergoes ethanolysis we get coniferyl alcohol and sinapic alcohol. These compounds can then go onto form all sorts of important aromatics, but we're getting ahead of ourselveshere.

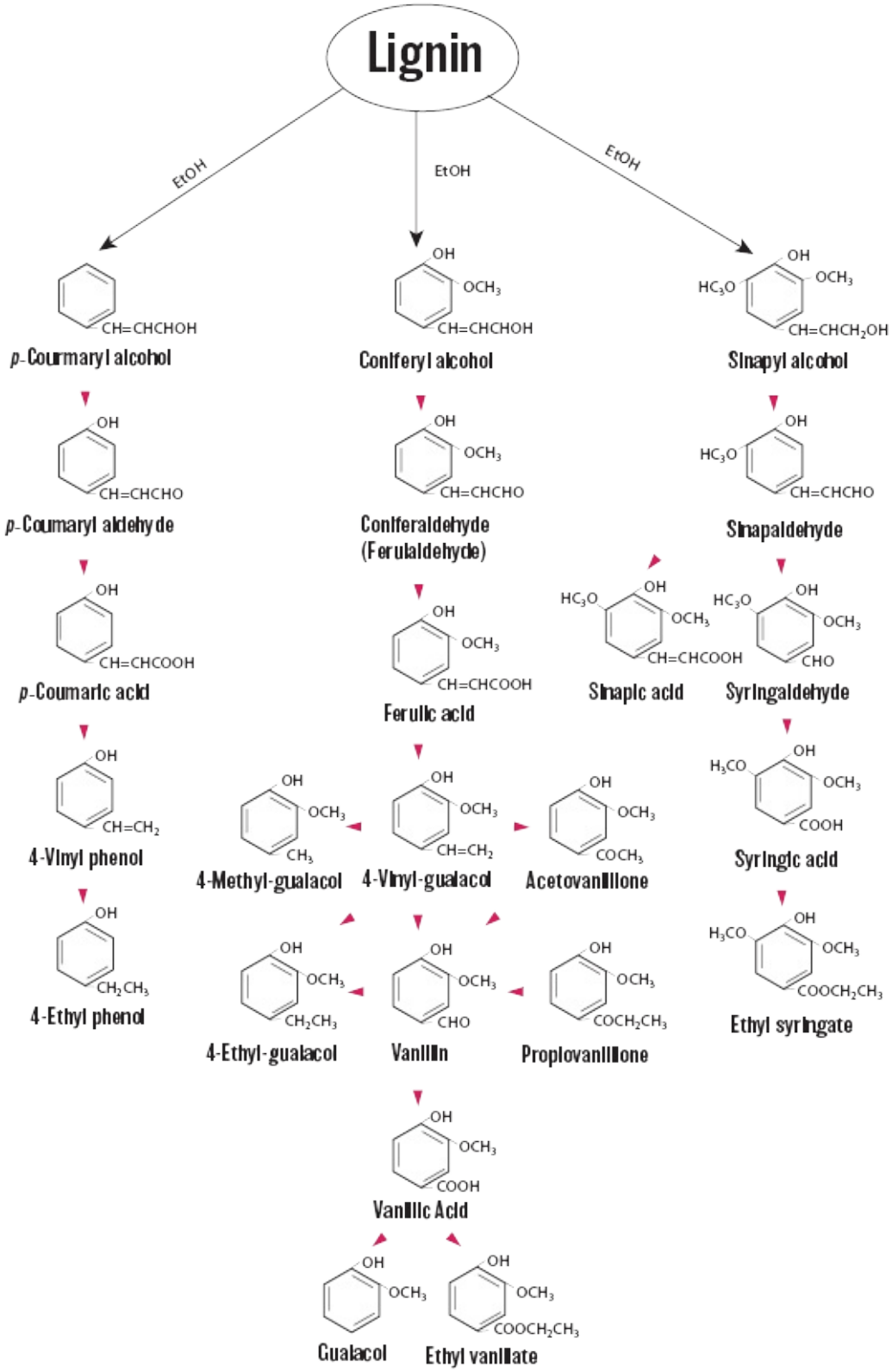

Lignin
EtOH
EtOH
EtOH
p-Courmaryl alcohol
Coniferyl alcohol
Sinapyl alcohol
p-Coumaryl aldehyde
Coniferaldehyde (Ferulaldehyde)
Sinapaldehyde
p-Coumaric acid
Ferulic acid
Sinapic acid
Syringaldehyde
4-Vinyl phenol
4-Methyl-guaiacol
4-Vinyl-guaiacol
Acetovanillone
Syringic acid
4-Ethyl phenol
4-Ethyl-guaiacol
Vanillin
Propiovanillone
Ethyl syringate
Vanillic Acid
Guaiacol
Ethyl vanillate

Figure 12 Progression of ethanolysis and subsequent oxidation of lignin (Lee, Paterson & Piggott, 2001)

In Table 2 (page) we see the effects of heat on lignin degradation byproducts. The table outlines the effects of four different heat treatments that may occur during cask production on the formation of lignin degradation by products. Note that with barrel toasting these compounds increase with increasing toast level. However, when we get to a full-on char, we see these compounds decrease, likely from heat-relateddestruction.

Table 2 Effects of heat on lignin degradation products

(adapted from IBD Learning Materials)

Product	Toast Temperature °C	Charred		
	100	150	200	
Coniferaldehyde	trace	4.3	24	4.8
Vanillin	1.1	3.8	13.5	2.8
Vanillicacid	none	1.8	6.8	1.1
Sinapaldehyde	trace	6.5	60	9
Syringaldehyde	0.1	3.8	32	9.2

Productive Reactions

Productive reactions describe change where compounds are produced during maturation. However, instead of things being added directly from the cask, these compounds are formed from interactions between compounds during the maturationprocess.

These reactions include changes that occur with our lignin degradation byproducts, as well as esterformation.

If we think back to our lignin degradation byproducts, we find ourselves left with some important precursors, namely coniferyl alcohol and sinapic alcohol. These compounds can then go on to interact with oxygen and form compounds such as coniferaldehyde (bready aromas), syringaldehyde (spicy aromas), and vanillin (vanillaaroma).

Oxygen plays a considerable role in maturation as we will continue to see throughout this chapter. Aside from its important role in the oxidation of lignin byproducts it also has an indirect role in the formation of esters. And esters are the other primary productive reaction we need to talkabout.

Esters are formed from the reaction of an alcohol with an organic acid. The sheer number of acids and alcohols available in the average new make spirit can lead to a bewildering array of potentialesters.

The most important ester formed during maturation is ethyl acetate. Ethyl acetate in small quantities has a slight fruity character but in larger quantities produces a solventy and almost ethereal type ofaroma.

Ethyl acetate is formed from the combination of ethanol and acetic acid which is often obtained from the wood (but may also come from distillation as well). It has a low aroma threshold in spirits and so little is needed to have an impact. The levels of ethyl acetate steadily increase over the course ofmaturation.

Table 3 Compound changes in spirit over time during maturation

(Adapted from IBD Learning Materials)

	Congener Concentration (mg/L)	
	NewSpirit	3-Year OldSpirit
HigherAlcohols	2500	2500
Esters	650	700
Sugars	0	1500
Acids	100	200
Aldehydes	80	50
Tannins	0	500
Ethanol%v/v	63%	60%

In the above table we see how many compounds change in amount over the course of maturation. This table is more specific to Scotch whisky but thematically holds true for other matured spirits. We can see that after three years the ester content goes up albeit only slightly. This only tells a piece of the story. What tends to happen is that some esters in the new make spirit are reduced during maturation while others are produced in their place. What occurs is an overall increase in esters and the aromaticcharacter.

Now, back to how oxygen affects our ester development. Oxygen is important in indirectly providing fodder for esterification reactions. This occurs mostly in the form of oxidation reactions whereby aldehydes may be oxidized to their prospective organic acids. These acids can then go onto become part of the ester productionprocess.

Subtractive Reactions

As the name suggests, subtractive reactions remove or subtract things from the new make spirit during maturation. These reactions are crucial to spirit quality. If we think back to the character of our new make spirit, (fiery, feinty, possibly sulfured, etc.…) there are quite a few things worthremoving.

The most obvious subtractive reactions are the removal of sulfur compounds like dimethyl sulfide (DMS) and dimethyl trisulfide (DMTS). If you work with grain spirits, then these are potentially problematic sulfur-containing compounds that can ruin a spirit's profile in high enough amounts. DMS and to a greater extent DMTS smell like cooked corn and cookedvegetables.

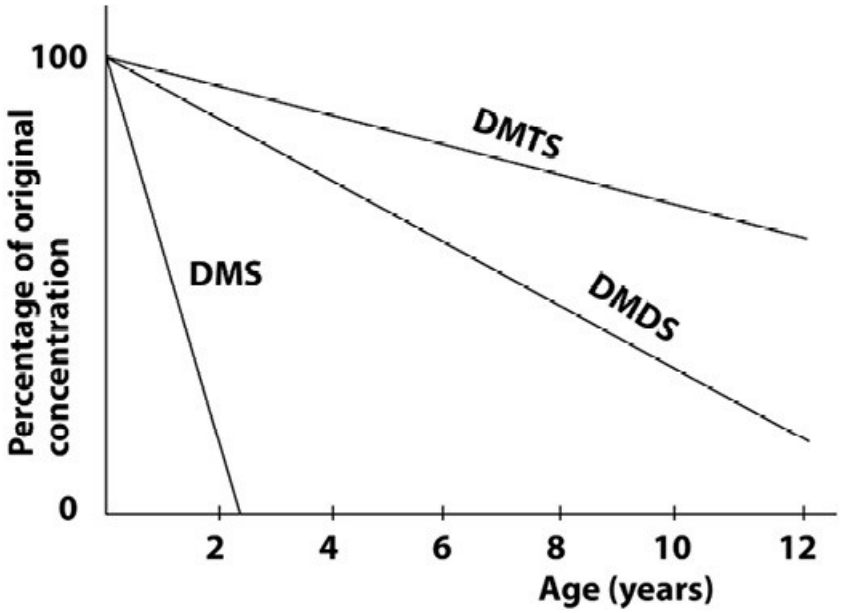


Figure 13 Reduction of sulfur compounds over time in the cask

(Image courtesy of The Institute of Brewing & Distilling)

These compounds come from a precursor in malt called S-methyl-methionine (SMM). Malts that have been more heavily modified and more lightly kilned tend to have greater amounts of SMM which means typical distiller's malt is occasionally rife with the stuff. Brewers have the benefit of boiling their worts prior to fermentation which blows off much of the DMS, but most distillers don't go through this step. So, how are we to handle DMS loads in our spirit? Well fortunately for us, DMS is nicely removed by activated carbon and guess what has a nice layer of readily available activated carbon? That's right, the char layer of a typical whiskey barrel. Our barrel's char layer tends to do a good job of removing these compounds from ourspirit.

DMS is also fairly volatile. So, whatever isn't removed from the spirit in the char layer is hopefully lost through evaporation. This is also the case for H2S (hydrogen sulfide) which is generally not that important for whiskey producers but can be a concern with brandy distillers or if you are using a high sulfur producing yeaststrain.

The main point here is that negative aromas and flavors are lost either through the char layer of the cask (assuming there is a char layer) or through evaporation. If the cask doesn't have a char layer as is the case in much traditional brandy production, then we are relying mostly on evaporation to provide these subtractive reactions forus.

Reductive Reactions

Reductive reactions may be viewed as a sub-category of subtractive reactions. The principle is similar in that through chemical reactions various immature compounds are reduced in their amounts and subsequent effects on spirit quality. This is often due to a negative or unwanted compound going through a chemical reaction and transforming into something more desirable or at least lessdeleterious.

Arguably the most important reductive reaction that takes place during maturation is the reduction of acrolein to acrylic acid. Acrolein is a pungent highly aromatic compound that smells something like horseradish. It can be detected in spirits at levels as low as 10 ppm (Serjak, Day, Van Lanen, & Boruff, 1954). It is formed through two methods. One is from glycerol metabolism by some strains of lactic acid bacteria. The other is from heat application to glycerol during the distillation process. Most spirits have at least some acrolein inthem.

Acrolein is not a nice character to have in spirits so we want to see it reduced somehow. Fortunately, acrolein is easily oxidized to acrylic acid in thecask.

Acetaldehyde is another example of a negative compound that can be reduced during maturation. While acetaldehyde is incredibly volatile (boiling point of 20.2°C), some may still find its way through distillation cuts and into the spirit. Once again, oxygen comes to the rescue. Acetaldehyde can be handily oxidized to acetic acid. Acetic acid can then be used for esterification reactions thus reducing the quantity of one off-note and increasing the quantity of a positive one inreturn.

Evaporation and Loss

One of the great pleasures of running a matured spirits program (besides the spirits themselves) is the simple act of walking into your warehouse full of casks. Even with the lights off the sensory impact is incomparable as the aromas of oak and spirit waft through the air into our eager noses. When you walk through the warehouse you are physically experiencing the maturation process take place in realtime.

Much of these sensations come from evaporation emerging from the cask. We've all been on the distillery tour where the tour guide mentions the "angel's share". There's usually some pithy joke about "happy angels" and comments on the subsequent losses in spirit volume. It's often spoken of in almost a negative sense as if to say, "man, things would be better if it weren't for those greedyangels".

Truth is that the so-called angel's share is incredibly important. It's a subject that we'll come back to a few times throughout the rest of the book, but without it,

our spirits would likely not turn out as well. We need evaporation to happen to reach the proper maturitylevel.

We've already mentioned how some compounds are lost through the process of evaporation. These are things such as acetaldehyde, H2S, and DMS. The loss of these compounds doesn't affect the total volume of our maturing spirit by any appreciable degree. However, the fact that we do lose volume over time does confer some other benefits onto our maturationprocess.

Later in the book we'll discuss the factors that affect the type and rate of evaporation, but regardless of how it happens what we are left with is progressively lower levels of liquid inside the barrel. This means that we get an increasingly larger surface area inside the cask that is exposed to air, namely oxygen. That oxygen is then available to spur on many of the aforementioned maturation reactions hopefully producing positive results in theprocess.

Anecdotally, I've got a friend that started paying attention to this phenomenon, almost by accident. His barrel filling regime would often leave him with a partially filled cask at the end of a run. After several years he had built up a sizable collection of these partially filled casks along with some informal data points. He told me that the casks he preferred were usually the partialfills.

But here's the thing: he's not crazy. There's some cool stuff happening here. A partially filled barrel gives the new make spirit a nice jump start on oxidative chemical reactions because of the oxygen liquid interface within the cask. Now, I'm not arguing that you should partially fill your casks. There are ample reasons not to do this, expense and space are two of the most important ones. However, for short term maturation cycles such as what my friend uses, it has itsbenefits.

But forget about the partial cask filling, because evaporation over maturation time gives us the same result. During this period, we see some of the negative aroma compounds evaporate and leave the spirit. We also see increased tanninpolymerization.

The effects of oxygen on phenolic compounds like tannins are complicated to say the least. However, we can say that oxygen helps to speed tannin polymerization. Tannin polymerization is when tannins begin to combine themselves into aggregate groups. These increasingly larger tannins can reach a size where they drop out of solution or adsorb to the wood cellulose and don't

affect astringency as much. So, while we're getting hydrolysis of tannin content throughout maturation, we're also seeing a reduction in their astringent effects through oxygen aided polymerization (Smith, McRae, & Bindon,2015).

Unfortunately, the story isn't so simple. As the barrel microclimate changes, so does oxygen solubility. This touches on a discussion in a later chapter dealing with warehouse climate, but oxygen is more soluble in our spirit at cooler temperatures and less so at warmer temperatures. So, during the hot summer months you would have less dissolved oxygen for oxidative reactions within the spirit, despite having a higher temperature to speed those reactions up. This is not to say that these reactions stop all together during summer, it's just that less oxygen isdissolved.

Another complication with oxygen and our liquid interface is how the oxygen enters the cask. Oxygen enters the barrel through the pores of the wood, but also more directly through the bung and the stave joints. As maturation continues, liquid spirit will continue to push its way into the wood, often several millimeters. As the wood becomes more impregnated with spirit, some have proposed that this lessens the ability of oxygen to enter through the wood pores. Besides, unless you are physically turning your barrels regularly, and exposing all the inside wood to liquid to keep it evenly wet, (something most distillers including myself don't usually do) then you are going to wind up with drier portions of stave wood above the liquid surface inside the cask. So, if the previous theory holds any truth (I'm not so sure), then you'd still see oxygen easily ingress through these drier portions ofcask.

Evaporation is important. Obviously, we don't want everything to evaporate. And we do want to have some control over it, but that is something we'll look at later. For now, there's one more topic we need to discuss before leaving our chapter on cask chemistry and that is the dreaded subject of "negativeflavors".

Negative Flavors

There is unfortunately no shortage of negative or "off" flavors found in poorly produced distilled spirits. And we're not talking beauty-in-the-eye-of-the-beholder kinds of flavors here. I'm talking about genuine, unequivocally, irredeemably, bad awfulness. These are compounds that put sensorial dents into

your otherwise beautifully produced spirit, taking your Rols and relegating it to the liquid equivalent of a ChevyNova.

There are plenty of papers detailing spirit faults in general. For instance, high amounts of diacetyl are a problem for some folks. Or have you ever smelled the butyric calamity that is a clostridium contamination? (It's a smell that would make vomit throw up.) Those are some big problems to have for sure, but they are also signs of problematic raw materials, hygiene, and/or fermentation and in some cases should not have been distilled atall.

What we want to focus on here are the potential negative flavors that can come with the process of maturation. I know a lot of people think that maturation is like a chemical band aid for bad spirits but that's ridiculously untrue. You can't put junk in a barrel and expect it to turn to gold at the end of a few years. And likewise, if you aren't paying attention to your casks or your maturation program then otherwise good new make spirits can pick up unwanted characters along theway.

The primary issues are flavors from molds. These are stale, earthy, mushroom-like aromas that can find their way into casks of all sort, but especially new casks. We'll get into this a lot more later in the book, but there are quite a few instances where you might be confronted with a moldy cask. The best thing to do: don't use it. Every cask you use should be visually and aromatically inspected before you put spirit inside. Without these precautions you could be sitting on the wrong side of a funky smelling spirit and trying to pass it off as something decent toconsumers.

A subcategory of the mold-related off-flavors is the formation of 2,4,6-trichloroanisole or TCA, for short. It causes a musty aroma akin to wet and moldy cardboard. TCA is also the compound responsible for cork-taint in wine and that is indeed where it is most often observed. However, it can quite easily find its way into spirits through the cask. Let meexplain.

For TCA to be formed you need three things to happen. First, you need wood. (Guess what cork and barrels are made of?) Second, you need mold which the damp conditions of many barrel warehouses often have in abundance. Finally, you need chlorine. I'll get into this in a later section of the book, but this is why I have strict rules in my own distillery about the use of certain cleaning products such as chlorinated bleach. Once you have met all three criteria for TCA

formation, you can be in for a world of trouble. The sensory threshold for TCA is under 20 part per trillion. In wine the threshold is reported as being only 4 ppt! To put that in perspective, imagine you have an enormous swimming pool of 10,000,000 gallons. You then put four drops of food coloring in the pool. That would be the equivalent of 4 ppt ofTCA.

Other negative impacts from casks can come in the form of leftover foreign materials from cask production or maintenance. This is most often something like nails stuck in as plugs from sample pulling. (Plugging a sample hole with a nail is arguably ok if the cask is being used for beer but should never be used for spirits.) Bits of metal such as nails, can potentially rust and introduce iron into the spirit. Iron has a nasty tendency to reacts with various compounds in the spirit and turn the color darker. Get enough iron into the cask and the contents will turn completelyblack.

Finally, you need to be careful about any previous contents that were once in the cask. This is particularly important with regards to ex-wine casks. If you're purchasing directly from a well known and respected winery, then you may have little to fear. However, if you are purchasing the casks on the open market through a broker and you are unsure of the provenance of the cask then you may wind up with casks that once held substandard wine. These casks might be riddled with high amounts of acetic acid and/or ethyl acetate, perhaps high levels of sulfur, or any number of other residual characters that can be left behind by a poorly cared for wine. We'll talk a bit about questions to ask before purchasing wine casks later in thebook.

Chapter 3

Cask Selection

After burrowing through the basics of barrel production and contemplating the concepts behind cask chemistry it's time for us to look at choosing the right cask for the job. This really can't be stressed enough. Matching the cask to the spirit you're trying to make is one of the most important decisions you can make in your distillery.

Sometimes these decisions are already decided for us. Take bourbon for example. We are required to use a brand-new charred oak barrel every single time. But even here, you can see there are a few holes that we can creatively poke around in. For instance, one of the most common misconceptions about bourbon regulations is that the cask must be made from AMERICAN oak. Nope. It does not.

Straight from the Chapter 4 in the TTB's Beverage Alcohol Manual bourbon is:

"Whisky produced in the U.S. at not exceeding 80% alcohol by volume (160 proof) from a fermented mash of not less than 51 percent corn and stored at not more than 62.5% alcohol by volume (125 proof) in charred new oak containers"

Notice that nowhere in the description does the word "American" show up in relation to oak. You find this is true for the other major American whiskey styles as well. Now, here's the rub. If you want to use a charred cask that isn't American oak, you'll need to work with a cooper to procure one because they don't show up on the market very often. There is a serious opportunity here to explore some interesting flavors and use oaks not commonly found in bourbon production.

Honestly, this scenario can play itself out with most spirit types in most countries. While the rules and regulations for the world's great spirits are often quite strict, they usually focus on the pre-maturation methods of production. The use of different casks is generally allowed. Even cognac houses, which have some of the most notoriously strict production regulations on the planet are experimenting with different cask types in several ways. While neither company can call it "cognac" (the rules are a bit draconian if you ask me), famed cognac houses Courvoisier and Martell have both released products utilizing used bourbon barrels in recent years.

This is all to say that's there's usually a lot of room to experiment in the warehouse. Besides, I've always held the belief that our industry could use a bit of innovation injected into the everyday production conversation. But none of it is worth a pile of oak chips if we don't select our casks properly. You must envision the type of spirit that you want to make and then make decisions to actualize that vision. Easier said than done, I know. It's all part of the process of making something memorable.

So, there's your first question: what do you want to make? You often hear things like the cask makes 70-90% of the character of the spirit. If this is true, then your cask is the most important investment you can make.

What makes a good cask?

It's an important question. Sure, you can base your cask selection on price and what's generally available, but you may not be happy in the end. I've had more than a few distillers drop their jaws to the floor when I tell them how much I occasionally pay for casks. "But 'so and so' sells them for only $185 each, why are you paying $235?!" Because I want the best wood I can find.

I've dealt with some fantastic barrel brokers and coopers over the years and I've also been let down by a few companies. I talk to other distillers about who they purchase from and I try to investigate any potential brokers in advance. And what have I learned? Mostly, that I'm still learning, but also that we're entering an exciting time for the cask market.

As the distilling industry continues to grow, it's only natural for tangential

industries to emerge and grow with us. We've already seen this with the increasing number of craft malting companies that have opened in the past decade. Now, there are a growing number of small coopers and independent barrel brokers coming into the market. Some of these companies are putting out some top-notch wood while others…not so much. (I have my preferred companies and you are welcome to get in touch for recommendations.)

A quality barrel is something that can largely be left to the eyes of the beholder, but there are some generalities that we can talk a little bit about. First, we want a cask that holds liquid. You'd think I wouldn't have to mention that, because isn't that the primary job of a barrel? And yet, in a growing industry where we're increasingly spoilt for choice, sometimes those choices are bad. A few years ago, I was working at a distillery in DC and decided to give a small new cooper a shot. The first couple of shipments went well and the price was right. Eventually however, I started noticing that some of the later shipments had a large proportion of leaky casks on them. These were not the tiny pin leaks that could easily be repaired in house. These were indicative of a larger production problem. The company was of little help at first. After some digging and I suppose a few more complaints from other clients, the company finally came clean and admitted that their heading machine was having some problems. I'm glad they could admit their mistakes, but if these leakers were leaving the facility it meant that they were either not pressure testing the casks (this is a must have for all recently coopered casks) or they were knowingly sending out faulty casks. Neither scenario was acceptable to me, so I dropped them as a vendor.

What else should we look for in a cask? Let's check out the staves next. Are there large knots in the wood? Is the grain straight or are there a lot of curves in it? Ideally, you'll see perfectly straight grained wood with zero knots in the staves, but it is always possible you'll see the occasional imperfection pop up. We can deal with that, but when every other cask has a couple of knots in it or large sections of wavy grained wood, then you know the cooper isn't using the best stave material. Knots and wavy grain can be a source for leaks so we should avoid them as much as possible.

Keep an eye out for any stave cracking on the outside of the cask. I've received more than my share of these imperfections. If the crack doesn't extend very deeply then that's ok, but more than a few millimeters and it's possible that the cooperage didn't properly bend the casks during the initial raising. These cracks may cause problems for the individual barrel down the line, but also may be

indicative of larger production issues with the cooperage.

Beyond that, when we talk about what makes a good cask, we're going to be largely thinking of quality of life improvements. Have the outsides of the staves been sanded down? That's a nice feature to have since it makes handling the casks an easier and more splinter-free experience.

How about the length of the chime on the head? This is the edge of wood that sticks out from the ends of the barrel head. Shorter chimes make it difficult to maneuver a cask by hand while a longer chime gives you something better to grip onto.

How are the hoops constructed? Are they galvanized steel? Are they tamped down in place properly? Do the edges of the head hoops have any burring that might prick or cut a worker's hand? Do the hoops have "hoop nails" in them? These are all valid questions to ask. For my casks I prefer stainless steel hoops that have been properly de-burred. I'm not the biggest fan of using hoop nails for hoop placement as I believe them to largely be unnecessary if the cask has been properly formed. They also make repairing the cask a bit more of a pain sometimes.

Oaks and Other Woods

Earlier in the book we went over the various oaks and other woods commonly used in cask production. We don't need to rehash much of that information here. Rather we just want to contextualize that information in the realm of cask purchasing.

American Oak

When it comes to cask maturation, American oak (Q. alba) is the undisputed King. Pick a matured spirit tradition and American oak has probably infiltrated it with its rich vanilla and honeyed ways.

Your choice of whether to use Q. alba may be already be dictated for you if you're an American whiskey producer and are after a traditional profile. With

high amounts of whiskey lactones, tannin, vanilla, and general “woodiness” virgin American oak lacks a lot of subtlety, especially the heavily charred examples. But subtlety may not be what you’re after if you’re trying to build a big and beautifully bold American bourbon.

Used American oak (“first fill”) casks tend to move more into honeyed character, but this is just as much due to the casks previous contents (typically bourbon) as it is to the cask itself. All the same, by the time the first spirit has left the cask, American oak is a much tamer beast. Large amounts of tannin have been depleted for a softer mouthfeel, while other characters such as the vanillins and lactones are still in decent supply.

Talk with your potential supplier about where they source their stave wood and the climate the trees grew in. Most American oak is harvested in Minnesota, Missouri, and Arkansas, but some smaller coopers are experimenting with Q. alba sources from other regions like New York and Virginia to showcase some of the subtle terroir differences.

When purchasing American oak, one of the biggest things I personally consider is the stave treatment prior to cask assembly. I look stave wood that has been seasoned for at least a full year and prefer staves that have undergone 24-36 months of seasoning. This gives the cask a better tannin character. Still, quite a few American oak casks are made with air kilned staves. In this case the staves may have only sat in the stave yard for 3-6 months which is not enough for proper seasonal cycling. These casks can still produce great spirits, but they are not my preferred choice. The best thing you can do is talk with your cooper about the method(s) they use. In some cases, you may be able to get the name of a customer and/or product that has used their casks and can then go shopping for a little at-home sensory assessment. All in the name of professional research of course.

So, what spirit types benefit from virgin American oak? Obviously our traditionally profiled American type whiskeys such as bourbon, rye, wheat, and corn. American grape brandy may certainly benefit from alba’s heavier overtones. Applejack style brandies absolutely require American oak to reach the correct profile.

Other spirits will benefit from used American oak. Q. alba makes an excellent addition to a malt whiskey program. The nuances of used American oak also

work well with agave, rum, and many brandies. I would go so far as to say that used American oak casks, especially bourbon casks, are some of the most versatile casks in the industry. They stand well on their own flavors but also make for a fantastic base to layer other heavier cask flavors on top of in a blending program.

French Oak and European Oak

If you remember from our brief introduction to oak in the first chapter, Quercus robur is what we generally refer to as “French oak”. But here’s the rub: You will sometimes also hear about Quercus petraea (sessile oak) being referred to as “French oak”. So, will the real French oak please stand up?

It’s complicated because both species grow in France in large numbers. Q. robur is what we generally call Limousin oak and Q. petraea is what we call sessile oak. Both species also grow throughout Europe and into parts of Russia and so you’ll hear things like “European oak”, “Russian oak”, “Hungarian oak” and “Spanish oak”. This type of nomenclature isn’t really that helpful when deciding what type of oak you want to purchase. Species identity arguably has a greater impact on the character of the oak than terroir does. Q. robur grown in northern Spain might be referred to as “Spanish oak” and will certainly behave differently than Q. robur grown in France (terroir difference). Likewise, Spanish grown Q. robur will also behave differently than Spanish grown Q. petraea which may also be called Spanish oak (species difference). Always ask your supplier what species they are selling you.

If we look at the above map, we get a glimpse of the distributions of robur and petraea in relation to some of the important spirit and wine regions in France that use them. In any given distribution footprint both species (and possibly other oaks) will (and often do) happily co-exist. Near the cognac region we have the Limousin forest which is mostly made up of robur (pedunculated oak). But located near many of the wine regions we have forests such as Tronçois and Damey that primarily grow sessile oak.

Robur is typically wide/coarse grained while Petraea is usually a bit tighter grained. Between the two, robur is the one most often considered for spirits maturation. But this doesn’t mean we should turn a cold shoulder to poor old

petraea. It just behaves a bit differently.

In many ways petraea behaves as a middle ground between American oak and robur. One example of this is in the amounts of lactones present. American oak has far more whisky lactones than robur does, but petraea sits comfortably in the middle here. We see the same trend with regards to the amounts of tannins released during maturation with robur being robustly tannic compared to American oak and petraea fits somewhere in between. Of course, all this has quite a bit to do with how the wood is treated by the cooper. Toasting and charring levels play a big role here, though admittedly it's rare to find a cooper that is charring either robur or petraea oaks.

Even though when comparing virgin toasted American oak to comparably toasted versions of robur and petraea, American oak is considered to be more aromatic, these European oaks can offer a lot to a cask program. But once again, the caveat to all this is getting the right treatments done. Many coopers of these oaks will work with you to build a desired profile and especially with the toast levels you'll find an immense amount of flexibility. You can get the barrel heads toasted to different levels than the inside of the cask for a wide range of possibilities.

Now, time for a sobering reality check. These casks are usually expensive. You can find a virgin American oak cask for roughly $200-$400 depending on the cooper and treatment. For robur and petraea you're looking at double to triple the price (if not more). For this reason alone, you don't see too many people biting the bullet on these casks outside of the brandy world where these casks (particularly robur) are part of the expected tradition.

Figure 14 Distribution of Q. robur and Q. petraea in France

(Image courtesy of the Institute of Brewing & Distilling

Most often you'll see these oaks in the form of used wine casks. Depending on which broker or winery you work with to obtain your casks, you'll find a wide range of possible characters and flavors. And that's before you even get to the wine contents the have previously left their tartaric mark on the inside.

Choosing a wine cask should be based on what you want the cask to bring to the spirit table. Is this going to be a finishing cask? Do you need something that is basically just storage? Do you want a freshly dumped cask with loads of wine character? What kind of wine character are you looking for? White or red? What about champagne casks?

Speak with your supplier about all these things. At a minimum you should ask the following questions:

What type of oak is it?

What kind of wine was in the caskbeforehand?

How was the cask originally heattreated?

How many years/seasons did the winery use thecask?

Did they use sulfur inside the cask duringstorage?

The type of oak is obviously important as American oak, petraea, and robur all exhibit different properties. The question of what type of wine was in the cask is a little more complicated. Most of these casks will have held red wine at some point but not all red wine is the same. Some are quite heavy and tannic while others may be lighter and more acidic. Of course, there are all sorts of wine profiles in between these extremes and each will have a different impact on

yourspirit.

What was the original heat treatment on the cask? I've already mentioned that charred versions of these casks are quite rare with the majority being toasted on the inside. Toast levels (which we'll get into more later in the chapter) vary quite a bit and considering that the heads are often toasted differently than the staves you can find yourself with all sorts of heat treatmentpermutations.

Of course, the economics of cask management for winemakers often means that wineries will use casks quite a few times before selling them off. Occasionally you might come across a winery willing to sell you a cask that has only held wine for one or two years, but this is most definitely the exception rather than the norm. It's not uncommon for wineries to hold onto casks for six or seven years by which point there are usually few extractives left in the cask effectively making them "neutral". Now, these casks are still of interest due to their previous contents, but they won't be that great for oak flavors. Neutral casks are generally best used as finishing casks rather than primary maturationvessels.

Finally, you need to know if the cask was treated with sulfur during storage. Wineries will often burn sulfur wicks inside the casks between uses to prevent against mold and microbial contamination. It's an effective technique and it's cheap which is why a lot of wineries like it. However, it's a problem for us distillers. Generally, we're trying to get rid of sulfur so adding our freshly distilled spirit to a sulfur ridden cask is usually not the best of ideas. It can produce some harsh burnt match aromas in the spirit. In most cases these aromas eventually blow off, but not always. And even then, it may take a while. Therefore, I recommend staying away from sulfured barrels. Instead, speak with your broker or winery about the use of ozone or steam to clean thecask.

So, with all this said, who are robur and petraea casks good for? I'd argue that these woods are not as versatile as American oak, but in quite a few cases there's really no substitute. If you're doing French-style brandy, then a heavy toast wide grained Limousin oak is going to be your best friend. Even a medium toasted petraea cask will be closer to an acceptable profile than American oak. These casks are also great for finishing projects and seem to compliment American oak profiles in all kinds of different spirits from rums to brandies to whiskeys. Even agave spirits do well in these casks if handledproperly.

Beyond these scenarios, there's room for some experimentation here. Speak with

some smaller coopers to see if they'd be willing to custom design some casks out of robur or petraea for you. Perhaps you could char these oaks and produce a bourbon fully matured in French oak. (Remember: the regulations regarding bourbon only require the oak be charred; nowhere does it specify what kind of oak must beused…)

Japanese Oak

Japanese oak, Q. mongolica, has been a hot topic of conversation in the whiskey world for the past few years. Ever since Japanese whiskey started winning more and more awards about twenty years ago, the prestige of these spirits has only grown (along with demand and price). Bloggers, tasters, influencers, and whiskey experts of all stripes seemingly salivate uncontrollably over the mere mention of the next Nikka or Chichibu release. Tears were shed when age statements were dropped, and auction houses fight to get their hands on the next lot ofKaruizawa.

The Japanese whisky industry as we know it today was largely built in the image of Scotland's whisky industry. Many distilleries go so far as to source barley, yeast, and equipment direct from Scotland. There has always been a unique technical and cultural bent to Japanese whisky that many people (myself included) find irresistibly alluring. In the past few decades, we've seen a widening separation between Scotch whisky and Japanese whisky. This is due to a few factors but certainly one we can't ignore for the purposes of this book is the introduction of Japanese oak into the mainstream whiskyconsciousness.

Japanese oak (Quercus mongolica) grows throughout Asia including Japan and thus was an obvious choice for cask cooperage in their burgeoning whisky industry. As we mentioned in the first chapter, this isn't the easiest oak to work with. It has a notoriously curved grain, is prone to lots of knots, and makes for a leaky barrel in general. A lot of coopers don't want to work with stuff, and besides the stave wood doesn't leave Japan all that often anyway. This fact alone makes these casks prohibitively expensive for a lot of distillers. I've personally seen prices reach as high as $5000 USD for 450-liter puncheons…that's PER cask by theway.

Now after you've collected your jaw from the floor of "what the hell", you

might still be asking yourself why anyone would want to use the stuff. Well the truth is that when these casks are made correctly, they are just downright interesting. There really isn't another oak out there like Japanese oak, with its intense notes of incense and sandalwood, it makes for some incredibly complex whiskey. Older samples drawn from these casks have been known to take on notes of melted butter, cinnamon, and ripenedpineapple.

Depending on where you source the casks, many producers request that the virgin wood be seasoned with sherry for one year (Yushi Noguchi, 2002). This may or may not be to your benefit and you should discuss this with any potential supplier of thesecasks.

I don't see this type of oak being useful for much outside of whiskey, at least when it comes to virgin wood. That's just an opinion, so feel free to prove me wrong. I could however see used Japanese oak casks making their way into quite a few finishing programs for rums, brandies, and more. A gin matured in Japanese oak would probably be incredible if the botanical profile was built to match. Just food forthought.

Oregon Oak

Oregon oak, Q. garryana, is perhaps one of the most recent oak woods to seriously enter the spirits conversation. It grows on the American west coast from Northern California to southern BritishColumbia.

There's not much to be said about it since the jury is still out on how useful it is for casks in spirits manufacture. I can say that when I was in graduate school for fermentation science at Oregon State about 10 years ago, the local winemakers had already largely abandoned it. The flavors were too much, too rustic, too dark. It just didn't play nice with the delicate Burgundian-style pinot noirs that Oregon is so famousfor.

That being said, a few distillers have made notable use of this wood, particularly Westland Distillery in Seattle. The purveyors of high-end west coast single malt make good use of garryana oak casks in a yearly special release. But even here, it must be said that they aren't typically using 100% garryana for these releases and instead are blending these casks with other casks such as sherry and bourbon. Unlike many of the other woods discussed in this book, this is one of

the few that I personally have not used, so therefore I won't offer much of a recommendation either way. I think that garryana oak is still in its industry infancy right now and we need more intrepid distillers to test its effects before we can really say what its role should be duringmaturation.

Cask Size and Shape

This section is likely going to upset a few folks and that's ok. It's all part of the conversation. In today's distillery landscape we can't escape the subject of cask size. Large distillers have the cash, space, and resources to sit on maturing spirit for long periods of time. They're playing the long game and it's really the only game they know. They are a hard group to competewith.

If you're in the beer industry you can argue that the big boys don't make particularly good tasting beer. I'd agree with you on that front to a large degree. Therefore, you can compete with them based on quality and charge accordingly. Your customers will (hopefully) understand that message of small craft quality versus big impersonal blandness and decide to pay premium cash for your premium brews. In my opinion that marketing tact has never worked as well with distilled spirits. I can sit there and tell you that I think Jack Daniel's Old No. 7 is a bit boring, but I most certainly can't tell you that it's bad. In fact, quite a bit of the higher tier products from JD, Beam, Sazerac, and so on are usually really good and often serve as quintessential markers for excellence. These guys and many others have been doing this for much longer than virtually any of the many small distilleries throughout North America and Europe and they are consistently pumping out quality product. Simply put, you're not going to outdo Jack Daniel's by making something so-so similar. Smaller distillers are required in many ways to produce something of higher caliber to compete and with shelf space at an ever growing premium, the price must be competitive aswell.

So, what's a small distiller to do? We've got bills to pay, employees to employ, depreciation on equipment to account for, and any number of other variables that seem to be constantly trying to squeeze our pockets for a few more cents. It's a tough business, so there is obviously appeal in the idea of getting a spirit on the shelf fast and faster to develop some sales revenue. And while there are a dozen and a half ways to do this (many of which will be discussed later in the book), one of the most common in the past two decades has been the use of

smallercasks.

In my distillery I usually speak in terms of what I refer to as “barrel equivalents” which in my mind is the standard 200 L (53 gallon) U.S. whiskey barrel. Since, I use a variety of cask sizes in my warehouse and I have owners that want to know how many barrels we have laid down at any given time, the idea of barrel equivalents or simply the number of 200 liter lots of whisky in storage, makes talking about this stuff to non-production staff mucheasier.

Now, 200 liters is normal for me and much of the spirits industry at large, but for many folks in the United States just trying to get their distilleries off the ground and out of the hands of bank repossession, much smaller casks are often used. Common sizes include 30, 25, 15, 10, and 5 gallons with some distillers even employing a few 3-gallon casks from time to time. I’ve used every one of these sizes at one point or another in my career. Some have produced quality results and others haven’t. The motivating theory behind using these sizes is that they offer an increased surface area to volume ratio for wood contact with the spirit. Therefore, extraction of wood compounds occurs at a faster rate and you wind up with a “matured” product in only a fraction of the time it would take to mature the same spirit in a 200-liter cask. It sounds great in theory, but there are a few caveats that need to be mentionedhere.

The primary benefit of smaller cask sizes is speed of extraction, in other words: additive reactions. Due to the increased surface area you will also get an increased absorption of some compounds into the active char layer (assuming the cask is charred). However, that’s about where the speedy benefits end. Other reactions that are equally important such as oxidation of phenolics do not necessarily increase at the same rate. Indeed, with smaller casks we typically get an increase extraction of phenolic tannins and many of the resulting spirits have a tell-tale soupcon of astringency that gives away the maturationregimen.

There was an interesting experiment done by Buffalo Trace back in 2012 where they took their standard new make spirit and put it into 5, 10, and 15-gallon casks and matured them along with their standard 53-gallon casks. They sampled them throughout the process and even allowed the spirit to reside in some of the small casks for up to six years. At the end of the experiment they were able to triumphantly press release their conclusions that “small barrel experiments are failures” (Preske,2012).

The whiskey press jumped onto the findings like collectors on a bottle of original Pappy. They gobbled it up and dutifully regurgitated the whole mess. Understandably quite a few small distillers who were successfully using these diminutive casks were less than amused. Here, in big distiller print was a scientific affront to their business models and products. Something felt off about the whole thing and the record neededrighting.

The problem in this case wasn't the casks but the spirit that went into them. Consider some of the above points about the speeds of various reactions during maturation. If you really think about it, the best candidates for a small cask are going to be spirits that have low levels (not completely absent, mind you) of fusel oils and low boiling point compounds. In other words, we need a spirit with relatively tight cut points duringdistillation.

You'll also remember from the last chapter that some grains seem to mature better than others with corn possibly being the biggest offender in this regard. Add all this up and it sure as hell sounds like a new make spirit from a large column still bourbon producer where cuts are fairly wide and corn is de rigor, may not have been the best choice to place in a smallcask.

Many years ago, I worked for a small craft distillery in the U.S. where our biggest seller was a smoked single malt whiskey. We matured it (the company still does this, in fact) in 15 and 30-gallon virgin char 3 American oak casks. For one of our single cask/cask strength releases we scored a 9.7/10 from Whisky Magazine, beating out pretty much every other whiskey (including some very high-end Scotches) in that issue. On another occasion I saw a video review of the standard strength version of that whiskey online and the very Scottish whiskey connoisseur giving the review suggested that the whiskey was likely matured for around six years (this was prior to mandatory age statements for whiskies under four years in the U.S.). He gave it a glowing recommendation, but he was wrong. That bottling had only been in cask for about four months in a 15-gallon cask. That cask strength bottling featured in Whisky Mag? About 10 months in a 30-galloncask.

So, no. I do not agree with Buffalo Trace's assessment that small barrels make bad whiskey. Like everything else in distilling, and I'm constantly preaching this to my students and clients, everything you do in the distillery affects the end product. Every decision, no matter how innocuously insignificant has an impact on the final spirit. If you want to use small casks, then fine, go on ahead. But

realize you need to build your spirit to suit those types of maturation conditions. That means selecting the right ingredients, using the right yeast, processing, and creating the wash in the right way, controlling fermentation and distillation correctly…it's noteasy.

So, what is the right way? I'm not wholly convinced there is such a thing, and a full discussion of this is well beyond the scope of this tome so I won't get into it too much. What I will say is that you have to basically build a lighter, low sulfur, low fusel oil spirit with a clean fermentation and tight cut points during distillation. Even then you may not succeed with small casks. There are just too many potentialproblems.

We've already mentioned that the primary benefits of small casks are their increased extraction rates. We've also mentioned that many of the other reactions don't typically keep pace. The problem goes deeper than that. A maturation system is just that…a system. The chemistry is incredibly complex, and we don't fully understand it. By extracting compounds from the oak into the system faster, you are changing the dynamics of that system and therefore how many of the other reactions willproceed.

The other issues with small cask sizes are more of a practical nature. First is the expense. A virgin charred 53-gallon American oak cask can be purchased for as little as $200. Same oak, same char on a 15-gallon cask? You're likely paying $150-$175 or more. So, you're paying close to the same price to mature about 30% of the liquid. That can have a significant impact on the price of the finalspirit.

Secondly, you've got issues with space to deal with. Small casks take up more space in the warehouse per unit volume. While this is partly a logistical problem, it also affects finances as well. You need more warehouse space, more labor to handle the casks, more racking material, more everything. It gets expensivefast.

How about large casks?

It's not something that comes up as often with many distillers in North America, but we should spend at least a moment on the use of largecasks.

In recent years there has been a lot of momentum behind building the idea of an

American Single Malt Whiskey. This has fomented an interest in the use of large sherry casks for maturation and finishing these spirits. The most common size for sherry casks is the 500-liter sherry butt. This holds 2.5 times more liquid than your standard bourbon cask. Port pipes are showing up in the market increasingly more often as well. These casks can range in size from 550-650-liters. You've got wine puncheons, hogsheads, and more, all holding considerably more volume than our standard 200-litercask.





Type	BUTT	HOGSHEAD	AMERICAN STANDARD BARREL (A.S.B.)	PUNCHEON	DUMPY PUNCHEON
Approx. capacity (litres)	500	250	191	550	463
Height (m)	1.27	0.86	0.88	1.13	0.99
Max. diameter (m)	0.90	0.72	0.63	0.96	0.95
Internal surface area (m2)	3.55	2.25	1.90	3.78	3.34
Surface/volume ratio (cm2/l)	71	88.5	100	67.5	72

Figure 15 Common cask sizes (Image courtesy of The Institute of Brewing & Distilling

As you might expect these casks have lower surface area to volume ratios and show slower extraction rates than your standard cask. Now, does this change the dynamics of the maturation system? You betcha. Does this change in maturation dynamics have a negative impact on the spirt? Notreally…

Here's the thing about extraction and the subsequent additive reactions: a careful balance must be reached. There is definitely too much of a good thing and things like tannins and aromatic aldehydes can quickly overwhelm a young spirit. Plus, many of the extracted compounds go on to be part of productive reactions and oxidation reactions which are necessary for a good mature character to develop. But with the increase in cask size we get a lot of potential for oxygen. This helps mitigate any potential rough notes from extractedcompounds.

The other thing to note about these casks is that they rarely reach the distillery brand new. Usually they've been used to mature some other wine or spirit first. This means that a lot of the extractives are already gone. In my distillery, many of the sherry casks that we use have been in a solera system for at least 20 years. When I use these casks, I'm looking for sherry character and the effects of oxygen on the immature spirit. I do get some wood extractives, but they are more subdued than in a new cask. Factor in the fact that many of these larger casks are produced from less aromatic robur and petraea oaks and you have less to worry about with heavy phenolic and aldehydecomposition.

Barrel Shape

A few words are worth mentioning on the subject of barrelshape.

"But aren't all casks essentially ovoid cylinders?" Yes, but it's a bit more complicated than that. Some casks are taller and narrower around the bilge while others are squatter. There's some range when it comes to these variations, but the easiest way to see the difference is to look at a traditional Burgundy cask versus a traditional Bordeaux cask while they are standing vertically on their heads.

Burgundy casks are squatter while Bordeaux casks are narrower. The difference evolved from their respective wine making traditions. Burgundy wine makers needed a squat barrel for aging chardonnay on the yeast lees, which contributes a nice creaminess to the wine. The wider bilge in the center of the cask allows for the yeast to better settle out. There is a slight volume difference as well with Burgundy casks clocking in at 228 liters and Bordeaux casks coming in at 225 liters, but three liters isn't enough to concern ourselves with (MacNeil,2018).

What we are more concerned about is the potential headspace formed inside the cask due to evaporative loss over the course of maturation. With the rounder Burgundy casks, you will have less surface area exposed to headspace initially formed on the inside of the cask in the beginning phases of maturation. Bordeaux casks allow for greater surface exposed to headspace earlier in the maturation process. This helps with oxygen exposure and ingress into the developingspirit.

For most maturation programs the difference between these two casks will be somewhat nominal. However, you should consider cask shape as at least a minor factor of importance in your maturationprogram.

Charring and Toasting

One of the most important factors that comes into play with regards to maturation is the type of wood heat treatment. Char and toast levels are incredibly important to the potential mature character of the finalspirit.

Most barrels are toasted at some point in their manufacture. Even charred casks are often toasted prior to charring for the purpose of shaping the cask properly. Toast and char levels vary but they all generate flavor compounds in the cask wood that can then be extracted into thespirit.

Toasting

There are three primary toasting levels used in the cask industry with different coopers offering a few in-between variances to widen the breadth of flavors

possible. For most coopers you'll see the terms "light", "medium", and "heavy" toast. The in-between levels that occasionally show up are usually things like "medium plus (+)" and such. We'll focus here on the primary categories and how they affect the barrelflavors.

Table 4 Aromatic compounds produced from heat treating oak chips (Nishimura, Ohnishi, Masuda, Koga, & Matsuyama, 1983)

	Toasting Temperature (°C)			
Product(mg/L)	100	150	200	Charred (>250)
Vanillin	1.1	3.8	13.5	2.8
Propiovanillone	0.6	1.1	1.4	0.9
Syringaldehyde	0.1	3.8	32.0	9.2
Acetosyringone	0	0.025	1.5	0.6
Coniferylaldehyde	Trace	4.3	24.0	4.8
Vanillicacid	0	1.8	6.1	1.1
Sinapaldehyde	Trace	6.5	60.0	9.0

Light toasts are accomplished with less time and often less heat. You may see toast times as low as 25 minutes or as high as just under an hour. The time depends on the heat used and vice versa. For instance, a light toast may be obtained by using 50°C heat on the inside of the cask for about 55 minutes, but if you want to accomplish a light toast faster you would need to increase the heat. Therefore, a light toast for one cooperage may be different than the light toast from another cooperage depending on the techniques used to getthere.

Light toasts provide only a slight color change to the wood and the subsequent spirit. The aromas are lighter as well. Depending on the wood being toasted you can expect aromas of caramel and vanilla and perhaps someclove.

Medium toasts go a bit heavier on the time and heat, perhaps 60-150°C for 30-70 minutes depending on the cooper. The color, aromas, and flavors imparted here get darker overall. Expect more vanilla coupled with notes of roasted nuts and a little coffee to emerge. Medium toasts are mostly used for red wine production and outside of used wine casks, you don't see too many spirits producers opt for medium toasted casks. Of course, that just makes them even more interesting for a potential blended cask program so it's worth thinkingabout.

Heavy toast is where things start to really get dialed up on the flavor and color. This is the most common toast used for Cognac production with Limousin oak. You'll get quite a bit more color and the vanilla will be cranked up to 11. You'll get more coffee notes, some spicy and toasted notes, and perhaps even some charredcharacter.

The toasting process creates a gradient in the wood with the surface of the stave wood inside the cask being most affected by the heat and gradually less toasted the deeper you go into the stave wood. Complicating our toast levels and their effects on the spirit is the fact that the heads are toasted separately from the inside of the cask and may be toasted to a different level than the primary stave wood. This is not an insignificant issue. The heads make up around 30% of the surface area inside the cask so there is the potential for a lot of control on toast flavors here. For instance, you might have a light toasted cask with heavy toasted heads. This gives you a ton of flexibility when it comes to cask selection. If you're not sure about the proper route to go, talk with your cooperage. They will have recommendations to offer based on what your desired end profileis.

Charring

Charring the cask is where things really get hot inside the cask. In fact, during the charring process the cask is literally set on fire from the inside. The subsequent char layer penetrates the stave wood to around 5 mm deep (just shy of ¼”). The spirit will actually penetrate beyond this later to a full 8 mm (3/8”) so having a properly seasoned stave wood with a good base toast is just as important as the charlevel.

Char levels go from 1 to 4 with 4 being the heaviest. A char 4 is often called “alligator char” because of the scaly appearance of the char layers and charflakes.

Char1

15 seconds of flametime

Effectively a super heavy toast with loads of wood aromas stillpresent.

Not a common char level used in the spiritsindustry

but could be useful for fleshing out a blendingprogram.

It should be noted that once we reach thecharring

process there is usually a decrease in vanillin levels inthe

wood. See the tableabove.

Char2

30 seconds of flametime

This is the char level where we begin to pickup

more roasted coffee and caramelflavors.

This is still not the most common char levels usedfor

spirits, but an increasing number of people are playing with this char to interesting effect. Once again, this could make a valuable addition to a blended caskprogram.

Char3

35 seconds of flametime

Char 3 produces much more spice, roast, and burnt flavors and a bit of smoke character as well. Gives good color development to new makespirit.

Char 3 is arguably the most popular char type in the spirits industry. Many of the large bourbon manufacturers use this char level as their primarychar.

Char4

55 seconds of flametime

Char 4/alligator char ups the ante on the smoke and burnt aromas and may give the spirit some tobacco and spicy notes aswell.

This is another popular char level, though not as popular as char 3. One notable distillery that uses this char level to great effect on their bourbon is WildTurkey.

There are other heat treatments that occasionally pop up in the spirits industry, though usually on an experimental basis. One of the more interesting of these was a char #7 treatment created by Buffalo Trace back in the early aughts. These casks were exposed to an unprecedentedly ridiculous 3.5 minutes of flame. (When I first heard about this experiment a few years ago I wondered how the casks were even still standing at that point.) They then put their rye bourbon mash #2 in the casks and matured them for over 15 years. The resulting spirit was reportedly excessively dry, burnt, and a bit bitter which sounds unappealing though the reviewer seemed to like it wellenough.

Rechar

The final thing worth mentioning in this section is the topic of rechar casks. This is a subject that occasionally gets brought up in the Scotch whisky industry and might be of interest to somereaders.

Some companies in an effort to save money and extend the life of a cask, may have a barrel recharred. This process involves scraping a few millimeters of the original char layer off the inside of the staves and recharring them. It doesn't produce the flavors or aromas of a brand-new cask but does breathe a bit of new life into it. The problem is that while it reintroduces a char layer, the process can't replace the other extractives that have already been pulled from the wood during previous maturation periods. Therefore, there is a bit of "flavor imbalance" with these regenerated casks (Reid, Conner, Jack, Patterson, & Freeman,2005).

Similarly, there are also companies that work on the tangents of the wine industry that will do a retoast of a barrel through a similar process. Because the process removes a bit of stave wood each time, it shouldn't be done on a cask more than once. Most folks opt to simply retire the cask into the furniture or garden industry and purchase new casks, but you may find yourself in a situation where these techniques are appealing so it's worth knowing what your optionsare.

Used Casks

We've lightly touched on the subject of used casks already at several points throughout the book. I'm a huge proponent of using once filled casks for spirits production for several reasons. You're giving new life to an otherwise abandoned piece of woodwork. The flavors are probably going to be beneficial to your own cask program. They are often cheaper than new casks (though this REALLY depends on what was in the cask beforehand). And we could go on and on here, but honestly, if you're reading this book you likely have at least a passing interest in the concept of reused casks, so I'll drop the salespitch.

For American whiskey distillers however, implementing used casks into your program can sometimes be difficult. Afterall, for most whiskey types in the U.S. you are REQUIRED to use virgin oak casks that have been charred. Otherwise your whiskey must be labeled as something like "whiskey produced from bourbon mash" or some such nonsense. That's fine for some people (St. George's excellent single malt whiskey proudly states on the bottle that it is "distilled from barley malt mash"). Most traditional bourbon and rye producers want to be able to simply call their spirit "bourbon" or "rye" and that's fine too. For those folks, this section of the chapter may only be interesting from the standpoint of providing mental fodder for finishing experiments. We'll get to specific maturation techniques later in the book, but for now let's look at the criteria for selecting suitable used casks for yourwarehouse.

The number one concern with used casks is what was in them before. Now, I'm not just talking bourbon, or sherry or rum or whatever. I want to know which bourbon, sherry, or rum was in the cask beforehand. The key word here is consistency. Not all bourbons are created equally and that goes the same for their spentcasks.

Laphroig on Islay makes a big deal about how they only use Jim Beam bourbon casks that are around five years old. Their distillery manager reportedly tried numerous other casks but kept going back to the Beams. That might partly have to do with the fact that Laphroig is owned by Beam Suntory (with a huge emphasis on Beam there…), but it doesn't change the central issue: they want the same casks from the same producer every singletime.

The reason is simple. If you are maturing your spirit in a used Jim Beam cask and then suddenly switch everything over to a Jack Daniels cask, the resulting

spirit is going to change. That change might be subtle, or it might be huge, but either way it's going to be different and the vast number of customers out there, often unbeknownst to themselves, place a premium on productconsistency.

For me, I make a point to my cask brokers that I want the same thing I ordered last time. If I ordered Four Roses casks three months ago, I want Four Roses casks now. Unfortunately, my distillery is small and I work with small brokers (usually) and sometimes it's just not possible for me to get the exact same thing every time no matter how much I scream into the phone or use ALL CAPS IN THE EMAILS. In these frustrating (and thankfully rare) instances I discuss my needs with my broker, and we work together to find a cask profile that closely matches what I'm asking for. It's not always easy, nor is it perfect, but I'm typically happy in the end which is about all I can ask for Isuppose.

And this brings us to a seriously important point with used casks. You need to find a good broker which is not as simple as it sounds. There are quite a few fly by night companies out there looking to unload the next batch of secondhand barrels to the first sucker that raises a fist full of cash. A good broker is quick to ship, will have ample stock that moves, and KNOWS their product. They will know the origin of the casks, what products came out of those casks, when the casks were decanted, and much more. The last thing you want is a broker selling you a bunch of casks that have sat in the warehouse completely dry for six months collectingdust.

I recently tried ordering some champagne casks from one of my brokers. The order was good, and we were all set. Then he calls me up to tell me that he wasn't going to ship them too me. Turns out that they had just received the shipment from the winery, and he went down to personally inspect and smell the inside of the casks. They didn't smell that great. Not bad, but not great either, and so he refused to sell them to me. My order was changed and my dedication to that broker was furtherreinforced.

The best casks are going to be freshly dumped and that contained products in them you would be fine with drinking yourself. Not a fan of Jack Daniels? Maybe ex-JD casks aren't good for your program. If you don't like the flavor of what was in the barrel originally, you're not likely going to enjoy the flavors it imparts to your own spirits through the caskwood.

The broker I use for sherry casks ships them to me with a few liters of the

residual sherry left in them. This is done partly to keep the wood moist during transport, but it also allows me to taste the original contents of the cask to ease my mind about cask contributionquality.

Speaking of sherry casks, a special word on the subject is in order. In recent years there has been increased interest in sherry cask maturation in distilleries throughout North America. This is due in no small part by an increased interest in single malt Scotch whisky like the Macallan and other so called, “sherry bombs”. The result is that production in the Scotch whisky industry has also expanded and they are sucking up a lot of the available sherry casks. You know what hasn’t expanded? The sherry industry. Sherry is a love/hate kind of wine. (I’m on the love side myself.) There just aren’t enough people out there buying bottles of sherry to push demand up that much. This leaves us with a serious supply and demand problem when it comes tocasks.

The work around that an increasing number of brokers and distillers have started using is that of seasoned casks. These are casks that hold a basic sherry for a period of only a few years (2-5 is common), before being dumped and sold to the whisky industry. The dumped sherry is then put into the vinegar industry or is distilled. This is a bit different from using retired solera casks for spirit maturation. The solera casks are potentially more intense in sherry notes but have lower levels of extractives since they have been under wine for usually several decades. The seasoned casks probably have a lower quality of sherry but also have more extractives available to give thespirit.

So, which one is better? It all depends. I personally use retired solera casks but will readily admit that these come with their own problems. Aside from the lower levels of extractives, these casks are older and may have small amounts of structural damage. Plus, they are expensive. Seasoned casks are more consistent in flavor from cask to cask and can give a good quality of oak flavor to the spirit. It should also be noted that most seasoned casks are made from American oak and not from one of the European oaks. Regardless, either is a fine option assuming you find a broker you cantrust.

With regards to other types of used casks, you can let your imagination go wild here as there are so many interesting casks constantly coming onto the market. Generally, I consider three types of used caskgroupings.

Table 5 Used Cask Types

Ex-Spirit
Bourbon, Rye, Wheat, Corn, Cognac, Armagnac,Calvados, Peated and Unpeated Scotch Whisky, Tequila, Rum, Liqueur, Amaro, Absinthe, Gin,shochu

The table above is not exhaustive, and you've probably thought of quite a few I may have missed. That's good. It's not about giving you a list but rather to get you thinking about possibilities. If you're wondering how some of these casks might affect your spirit, an interesting experiment can be done. Go out and buy the base liquid for the spent cask that you're thinking of putting your spirit into. Maybe a nice but inexpensive ruby port or smoky Islay whisky. Add a few drops to a glass of the spirit you want to mature. Do the flavors work? It's not a perfect experiment, and even calling it an approximation might be a stretch, but it will give you an idea of the flavor direction you might be headed in. Before spending loads of money on some crazy casks that your broker is excitedly trying to push on to you, it might be worth you time to make sure that the potential flavor combination has a chance ofworking.

If you have a bit more time on your hands you can purchase some oak chips or cubes made of the same wood species you're planning to use. Soak them for a few days in whatever liquid you'd like to purchase an "ex" cask of. Then infuse the chips/cubes into a small amount of your spirit and let it sit for a week or two. Once again, this will only give you an idea of the flavor direction, although this will get you closer to reality than the previous experiment because it accounts for the addition of more wood into yourspirit.

Beyond the flavors from the casks, we want to make sure that we're purchasing casks in good condition. Ideally, we're getting barrels that show signs of good storage and handling by their previous owners and the barrel broker. This means that all the staves look to be in good shape, the cask has been freshly dumped and/or leak tested. There should be no musty, earthy, moldy, or sulfur aromas coming from the cask. The hoops should be in good condition. Rust on the hoops is ok so long as it's merely surface pitting and the hoops show a strong and uniform thickness around the band. Some brokers will go the extra mile here and replace the hoops on some casks, but thisvaries.

Now that you've decided on which cask to purchase and why, you need to think about your warehouse environment. All the wood science and cask money in the world isn't worth a cent if your warehouse isn't up to snuff. This includes things such as construction and spacing, but also the micro and macro climates your warehouse provides. In the next chapter we'll look at how the building and the environment come together to affect our maturationprogram.

Chapter 4

The Warehouse

In this chapter we're going to look at the maturation warehouse. The physicality of the warehouse is something that you should put a lot of thought into. You may not have much of a choice in your warehouse environment. It may be that you've spent years trying to open your distillery and had to take a less than optimal space just to get things going. That's ok. If you keep the lessons in this chapter in mind, you can still build a maturation program that you can be proud of.

The Maturation Warehouse

The maturation warehouse is one of the most important components of a successful maturation program. Unfortunately, the warehouse is often relegated to the distillery back burner in favor of thinking more about the casks themselves. This is a huge mistake. The warehouse that holds the casks is every bit as important as the casks themselves. Think of your warehouse as a cask for your casks.

What is the ideal maturation warehouse? The answer to that really depends on your goals and the spirits you're trying to make. We can generalize and make a few concrete statements, however. First, we need something of sound construction that shelters our casks and employees from the harsher elements like rain, hail, snow, etc.… We want a good amount of space to store our casks, access them for sampling, and to be able to move them around when the need arises. We also want a space that is safe, not just for our casks but for our employees and potentially any customers that may come onto the premises. And we need something that meets any local building code requirements.

If money were no object, then building this kind of warehouse would be easy. Unfortunately, few companies have unlimited capital to throw at warehouse construction, so some folks feel like compromises must be made. Considering the amount of literal liquid capital tied up in a maturation warehouse, compromising on any of the above goals can be a costly mistake. So, let's look at some of the construction factors we should consider when building out our ideal space.

Construction

Let me first start out by saying that I am not a contractor nor an engineer. I've never worked in the construction business. Therefore, I am not an expert in building your warehouse. I can only offer advice and it's up to you to decide whether it will work for your situation. There are a growing number of contractors and engineers that understand distillery and maturation house buildouts, some of whom even specialize in it. I highly suggest speaking with some of these folks to get a better handle on what you need for your project.

The first decision you need to make is whether your maturation space will be somehow contiguous with your existing production space or if you are going to build a separate building. Having a separate building built solely for the purpose of maturation is by far the most preferable scenario here as it affords you the greatest number of options. In many situations this may not be possible, so we need to think about that.

If you are locating your warehouse adjacent to your distillery space, then you need to have a way to keep the two operations separate from each other. It isn't a great idea to have maturing casks sitting next to a hot still all day, or on a floor next to dumped stillage and fermenter lees. Not only can this negatively impact your maturation progress, but it is also a safety concern as well. Let's say you're having the worst day of your professional life and a fire breaks out in the distillery. If you have wooden casks sitting in there you've now got two additional fuel sources to add to that fire: the cask wood and the spirit inside. If the casks are properly bunged and sealed, you might even be risking an explosion. So ideally you should have your casks situated in another room (this may be required by law depending on the country you're in), with a way to shut the door and separate the two spaces safely from each other.

When building out the warehouse space you need to consider a few things. How insulated do you want the space to be? This is a question of warehouse climate that we'll address more thoroughly later in the chapter, but for now we can just say that this is a question of how much you want the outside temperatures and humidity to affect the maturing casks inside your warehouse.

Access to floor drains for cleaning and other housekeeping operations is critical. For many smaller distilleries, the warehouse space is also where the cask filling operations take place. Spills happen and high abv spirit sitting around on the floor is not the safest thing in the world, so floor drains once again prove their worth here. A slightly sloped floor of 0.5-1.0% leading into a grated trench drain is perfect. It is also worth considering having the floor made with a non-slip surface for better grip and traction.

You also need to consider the amount of space required for your operations, and not just floor space. We need to know vertical space as well. This is a complicated question and one worthy of an in-depth discussion.

A standard 200 liter American oak bourbon barrel ("ASB" to much of the rest of the world) is approximately 34-36" (86-92 cm) tall, about 21" (53 cm) wide at the head, and 25.5" (65 cm) wide at the bilge. How much space do you need to store 100 of these casks? Let's assume that they are just going to be palletized at 4 casks per pallet on a standard 48" x 48" (1200 mm x 1200 mm). (There are larger pallets out there that some companies use to accommodate 6-9 casks but the standard "4x4" pallet makes for an easier example due to its ubiquity.) With four casks on a standard pallet it's going to be tight fit, but it works.

Now, assume you get the casks perfectly aligned on the pallet and they are as close together as you can possibly get them. This means the width of your pallet from the bilge of the casks will be about 50" (127 cm). That's just over 17 ft2 (1.6 m2). That means that in a space of 170 ft2 (16 m2) you can fit 40 casks! And that's just for a single layer. If you stack those pallets 3 or 4 high (larger distillers will go up to around 6 pallets high but you need really good pallets and confident forklift drivers for this), then you can fit 120-160 casks in a 170 ft2 space. Sounds great doesn't it?

Here's the problem though. In this scenario we haven't allowed for any space between the casks. Usually you allow for at least an inch or two (2.5-5 cm) so that you have some wiggle room when placing the casks. That adds another 1.75

ft2 (0.14 m2) to our required space for a pallet. Then you need to factor in the space required for moving the forklift around which for most drivers is significant. Suddenly, your tiny efficient warehouse has grown to something much bigger.

The amount of space you require for storage is not as simple as attaching a specific amount of area to a certain number of casks. There are just too many factors at play here. Everything from the type of storage system, climate requirements, sampling methods, and much, much more will affect how much space you need for your system. And that's before we even get into safety and fire prevention. Everyone is a bit different, but the hope is that by the end of this chapter you'll have a better idea of what suits your needs.

Construction Materials

Drive through the Kentucky countryside and hop on the Bourbon Trail. Cruise up the driveway of a distillery that interests you and eventually you'll begin seeing large white or grey-ish buildings dotting the landscape. They're usually within a stone's throw of the distillery proper. These seemingly boring pieces of architecture are the rick houses where the casks are stored. Some are epic in scale and scope while others are unassumingly quaint.

In the old days, these buildings would be made from wood. It was readily available and easy to work with. Now adays you're more likely to see metal siding. In the most recent warehouses, you may even see the exterior walls completely composed of concrete. All are suitable for construction but will confer different benefits to the maturing casks.

The building of a warehouse can be as simple as pouring a leveled concrete slab atop a stable foundation making sure all necessary plumbing lines are also installed beforehand. A basic light metal frame can be thrown up and sheeted walls attached. The walls can then be insulated…or not. This is for a rather simple one- or two-story warehouse. If you're wanting to go for something a bit larger, say in the vein of those monolithic bourbon country structures, you're going to need sturdier materials to get the job done such as larger frame posts, deeper foundation, and so on. Talk with your contractor about your needs.

That's the simple side of it. But as we know, warehouses for distilleries contain

large amounts of flammable material and therefore require some extra features of the building process.

First, think about the distance of the building from the distillery proper. The “standard” in the bourbon industry is 100 yards (~100 m). Speak with your local codes official and your fire marshal. They may have different requirements based on thelocale.

In addition to the distance between buildings, there should ideally be some sort of non-flammable material atop the ground surrounding the building such as pea gravel. This material should extend out from the building at least 20 ft (6m).

Proper drainage is a must. You need to have a system in place that can handle 125% of the total liquid volume contained in the warehouse. These emergency systems come in quite a few forms these days so talk to the proper regulatory authorities regarding your options. Diageo installed some interesting flood breaking doors that can rise of from the floor and contain the liquid inside the building in the event of something like this happening at their Bulleit Distillery. It’s not a cheap option, but it’s an effectiveone.

You also need good ventilation in these buildings. Evaporation during maturation means quite a bit of alcohol vapor will build up over time if not ventilated thoroughly. I’ve been inside warehouses where this was an issue, and aside from the inherent dangers of such a scenario, it made physically standing and breathing in the warehouse for the employees almost impossible. The bare minimum recommendation as per the National Fire Protection Association (NFPA) is ventilation of at least 1.0 cfm (cubic feet per minute) per square foot of floor space. For more information see the NFPA codes 90 and 91 (NFPA, Standard for the Installation of Air-Conditioning and Ventillating Systems, 2015) (NFPA, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,2010).

All electrical work should be installed to NEC Class 1 Division 2standards.

Automatic sprinkler systems with high volume throughput can potentially mitigate the damage from a catastrophicfire.

Finally, if you live an area where lightning storms are a real concern, then installing lightning protection equipment on the warehouse may be necessary. Speak with your local fire department and contractors regarding suitable options (DISCUS,2005).

Safety

Obviously, there are a few safety concerns regarding maturation warehouses. Every couple of years it seems something tragic and catastrophic occurs in the spirits industry with warehouse collapses, fires, and mother nature just generally being a jerk.

In July 2019 Jim Beam lost a warehouse to a lightning strike. The warehouse contained 45,000 casks of young whiskey. That’s a lot of product loss. The company also had to pay some hefty fines for the adverse environmental impacts of the fire.

In 1996 Heaven Hill lost 90,000 casks in one of the worst industry fires in history. Wild Turkey saw a substantial fire in 2000. Jim Beam suffered another loss in 2003 where a massive fire was actual transformed by high winds into a “bourbonado”. So, yeah, terrible things happen and I’m only talking about the fires. There are warehouse collapses due to failing supports, tornados, and more. Even in the relatively calm climate of Speyside, Scotland there have been warehouse roof collapses from excessive snowfall. It’s a sobering reality of the business.

How do we approach safety in our maturation space? We've already covered some of the things with regards to the building itself. Sound building materials and support coupled with good drainage, lots of ventilation, and high-volume sprinkler systems are just a few of the things we can do. Employees should be properly trained to work in the warehouse. Steel toed boots always, licensed lift and equipment operators, access to food-grade fire extinguishers, and more. The warehouse should be regularly assessed for developing cask leaks, which is easier to do in some organizational systems than others as we'll soon see.

Most of this stuff is simply common sense. If you know how to work safely in a distillery then you should be able to handle the added safety responsibilities that come with a maturation warehouse. That's not an invitation to let your guard down. Many warehouse workers I know, often work by themselves. Bad things can happen and if your facility isn't properly designed or your workers well trained, someone can get seriously hurt. Stay vigilant.

Warehouse Climate

Let's take a step away from the logistics of building a warehouse and take a closer look inside. More specifically in this section we want to look at how the warehouse climate affects the maturation process. The two variables that we are concerned with are temperature and humidity.

Scotland is quite different than Kentucky and I'm not just talking about the accents. Scotland is wet and cool. The temperatures are relatively mild throughout the year with a fair amount of rainfall. The winters typically don't get too cold and the summers rarely get too hot. It's a moderately stable system. Contrast this with Kentucky and you've got a completely different situation. Kentucky is hot during the summers. And sure, it may feel humid and sticky outside on some of those hell-fire dog days in August, throughout the year humidity levels range from around 61% in April to 73% in September which while not exactly dry, still isn't bone-soakingly wet. Temperatures in Louisville Kentucky reach an average high in July of 89°F (31.7°C) (Monthly weather forcast and climate for Louisville, KY, 2020). Scotland on the other hand hovers around 80% humidity for much of the year with average daytime temperatures in July going up to just shy of 65°F (~18°C) (Climate for Scotland, n.d.).

Clearly the climates between these two regions are quite different from each other. Those differences can have a tremendous impact on maturation processes. If we assume that your maturation warehouse attemperates itself with the outside climate according to the changing seasons, then you will expect that your maturing spirits will feel those climatic changes to a certain extent as well. How much the outside climate affects your casks depends on ventilation and building insulation. If you have a perfectly insulated building with little to no changes in inside temperature then these issues may not seem that interesting to you, but no matter how you've constructed the building, the inside will exhibit its own climate.

Higher temperatures favor faster extraction and faster chemical reactions during maturation. Conversely, lower temperatures will slow things down.

Humidity is just as important a consideration though it's one that many distillers tend to think about the least. High humidity favors greater evaporative loss of ethanol over that of water. The flipside being that low humidity warehouses tend to see more water loss from the cask instead of alcohol.

The overall effects of climate conditions on maturation can't be understated. Going back to our original distiller destinations of Scotland and Kentucky, we see dramatic differences in evaporative loss over time. In Scotland distillers expect to see an average of 2% total evaporative loss from each cask per year whereas in the southern U.S. the loss averages around 4-5% per year. In hotter parts of central America and the Caribbean you may see evaporation reach averages of 10% or more per year! (Calculating cask losses per annum is quite a bit more complicated than this due to leaks forming in the casks, spills and so forth, but the numbers above should give you an idea of the ballpark evaporation we're discussing here.)

The humidity differences between the regions produce very different results as well. Since higher humidity favors more alcohol loss from the cask, Scotland's casks generally lose alcohol over time. It's common for initial cask fill strengths to be around 63.5% abv. After 10 years the alcohol content may lower to around 58% abv. In fact, there have been a few cases in the industry of Scotch whisky sitting in cask for so long (several decades) that the alcohol level dips below 40% abv. When it does this it can no longer be called Scotch whisky (SWA, n.d.). That's a tragic end for a long-kept whisky.

Kentucky has the opposite issue. The low relative humidity in their warehouses tends to cause alcohol levels to increase over the course of maturation. This is why you see cask strength bourbons on the market weighing in at 65-70% abv even though the maximum legal fill strength for bourbon is 62.5% abv. This is not to say that alcohol is not lost during evaporation in Kentucky, just that overall more water is lost than alcohol, thus increasing the overall alcohol concentration in the cask.

OK, you say. Big deal. Why is any of this important?

Remember how we discussed earlier in the book that fill strength affects maturation reactions? Well those theories come into play here as well. As the alcoholic strength of the cask slowly changes, so do the types of reactions that occur. In Scotch as the whisky matures to a lower alcoholic strength in cask, more compounds such as wood sugars are extracted into the spirit. These reactions happen at higher alcoholic strengths as well, but they happen faster as spirit strength goes down. With bourbon we see more extractives getting pulled into the spirit earlier in the maturation period, and higher rates of lactone pick up later when the spirit strength slowly ticks up.

Something worth mentioning here is the idea of seasonal cycling of spirits. Some distilleries mature their spirits in climate-controlled warehouses so that conditions are relatively static throughout the maturation period. Other distillers refuse to have anything approaching climate control in their warehouses so that the casks go through what is often referred to as “seasonal cycling”. Seasonal cycling as the term implies is when the casks are allowed to exist in relatively similar climate cycles to that of the outside seasons. So, during winter the casks and their liquid will be at much lower temperatures while during the summer the temperatures will be considerably higher. Great spirits come out of both systems so is there really a benefit to one or the other?

The reasoning behind seasonal cycling has always been explained thus: as the temperature goes up, it pushes the spirit deeper into the cask wood, extracting more of the wood compounds. As the temperature goes down, this spirit is drawn back out of the wood with its load of extractives. It’s a bit more complicated than that. Let’s look at it a bit deeper.

When water heats up its volume increases and its volume decreases as the temperature goes down (things get a bit funny as we approach water’s freezing

point, but we'll ignore that for now). The same can be said for spirit. As the temperature goes up the liquid will expand. Imagine that happening inside a newly filled cask that has been perfectly bunged and sealed. We've just filled the cask with a liquid at room temperature to the top of the bung hole. We insert our bung, hammer it down and now there should be virtually no headspace for the liquid residing in the cask. So, what happens when that liquid heats up from warmer temperatures in the warehouse? It expands and pushes itself deeper into the wood. That's pretty simple right?

Eventually we get some evaporative loss from the cask which creates an increasing amount of headspace inside the cask. Once we have headspace the situation changes a little bit. Liquid will still move into the pores of the wood, but it is also expanding into the headspace of the cask. This, in theory, has a lot to do with internal cask pressure. If the pressure on the liquid is high as it would be in a hot cask that is nearly full then the spirit will push deeper into the wood. If that pressure goes down, then the liquid doesn't push into the wood as much.

Complicating things even further is the size of the warehouse itself. Larger warehouses typically take longer to heat up and cool down than smaller warehouses. This can change the dynamics of seasonal cycling considerably.

Warehouse Types

The type of warehouse you build and manage will have an impact on the barrel climate conditions such as temperature and humidity. There are four warehouse types commonly used in the industry and they are all worthy of consideration when designing your maturation program.

Dunnage Warehouse

The dunnage warehouse is arguably the oldest type of maturation warehouse and cask organization. If you've ever toured a single malt Scotch whisky distillery, in all probability you've been able to at least glimpse one. These are the warehouses that the distilleries often allow visitors into partly because they help to convey a romantic image of times long past. These buildings are poetic

anachronisms with rustic wooden beams encasing a damp, dark, dusty room that seems to swallow up the slumbering casks therein.

A dunnage warehouse is simply four walls, a roof, and little else. The walls are often concrete or simple masonry. The floors are typically a mixture of dirt and gravel. The rooms are darkly lit. Casks are laid out on the floor hoisted upon wooden 4x4 posts. On top the first layer of casks, another set of posts are laid down so a second layer of casks can be rolled on. There may be a third layer atop that.

Dunnage warehouses are all about consistent cool temperatures and high humidity. The casks are kept low to the ground where the cooler air resides. The dirt and gravel floor retains a lot of moisture that then hovers in the cool air surrounding the casks.

As you can imagine these warehouses are not the most efficient uses of space. With casks arranged only three high, we're not really utilizing much vertical space here. There is usually quite a bit of space between cask rows as well so that workers can more easily reach individual casks. Because of the inherent space inefficiencies, these warehouses seem to be slowly going extinct.

Still there is a bit of magic to them. Their cool confines just feel…cool. These warehouses are more about consistency than efficiency. The limited tier system keeps everything within a similar temperature and humidity gradient. Cask maintenance is a simple task because of the open spaced floor plan. They are also relatively inexpensive to build and maintain.

The gravel floors do require lifts with tires that can handle that type of terrain. But the gravel does confer an interesting environmental advantage. In times of low humidity, it is possible to spray water onto the floors to boost the indoors humidity surrounding the cask. This is a common technique in some calvados warehouses for example (Neal, 2011). In fact, the chai (pronounced "shay") warehouses of many French brandy manufacturers would arguably classify as dunnage systems.

Truthfully, the old dunnage system is becoming more and more of a historical curiosity as the low level of space efficiency makes them a poor choice for distilleries with large production capacities or that plan on expanding at some point. The charm and consistency that they offer may be enticing factors for

some smaller producers.

Racked Warehousing

The modern rack house or “rick house” is a popular option for many distilleries in North America. This is the type of warehouse many people picture when their minds drift to the classic bourbon cask house with wooden floors and tiers upon tiers of barrels bathed in warmth from the sun split rafters from above.

These warehouses were a logical step in evolution from the relatively rustic and quaint dunnage system to something bigger and more efficient. As we discussed earlier, rick houses are simple in design, essentially just four walls with a roof sitting atop a concrete slab. Afterall, if you’re trying to maximize space efficiency, you might as well do it in a cost-effective way.

The standard rick house can hold approximately 20,000 53-gallon casks. They are built around the premise of tiered rows of barrels and usually reach 7-9 floors high with three layers of casks per row. In recent years to meet demand these warehouses have been increasing in size and capacity. Now it’s not too uncommon to see rick houses hold 55,000 barrels or more. The larger size and capacity mean that increased safety measures must be put into place such as mandatory high-volume sprinkler systems. Heaven Hill uses a 300,000-gallon water tank connected to two pumps capable of pushing 2,500 gallons per minute to feed their sprinkler system in case of an emergency.

Like the dunnage system, casks are rolled by hand or with the aid of mechanical lifts onto wooden rail tracks to form long rows of barrels. The casks at the end of the rows will have wooden chocks placed underneath them to ensure they don’t roll off and potentially injure someone or something.

High Temperature/Low Humidity- Alcohol %v/v goes up	
Floor #	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
9	0 0 0 0 0 0 0

	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
8	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
7	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
6	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
5	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
4	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
2	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
	0 0 0 0 0 0 0
1	0 0 0 0 0 0 0
Low Temperature/High Humidity- Alcohol %v/v drops	

Figure 16 Basic configuration of standard rack house

While these warehouses are more efficient in the use of space (due solely to their extensive use of vertical space), they do create a bit more of a spectrum when it comes to maturation conditions. Dunnage warehouses are relatively static affairs with casks existing in roughly the same temperature and humidity levels. Unless the company has implemented some kind of climate control, the rick house will typically have a wide temperature and subsequent humidity gradient. This is regionally dependent of course, but it still happens. Heat rises while cooler air sinks. So, the higher up in the warehouse you go, the hotter the casks tend to be and the lower the humidity level surrounding them. The first floor is generally the coolest and most humid. In Kentucky, the temperature on the lower levels during the summer might be closer to the average outside temperature of around 80-85°F (26.7-29.4°C) whereas the top-most floors at the same time may reach well above 120°F (48.9°C). In fact, there may be upwards of 15°F (9.4°C) difference between individual floors.

From these conditions you can imagine that quite a few maturation scenarios occur. At the topmost levels you will likely have casks that are losing water faster than alcohol from evaporation in the hot and dry micro-climate. These casks will therefore have higher alcoholic strengths at the end of maturation. On the lower levels we have the exact opposite occurring. Alcohol levels are dropping from the cool and humid air. If the warehouse has little to no insulation, then these effects are even more pronounced.

Since there are so many micro-climates that mature the spirits a little bit differently from the other areas in the warehouse, it’s only natural that some distillers form an affinity for certain areas where the casks tend to produce their favorite maturation profile. Booker Noe of Jim Beam and Booker’s Bourbon fame (among many things, the man was a legend), famously liked the “center cut” of the warehouse. This is the area in the center of the vertical warehouse tiers that he felt made the best bourbon character and that’s where he looked for casks for his namesake bourbon. Other distillers prefer casks from the very top of the rick house while others like the slow cool effects on maturation from the bottom of the pile.

All the differences and differentials mean quite a bit of cask variation. If you're maturing a lot of casks, then large blending operations can smooth out those differences more easily to reach your desired profile. If you are a small producer then things are a bit tougher and the risk for batch to batch variation may be high.

A variation on the rick house that I think needs to be included here and briefly discussed is the use of barrel racks. This is a common system in smaller distilleries with only a few casks or in distilleries that use smaller cask formats such as 15 and 30 gallons.

Figure 17 Casks on a metal racking system

Barrel racks are simply metal cradles that hold two casks per unit and allow for relatively easy stacking. They are common in the beer and wine industries.

I have mixed feelings about metal racks. I do use them from time to time, because they look nice and are an aesthetically pleasing way to show off the casks for tour groups. I've spent most of my career using them and have concluded that the only real benefit they have over other cask organization systems besides aesthetics is that they make sampling easier. Of course, for some distilleries that rely on a lot of foot traffic in the form of tours and tastings, aesthetics is nothing to turn your nose up at. And being able to take an easy sample is a real time saver when you're trying to assess multiple cask lots.

The reasons I don't like racks are that they are expensive and not the most efficient use of space. As of this writing you can easily find new racks around $100 each but as you can imagine, that adds up quick. For every 10 barrels you lay down you've now got to shell out $500 for storage equipment. And I'm only talking about the "double bar" racks here. I won't even consider single bar racks because they are lacking in the safety department. Double bar racks have two bracing bars on each side of the rack that allow for you to insert your lift forks through while single bar racks only have one. While you can certainly pick up the racks with the lift forks perpendicular to the casks (basically one fork tong under each cask), you'll be glad that you spent the extra $20 for the two bar set up that allows you to pick up the casks from a different direction. Warehouses are often a tight fit for forklifts and it's nice to have options. Therefore, if you're purchasing racks for your casks, I strongly suggest you get the two barred racks only.

The other issue is that racks are not as efficient with regards to space usage. You can stack racks close together but there are usually practical limits to this depending on the warehouse space in question. Vertically the issue is much more apparent. The racks themselves are usually around 8-14 inches tall. That means for every stack of five racks you're losing around 4-5 feet of potential space. That may not seem like much but for warehouse situations where vertical height

is an issue every inch is precious.

Another issue is that barrel racks force the casks above to exert weight directly on the casks below. The way the racks are positioned on top of the lower barrels usually forces this weight to focus around the barrel head and can occasionally cause leaks to form. In some of my older casks, I've had to remove and/or reorganize entire stacks because the standing weight from the other casks above them was causing leaks to form in the croze of the barrel heading.

My final issue with barrel racks is that they require a fair amount of skill to stack safely. While some people go higher, I have always felt that a stack of five racks is the maximum safe height. And if you aren't stacking the casks perfectly in every rack in a single column there is the risk that the column will lean a bit. This problem is exacerbated by older casks that may have deformed staves that can throw off a perfectly level rack stand atop the cask. A leaning tower of racked casks is a dangerous situation for both employees and visitors.

Palletized Warehouse

The palletized warehouse is the most recent natural evolution of the distiller's incessant search for better space utilization. It is exactly what it sounds like. You put casks on wooden pallets and stack them atop each other.

The palletized warehouse building is designed in similar fashion to the other warehouses we've discussed. All you really need is four walls, a roof, and a concrete slab. The real difference with palletized warehouse systems is just how tightly packed they tend to be.

In the traditional rick house, you have casks laying on ricks that are attached to support beams. This means that the casks will often put some additional strain on the building itself, however indirect. If the building begins to lean, it can potentially lean into support structures which can further unbalance the maturing cask weight. Better engineering and rick house design largely eliminate this concern, but palletized warehouses eliminate the issue completely.

The palletized system allows for much greater space efficiency than the typical rick house. Casks are stood vertically on their heads onto a pallet. Usually this is done with 4, 6, or 9 casks per pallet depending on the pallet size. The casks can

then be efficiently stacked on top each other in organized rows. The stacks will usually go about six pallets high. Some companies have even forgone the use of pallets completely and stack the casks directly on top of each other. Diageo uses this technique to great success in their Montreal, Canada warehouse.

While a lot of larger companies have moved towards the use of palletized warehouse because of the great space saving benefits they offer, these warehouses have not escaped controversy. First, is the lack of airflow surround the casks. To mitigate this, these warehouses usually need more ventilation and fans set up in the walls of the building to properly circulate air and vent out the cask evaporation.

Second, is the concern for leaks in the casks. With the casks standing on end, a fair amount of pressure is applied to the cask bilge which is not the direction that the cask was designed to withstand force. Some distilleries have complained of an increase in cask leakage as a result. Making the situation worse is the fact that now the casks are so tightly packed together, finding and repairing the culprit leak(s) requires more time and effort on the part of the warehouse team. To mitigate these problems, some distilleries and warehouse teams have been experimenting with slight changes to hoop placement on the casks to further strengthen the overall cask support.

Finally, there is concern that vertical stacking of casks will lead to flavor changes in the spirit. In the case of bourbon, the heads of the casks are not charred. If you'll remember some of the cask chemistry, we spoke of earlier in the book this means that the heads have the potential to impart vanilla aromas more so than the charred stave wood. In a vertically stacked cask system, the liquid inside the cask is only in contact with both heads for a brief period before evaporation causes the liquid level to lower away from the top head. The concern is that now, the top head is no longer contributing vanilla character to the spirit (Veach, 2017). The argument against this is that even though the vanilla contribution from the top head is minimal, the spirit remains in constant contact with the bottom head. Contrast this to a situation where the casks are on their sides. The liquid is still evaporating, and the liquid level is lowering itself evenly on both heads. I suspect that the overall extraction from the head wood in both scenarios is similar.

The Solera Method

Solera systems have become a bit of a buzz topic in some circles in recent years. Once solely relegated to the world of fortified wines such as sherry, we've seen the solera system pop up in increasing numbers of distilleries. Unfortunately, there's a lot of misunderstanding about exactly what a solera system entails and how to run one. We'll take a few moments here to work through the details so that you have a good understanding of the subject. You can then decide if such a system is worth implementing in your own maturation program.

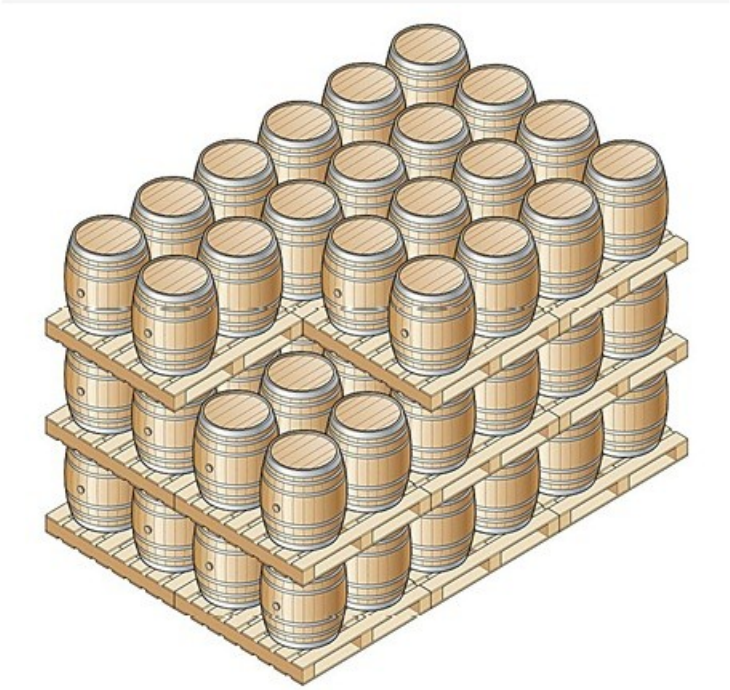


Figure 18 Palletized system for casks (Image courtesy of The Institute of Brewing & Distilling)

The solera system is not so much a warehouse type as it is an organizational system for liquid management. Choose the type of building you'd like to have then choose your cask racking system. You can do a solera system with a dunnage warehouse, a rick house, or a palletized warehouse. This is because a solera system isn't about how the casks are organized but rather how the liquid inside is organized. Let me explain.

Imagine you only produce one barrel of spirit per year. You've been doing this for five years. Every year you stack the newest barrel on top the one from the year before. At the end of five years you decide that you want to bottle some of the five-year-old spirit but not all of it, say only ½ to ¾ of the contents of the cask. You take the liquid out and then bottle it. Now that bottom cask is partially empty with some residual five-year-old liquid in there. What can you do? Well you can drain some of the liquid from the cask above it (the four-year-old stuff) into the five-year-old cask to top it off. Now the four-year-old cask is partially emptied so you decide to top it off with liquid from the three-year-old cask above it. You keep doing this until you get to your year one cask which is then topped off with new make spirit. That is a solera system in a nutshell. We are constantly blending slightly younger spirit with slightly older spirit.

Now why would someone want to do this? It's all about mitigating year to year variation and attaining a level of product consistency. If you think about it, this makes perfect sense for a product like sherry. Sherry is a wine so it can only be made once a year. After that, any more liquid production must wait until the next harvest season. While much of the world's wines opt to have a vintage year dated onto the bottle and embrace year on year variation, some wines such as sherry prefer to be released as non-vintage. The sherry producer carefully cultivates a product identity and wants to ensure consistency between the different years. The solera system is good answer to that.

Distillers of all stripes and types have started to dip their toes into the solera process. For some it's about consistency. For others it's about creative blending

options. And for some it’s more about having some nice sounding buzz words for the marketing copy.

Traditionally each tier of a solera is called a “criadera” with the bottom/oldest tier called the solera. All the tiers combined make up the “solera system”. The criadera may be literally stacked in age order atop one another or they may be in completely different warehouses. How you physically keep up with the casks is up to you. The key is simply being consistent with your blending and technique.

You can retire old casks as you see fit if they are becoming structurally unsound or are not producing the results you want. The casks can be replaced with similar casks or different. Just be wary that a solera system is essentially a balanced liquid ecosystem. If you replace a 20-year-old bourbon cask with a brand-new virgin heavy charred bourbon cask, then your blend is going to change. In large soleras this may not be considered much of an issue as things can be “blended out”, but in smaller systems, little changes like this can have monumental impacts.

The other thing that I must warn you about soleras is the use of age statements. Talk to your regulatory authority before attaching an age statement to a solera product. Since the liquid coming from the solera tier is a mix of liquids of different ages, and we must assume that over time even a small portion of liquid from the very first batch still swims around in there, it can be difficult to assess a product’s age. Some folks try to figure an “average” age of the liquid while many just forgo the age statement all together. In fact, if your facility is in a region or country that requires a minimum age such as in Canada and the UK where whisky must be three years old in order to use the term “whisky” then you shouldn’t consider placing the spirit in a solera until after the minimum age requirement has been met. Otherwise you might be asking for some regulatory headaches when it comes time for labeling and product release.

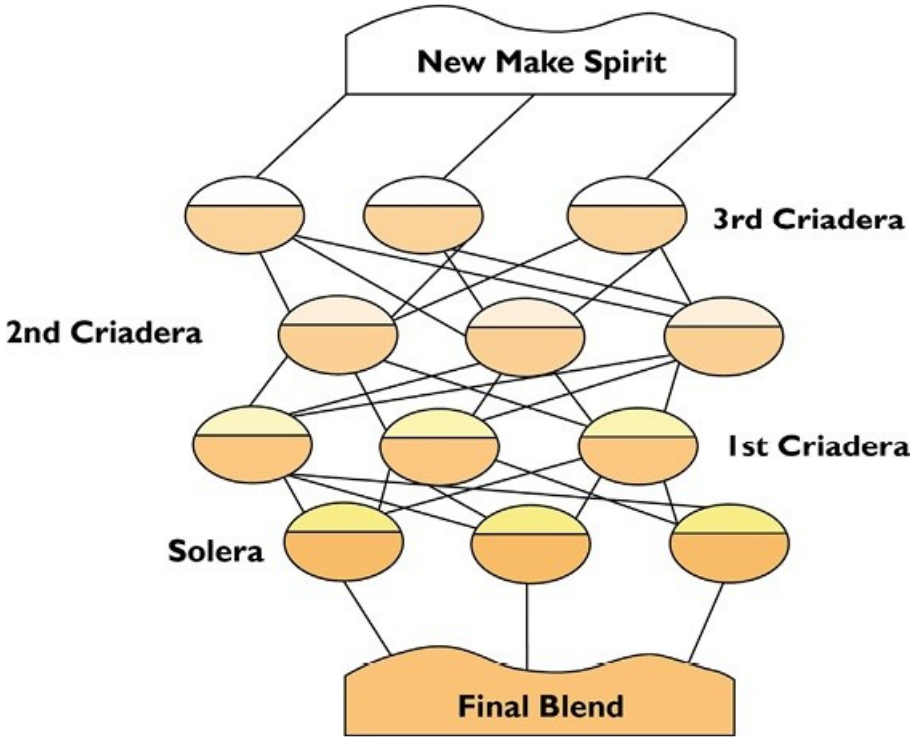
Chapter 5

Maturation Techniques

The idea that there are “techniques” behind spirit maturation might sound absurd to some people. Afterall putting liquid inside a barrel and waiting doesn’t sound like much of a “technique”. That’s ok. I’m here to convince you otherwise. Every decision you make in your distillery, no matter how insignificant, affects the final product and that most definitely includes decisions surrounding the maturation program.

Sure, you can simply place your spirit inside the cask and hope for the best, but why would you entrust so much of your company’s financial future to mere hope? Actively thinking about and creating a viable maturation program for the type of spirit you wish to make is the only way to consistently succeed at your goals. If that’s sounds a bit too self-help guru for you, rest assured I’m coming at this from the point of view of not just a producer but a consumer as well. I WANT you to make the best spirits possible. Not only will it help you succeed in your distillery business, it also puts more quality products on the store shelves. And I am all for having more great spirits to try.

The first section of this chapter will focus on the traditional techniques used in whiskey, rum, brandy, and agave spirits production, making special note of any production or maturation differences where appropriate. In the next section we look at the addition of things such as woodchips and oak extracts. The third section in this chapter looks at the process of cask finishing and all the ways you can use it to further add layers of complexity onto your matured products. Finally, we’ll take a brief look at the myriad of rapid maturation techniques popping up in the spirits world these days.



Maturing Agave Spirits

Let’s start our spirit maturation journey with agave. This is an interesting case because so much of the agave world never sees the inside of a barrel and the liquid that does usually only fleetingly. A lot of agave’s vibrancy as a spirit is exhibited in its immature form. All the same, at some point people realized what a cask could do to elevate the humble agave spirit to a new level. In recent years we’ve seen an increase in high end releases from tequila producers and to a (MUCH) lesser extent mezcal producers that have included cask maturation in their production.

I don’t believe that agave has long held reticence for the cask solely because of its inherent rusticity. As usual with these kinds of things there’s an issue of ingredient supply at hand, and if we consider oak to be an ingredient then most of the agave spirit geography is sorely lacking. Many of the agave spirits produced in Mexico are born in arid regions with high temperatures, so not exactly the best place for most oaks to grow, especially white oak. If you can’t source it locally by being able to cut it down within a few kilometers’ radius, there’s little incentive for the small mezcal or tequila producer to get into cask maturation.

It’s typically the large brands that have forayed into the world of cask matured agave spirits. Most of the casks entering the tequila warehouse are used bourbon casks or used French oak barrels. Virgin wood is just not as common with these spirits.

There are three classes of aged tequila (and loosely by extension, mezcal).

Reposado – Tequila matured for 2-12 months in casks of either French or American oak.

Añejo – Tequila matured in casks no larger than 600 liters for at least 1 year or more.

Extra Añejo – Extra “aged” tequila matured in casks no larger than 600 liters for longer than 3 years.

The average temperature in Jalisco in January is about 17°C while it jumps to 24°C in August. This means that Jalisco is not only a generally warm climate but it’s warm for most of the year. This is a stable maturation climate compared to more northerly climates like Kentucky. As such the casks don’t go through extreme seasonal cycling and extraction generally happens rapidly. Therefore, the comparatively short maturation times listed above should come as little surprise. A lot can change in the agave cask within a few months. If you’ve ever tasted the dark richness of an extra añejo you know that even four years in a used bourbon cask can contribute some intense notes to the spirit. Speeding things up even more is the fact that many agave spirit producers enter the cask at around 55% abv and sometimeslower.

The climate of course affects the evaporative loss as well. In the lowland areas around Jalisco yearly volume losses of 5-10% are not uncommon. In the cooler highland areas this value trends downward. Some distilleries maintain underground bodegas (warehouses) that allow them to purposely keep the casks cool and maintain higher humidity. A few distillers will even go the extra length of installing sprinkler or misting systems to raise humidity. In these cooler situations, evaporative loss can be as low as 2-3% perannum.

Over the course of tequila maturation, you’ll generally see a decrease in higher alcohols, and an increase in acids, esters, and aldehydes. Obviously, the peppery vegetal character of the underlying agave spirit is one of the big attractors for many people when it comes to tequila, so a balance often needs to be struck. The longer the spirit matures, the more that vegetal agave character risks being overcome by maturation character. Some people really enjoy this, but for me personally this is why I prefer reposados to the longer matured categories. A well cared for and blended reposado balances agave character with cask-derived nuance. However, with reposado there is a wide variety of maturation characters on the market largely due to the relatively lax rules regarding its production. Many reposados are matured in standard ex-whiskey casks from Tennessee or Kentucky, but some are placed in large vats of 20,000 liters or more. When the cask gets to this size, the wood influence is comparatively minimal. Depending

on where you sit with the flavor of tequila, that may be a good or a badthing.

Maturing Brandy

Brandy is a bit of a not-so-secret love of mine. It is arguably the most expansive spirit category with so many different fruits being fermented and distilled into an aromatic symphony of flavors. Factor in the different distilling traditions from France, Germany/Austria, and the U.S. (to name but a few) and you have a mind-boggling array of products. Many of these spirits never see the inside of a cask and are instead released as “eau de vie”. However, some of the most important brandy traditions mandate the use of oak at some point in their production. These include the French and American brandies. It’s with these spirits that we will focus our attention anddiscussion.

Cognac, Armagnac, and Calvados all share similar production DNA and philosophies, and this is especially true when it comes to maturation regimes. Some of these concepts may seem a little odd and even obtuse to those that come from more of a whiskey principled background. However, I am of the belief that studying different distillation disciplines will make you a better distiller. Certainly, there are quite a few doctrines and techniques within the brandy traditions that can be applied to other spirits for some truly uniqueresults.

The first thing that must be understood about much of the French spirit maturation tradition is that they approach it as if the spirits were wine. That is to say, the cask is not viewed so much as an ingredient but more as a tool. Hopefully, the difference will become much clearer as we progress through thissection.

Let’s use cognac as our typical brandy spirit. Cognac comes of the still with an average strength of around 70% abv. The spirit is usually placed inside a cask immediately with little to no dilution meaning the entry strength is often the distillation strength. The cask varies by tradition and region, but since we’re discussing cognac here, the most common choice is heavy toast Limousin oak, our wide grained Q. robur buddy that grows in southwestern France. The cask size may be anywhere from 225-350 liters. The cask is often new, but it may also be a once or twice usedcask.

Once the spirit enters the cask it is left to mature for an initial period of 9-12 months. During this period, the goal is to extract desirable compounds into the spirit. After the 12 months is up, the spirit may then be transferred into a neutral cask for the remainder of the maturation period. It's during this period where the primary goal is oxygen ingress and the oxidation of various compounds. Tannins from the initial cask will be heavily hydrolyzed during this period as well (Robin H. G.,2016).

This is an interesting system that allows for a lot of cask reuse. In the U.S. whiskey industry, you are required to use a new barrel every time for most major whiskey styles. In cognac production, you use a new cask only when you needto.

Let meexplain.

As I mentioned before, we take our initial new make brandy spirit and put it into a new heavy toast Limousin oak cask for about one year. When we transfer the liquid out of the cask into a neutral barrel, what do we do with the original cask? After one year it likely still has quite a bit of extractives left in it. So, we store it for next year's use. The following year comes around and we put our next vintage's new make spirit into it. But since it has been used before and the extractive levels have subsequently decreased, we need to let the spirit stay inside the barrel for a longer period of time before being transferred into a neutral cask, say 2 years this time. We can probably eek another extractive period out of it before it too becomes neutral (understanding that the extraction period will be even longer once again). After this third use, we can rotate it into our neutral cask stable. It can all be a bit disorienting, but it isefficient.

This isn't the whole story with brandy, however. Note that we're starting out in the cask at 70% abv which is higher than many distilling traditions. At this level, we're favoring the extraction of more alcohol soluble compounds such as lactones at the expense of less extraction of wood sugars and other compounds. So, what do we do? We dilute the spirit with water to reach a desirable strength. But, in the cognac world this is rarely done all in one fell swoop. The fear is that too much water too quickly may cause a process called saponification tooccur.

Saponification sounds a lot like "soap" doesn't it? That's because saponification is the process in which soap is made. It occurs when fatty acids in the spirit react with a base (in this case water), and they are effectively converted into soap (which is simply a salt of a fatty acid). This causes a bitter soapy taste in the

spirit and should be avoided. The way to inhibit the saponification reaction is to slowly add water over longer stretches of time. The precise method differs depending on the distillery, but many producers will bring the strength of a cask down about 1-2% every six months for a total drop of up to 4 % abv (or maybe even 5%) peryear.

In cognac the casks are usually kept in humid, dunnage type warehouses so the evaporation that takes place usually favors alcohol. This in turn brings the strength of the cask down even farther just a bit everyyear.

Maturing Rum

Rum is perennially underappreciated and under-respected. Because the category has been one of the last to make its leap to premiumization, it can sometimes feel like rum distillers are just doing and using whatever they can with little thought or plan. That line of thinking couldn't be further away from the truth but in the northerly climes of the USA and Canada as well as western Europe, whiskey and brandy have cemented their thrones as the king and queen of sophisticated spiritous imbibing so the bias is most certainly there. I can't count the times I've heard whiskey distillers tell me that rum was "easy" or "simple" when they themselves had never made the stuff fromscratch.

I'm here to tell you in solidarity with all my rum producing brothers and sisters out there that rum is anything but simple. Good rum is an immensely challenging and subsequently satisfying product tomake.

True, most rums remain as unaged and/or white products, but an increasing number of distilleries are using casks to their full purpose and producing all styles of rums at incredibly high quality. There are so many flavors and styles of rum out there that it truly boggles the mind. In fact, I had an assistant once who's night gig was as a high-end mixologist for a local cocktail den, and she told me she was thinking of switching her home bar to only using rum. When I asked her why she told it was because rum has all the flavors she would ever need. There's something truly poetic about that sentiment for the rum-o-phile in usall.

In any case, due to the sheer breadth of rum styles out there, there are quite a few avenues we could go down when it comes to rum cask maturation. First, let's get

something out of the way. Not all clear rum is unaged and not all dark rum is aged. Some “dark” rums may be heavily colored or spiced and have never seen the inside of a cask. Conversely, many clear rums have been cask matured for several years to mellow and smooth out some of the immature spirit’s character prior to being carbon filtered to remove the color and then bottled. It sounds like a lot of work, I know, but some consumers prefer a clear product but won’t necessarily drink an immature tastingrum.

The choice of cask and maturation technique for rum is heavily dependent on rum region and tradition. In many parts of the Caribbean such as Jamaica, Guyana, and Barbados ex-American whiskey and bourbon casks are the go-to vessels of choice. The casks are often first-fill, though this will vary from different distilleries and product ranges and provide the correct level of vanilla and honeyed sweetness to the rums along with a pleasingtexture.

In the United States, many rum distillers of the craft distilling new skool are using virgin heavy charred American oak casks to great effect. This puts a distinctly American touch on the procession and the resulting rums can be big and intense, with loads of vanilla, coconut, and tannin. If you need liquid proof of the power behind these casks, try some of the excellent rums produced by the equally excellent Maggie Campbell at Privateer Rum in Ipswich Mass. Quite a few of her best matured rums have seen new American oak at some point (a meticulous perfectionist, Maggie known to “fit the spirit to the cask” and will implement quite a few used casks into her program as well depending on what she thinks will suit the spiritbest).

However, in the U.S. there are a few rum producers that eschew the use of new casks in favor of used. Alba wood may be tossed aside for robur at some distilleries and even the use of things such as port and cognac casks pops up from time totime.

French rum blenders, Plantation Rum, famously source their rums from all over the world and then bring them back to France to finish their maturation in ex-cognac casks. (Plantation Rum is owned and managed by the same people behind Pierre Ferrand Cognac, so they have a wealth of quality casks at theirdisposal.)

Most rum is matured in hot humid environments such as Caribbean islands and central America. Excellent rum is produced in these climates but that’s not the

only way rum will mature well. The aforementioned Privateer Rum matures their rums in the comparatively cool climate of New England. Even rums that you might suspect are matured in hot warehouses may not be as such. Guatemalan rum producer Ron Zacapa matures their stocks in warehouses located 2300 meters (about 1.4 miles) above sea level which provides a much cooler maturation climate than the humid environsbelow.

Entry strength of the spirit varies quite a bit between producers. Maggie Campbell puts many of her rums into cask at 55% abv but you may see other producers across the globe go into cask as high as 80% abv. There's not a single recommended tradition here and with rum it's best if you approach it with an eye towards what will work best for your spirit rather than following the protocols of another distiller in some far away land. New England has almost as long a history with rum as many Caribbean countries and each can make exquisiterum.

The amount of time that rum matures should be based on your goals and in line with your maturation environment. Many rums are not that old. Jamaica's cult-worship of a rum, Smith and Cross is only in cask for three years. However, Flor de Caña in Nicaragua regularly releases rums at 7-12 years of age. Another bartender favorite is El Dorado's 15-year-old and they also put out an inexpensive but coveted 21-year-old version as well. Where this falls apart a bit is the previously mentioned Ron Zacapa whose most well-known product is the Ron Zacapa 23. The '23' gives the impression that it's 23 years old, but alas it is not. Through much consternation and indignant outrage by the rum obsessives it came to light that Ron Zacapa is aged in a loose variant of a solera system and the 23 is in reference to the oldest criadera. Therefore, the rums in Zacapa 23 actually range from 6-23 years of age on average. The company gets away with this sleight of hand by not putting the '23' next to the words 'years old' and can thus claim innocence for causing any obvious confusion. (Regardless, it's a damn good rum and worth having on yourshelf.)

Maturing Whiskey

Much like rum, it can be a bit difficult to peg whiskey into a single maturation socket. There are just so many producers making the stuff in so many different parts of the world, and these areas all tend to have their own preferred traditions andpractices.

In the United States, it's well known that the bulk of the whiskey produced must enter a virgin charred oak cask at no higher than 62.5%. There are some notable exceptions to this rule such as corn whiskey which allows for the use of used casks, but generally when we talk about bourbon, rye, wheat, or even American malt whiskey, we're talking about American oak with a char 3 or 4 and a starting abv of62.5%.

The maturation time in the United States is all over the place with some producers using small casks sitting on whiskey for a period of only a few weeks while others will go for decades. "Straight" whiskies are required to be at least two years of age and Bottled in Bond versions need a minimum of four years. Time is always going to be a question of product profile and objectives. If your whiskey isn't tasting the way you want it to at two years, then you may need to wait longer. Likewise, diligent sampling is important, because with new American oak casks, it can be very easy to over oak a spirit where the maturation character completely takes over and you can't tell where the whiskey begins or ends on thepalate.

With American whiskey we're talking big and bold flavors and it can be a lot for our senses to assess. For my money, I've always found the sweet spot for bourbon to be around 6-8 years old which is when the sweetness of the cask balances with the sweetness of the corn character. This is also when a lot of the immature character from corn really subsides. Rye whiskey on the other hand seems to be better at 4-6 years of age which is just enough for the barrel character to really take hold without washing away the beautiful spice notes of the rye grain. Wheat whiskey for me hits its peak even earlier. I've tasted some excellent wheats at only one year in the cask and the delicate floral notes of the wheat really sing. On the other side of that however is a well-known wheat whiskey commonly found on the market that sits in cask on average around seven years. While it's an acceptable whiskey, for me it has always come off as a bit long in the tooth with the wheat notes almost completely washed out by the oak. Of course, all of this comes with the caveat that so many other things such as distillation techniques, entry proof, cask size, warehouse type and environment, etc.., all affect the optimal maturationtime.

What about fill strength (proof)? Here again we see quite a bit of variation but most of the whiskey in the U.S. enters the cask at around 62.5%, the legal maximum for most styles. This has a bit to do with preference towards the maturation promoted at this strength, but it also has just as much to do with

simply conserving warehouse space. Higher fill strength means less cask volume needed for maturation (which saves money on casks) and subsequently less required warehouse volume (which saves space/money on thewarehouse).

In recent years there has been a vocal group of American whiskey producers advocating for lower fill strengths. This has a lot to do with the type of extraction that occurs at the lower alcohol levels, but a few distillers are doing it to honor historical accuracy and techniques. Kentucky Peerless experimented with a few different fill strengths before finally settling on 53.5% abv (107 proof). Speaking with one of their distillers several years ago, they said they just liked the way it tasted even going so far as to say that a scant bit lower at 52.5% just didn't fit quite as well. Considering the quality of their products I'm inclined to side with their desire for extreme specificity. That fill strength works perfectly for them and their distillation program. Once filled the casks enter a traditional Kentucky rack house system. (It should be noted that they release their whiskeys at cask strength, so a low entry proof has its benefits for final product palatability and acceptance aswell.)

Todd Leopold of renowned Coloradan distillery Leopold Bros. has been vocal about low fill strengths for many years now. He famously enters quite a few of his whiskies into cask at 100 proof or below. His argument for the historical referencing of this technique is that a lot of pre-Prohibition era distillers would go into cask at these low strengths. The theory is that the whiskey matures "faster" this way. As we've discussed in previous chapters, I'm not wholly convinced that maturation occurs faster but certainly some of the extractions do speed up. Regardless, if done properly as is the case with Todd Leopold's whiskies, you get a wholly unique set of maturation characters that can be a real treat for the curiousconsumer.

But what about other world whiskies? With all the curiosity surrounding the world of single malt whisky it is natural to wonder how someone like The Macallan attains the character in their whisky. With much of the whisky world built on the foundations of Scotch whisky, the maturation programs used by many of the world's great single malt distillers largely vary based on climate and warehouse conditions. The inherent maturation techniques and cask selection remain relatively the same. Indeed, many of these distilleries (especially the well-funded of the bunch) have used Scotch whisky distillers as consultants on their distillery buildouts so it's natural that similaritiesarise.

In Taiwan we have Kavalan who used the late Dr. Jim Swan as their primary consultant. Kavalan has made interesting use of their hot and humid Taiwanese home combined with sourcing excellentcasks.

Australia and New Zealand have steadily been gaining reputations for formidable single malts and make heavy use of the local wine industry for casks. With varied climates throughout New Zealand and Australia, there is a plethora of interesting maturation characters atplay.

Go into the Scandinavian reaches of Sweden and Norway and you'll also find unique single malt production, including Mackmyra just outside of Gävle, Sweden. With northerly climes and an emphasis on using Swedish oak (both Q. robur and Q. petraea) these guys are making some exciting whisky. We could go on and on with Japan's use of Japanese oak, and Germany's use of old beer casks, to French cognac cask matured malts and soon.

The prevailing theme here is a reliance on first fill casks (once used by another distillery for things like bourbon) and allowing the influence of regional climate to have its due. Many distilleries rely on a single cask type for their malts but quite a few make use of a blend of casks such as ex-bourbon and ex-sherry casks blended together. It allows for a greater amount of blending options and product extensions when you can source good wood. But make no mistake: the single malt world lives and dies by the use of ex-bourboncasks.

Fill strength for single malts is typically higher than that of most bourbon. Instead of 62.5%, the initial fill strength is commonly between 63-64% abv. This alcohol level seems to suit maturation in first fill casks but once again this may change depending on the distiller. I personally will fill most of my casks at 63.5% but will tick a few percentage points lower when filling larger sherry butts and port pipes. It may be a small difference, but it does speed up initial cask extraction reactions in these larger casks that have less internal surfacearea.

Alternative Maturation Techniques

In this section we're going to briefly look at some alternative maturation options and techniques. These are in my opinion a bit separate and different from "rapid aging" techniques that will be discussed later. This is not a question of

authenticity or intent. I have my own opinions on such things as I’m sure you do as well. For me, the difference here is simply a level of technology involved. Sure, some of the techniques we’re going to discuss here could easily be lumped into the rapid maturation category because they do speed up certain processes. But that’s not usually the goal with these techniques. Much of the time these techniques are meant to add, amend, or ameliorate the maturation profile of a more traditionally matured spirit, i.e. one that is already maturing or has already matured in a standard cask. In other words, they aren’t meant to wholly replace traditional maturation methods. Let’s look a bit closer at some of these techniques so you can see what Imean.

Stave Additions and Woodchips

Every few months I meet an amateur home distiller that asks me to try their hooch. Sometimes it’s crystal clear white dog and sometimes it’s even good. The problems really arise when Mr. Home Distiller who is only producing one or two liters a month tries to imitate the profile of matured rum, whiskey, brandy, and so on with such little volume. They will typically do this in one of two ways: by using the hilariously tiny one to two-liter casks available from online retailers and the occasional distillery gift shop or by using oak chips, cubes, powders, and other similar products. We’ve discussed some of the issues with small cask sizes earlier in the book. Direct oak additions however come with their ownchallenges.

There is a myriad of these products on the market for both the home wine maker/brewer/distiller and the commercial operators as well. Direct oak addition products include (but are not limited to) things suchas:

Oak cubes and chips (Often available inseveral different species and toastlevels.)

Oakpowders

Oakspirals

Oakstaves

Oak “Honeycombs”(blackswanbarrels.com)

Pellets

The issue with using direct oak additions to immature spirit is that wood surface area to spirit volume is different than that of a standard barrel. This is a bigger problem with irregularly shaped items like chips and powders. Let’s do themath.

For this example, we will work with cubes because the math is relatively simple. Let’s say that a single wood cube is about 3/8” (10 mm) square on each side. That means that we have an exposed surface area of 600 mm2. A 30-gram pack of cubes will contain approximately 30 cubes at roughly one gram per cube. (This all varies a LOT between different manufacturers, but just stick with me.) With 30 cubes at 600 mm2 per cube that means we’ve got 18,000 mm2 of exposed surface area per 30-gram bag. Let’s say you dump that into 20 liters (5 gallons) of spirit. How does that compare with the surface area of a standard 200-liter bourbon cask? The surface area to volume ratio of a standard barrel is generally around 9,000 mm2 per liter (Singleton, 1974). That’s 180,000 mm2 per 20 liters (5 gallons). If you use one 30 g pack of oak cubes for 20 liters of spirit then that means your effective exposed oak surface area is only 900 mm2, a full tenfold decrease. Here we see that oak cubes don’t provide as much surface area for the spirit as we mightlike.

When you go to your local homebrew or winemaking shop and purchase a little one ounce/30 g pouch of oak chips or cubes, the directions often state a usage

rate far lower than the theoretical optimal. (These products are usually meant to go into wine or beer, so the usage rates reflect those intended uses.) Even conservative dosage rates recommend 1-2 ounces (30-60 g) per five gallons (20 liters). If we go by our math above, then we should be using about 10 ounces (300 g) per 20 liters of spirit to match the surface area of a standard cask. But this is a bit like comparing apples to cars…they aren't even in the sameballpark.

First, let's establish what these types of additions do. Oak cubes/chips simply provide a rapid extraction of oak compounds. That's it. Nothing more and nothing less. It's a very narrow view of maturation character in my mind. In fact, these products ignore many other facets of the maturation process, such as deeper penetration into the sub-toast/sub-char layers, immature character removal by the char layer, and much more. The maturation character gained by solely using chips or cubes is fairly one dimensional, which is why the products given to me by the amateur distillers often disappoint. The base spirit may be good, but you just can't mimic proper maturation character on such a smallscale.

I do think there are some handy uses for these wood additions. Let's say you've matured your spirit in a standard 200-liter bourbon cask, virgin oak and heavy char. You might be happy with results, but what if you'd like to do an interesting line extension on that product? There are all kinds of routes you could take, but certainly one of the easiest would be a direct oak addition to the spirit to pick up some additional flavors and extractives. The most famous example of this is Maker's Mark 46, a line extension by the Maker's Mark team on their standard wheated bourbon. All they do with Maker's Mark 46 is take their standard bourbon at cask strength and insert 10 toasted French oak staves (I assume they are using Q. robur) into the cask for nine weeks. Along the way it picks up some of the character of the French oak for a uniquefinish.

This technique has some obvious advantages compared to more traditional cask finishing techniques that we'll discuss in a bit. First, lower expense of not having to purchase an entire cask for finishing. It also allows for some interesting combinations of stave wood such as mixing staves from different wood species, fire treatments or from casks that held different types of liquid. Imagine what would happen if you added a few staves from a new heavy toast French oak cask, an ex-Jamaican rum cask, and a cask that used to hold an imperial stout. That would be no ordinary finish that's for sure. There are a lot of possibilities to behad.

The final thing that I'll say about direct oak additions is that the smaller formats such as chips and cubes can be beneficial in the prototype phase. Yes, I know I just gave a whole explanation about why they don't work that well as the sole source of maturation character, but if you are just curious about how the flavor of a certain type of wood or spirit finish might pair with your new make spirit, chips and cubes can be a useful tool to get a (very) rough approximation of how these parameters will affect things. Companies like Stavin and Black Swan make quite a few different takes on the small oak addition format and they are all worth playing with. If you want to see what the effect of a port wine cask might have on your spirit without spending a large amount of time and capital on a large amount of liquid, you can simply take some chips or cubes and soak them in port wine for a week, then infuse them into a small amount of spirit to see if the flavors will match. You can even take the step of first soaking the cubes in hot water for a few hours to deplete some of their heaviest "new oak" extractives before adding your desired wine/spirit/beer. This should more closely mimic the effects of using some kind of "ex- "cask on yourspirit.

Boisé and Oak Extracts

Another handy and interesting use for oak chips is in the production of boisé. Boisé and the use of oak extracts is an old French brandy technique. It's not something that you see very often outside of the brandy world, but that's precisely why it's worth considering if you are interested in doing something new. The more tools you have in your distiller's toolbox the better off you'll be when you want to create something new or fix a potentialproblem.

Boisé is simply a water extraction of oak extractives that can be used to "touch up" finished spirits. These extracts are not really used so much for color additions, though they can have that effect. Their primary purpose is to provide tannin and structure to a spirit for the sake of product consistency. This is especially important if you're dealing with a cask or casks that have been used several times and their extractives heavily depleted. A boisé will allow you to keep the spirit coming out of those casks consistent with the spirit coming from younger casks. Boisé can also be used to help store casks by keeping them wet on the inside without removing too much of the cask extractives, and in the case of neutral casks, can even help rejuvenate them a little bit (Robin H. G.,2016).

Finally, if you want to get creative with your oak extract you can use a different type of oak extract than the wood in your primary maturation vessel, such as a boisé made using Spanish oak added to spirit matured in American oak. This gives you an added dose of creative flexibility andfreedom.

It is possible to purchase boisé commercially but making it in the distillery is simple. Ideally you use the best quality oak chips you can find, preferably ones that have gone through at least 2-3 years open air seasoning. However, the main thing is that you use chips that you find sensorially pleasing. Don’t use just anything off the homebrew store shelf that’s been collecting dust since the day they opened. There are several reputable suppliers out there (seeappendices).

Figure 20 Oak chips

Recipes for boisé vary from producer to producer but start out with around 1 pound of oak chips per gallon of water (150 grams per liter will work for metric users). You'll want to macerate the chips in hot water for 6-8 hours. The water should be close to but not actually boiling so as to not blow off too much of the volatile oak compounds-200°F (93.3°C) will work just fine. After the maceration period is finished you can strain out the chips from the water. If you'd like you can continue to add chips and perform multiple macerations on the same water to increase the extract concentration but after the second infusion, there's going to likely be diminishing returns. Once you have your oak water extract, allow it to cool to room temperature. Finally, add your chosen spirit in an amount that will boost the alcohol content of the boisé to above 25% abv. This is to help stabilize and protect it during storage. You can choose to use the boisé immediately, but the best extracts and results come from boisé that has been allowed to age. Famed brandy producer Hubert Germain-Robin has been quoted as saying, "A good boisé is thirty, forty years or more. I want one with at least fifteen years so I can use different boisés with different characteristics the same way I use different types of brandy in a blend. (Rowley,2017)"

Dan Farber of Osocalis Distillery in Soquel, California has long been one of my favorite people in the industry. When I called him regarding the use and production of boisé, he kindly offered a few words on the subject. He pointed out that the quality and character of commercial products can be "all over the map" and that experimentation really is your only guide here. When discussing the production of one's own boisé in the distillery he made a few importantpoints.

First, you can extract the oak with water, but you can also do it with spirit and the results for the same oak source will be completely different. Think back to some of the earlier points in the book when we discussed wood chemistry and the effect of fill strength on maturation. Those lessons come into play here. If you extract only with water, the extractives will be much more hydrophilic in nature which would include things such as the wood sugars and color compounds. Conversely, let's say that you extract with 70% abv spirit. In this case you'll be pulling out more oak lactones and similar compounds. Remember

we’re using the same wood but are getting completely different results. You can change other parameters such as extraction time and temperature to affect the final quality of the extract as well. Everyone has their own method and experimentation is key to reach your desiredresults.

Dan also chimed in the importance of age and maturity in the boisé. He points out that many of the larger cognac houses have boisés that are over a century old. He has been making his own boisé for over thirty years and has extracts ranging from over 20-30 years of age. He has never used any of it for his brandies, partly for marketing reasons (see below), but also because he feels they are still tooyoung.

The major drawbacks of using boisé concern legislative/regulatory issues, and marketing/brand perception. First, are you allowed by your local spirit regulatory body such as the TTB or the SWA to add oak extracts to your spirits? Always check before youadd.

The question of marketing and brand perception is considerably more fraught and complicated. It’s not something that I’ll go into any great depth here because I’m not an expert on such matters, but there is the occasional kerfuffle between purists and companies that practice these kinds of additions. Purists get upset when anything deemed as an “additive” is added to their beloved brands. The most vocal of these will scream of your sacrilege from the tallest mountain potentially scaring off would-be consumers who may not have a full grasp of what all the fuss is about. I personally don’t take umbrage with the use of boisé, but neither do I use it in my own distillery. It’s just not a technique that I personally have much interest in but if the occasion or need arose, I would take no issue with implementing it in my own program. This is another question you must answer for yourself and form your own opinion about. Just be wary, before getting into any type of “alternative” maturation technique, there will always be a buzzkill trying to take you down a peg or three. But the truth is the use of these techniques is all about producing the best and most consistent product possible. In the hands of a true craftsman, boisé is just another tool of the trade, used to make something incredible out of humble ingredients. However, in the hands of someone less trained, these techniques can render a spirit that is flat, dull, and at the same time overdone. In other words, it’s not the tool that makes the spirit good or bad, it’s the distiller and how they use thosetools.

ABV Alterations

Related to the use of boisé in that this is a characteristically French technique is the steady alteration of cask abv. For most distillers, any alteration of alcohol concentration in the spirit occurs via evaporative losses or through the direct addition of water after the cask has been dumped for blending and bottling. However, it is possible to dilute in the cask as well. This has a fewbenefits.

First, by starting out at a higher alcohol level and then slowly diluting with water over the course of maturation you can affect the speed of extraction of certain cask components and change the reaction chemistry over time. Secondly, by diluting inside the cask, you are steadily bringing the spirit closer to the eventual bottle strength at a slow pace. Quick dilution of matured spirits runs the risk of shocking the spirit and causing some ugly saponification reactions to occur in thespirit.

Believe me, the risk of a bitter “soapy” taste from rapid post-cask reduction is very real. I remember judging whiskey for a national competition a few years ago. On the same panel with me were a few of my friends including Mr. Dan Farber. The number of whiskeys brought to our panel that had clearly been crash diluted and subsequently saponified was shocking. It’s a flavor can be difficult to describe outside the term “soapy” but once you’ve been trained to spot it, you’ll pick it out of the lineup every time. And it can make or break a spirit, turning something that would otherwise be excellent to merelyOK.

So, how do you add a slow dilution scheme to your maturation program? I’m not gonna lie. It takes some work and occasionally more casks. The extra effort in my opinion is worth it in some situations, but many folks understandably don’t want the hassle. Let’s say you’re going into the cask with a fill strength of 70% abv as is common in many rums and brandies. You’ve got your spirit in the cask and perhaps you let it sit at 70% for a year. Depending on your climate, at the end of the year, the alcohol concentration has either gone up or down (unlikely that it would stay the same) and you’ve probably lost some volume inside thecask.

After that first year, let’s say that you begin to decrease the alcohol concentration by 1-2% every three months. If you’re working in a cellar where the abv inside the cask is dropping, then this is typically easy to do. In a humid climate you might see a 0.5%-0.75% abv drop per year, add in a 1-2% decrease every few

months and you'll be taking that 70% abv spirit down to 60-65% abv by the end of year two. Keep going like this and you'll find that you've inched closer to bottle strength within a fewyears.

Things get a bit more complicated when your casks are sitting in a dry warehouse with increasing abv's over the maturation period. In this scenario, a seasonal dilution in the cask essentially fights off the effects of abv increases over time. Perhaps you want those abv increases, but if you don't then a steady dilution program might be the way togo.

In order to make this kind of thing work, you have to know the weight of the cask, the fill strength of the spirit, and the fill weight of the spirit so that you can properly calculate evaporative losses and dilution additions. It's a lot more work for sure. Once again though, this is just another technique for your maturationtoolbox.

One final point of consideration when thinking about this type of gradual dilution program is what you use for dilution. If you live in a wet area away from polluted cityscapes, then rainwater is a great way to go. (I strongly suggest testing the water first!) Otherwise, use reverse osmosis or distilled water with a dissolved solids content of less than 5ppm.

The other option is to use already diluted spirit for further dilution. This is far more interesting for flavor conservation, though it does require more tanks, casks, and spare spirit stock. What you can do is take a batch of well matured spirit and dilute it to 20% abv and store it inside a neutral cask. This can then be used to gently dilute your maturing casks over time. This is a challenging way to go, but because you are diluting with spirit and less water, then you can keep the flavors of your casks from diluting too much. Food forthought.

Pressure Cycling and Sonic Maturation

Here are two techniques that occasionally make the news in trade publications. The first is pressure cycling which is essentially what it sounds like: you are changing the pressure inside the cask. The most famous example of this is from Seven Fathoms Rum where they submerge their casks of the coast of the Cayman Islands (it's a secret location for obvious reasons) at a depth of seven fathoms (42 ft/12.8 m). This puts roughly 33.3 pounds per square inch (2.29 bar)

of pressure on thecask.

When they were messing around with the original idea of submerging the casks in the ocean for maturation (apparently there are some serious scuba divers on the team), they tested their theory by filling some casks with water colored with green food coloring. The casks were submerged and exposed to higher pressure cycles due to pressures changing with high and low tides. After a few months they pulled them back up and looked at the stave wood. The green food coloring had penetrated much deeper into the staves than casks that were at sea level. This led them to the idea of maturing the casks in an increased pressure system. Interesting, yes. Practical for most distillers…probablynot.

A much more common alternative maturation technique is the idea of "sonic aging". You may have come across a story or two about the occasional distillery blasting music through massive speakers strategically placed throughout their warehouse. Of the distillers who practice this technique, some will even humorously explain that their casks "prefer" certain types of music. A few years back when I was visiting Copper and Kings in Louisville, their distiller told me that the casks seemed to like Zeppelin the best. Not sure if cask preferences ever change but I'll admit IV is a killerrecord.

Of course, this all begs the question as to why you would blare music at your maturing casks. The idea is simple. It's all about using energy in the form of sound waves to agitate the contents of the cask and increase extractionrate.

The science is a bit dubious on this to be honest and I'm not sure if anyone could ever completely convince me of the technique's efficacy. Most of the time I hear about distillers using rock music to cause the vibrations. Metallica even built a whiskey brand with the help of the late great Dave Pickerell called "Blackened Whiskey" which was matured in ex-brandy casks while exclusively blaring Metallica in thewarehouse.

This isn't exactly a new idea. After American prohibition there was a renewed interest among distillers in speeding up the maturation process so that they could hit the shelves faster. In 1937, L.A. Chambers filed a U.S. patent for the fast maturation of spirits using a "compressional wave oscillator" placed inside the barrel. The oscillator would create pulses and vibrations that would increase liquid contact and extraction of oak components (U.S.A. Patent No. US2088585A,1937).

It’s an interesting technique on paper and perhaps there is some merit to it. It’s most vocal practitioners often preach from the mountain top about the merits of “sonic maturation” going so far as to mention the effects of different types of music. Reggae has a different effect on the cask than rock vs classical vs rap vs bluegrass and so on. And while I’m not wholly convinced that it works, I can’t say for certain that it doesn’t which is about as agnostic of an argument I can offer in the world ofdistilling.

Closely related to the practice of sonic maturation is the placing of casks on ships and sailing them around the world’s oceans. The most famous example of this Jefferson’s Ocean Bourbon. Barrels of Jefferson’s Bourbon are loaded onto a ship and allowed to sail the high seas for 3.5-4 years. The company believes the resulting bourbon to be more heavily extracted and has subtle brine character from the oceanair.

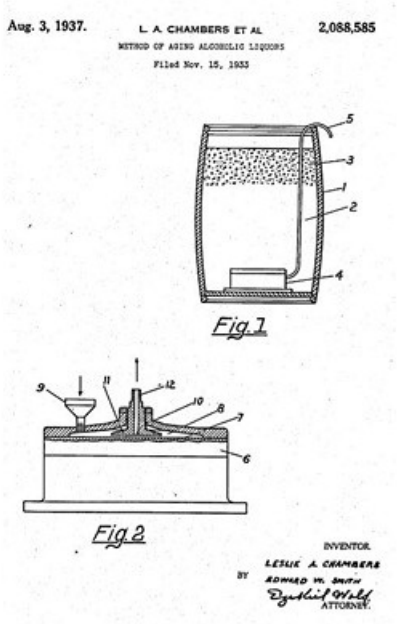

Aug. 3, 1937. L. A. CHAMBERS ET AL 2,068,585
METHOD OF AGING ALCOHOLIC LIQUORS
Filed Nov. 15, 1933
Fig. 1
Fig. 2
INVENTOR.
LESLIE A. CHAMBERS
EDWARD W. SMITH
BY
ATTORNEY.

Figure 21 Chambers' patent design for aging liquors

Many aquavits also see time inside a cask. Linie is one of the more well-known brands from Norway and also puts their casks out to sea. The name “Linie” is a loose reference to the equator, which by company rules means the casks must cross the equator aboard a ship at least two times. The typical time at sea for Linie casks is about fourmonths.

My only comment on this is that there are quite a few competing factors at work in this scenario including wild temperature variations from sailing near the equator multiple times to possible ventilation issues depending on exactly where the casks were kept on the ship. It’s a fascinating idea, but not one that most distilleries would have the capability to undertake on a regularbasis.

Finishing

Getting back to more traditional techniques, we should briefly discuss the process of cask finishing. This is something that has been very much in vogue in recent years (mid to late 2010’s). I suspect this has a lot to do with market saturation and the ability to gain valuable market attention share with relatively minimal effort or cost. Of course, that’s the cynical way to think about it. It could just as well be that finishing allows for some creative flavor additions to many spirits. Whiskey is probably the biggest practitioner of the technique but increasingly we’re see more brandy, rum, and tequila products entering the market with unique caskfinishes.

The process is simple. Take a fully matured spirit from its primary maturation vessel and then put it in a different vessel with a different profile. So, if you’re starting out with a six year old bourbon matured in brand new char 3, 53 gallon casks, you can then take the decanted bourbon and place it inside an ex-oloroso sherry cask to pick up some unique dried fruit notes, or perhaps an ex-Jamaican rum cask for some tropical notes. You could even put it into another brand new American oak cask for a “double oaked” effect. Woodford Reserve does this with their Double Oaked Bourbon. The bourbon is matured standard heavy char

bourbon casks for several years before getting racked into new light charred cask for a second extractionperiod.

The goal of finishing should be to add complimentary or otherwise interesting notes to the spirit. The finishing period depends on the finishing cask and how it has been treated, but usually lasts anywhere from 6-24 months. Sometimes you can finish a spirit in less time than this but far too often the examples I taste at 2-3 months of finishing are somewhat lacking on flavor delivery. It all depends though, and you need to be diligent in yoursampling.

Ideally the spirit being finished is at its optimal maturation point before entering the finishing cask. You don't want to take a young tasting distillate low on extractives and maturation character from its primary maturation vessel too early so that it can "finish" in a different cask. In many scenarios this simply results in an immature tasting "finished"spirit.

Finishing is more art than science however, and it takes experience to know when a certain spirit will be ready and work well with a certain cask. You're setting your loved and nurtured spirit up for a bit of romance with a new cask and playing matchmaker is never as easy as you think it's going tobe.

Rapid "aging" Techniques

Look at the title of this section. You likely fall into one of two camps: the one where you just rolled your eyes at the mere mention of rapid aging or the one where you have a genuine interest in what these procedures offer. If you've been reading this book in chapter order up to this point, then you can probably guess which side of the fence that I sit on. I'm not much of a fan for rapid "aging" which sounds like an oxymoron tome.

Many of the techniques we're going to discuss in this section have been making headlines in newsprint big and small. The claim is always the same. "Distiller in X-City produces 20-year-old tasting whiskey in three weeks! Experts can't tell the difference!" I've tasted quite few examples of the different techniques out there and have never been convinced that this is the future of spirits production. And that is coming purely from a taste standpoint. I'll admit to tasting one or two drams from rapid age producers and being impressed with them. Some were

even downright good. But none have been excellent, and none have proven to me that these techniques can produce a spirit that competes with the quality and caliber of a traditionally maturedspirit.

Here's the thing: despite what their practitioners often claim, very little about any of these techniques is truly new. Large scale distillers have been trying to find a way to hack the maturation code since the 1800's. The goal of these experiments has always been about getting a similar maturation profile to a traditionally matured spirit. Afterall, isn't flavor the most important thing at the end of the day? Forget about the marketing and the brand values and all the other philosophical bloat that goes along with producing spirits in the modern economy. All the average consumer wants is something delicious to drink. If you can do that in a fraction of the time than it takes to do it with traditional methods, why wouldn't you investigate rapidaging?

In 1885 Joseph Fleischman released a small book called The Art of Blending and Compounding Liquors and Wines wherein he describes methods to essentially make imitation whiskey and other spirits with what essentially passed for neutral spirit in the day. One "whiskey" recipe looked something likethis:

Spirits…45gallons

Prune Juice…0.5gallon

New England Rum…0.5gallon

Coloring…4ounces

Beading Oil…1gallon

The goal was to replicate the appearance, aroma, and flavor of real whiskey while using ingredients that were considerably less expensive than liquor matured (and suffering from expensive evaporative losses) in wood. The coloring was usually just spirit caramel, theoretically not too far removed from the stuff that gets used by many distilleries today. The beading oil, however, wouldn't pass muster with today's consumers or regulatory agencies. The recipe

for beading oilwas:

Oil of Sweet Almonds…48oz

Sulfuric Acid…12oz

“When cool, neutralize with ammonia and then dilute with double the volume of proof spirits. The sulfuric acid must be chemically pure.” (Fleischman,1885)

Just what is “beading oil” you ask? It is designed to put an artificial “bead” on spirits. Beading was a way (and in some rural distilleries throughout the world still is) for distillers and customers to check the alcoholic strength of a spirit. With hydrometers a rarity and many unscrupulous retailers, this was a way to hopefully fool the whiskey purchaser into thinking the spirit was stronger than it actuallywas.

As prohibition dawned, bootlegging recipes like this and the procedures that went along with them became increasingly more common. You might add creosote for instance to simulate a smokey Scotch whisky. These kinds of shenanigans are fortunately quite rare in our modern era (though still more common than youthink).

After American prohibition, the spirits industry was put under a lot more scrutiny. But now the industry was behind the consumer curve. Distillers hadn’t been able to legally produce their wares for well over a decade and their stocks were severely depleted. In this situation, many companies turned to science to see if the maturation process could beaccelerated.

A quick perusal of the related patents issued by the U.S. Patent Office between 1933-1940 gives an interesting snapshot of the thought processes of the day. Many inventions and techniques involved keeping the spirit inside the cask but somehow adding agitation and/or heat. Typically the spirit would be heated to 110-135°F (43-57°C) and then agitated with some kind of motor or internal baffle plates, increasing the extraction rate and exposing more wood surface area to liquid (figure 22, United States Patent No. 2017235, 1935) (Figure 23, United States Patent No. 1990266, 1935) (Figure 24, United States Patent No.

2180685,1939).

There were a few attempts to be a bit more elegant in concept and design. One of the more interesting patents of the era was from Clarence Reiman who appeared to do quite a bit of “out of the barrel” thinking. His patent proposal, officially patented in 1938, eschews the concept of the cask almost completely and instead homes in on the important maturation reactions that were understood to happen. This included extraction of wood components, removal of immature character, and an emphasis on esterification reactions. His process actually covers a series of proposed techniques, but essentially boils down to using small amounts of broken up cask char for extraction and chemical adsorption, the addition of hydrogen peroxide for oxidation, and bringing the distillate close to its boiling point in an enclosed container so that esterification reactions were accelerated (United States Patent No. 2132435,1938).

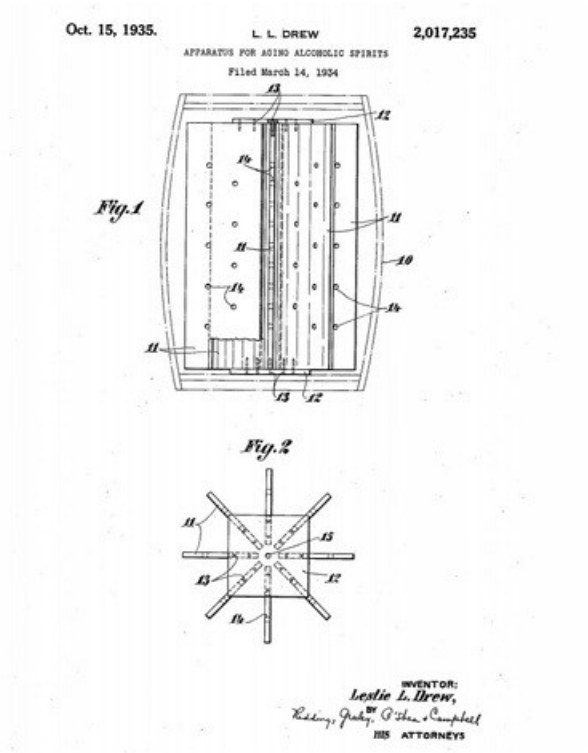


Figure 22 L. L. Drew's patent design for rapid aging

(United States Patent No. 2017235, 1935)

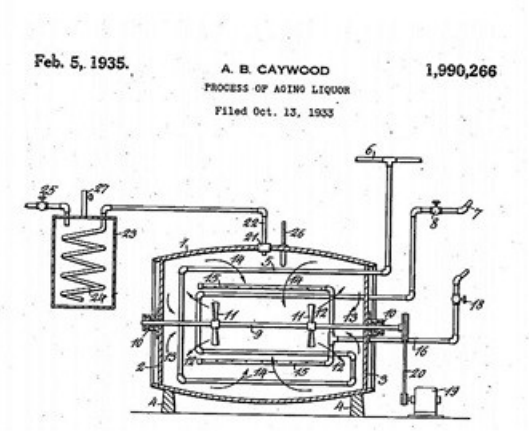


Figure 23 A. B. Caywood's patent design for rapid aging

(United States Patent No. 1990266, 1935)

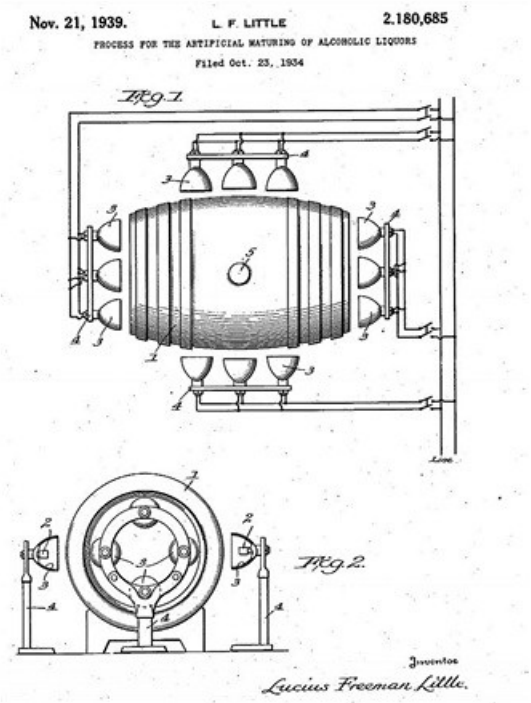


Figure 24 L. F. Little's patent design for rapid aging

(United States Patent No. 2180685, 1939)

It's with Mr. Reiman's thinking that we come to the present day. I've had quite a few companies and salespeople try to recruit me and my spirits to their rapid aging efforts. I've never taken the bait. Many years ago I had a perfectly pleasant gentleman come in the door of my distillery and after the initial small talk and niceties, he began to give me the hard sell on this "new" technology that could "age" a spirit in just a few weeks. For proprietary reasons he couldn't give me much in the way of a description as to how the process worked but it involved accelerating, you guessed it…esterification reactions. The scientist in me was categorically curious and fortunately he brought me an example of his work so that I could compare it to a traditionally matured product. I brought to the table a five-year-old bourbon and compared it to his "whiskey". The two spirits weren't even close to each other despite his salesman-like protestations to the contrary. I was polite, but I told him in no uncertain terms that I would never want to put my spirit through his process. Sure, he had managed to get some oak "flavor" in there, and the distillate somewhat "smooth" in character, but beyond that it was rather dull, flat, and dare I say it…artificial tasting. It had this nebulous character to it that I couldn't (and still can't) quite describe, but it just didn't taste right. It wasn't even a question of quality because it was so innocuous that you could almost say that it was quality-less. Not bad nor good. Just bland, like if beige were somehow both the spirit and my feelings about it. Uninteresting to afault.

The concept of accelerated esterification reactions in the spirit is where quite a bit of the rapid aging technology has pushed itself. Bryan Davis of Lost Spirits in Los Angeles, California has famously come up with his own take on this fast esterification concept. In his version, the spirit is similarly exposed to charred or toasted oak wood and simply heated to 140-170°F (60-76.7°C) for a period ranging from 12-336 hours. The high heat rapidly extracts acids from the barrels and speeds up the esterification process. Progress can be monitored by choosing a reference compound which according to Davis' patent is often ethyl decanoate which is an ester with a waxy/apple/brandy amalgam-like aroma and is commonly found in matured spirits. In this case, the esterification process is allowed to continue until ethyl decanoate reaches a level of 1.5-1.7 times its

starting concentration in the spirit (United States Patent No. US2014/048421,2015).

Here's the thing with Bryan's invention that I find particularly fascinating. It kind of works. I've tried several Lost Spirits products over the years, and I have to say that with the accelerated maturation project, Bryan has come closer than anyone else to matching a traditionally matured profile. Read that sentence closely and you note that I didn't say it was a perfect match. While the example I tried was indeed very good and a delicious spirit on its own, there was still just a soupcon of something off. Again, it's hard to pinpoint exactly what it was, and perhaps if I had tasted this product completely blind, I might have been totally fooled into thinking that it was a 10-year-old spirit. Still, my experience left me impressed but far fromsold.

The other bit of rapid maturation technology that sometimes gets touted about these days come by way of Cleveland Whiskey. (Disclaimer: I have yet to try one of their products, so I have little in the way of judgement to pass on the actual quality of their whiskey.) Cleveland Whiskey takes a different tack than Lost Spirits esterification acceleration. Tom Lix, the founder and CEO of Cleveland Whiskey, allows his base bourbon to mature in a cask for around 6 months or so. The whiskey is then transferred to a separate vessel while the barrel is then cut up and added to the vessel with the liquid. Pressure is then applied in cycles from -2 atm to 10 atm for about 24 hours (United States Patent No. US2013/0149423,2013).

As you can imagine, this technique produces a different profile than the esterification route. Reportedly, the taste is a bit over-oaked and tannic (Sampson, 2015). However, others really seem to enjoy it. Supposedly during the distillery tour, Cleveland Whiskey is blind sampled alongside Knob Creek and between 60-70% of folks prefer the CW (Knapp, 2013). As per my previous disclaimer, I have no experience with these products of my own, so I won't comment eitherway.

This technology does seem to allow for some interesting experiments. Cleveland Whiskey has several products where they use this system to add flavors of unique woods such as hickory, black cherry, and honeylocust.

The final technology we'll talk about in the realm of rapid aging is a process pushed by the company Terressentia, a bulk spirits supplier and private label

bottler out of South Carolina. Their process involves ultra sonication of the spirit in the presence of wood. This is essentially a super charged version of blasting 2 Live Crew at your casks for three years straight. However, their version claims to reach optimal results within a few days. The process involves sonicating the spirit in the presence of wood using frequencies ranging from 20,000 Hz to 170,000 Hz and power of 3-5 watts per liter of spirit (United States Patent No. 7063867B2, 2006). The temperature of the liquid will raise somewhat due to all the energy being thrown at it and therefore the reactions will speed up even more. It's an interesting process and one that is getting carried out on a large scale at the O.Z. Tyler Distillery in Kentucky as at least some of their whiskey is using this process (McLafferty, 2016). (O.Z. Tyler is owned byTerressentia.)

There are quite a few other technologies out there being promoted as circumventing Father Time and Mother Nature when it comes to spirit maturation. Some work better than others. The big issue I have with most of these is that they tend to focus on one or two aspects or reactions in the maturation process. To date there have been hundreds of sensorially active compounds discovered in matured spirits and while the bulk of maturation character comes from a small subset of these, the other minor players still have a large cumulative effect. In other words, I can add oak flavoring to a spirit and get quite a bit of mature character for my buck, but I would be ignoring countless other reactions and the resultant compounds in the process that make up true maturationcharacter.

However, I'm a pragmatist and a realist. I recognize that the technology, understanding, and ideas surrounding rapid maturation techniques are getting more sophisticated all the time. Who knows? In a few short years perhaps, someone will finally crack the maturation code and change the way we look at traditional cask maturation techniques forever. All I know is that for now, we ain't there yet. So, I'll continue using my primitive wooden barrels thankyou.

Chapter 6

Sampling and Blending

This chapter is going to be a bit odd at times. It certainly feels strange writing it. The reason is that with rare exception I don't think there is much in the way of rules on blending. Every blender does things his or her own way and so much of it is based on gut intuition and humanness. I can only tell you how I do things and give you advice. But I encourage you to talk to other blenders. See what they have to say and how they approach things. You'll be amazed at the variety of techniques and philosophies in play and how so many of them produce great products despite their differences.

I've always felt that the concept of blending has been poorly understood, particularly in the United States. Maybe it's in our American blood that things should be solitary and singular, as if these qualities confer extra "purity" to a product's essence. Even our wine is often single varietal to showcase the "true" character of the grapes.

There is the issue of the merchant bottlers who are unfairly maligned by much of the distilling elite. If you didn't mash it, ferment it, and distill it, then you didn't truly make it. That's a bit ridiculous if you ask me. Sure, there are the companies that are quite literally emptying a cask, bottling it, and slapping their name next to the phrase "produced by" while obscuring the spirit's true provenance as much as is legally allowed. I admit that I have little patience for that kind of practice. But there are just as many if not more companies out there purchasing interesting casks from all over the world and blending them together into some of the most exciting spirits sitting on the shelves.

Then we get to impressionistic feelings on the product term 'blend'. A blend is too often considered inferior to its un-blended counterparts such as single malts and grain whiskies versus blended whiskies like Johnnie Walker.

I'm here to fight for the blend. Johnnie Walker Black purportedly contains 30-40

different whiskies. Blending that many spirits together and getting a consistent product out of the deal is a challenging feat worthy of respect, whether you enjoy the product or not.

The act and art of blending encompasses more spirit traditions than people realize. The large cognac houses work primarily in blends. Many rum brands are composed of different rums to produce their unique flavors. Even single malt Scotch whisky, that most hallowed ground of whisky making is often a blend. Wait. What?

That's right. A lot of single malts are actually blends just not in the way that many folks think of when they hear the word blend. Many single malts are blends of whiskies from different cask types such as a blend of ex-bourbon and ex-sherry. I would go so far as to argue that unless you are releasing only single cask spirits, then any time you mix two or more casks together that you are blending, even if they are the same cask type.

Spirits and casks are organic in their nature and rarely behave in predictable patterns over long periods of time. In other words, you could have an entire room full of single malt whisky of the same age, all in the same cask type, all kept at the same temperature and humidity and for whatever reason, more than a few of those casks will taste different from each other. Maybe not wildly different but different nonetheless and that means you've got to combine your casks in a way that makes a consistent product from batch to batch.

Sampling

A successful blend is made up of good casks. Contrary to popular belief, there are not that many situations where you can accept a bad cask of spirits and simply "blend it out". Of course, to keep from having a bad barrel of spirits in the first place, we need to keep track of how each barrel is maturing, taking notes, and being proactive.

How often you sample is something that you really need to think long and hard about. If you are using smaller casks and only maturing your spirits for a few months, then your sampling program is going to look a lot different than someone who is maturing their spirits for decades. I will offer some advice here,

but it is up to you to decide what system and frequency works best for you.

For my program which is based on whiskies meant to mature for between 5-20+ years, I sample more in the early maturation period, periodically during the middle phase and then more frequently again as the maturation period nears its completion. For example, if I'm maturing a whisky for what I believe will be released at around 5 years then I will sample the cask about every 3 months in the first year then I'll back that down to every 6 months for the next few years. About 6 months out from its 5-year birthday, I will probably sample every month or two, in order to ensure everything is ready for primetime.

It can be tempting to sample more often than that, but I urge you not to. Sampling every month in a standard size cask won't tell you much about how things are going after the first year and besides, every sample you take is just that much less spirit you could eventually have to sell.

The key thing is to be consistent, and most importantly, keep notes. Every time you sample a cask you should take notes on the color, the mouthfeel, flavor and aroma. And how you assess each sample is just as important as the notes that you take.

How to Sample

Samples should be assessed in a quiet room with abundant natural light. Try to do your sampling during the mid-morning hours in between breakfast and lunch. Your palate will be better suited for tasting if you are farther removed from eating breakfast and beginning to get hungry for lunch. But you do not want to be too hungry. If you are starving, you will not register the sensory experience very well and besides, you may become intoxicated more easily which will dull your senses even more.

Avoid heavy aromas and flavors for at least the morning prior to sampling, but preferably for twenty-four hours before. Tasting is serious business if you are going to do it right. That means no spicy food, smoked foods, and so on. Avoid tobacco in all forms prior to sampling. Even coffee, yes coffee, will adversely affect your sampling ability. Avoid it if you can. Save your cup of joe until afterwards.

The room should have as little visual, audible, or aromatic distraction as well. I know we have all seen pictures of distillers sampling a glass of their wares straight from the barrel in their warehouse. It looks romantic but honestly your warehouse is one of the WORST places to effectively sample. The lighting is usually terrible, and while the smell of maturing oak casks is something I wish they would make into a candle, it is definitely an aroma that will throw off your tasting notes. Save the warehouse sampling for the PR photos. Do your sampling elsewhere.

Make sure you have showered so that you do not smell of body odor. Avoid heavily scented soaps, shampoos, and deodorants. These will all throw you nose off track.

Put out some unsalted crackers and spring water as well as a receptacle for spitting and dumping. Make sure all glassware has been properly washed without heavily scented detergents or soaps.

Glassware should be simple. The ideal sampling glasses are small wine sampling glasses or the Glencairn whisky glasses. They both have their pros and cons. The wine glass has a nice stem to keep your hands from warming the contents of the glass, but the inward taper of the upper portion of the glass can overly concentrate alcohol aromas if you are sampling at cask strength. The Glencairn avoids the taper but has a design that causes some people to overly handle the glass and warm the liquid inside with the heat from their hands. These are honestly minor points, and either are perfectly suited to the task at hand. Just pick one and stick with it. The key is to not mix and match. Use the exact same glass type for all your samples.

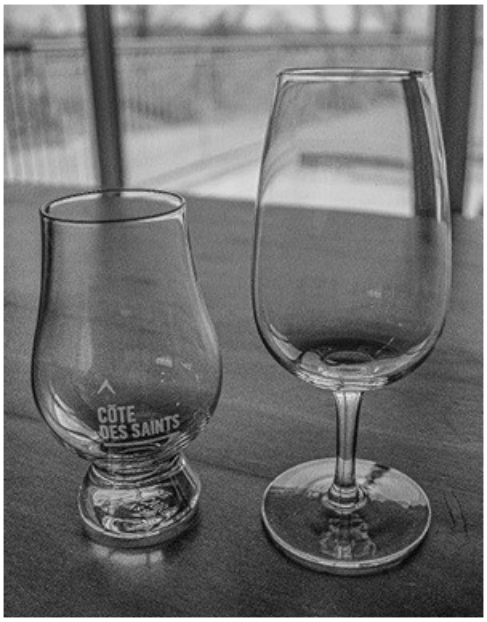


Figure 25 (left) Glencairn glass (right) 7.25 oz wine sampling glass

I personally keep both around but tend to favor the wine glasses for serious sampling. I use 7.25 oz ISO standard wine tasting glasses.

Next, you need to assemble your samples. Make sure your samples are all around the same temperature. I suggest 15-20°C (59-68°F). You only need a small amount per sample. I advise pulling a total of 100 ml per cask even though you are only going to sample about 20-30 ml at a time.

The reason I suggest so much is that I believe samples should be assessed in stages at different strengths. Starting with 100 ml of liquid gives you plenty of liquid to make any necessary dilutions more easily. Much of the industry suggests diluting all samples down to 20% abv and performing sensory analysis at this level. There is a lot of science to back that up. At such a low alcohol concentration, a lot of the volatile aroma compounds are released into the headspace of the glass and are more easily assessed. You also have less ethanolic burn to deal with which in turn helps to suss out more the spirit's character.

Other people argue that a spirit should be judged at close to bottle strength because that is how many people will initially experience it. Still, others swear by only sampling at cask strength.

I think you should taste cask strength and a diluted strength such as 50% abv. Preferably you taste a 20% abv dilution as well though I will admit that for my own program, I tend to not get as much information out of the 20% as I do the other two sample strengths. Everyone is different in this regard and you should find the sampling regimen that works best for you. The main thing is be consistent.

First, sample the spirit at cask strength. This will give you an initial impression of the major cask effects and how the profile is developing. I do not suggest swallowing to assess the finish on this one. Even though you are only going to sample about 20 ml of liquid per sample, at cask strength the alcohol quickly adds up and before you know it, you're drunk, and the results of the sensory analysis become meaningless. Instead, just spit out the sample, eat a cracker and

rinse with some spring water to refresh your palate.

Next, you can calculate and add a little bit of filtered water to your sample to bring the abv down to near bottle strength. Go through the same exercise as before. Sniff, swirl, smell again, and sample as you are normally accustomed to, just be consistent with your technique each time. I do not suggest swallowing this sample either unless you are only assessing a few. Usually after you spit out the sample there is just enough liquid residue left on your palate to give you a decent impression of the finish, so do not stress.

Finally, if you would like to go a bit farther, dilute the remaining bit of your sample down to 20% abv and sample again. Take notes at each turn. There is a lot to assess.

Make sure that you really coat your palate with the spirit and roll it around in the mouth. Understand its texture and mouthfeel. Try to suck in just a little air through your mouth over the sample and then exhale through your nose. This gives you some of the retro nasal aromas. Between every sample or two, try to reset your nose's ability to smell. This is done by quickly sniffing something relatively mild or neutral. A trick that many wine tasters use is to sniff the inside of their elbow which is supposedly one of the most "neutral" smelling parts of the body. I have been using this technique for years and can vouch for its effectiveness.

How is the spirit evolving in the cask? Are there immature notes that are still sticking out? Is the cask contributing the right amount of color, tannin, and extractives? Is the mouthfeel heading in the right direction? There is a lot you can ask and observe here. Just be thoughtful. No detail is too slight.

Jot all your thoughts down about the cask sample and date it. Keep these records in a file that you make for each cask. That way you can go back through the life of the cask to see how the spirit evolves through maturation. This also will help give you a better picture for where the cask contents will end up. Maybe a cask is showing a lot of complexity at a young age and would be a good candidate for a single cask release. Or perhaps it is feeling light and fruity and might make a good anchor as the base of a larger blend. Or maybe it is headed in a bad direction and you will need to assess it again in a few months to see if it improves or if you should try to somehow correct it. There are a lot of decisions that need to be made in any successful cask program and the only way to take

the best course of action consistently is to have a lot of data points at your disposal.

Obviously, the system I advocate here is much easier to implement if you have a small number of casks. In larger programs it simply is not realistic for a lot of distillers to sample every single cask. In my own program, I reserve Fridays as a sampling day. I have my assistant pull 10-20 samples and we take a few hours near the end of the day to assess everything. It is a nice cozy system and one that works well for our boutique malt whisky distillery. I also realize that as our program continues to grow, I will have to be more selective about which casks I sample and how often.

Larger operations get around this issue by having dedicated blending and sampling teams. That is much of their job; simply sampling casks. On paper it sounds like a dream job, but I can assure you that it is one of the more difficult gigs in the spirits industry. There is always a lot to sample and palate fatigue can quickly become a real problem, especially if your company is relying on you to stay sharp and make consistently smart decisions on the right course of action.

If you have a lot of confidence in your distillation and maturation techniques, then another option is to simply sample one or two casks from a larger lot and make decisions based on these subsamples. It is a viable method, but I still advise that every cask get sampled at least a few times throughout its life and certainly right before it possibly goes into a blend.

Blending Strategy

When you begin the blending process, it is imperative that you have a strategy in mind. By that I mean, you need to envision the type of spirit you want the blend to be. Think about the color, the nose, and the palate. Do you want something big and bold that leaves little to the imagination or do you want something subtle and nuanced that requires a lot of attention from the drinker? Maybe you want something in between or something else entirely.

This is all about building your house style. Blenders are human and humans have different biases and preferences and sensory inspirations. Unless you’re being brought into a larger firm to take over the blending role from someone else with

an already established product line that you have to replicate, you will likely be putting your own blender's take on things. Think of it as your virtual fingerprint. Blending is one of the more personal and involved expressions of the distiller's craft and one that takes quite a bit of time to master.

Things You'll Need

Before you get started you should take stock of the equipment you have at your disposal. Of course, you will need samples of your casks, as well as sample glasses, but there are a few other accoutrements that will make this process easier, more accurate, and subsequently more reproducible.

Graduated measuringcylinders

Pipettes

Watchglasses

Stir plate with magnetic stirbar

Whitepaper

Notebook andpen

The graduated measuring cylinders should be made from lab grade borosilicate glass. Do not bother with the cheap plastic ones. They are not very accurate and when it comes to designing a blend, accuracy is one of the key pillars. And on that note, not all glass is the same. Purchase Class A borosilicate glass graduated cylinders. They cost more than their Class B counterparts, but they have a tighter tolerance to accuracy and will last longer. However, in a pinch if all you can find is Class B then go for it. Just know that the accuracy tolerance for Class B is generally half of Class Aglass.

I like to have quite a few sizes handy. Typically, I will purchase a few 10 ml, 50 ml, and 100 ml cylinders with lesser quantities of 250 ml, 500 ml, and 1000 ml cylinders hanging on the shelf in case I need them. The most useful size for me

during blending is the 100 ml because it makes blend percentage calculations unnecessary. You may prefer something bigger for your blends, but I would not go smaller than 100 ml. Some of the percent changes and additions to your blends can get so miniscule that trying to make those amends in anything smaller than 100 ml cylinders becomes incredibly difficult to get precise and onpoint.

If your graduated cylinders are accurate, I personally do not feel there is much of a need to get hyper-accurate pipettes. The function of the pipette for me has always been to more easily add small amounts of liquid to a more accurate receptacle. I use 10 ml glass pipettes with a rubber bulb, and they work well enough for me. You may want to invest in something fancier and that is fine too. I know folks that use nothing more than super-cheap plastic 1 ml pipettes. The role of the pipette during blend formation is not complicated and does not require anything overlyengineered.

Watch glasses are simply glass lenses that can be placed on top the sampling glasses. They keep the volatile aroma compounds in the glass headspace fromescaping.

A stir plate with a magnetic bar is a nice gizmo but is not completely necessary. You can use one of these devices to better mix up your blended sample components. The same feat can be accomplished by stirring with a spoon or a straw, but this is far moreconsistent.

Good ol' fashioned white paper should be on hand because it allows you to better assess the color of a sample. Most of us do not have access to perfectly well-lit white rooms. A cheap piece of white printer paper allows you to hold up the sample glass next to it to better see the spirit's natural color. In darker rooms I have even seen some folks hold a lit lighter up behind the paper to better illuminate the glass and its contents. This is not something I recommend because alcohol is flammable but also because I do not feel like a lighter flame produces the best light for thissituation.

Finally, you need a notebook and a writing utensil. You are going to be taking notes…lots ofnotes.

The Blending Process

Let me start this section of by saying that I am going to describe to you how I approach blending. Every blender has his or her own method(s) that work for them. Blending is a constant learning process and even the folks that have attained the official title ‘Master Blender’ would probably tell you that they are still learning. This is largely because a blend is based so heavily on one person’s sensory perceptions and humans are big dumb apes…we are notperfect.

All that being said, I don’t believe that there is much in the way of a “right” technique for blending or for that matter a “wrong” technique. I will describe to you how I do things, but I encourage you to speak to and read about other blenders and how they approach things. Ultimately, it is up to you to find the program and method that works best for your distillery andproducts.

Since blending is an exercise in sensory analysis, I will typically perform the task in the morning hours preceding lunch but separated far enough frombreakfast.

I will make sure that all the samples I need have been pulled and are in the exact same type of glass with the same volume of sample allocated to each one. I like to do my sampling for blend building at 50% abv so I will make sure all the samples have been diluted to that level. This abv is a nice way to standardize everything and makes blending math a bit easier down the line. It is also closer to bottle strength and gives me a more accurate impression of a consumer’s initial perception of the product. Besides, if I have been doing my job, then I have already sampled all these casks before at cask, bottle, and sometimes 20% abv strengths and I should have the written sensory notes toreference.

If it is going to be a while between when the samples have been taken and when I can sit down to assess them, I will ensure that my assistant puts a watch glass on top eachsample.

I start by quickly assessing the color of each sample, looking for any anomalies in the group. If something stands out as out of character, I will put it aside immediately so I can go back to itlater.

I then go down the line and take a quick smell of each sample without swirling the glass. This is so I can smell the immediate headspace and the most volatile components first. If anything smells off or otherwise out of character, I pull that sample away from the pack to assess itlater.

Next, I go through and smell everything again, this time after I have swirled the glass. Same program: note if anything is out of character and put it aside. (Usually these casualties areminimal.)

Because blending can be so sensorially taxing, I do not usually taste through the individual samples on a blending day unless for some reason it's the first time I'm encountering a particular cask sample. Trust me, there is plenty of tasting later when I begin assembling theblends.

If I am blending casks for an existing product, I will make sure that I have a sample of the product on hand as a reference. If this is a new blend, then I will have handy a written list of descriptors I want to design the blendaround.

In my distillery I have a wide array of cask profiles available to me. They all contain essentially the same whisky (leaving aside the yearly differences the arise from the fact that we grow a lot of our own barley). They have all been matured in a similar environment. The effect of the cask is therefore of immense importance to how I approach blending. If your blend is going to contain different types of spirit, say rye blended with wheat or malt whiskey or perhaps blending different grape varietals together then your approach is going to be a little bit different from mine. You will have the added variable of base fermentable character that needs to be factored in and weighted in your blending decisions. Either way, (and I cannot stress this enough) you need to have a vision of the type of blend you want to create in your mind before you begin. It will save you a lot of frustration and aimlesswandering.

My cask program is about 50% ex-oloroso sherry casks, 30% ex-bourbon, and 20% of what I call specialty casks. Let's keep things simple and deal with the bourbon and sherry casks only. This is actually a similar situation to many Scotch whisky single malt distilleries so it should be easy tovisualize.

The first thing to do here is to understand which type of cask does what. My sherry casks (500 L butts from a 25-year-old solera) give nice dry and fruity notes to our whisky. They contribute a slight vinous quality and low amounts of tannin and a medium to full mouthfeel. My bourbon casks generally contribute honey and vanilla notes with a bit more sweetness andtannin.

Essentially what I have described here is a "heavier" component whisky (ex-sherry) and a "lighter" component whisky (ex-bourbon). Now, how do I go about

blending these two components together? Outside of keeping a good set of notes in case you want or need to repeat the blend, there is not much in the way of a concrete rule set to hang your hat on. That is a freeing situation to be in, but just like being given a car with unlimited gas and time, infinite possibilities can often freeze you in yourtracks.

If I were approaching the above scenario, I would start by blending together the samples from each cask type separately so that all ex-bourbon casks are put together and all ex-sherry were put together. Remember, by this point I have already gone through the samples multiple times and pulled out samples that I deemed atypical. In theory, the samples I am pooling together all have comfortably close characters that I can feel ok doing a mini blend here. Now, if they are all so close, you might be wondering what the point is in blending them together and not just using one sample as a representative of the whole group. I do this because I want to see “the forest for the trees” so to speak. What I mean by that is that even though I have tasted every single cask going into my blend and thoroughly assessed them for atypicality, there may be tiny differences here and there that I didn’t necessarily pick up on. Essentially what I am doing is breaking up my larger blend into initial “mini-blends” that will give me an idea of the overall character of each casktype.

So, at this point I have got essentially two components to blend together, an ex-sherry cask component and an ex-bourbon cask component. Now, my blend has gone from a daunting set of several casks to effectively two whiskies. I will double check to make sure that the alcohol level of each component is the same as the other, for me that is usually around 50%abv.

I believe in using lighter charactered spirits to form a base or anchor for heavier flavors. This is a common philosophy in quite a few spirit traditions including rum, Scotch whisky, and cognac. The heavier components are added more sparingly and in smaller amounts while the lighter components are used as a base to anchor the bigger flavors. To borrow from the world of blended Scotch, some of the intensely smoky Islay whiskies are used in quite a few blends. However, their characters are often intense and can overpower other components in the whisky, so it is not uncommon to limit the big Islay whiskies to less than 5% of the total blend. Meanwhile lighter flavored grain whiskies that were produced on a large column still and are highly subtle and nuanced may make up 50-60% of a blend to provide a base to layer heavier flavored drams on topof.

In this scenario I would simply start with a 1:1 blend of the two components to see where that gets me. In all likelihood the sherry cask is going to overpower my more delicate bourbon casks and besides, I might want more vanilla and tannin from those younger bourbon casks anyway, so I'll up the percentage of the bourbon a bit and pull back on the sherry. Maybe this time I will do 60% ex-bourbon and 40% ex-sherry. Each time I make changes to the blend I add everything to my graduated cylinder as precisely as I can, cover my hand over the top and shake it up to make sure everything gets properly mixed in. You can do this on stir plate as well if you wish. I then go through my sensory exercises and assess the blend taking notes at each step. Maybe it needs more tannin or less tannin. Maybe I want more fruit from the sherry cask. Maybe I want…well, you get thepoint.

Eventually I will land on something that I like. But that is not the end of the story. Just like purchasing a home or a new car, I believe in sleeping on it before making the final decision. I will put my samples away and go home. Come back the next day and taste it. A good night's rest can do wonders for mental and sensorial clarity. If I have done my job, then hopefully I will still feel good about my blend the next day. But maybe I will not and in that case I will tinker with it some more. Eventually we will getthere.

But I am not doneyet!

Remember those atypical samples that I may have had to pull and put aside? If any of them are showing positive attributes despite being out of character from their siblings, I will take my base blend and see if I can blend in small amounts of these atypical whiskies. And the process of tinkering, resting on it, and tinkering some more beginsanew.

My overall technique is to break the blending process down into a series of mini- or sub-blends that I then make slow and calculated additions as needed. This process makes it easier for me to wrap my head around all the flavors and samples I am working with and allows me to more easily chase the traits I previously outlined for that particularblend.

The final thing I do before wrapping up is to check my blending percentages. As I said earlier, I blend with everything at 50% abv. Not only is this closer to a typical bottle strength but it is also convenient for blending math meaning I can calculate percentages based on proof gallons (in the U.S.) or in liters of absolute

alcohol (the rest of theworld).

I know some distillers blend based on the number of barrels because they don't want to have a partially emptied cask sitting around at the end of a blending session, but if you've read all the previous chapters in this book up to this point you can easily understand the problems with this line of thinking. Casks will have different evaporation rates and alcohol concentrations. This makes blending on whole cask numbers wildly inconsistent if you are planning on doing more than one batch of the product. If I have a partial cask left over from my final blend percentages, I can easily blend it into another cask for something atypical that I'll use later, or I can simply transfer it into a neutral cask or steel container if I'm going to use it sooner. There are quite a few options and all of them are much more satisfactory to me than marring my blend percentages because I just do not want to deal with a partialcask.

If all this sounds taxing and even daunting, that is because it is. Creating a blend is not an easy task. Admittedly I am probably not the most efficient blender out there, but I consider myself fairly obsessive about it and I dearly want to get it right. Not just for me but for the thirsty customer that will hopefully spend their hard-earned cash on one of mybottles.

So, are we done? Notyet.

Marrying and Vatting

Now that we have our blend formulated, we need to put the batch together. I calculate my blend percentages based on alcohol equivalents such as how many proof gallons or liters of absolute alcohol coming from each cask. Therefore, I blend with all my samples at the same alcohol level (typically 50% abv), because it makes the math and formulation easier for me. Not everyone does it this way, but it is works forme.

Let's say we settled on a blend of 60% ex-bourbon casks and 40% ex-sherry. Not the fussiest of blends, but easy to visualize for this example. I can add an empty blending tank to my scale and calculate the necessary weight additions from each cask type I need to add to reach my blend percentages. I can then dilute the whole thing down to a bit over my intended bottlestrength.

Once I have got everything blended, it would be tempting to say we are done and celebrate with a cold one at the local pub, but alas no. We are trying to make something world class here, so we are going to vat the casks together and allow the components to marry together inside thetank.

The reason for marrying is that our blend components need time to gel with each other and become a more cohesive whole. It's a hard concept to wrap your head around if you're not used to the blending process but dumping the casks for immediate dilution and bottling tends to produce a spirit that lacks structure and discernible characters. Therefore, I recommend letting the blend marry for 2-3 months if possible so that every component comes together the way it should. (And yes, this also means that the test blend you tasted after days/weeks of exhausting sampling work was not quite the final product, but trust me, the marrying process will actually improve on yourefforts.)

You have some interesting choices here during the vatting and marrying process. You can simply disgorge all your casks and blend them together into a stainless-steel tank and let them sit. Or, you can re-cask them into neutral wood. Or, you can finish the blend inside a more flavored cask. There are all kinds of things you can do. Like I said, norules.

Stock Management

The question of stock management in the distillery is perhaps one of the toughest queries to answer in the business. I have heard all sorts of "guidelines" over the years, some making more sense than others. Honestly, the answer for how to manage stocks in my distillery is going to be completely different than how to manage them in your distillery or yourpeers'.

One of my friends and mentors, the inimitable Douglas Murry of Diageo, was asked by a student at a workshop he and I were speaking at, how Diageo decides how much and when to make whisky. Even he pointed out that it is incredibly difficult to predict such things as the fickle desires of spirits consumers 15, 10, or even 5 years out. His answer, and I am paraphrasing here, was that when things are good, they generally make as much as they can and when things are on a downturn, they pull up the reins abit.

But you see, a company such as Diageo has an immense amount of resources and can afford to sit on stocks of casks for a few more years if a lack of sales warrants such a decision. This is a lot tougher to do for smaller distilleries with even smaller numbers ofcasks.

So, yeah. It can be tough to give guidelines or rules of thumb, but I'll do my best to provide a few principles that have helped me over the years with the distilleries I've managed and the clients I have consultedfor.

First thing's first. What kind of products are you trying to make? And be honest about how many products you intend to make. If you are not trying to hit a super-premium or luxury price point, then I would not invest in large amounts of expensive casks. Focus on less expensive American charred oak for instance or ex-bourbon casks. The financial bottom line for barrels is real and can seriously impact your shelf price if you are notcareful.

Are you planning on making one product or twenty? Will these products be in regular supply or will they be seasonal or one-offs? Knowing the answers to these questions will help you plot amap.

Next, decide approximately what the intended maturation period for each product is going to be. I know that I have waxed idiotic at length earlier in the book about how decisions should not be based on age, which is true. BUT you still need to have a general idea of what your maturation time will be. This will allow you to better plan for thefuture.

Let's use my own program as an example. As of this writing, I am the head distiller for a farm distillery in rural Quebec, Distillerie Cote des Saints. We focus on single malt whisky using mostly grain that we have grown ourselves. About 50% of our program is based on sherry casks (ex-oloroso), 30-40% ex bourbon, and 10-20% experimental casks (ex-amaro, Jamaican rum, armagnac, etc.). In Canada, the law says we must mature our spirit for three years before we can call it whisky. So, there is a baseline. Threeyears.

But we are interested in releasing luxury priced whisky. Three years is not likely going to cut it for the price tag we are shooting for and besides, I suspect it will not be ready then (2022) anyway. The likely first release will be 4-5 years old (2023-2024). And we are only going to release a small portion of the whisky that is at that age, say about 10-20%. The remainder will continue to sit until they

have reached another maturation milestone, say the 10-year mark. The following year's release will be pulled mostly from the second distilling season. Now we are getting the casks a bit older and the maturation profile is getting more complex and integrated. If we must, we can get a little more aggressive with our packaging numbers. However, the goal is to not release any more than 50% of any one distillingseason.

I know. That sounds insane to some people. Refusing to sell 50-90% of a year's distillations for some far-off imagined release date is not financially easy to do. People want cask matured spirits, and it can be incredibly tempting to release everything you can when you can. But let me illustrate some math to show you myreasoning.

Let's say that at year 5, I want to release 250 cases of 12 bottles (750 ml bottles for a total of 9 liters per case) at 50% abv. This means I need 2250 liters of 50% abv spirit. (I know that is not much but stay with me.) Let's assume that I have a conservative evaporative loss of 4% per year here in Quebec and that I'm averaging a 0.5% abv loss per year which is admittedly a bit extreme but I'm of the belief in being conservative with these numbers. I enter the cask at 63.5%abv.

The casks will therefore be at 61% abv at year 5. This means that I need approximately 1850 liters of spirit at 61% abv to reach my required 2250 liters of 50% abv finishedspirit.

Now, if I calculate back the amount of evaporative loss that would give me my 1850 liters, I find that I need a starting volume of about 2270 liters. In other words, I need about 11.5 standard 200 liter casks to start with in my first season to reach my goal. If I am only going to release 10-20% of that stock, then that means my first year I need to produce between 50-100 standard casks. (Since I use a multitude of cask sizes from 200 liters up to 650 liters, refer to a 200-liter cask as a "cask equivalent" meaning a 500 liter ex-sherry butt is 2.5 cask equivalents.) That is not too hard to do, even on a small scale. The remaining ~90 casks are then set aside for laterrelease.

The next year's release will be around 500 cases which means I need to plan on having twice as much liquid ready by then, so ~23 casks with a hold back of around 180 casks. In 2026 we will want to push out 1000 cases, so we will need to double our production efforts again. You can see how this works. Now,

realistically I cannot double my production every year because we only have so much space, equipment, and employee hours. Therefore, the plan from the beginning to was to have a soft first year of production to dial in the techniques and processes, and then essentially to max out our production capacity the end of year two. While this is a large investment on maturing stocks and all that entails, having a large amount of stock in the warehouse will better allow us to weather unforeseen storms in thefuture.

But let's get back to our hold-back stocks for just a moment. Let's say I have got 90 casks (18,000 liters) from our first distilling season and they are allowed to reach the 10-year mark. Assuming no losses from leaks or accidents (a miracle if there ever was one), then at year ten I have got just under 12,000 liters of 10-year old stock sitting at approximately 58.5% abv. If I want to do a 10-year old release, and that is the oldest I want my stocks to ever get then I have got 12,000 liters to work with and there is no problem. But I know that the company wants to eventually have a 15 and possibly a 20-year old whisky, so I must plan forthat.

At year 10 in the distillery's life, I would like to think that business is going well, and we will need more than 250 cases to satisfy demand for a new product. Therefore, we will likely release about 33% of our 12,000 liters. That is 4,000 liters which would give me 520 cases if I dilute down to 50%abv.

The remaining 8,000 liters will continue to mature. Another five years and I am left with just shy of 7,100 liters to work with. Take another 4,000 liters for a 15-year old release leaving me with only 3,100 liters for a future release and this too will suffer from evaporative losses and continued abvdecline.

This all assumes that evaporative loss and abv changes are linear which I can assure you they rarely behave that way. This also assumes that we never drop our 5-year old product (we likely will) and that all our stocks go into essentially one blend (not likely). You can see how maddeningly complicated and difficult this all gets in a hurry. That is why it is best to constantly be having the conversation with your product development, marketing, and sales teams regarding available liquid stocks at any given time. Even a semi-annual meeting where everyone sits down to get on the same page will save you an immense amount of headache and keep everyone's expectationsrealistic.

Of course, this is all quite a bit easier if you have determined that the maximum stock age you need is less than five years and that you only want one product age

and profile. Then you simply sell everything that is “ready”, and you are off to the races. But be warned: that philosophy works great for some folks, but unless you have got deep pockets, it can be tough to pivot when the market changes and you find yourself wanting for older more maturestocks.

Every distillery’s situation is going to be a little different. Granted the scenario I’ve outlined above is a bit more difficult to plan out than if I only intend on releasing one type of whiskey, but it gives you an idea of how some of the things regarding stock management arehandled.

Chapter 7

Sensory Panels

Regardless of how you decide to approach the blending process, I always feel like it is a good idea to get other people involved. Once your precious blend is where you want it, you should get other people's opinions. I have done this all sorts of ways over the years from the very casual "wanna taste this new blend with me and tell me what you think?" to highly formalized trained panels that take weeks to build.

The casual route is certainly appealing, but it is not the most beneficial if you are trying to take your blending activities seriously. Even if you do a set up where your friends are tasting things blind, there is a bias built in that can be hard to get rid of and you may not get the most accurate or honest assessments. Besides, you need to really ask yourself what you want out of a sensory trial to begin with. If you just need to know whether your blend is binarily good or bad, then it is possible to make a casual set-up work even if the statistical underpinnings are going to be dubious at best.

If you opt for the casual route, then have everyone go in as blind as possible. Do not tell anyone what they are tasting or why they are tasting it. Throw in some of your other products or products from your competitors. Have score cards and places for comments. Limit the number of tastings to less than six and randomize them. Denote each sample with randomized set of three letters such as 'AJE', 'ITM', or 'QBS' because using numbers will cause some people to have an inadvertent ranking bias where higher numbers may be assessed or ranked differently than lower numbers. Do not let anyone talk during the sampling, this is not a party. You are trying to throw down a mentally organoleptic gauntlet for the participants so that you can get the most honest and useful feedback possible.

Even with all these tools and stipulations, there are problems here. The biggest issue is that unless the group of people you are using as a panel have been

trained in sensory analysis as a uniform body, then individual panellists will inevitably have different terminology. That makes things confusing when someone says something like “buttery” and someone else says “butterscotch”. These are both terms used to describe diacetyl, but you may not realize they are talking about the same thing (or maybe they are not) if they don’t have a common lexicon of sensory terms to work with.

What if you are replicating or batching a new lot of an existing product? Do you need to do this? If you want to be consistent, yes, you do, but there are better methods out there for sensorially checking batch consistency. Enter discriminatory testing.

Let me start out by saying that despite having sat on more sensory panels than I can remember as well as setting up dozens more over the years of various types, I am NOT a statistician or a sensory scientist. Believe me, this is one of the more complicated rabbit holes you can fall down in the world of food science and beverage production. I had several sensory science friends while I was in grad school researching wine fermentations and those guys spoke a completely different language. Believe me, it is fascinating stuff and I suggest you learn more. But there is a reason why many larger breweries and distilleries higher sensory scientists for the specific job of running sensory analyses. It is a highly specialized kind of work. Thankfully, this kind of sensory test is not that complicated to perform or explain.

Triangle Test

The triangle test is simple in execution and analysis. It can be done with little equipment and the analysis can be performed in Microsoft Excel rather quickly.

In a triangle test, a participant is presented with three samples. Two of them are the same and one is different. The participant’s job is to pick out the one that is different. It is quick, easy, and statistically valid.

To set up a triangle test, all you need to do is to have some clean glassware, label the samples with random three letter codes as described earlier and pour your new blend alongside your last or reference blend in anyone of six combination orders. You will then present these to your participants.

You should get at least five participants for the results to be even remotely meaningful or statistically valid. The more people you have, the better the test will be. You can have participants take the test more than once to raise the number of “replications” but for a variety of reasons outside the scope of this book I would advise against it.

Ensure that the samples are poured just prior to tasting (or as close to that time as is possible). Give the panellist(s) a quiet room without distracting sights, sounds, or aromas. Present them with their three samples.

Let’s say that the reference or old blend is represented by ‘A’ and the new blend is represented by ‘B’. The six combination orders you can present them with are AAB, ABA, BAA, BBA, BAB, and ABB. You should randomize this among participants. Participants only have to do the test once but twice is better.

Statistical Analysis

You can see by the design of the test that an assessor has a 33% chance of simply guessing which is the odd man out in the samples. That 33% probability gives us something statistically important to hang our hats on.

Our baseline (or “null”) hypothesis is that there is no perceivable difference between the new blend and the old or reference blend. Therefore, we expect a high number of incorrect answers from panellists. Makes sense, right? If there are many incorrect answers then that means the study participants were not able to tell which sample was different. That being the case then we can assume that statistically there is no perceived difference.

But how do we calculate that? Let’s walk through a hypothetical triangle test to explain.

Imagine our two blends. ‘A’ is our reference/first batch blend. ‘B’ is our newest blend that we hope matches our reference in profile.

Our Null Hypothesis (H0: A=B) is that there is no statistically discernible difference between the two blends. The alternative is that there IS a difference (Ha: A≠B).

We have recruited 30 people willing to take the triangle test for our products and we have paid them with a dram and a distillery keychain, so they are somewhat happy about it all.

After the test has been performed, we find the following results:

Correct Answers: 24 (the participants were able to tell which sample was not like the other two)

Wrong Answers: 6

What you are trying to find is what is called a chi-square value (X2). This value will allow you to see if your test is statistically significant, but more on that in a bit.

The equation for finding our chi-square value is:

$$X2 = \sum \frac{|O-E|2}{E}$$

Oc is the observed number of correct answers.

Oi is the observed number of incorrect answers.

Ec is the expected number of correct answers. The number of expected correct answers is simply the number of participants multiplied by the probability of them simply guessing and getting it right which as we have previously stated is 1/3. So, in this case the number of expected right answers would be

30 x (1⁄3)= 10

Ei is the expected number of incorrect answers. The number of expected incorrect answers is simply the probability of choosing the incorrect answer by chance (2/3) multiplied by the total number of participants.

30 x (2⁄3)= 20

With me so far?

Our equation will look like this if we plug our numbers in:

$$X2 = 19.6 + 9.8 = 29.4$$

$$X2 = \sum \frac{|24-10|2 + |6-20|2}{10}$$

$$\frac{20}{}$$

$$X2 = \frac{142 + 142}{10}$$

$$\frac{20}{}$$

Now that we have our chi-square value, we can go look it up on a chi-square distribution table which for our purposes only contains a few numbers (chi-square distributions are used for several other statistical approaches much more complicated than our simplistic triangle test).

Table 6 Chi-Square Distribution Values

d.f	0.995	0.99	0.975	0.95	0.9	0.1	0.05	0.025	0.01
1	0.00	0.00	0.00	0.00	0.02	2.71	3.84	5.02	6.63

In the top row of the table we see the letters ‘d.f.’ which stand for “degrees of freedom”. That is a fancy statistical analysis term that is well beyond the scope of this book for an explanation. For our purposes it is only going to be ‘1’ (Dixit, 2007). The numbers in bold in the top row of the table indicate the probability of being wrong if you accept your null hypothesis, often referred to as the ‘α’ value. For example, if we choose and α-value of 0.05 that means that if we accept our null hypothesis that the samples taste the same, there is only a 5% chance that we are statistically wrong. The bottom row of numbers is our chi-square distribution values.

To accept our hypothesis that our blends have no perceivable differences among tasters with an accepted confidence (α-value) of 1% (0.01) then our X2 value would need to be less than 6.63 which 29.4 clearly is not. Therefore, we reject our null hypothesis and accept the alternative which is that our new blend is perceived as tasting different than our old or reference blend. For a blender, that would mean we need to head back to the drawing board and reformulate.

If you do not want to go through the hassle of calculating everything out as we did for the previous problem, there have been some convenient tables drafted in recent years that make the triangle test analysis even easier.

Table 7 Critical Values Table for Triangle Test

Minimum number of correct responses required to reject a null hypothesis of A=B with a total number of participants 'n'.

n	Significance %					
30	20	10	5	1	0.1	
5	3	4	4	4	5	-
6	3	4	5	5	6	-
7	4	4	5	5	6	7
8	4	5	5	6	7	8
9	4	5	6	6	7	8
10	5	6	6	7	8	9
11	5	6	7	7	8	10
12	5	6	7	8	9	10
13	6	7	8	8	9	11
14	6	7	8	9	10	11
15	6	8	8	9	10	12
16	7	8	9	9	11	12
17	7	8	9	10	11	13
18	7	9	10	10	12	13
19	8	9	10	11	12	14
20	8	9	10	11	13	14
21	8	10	11	12	13	15
22	9	10	11	12	14	15

23	9	11	12	12	14	16
24	10	11	12	13	15	16
25	10	11	12	13	15	17
26	10	12	13	14	15	17
27	11	12	13	14	16	18
28	11	12	14	15	16	18
29	11	13	14	15	17	19
30	12	13	14	15	17	19

The above table is incredibly simple and intuitive to use. Just look up the number of participants on the left, decide what level of confidence you want to have in your results by choosing a significance percentage and then look up the number of correct answers in the corresponding cell that intersects. That value is the minimum number of correct answers it would require for us to reject our hypothesis that our blends taste the same. So, in our earlier example we had 30 participants in the study. We want to be incredibly sure in our study, so we are going to choose a significance level of 0.1%. Looking at the table, going right across the row for 30 participants and intersecting with the column for 0.1% significance we find that we would only need 19 correct answers to be reject our null hypothesis. Our tasters gave us 24 correct answers, so we must have been really off our blending game that day.

Other Sensory Tests

The triangle test is perhaps the easiest sensory test to set up for a small to medium sized distillery. It does not require too many participants to get good results, it is easy to understand, and requires virtually no training for the participants. Still, there are other tests that you might feel are worth considering. I am not going to go into great detail here. A summary of each will have to suffice. There is a ton of information out there should you like to pursue any of these tests for your own program.

First, let’s talk about the triangle test’s baby brother, the duo-trio test. The duo-trio test presents each participant with a single reference sample and two coded samples. One of the coded samples is the same as the reference while the other is not. So, in our previous example we might present our original reference blend A as the reference and then present two anonymous coded samples one of which would also be blend A and the other blend B. The participant would then need to tell us which coded sample matches the reference sample.

Once again, this test is easy to understand and perform. It has been found to be a good test for products that have high flavor or aroma intensities and some people feel spirits fall into that camp. The main problem with it is that you need more participants for it to be statistically valid. Seven people is a minimum but to get

really good results, some people argue you need at least 16 assessors. That might be difficult to do for some distilleries.

You may also want to build a formally trained sensory panel. This can be helpful if you are interested in developing a ton of products through different blends out of your warehouse.

Building a trained panel is time consuming and may even cost you some money. Here's the deal: you find a group of tasters say around 10-15 who are then formed into a dedicated panel. You spend several weeks together training them to assess different flavor, aroma, and mouthfeel attributes eventually getting to the point where everybody shares the same lexicon. Then you can administer the tests, giving out samples and asking the participants to assess them for various sensory attributes like floral aromas, butteriness, alcoholic heat, and so on. The statistical analysis of these tests is robust but fairly complicated and well beyond the scope of what we are talking about here. Suffice to say, you can get a LOT of information on a new product using a trained panel. The nice thing about having a trained panel is that they are trained, meaning you can use them for multiple projects over long periods of time.

Chapter 8

Cask Inspection and Maintenance

It might seem strange that I am placing this chapter at the end of the book. Stylistic choices and all that, I suppose, but it is not as odd as it seems. Honestly, just like so many other things in the world of distilling, physically working with wooden casks is very much a personal endeavor. Which is to say, everyone has their own way of doing things. The chemistry and maturation changes are dictated by the laws of nature and can only be controlled so much by human intervention. Therefore, I focused on these subjects early on. Cask inspection and maintenance however, is definitely something designed for the human hand. The subject matter in this chapter is simply a series of tips and tricks of the trade that I have accumulated over the years. I have been fortunate to work with and study under quite a few people much smarter than me. People who have always been willing to answer questions and share their individual experiences when it comes to the world of cask maturation.

To maintain a successful and functioning cask program, you must physically work with your barrels. There is no way around it. Sure, it may take years for your spirit to properly mature inside the cask, but the cask itself also changes over time and you can't simply "set it and forget it" within the nether reaches of your warehouse. Casks need maintenance whether they are full of maturing spirit or if they are sitting dry awaiting their next fill.

This is all in pursuit of finding and using "good wood". Good casks make good spirits. Treat them well and the favor will be returned. Ignore them and you may well wind up with some bad spirit.

Besides, just like everything else in life, bad things happen. Casks will leak. Empty casks may dry out or otherwise be in bad shape. Fortunately, these are things that can be prevented or repaired…if you have the know-how.

The beginning is always a nice place to start so let's take a few moments to

discuss initial cask reception and inspection.

Cask Reception and Inspection

Let me say this now: It does not matter who or where you purchase your casks from. Every single one should be inspected upon reception and prior to filling. Every. Single. One.

Even with all the automation and high-tech machinery many coopers now use in the production and revitalization of casks today, barrels are still largely a human-produced commodity. This means, that despite the best of intentions and even the most strident and stringent of quality control programs, mistakes happen. Faulty and sometimes downright bad casks do occasionally get through. You have put a lot of time, effort, and money into producing your new make spirit. Do not screw it up now by placing it into a bad cask unawares.

If you are receiving virgin casks direct from the cooper, you often have little to worry about assuming the cooper has a good reputation. Even so, give each barrel a good visual once over making sure nothing seems amiss.

There should be little to none in the way of knots in the stave or head wood. Staves should have no cracks or signs of insect damage. Hoops should be clean with no rust and should be placed and aligned perfectly perpendicular with the longitude of the cask. The bunghole should be covered in some way, either with the bung itself, a silicone place holder, or tape to ensure no errant pests or insects have found their way inside. The overall appearance should be clean with no signs of mold or dampness from improper storage prior to shipping.

Take a small flashlight and peep inside the cask to ensure that the toast or char level looks correct to your specifications. Make sure there is no mold growth and that the wood smells fresh. Barrels with bad aromas should be returned to the cooper. Simply put, if the cask does not look, feel, or smell right you should contact your cooper and discuss it with them.

Other things that I like to look at include checking to see if the stave wood exterior has been shaved down. A pet peeve of mine is burring on the chime wood and end/chime hoops. I try to work with coopers and suppliers that ensure

these components are smooth. Yes, I know that I should be wearing gloves whenever I work with casks, but real-world scenarios can be cruel, and I am also a moron so sometimes I wind up handling a cask without proper protective gear. Burring on the ends of the casks means metal and wood splinters in my hands and I cannot count the number of times I have had to reach for the first aid kit tweezers after rolling a cask in the warehouse. It is a simple quality of life improvement that I wish more coopers were cognizant of.

Used casks are a bit more of a mixed bag. You must pay a lot more attention to all the above criteria. Therefore, it pays to use a cask broker you trust.

I purchase casks from all over the world, but I only use two brokers to do so. Both companies have extensive lines of quality checks to ensure only the best casks find their way into my warehouse. Even so, the nature of used casks means that different lots may have been treated differently. For instance, I purchased a couple of 600 liter tawny port pipes a while back. Upon receipt, the casks looked a little rough. Some of the staves were warped and a few of the longitudinal stave seams were showing some severe stress. But once I smelled inside the cask, I knew that I had to make a special exception for them because the aromas were incredible. (At the time of this writing, these casks are maturing some of my current favorite stocks.) So, I decided to work with these casks, warts, and all. They have had a few leak issues that I have had to handle, but it has been worth it.

With used casks, you really need to redouble your inspection efforts to make sure you are getting something of quality and that is usable. Make sure the staves and the hoops are in good shape. Overly rusted hoops may be indicative of poor handling or storage conditions. Look inside and smell the cask. If the barrel formerly held some kind of spirit, then it should smell like what was once in there. Preferably the cask was recently disgorged, and the inside is still wet. My sherry cask supplier ensures that around 10-15 liters of sherry stay inside the 500 liter butts I purchase so that the cask maintains some internal moisture during storage and shipping.

There should be no musty or moldy aromas. This is especially important if the cask previously held something more prone to spoilage such as wine or beer. With regards to wine, make sure there are no sulphur aromas emanating from the cask. Hopefully, you discussed the need of sulphur-free wood with your wine cask broker prior to purchase, but it pays to check and be sure.

Cask Storage

It is best to fill your newly acquired casks as soon as possible and certainly within a month or two of reception. Sometimes, however, that is just not possible. Production needs sometimes change and before you know it you have got barrels sitting dry in storage collecting dust.

Many larger distilleries for lack of internal building space, choose to keep their empty casks outside exposed to the elements. I have done this myself with virgin oak and it does the job. Of course, this all depends on the local environment. Ideally casks should be stored in an area with a little bit of humidity in the air, but not so much that mold can take hold. The ideal storage humidity whether the barrels are inside or outside is 70% (Recommendations for Storing and Using Your New Canton Barrel, 2014).

When I worked in Tennessee, we kept most of our virgin casks outside for up to two months prior to filling. The warm humid air caused us little in the way of trouble though the occasional rainstorm would eventually cause small amount of surface rust to form on some of the hoops. Not too big of a deal. If I were working in a drier climate like Arizona, I would try to either fill the casks as fast as possible or store them inside a more climate friendly warehouse.

The goal is to not let the wood dry out too much. You want to keep access from potential pests to a minimum and always keep an eye out for any nefarious looking mold growth. Mold growing on the outside of the wood is usually ok, but if it gets inside the cask from a missing or loosely fitted bung then you can wind up with some bad aromas.

If you are keeping the casks on the inside of a warehouse, there are a few other things to keep in mind. First, try to keep cask wood away from your main production area. The number of errant fluids and cleaning chemicals that may find their way via splashing, spraying, dumping, and more is not usually a good thing for the wood.

Second, and this is a big one: do not use chlorinated cleaning products anywhere near your cask wood. Chlorine combined with wood and certain types of air borne fungi can lead to the production of 2,4,6-trichloroanisole also known as

TCA. Wine lovers reading this book may recognize TCA as the compound primarily responsible for cork taint in wine. At high levels it smells like cardboard, wet cement, or a formally flooded basement. What is a “high” level? TCA is one of the more sensorially potent compounds in the beverage world and it has been shown that people can easily detect it in the parts per trillion range. To put that in perspective, imagine an Olympic-sized swimming pool. Now add one drop of food coloring to the pool. Congratulations, you have just added one part per trillion of food coloring. TCA has been shown to be detectable in wine at levels as low as 1.4 ppt (TCA Analysis, 2020). While the detection threshold for TCA in distilled spirits is almost certainly higher than that for wine, preventative measures should nonetheless be taken to ensure it does not creep into the warehouse. I have heard from other distillers over the years that have had to deal with TCA issues, and it is usually incredibly difficult and expensive to get rid of.

I personally have banned all chlorinated products from my facility. This does not completely protect me from the potential problem of TCA, but it is an easy step in the right direction.

Preparing the Cask for Filling

Here is another one that everyone seems to have their own opinions about. Your cask has been sitting in storage for however long and now it is time to fill it. The question is, do you go ahead and just fill it or do you somehow physically prepare the cask for filling to ensure it holds liquid?

Most distillers I know err on the side of caution and use some kind of method or technique to check for possible leaks. Even if the cask was just unloaded from the freight truck and was coopered only the week before, the consensus seems to be that it does not hurt to check for leaks and it’s better to be safe than sorry.

In theory, if you really trust your cooper, you could just simply fill the cask blind with no pre-treatment. Some people do this and have no issues. The argument for going this route is that pre-treatments could strip the cask of valuable extractives. (We will see in a moment that this should not be much of a concern.) Besides, pre-treatments introduce another working cog into the distillery machine and that can complicate things for some people. Regardless, I and a

whole slew of other distillers recommend pre-treating the casks prior to filling.

Pre-treating a cask prior to spirit filling usually involves the addition of water and/or steam to ensure that no leaks are present, and that the cask will properly hold liquid. There are several techniques, and everyone has their favorite.

Continuous rinsing with hot water for 5-10 minutes

Adding 10% of the cask volume in hot water, bunging and holding for several hours.

Filling with cold water for 24-48 hours

Filling with hot water for 24-48 hours

Standing the cask on end and filling only the outside of the heads each with water for 24 hours

Steaming the inside of the cask

Submerging the entire cask in water

The Continuous Hot Water Rinse

This technique is more common with fresh and newly coopered barrels. It essentially involves inserting a rotating spray ball into the cask and pumping non-chlorinated hot water into it for 5-10 minutes. If you do not see any leaks, then you are probably good to go. My problem with it is that some leaks take longer than 10 minutes to rear their annoying little heads, so I do not find this process to be particularlyeffective.

Adding 10% Hot Water for Several Hours

There are two versions of this technique. Both involve filling about 10% of the

total cask volume with non-chlorinated hot water (20 L of 122-140°F (50-60°C) water for a 200 L cask). One version requires that you let the cask sit for 3-12 hours on one end then flip it and let it sit on the other end for another 3-12 hours (Recommendations for Storing and Using Your New Canton Barrel, 2014). The cask should be bunged during this time. After both sides have been soaked in the hot water, the cask can be dumped and is ready for filling (assuming no leaks have poppedup).

The second version involves bunging the cask with a silicone bung after the hot water has been filled into the cask. The cask is then moved around so that the water wets all areas inside the cask. After a few minutes of this, you can try to remove the bung. If there is a bit of suction or pull on the bung towards the inside of the cask then that means a vacuum has been created and the cask is probably leak-free. If the bung comes out easily then there is probably a leaksomewhere.

I find the first version of this technique to be a bit more helpful as it gives you a better indication of where any potential leaks might be. Essentially if there is a leak then you will see a spot where water is seeping out. The second version is faster, but you are relying on indirect evidence of a potential leak. Assuming there is a leak, you then must go through a separate process to find it. Besides, neither I or my employees have time to stand there, rocking dozens of casks back and forth for 5-10 minutes each. What sounds like a time saver is quite the opposite in myopinion.

Filling with Cold Water for 24-48 Hours

There are going to be lots of folks that disagree with me, but this is my preferred method for preparing casks for filling. It is quite simple: just fill the cask with non-chlorinated cold water for 24-48 hours. If no leaks form after 24 hours, then dump the water and you are good to go. If you see a leak or two, let the water sit longer and top up the cask if necessary. Change the water completely after 48 hours if the leaks have not completely disappeared so that the water does not get stagnant and create off-aromas in thecask.

I will be the first to admit that there are some drawbacks here. First, is that you must have a bunch of casks sitting around on your warehouse floor taking up

valuable space while they soak. Second, it is not the most efficient use of water. Still, the reason I like it is that it requires minimal time and effort on the part of me and my employees meaning we can focus on other aspects of the distillery while the casksswell.

Filling with Hot Water for 24-48 Hours

This one seems to get some of the most controversy and it really should not. Fill the cask with non-chlorinated hot water (122-140°F or 50-60°C) for 24-48 hours. On the surface, this does not sound too different from the last technique, but the big exception here is the water temperature. The addition of hot water, many people claim, risks extracting valuable volatiles from the cask, volatiles that could and should be going into our preciousspirit.

I suspect there is a sliver of truth in these suspicions, but I also suspect that the amounts of lost extractives are negligible. World Cooperage based out of Napa, California did a small bit of research on the subject back in 2001. It found that wines placed into toasted casks that had been prepared with 24 hour hot water soaks exhibited higher levels of lactones than other cask preparation treatments (Meves, 2001). This research was done only with toasted wine barrels, but it might be of interest to people using charred casks. The only reason I am not a huge fan of this technique is the sheer amount of hot water required. Not only are you using a LOT of water, but it all must be heated as well, which requires quite a bit ofenergy.

Standing the Cask on End and Filling Only the Outside of the Heads with Water for 24 Hours

This technique is preferred by some folks who work with a lot of used casks. Simply stand the cask on one end and fill up the cupped area of the head to the brim of the chime on the cask with hot or cold non-chlorinated water. Let it sit for 12-24 hours. If the liquid level is roughly the same, then that head is probably tight. Flip the cask over and repeat the process on the otherside.

The benefits to this method are obvious. There’s little water usage and no serious amount of water ever enters the cask, lowering the risk of extraction and removal

of the casks flavors. This method presupposes that the only source of potential leaks in a cask is going to be in and around the barrel heads. While the heads are where most potential leaks tend to be found, they are not the only source of leaks and this method severely underestimates potential leaks from the rest of the stave wood. It works well but be prepared to fix the occasional staveleak.

Steaming the Inside of the Cask

If you have access to a steam injection system, you can inject steam directly into the cask for a few minutes to prepare it for filling. This is something that tends to be more often used by winemakers, but it can be attractive to some distiller as well. It works best with new virgin casks. However, it does not do the best job of singling out leaks verywell.

Submerging the Entire Cask in Water

If you are using small format casks, say under 30 gallons and are only using a few of them at a time, I have known a few folks who submerge the entire cask under water. Usually this is done in a converted 1000 liter plastic tote or otherwise suitably largetank.

As long as the water is chlorine-free then this is incredibly effective at swelling the wood fibers and ensuring the cask does not leak. You generally leave the cask bunged and weight it down to keep it submerged. (If you filled it with water, you would then have the unpleasant process of trying to lift it out and empty the water from inside the cask. To me this sounds like a chiropractor’s appointment just waiting tohappen.)

There are a few problems with this technique. First, is keeping the casks submerged can be a challenge. Second, is that just like many of the other preparation techniques we have talked about, this does not give us a good indication of where potential leaks might be. All the same, I have known some folks to do this and swear by it for new virgin oak casks of 10-15 gallons insize.

Maintenance and Repairs in the Warehouse

Here we go. This is an enormous topic. Fixing and maintaining casks in the warehouse, especially problematic ones, is sometimes a full-time job for specialists hired on at larger distilleries. Larger operations like Jim Beam often have what they call “leak hunters” whose job it is to wander around the warehouses looking for and repairing barrel leaks (Kokoris, 2016). It is not an easy job and there is often a lot todo.

Leaks happen. It is just the nature of cask management. Barrels affect their contents while the warehouse environment affects the barrels. And it does not matter who the cooper was, how straight the wood grain, or how much technical wizardry went into the production of a cask. There is always a chance that a leak willform.

Leaks come in a variety of severities and placements. In my experience most leaks occur somewhere around the barrel heading, often in the croze. Unfortunately, these can be some of the most frustrating leaks tofix.

Leaks will also show up occasionally through the stave and head joints. You may even see some leaks emanating from the middle of the stave wood itself. Luckily, all of these can be fixed with a little know-how andingenuity.

Tools of the Trade

To do any job correctly you need to have the right tools. I advise investing some money in a few items that will help you when handling and repairing barrels. Not all the following items are completely necessary, but they will make your life easier in thewarehouse.

At a minimum you shouldhave:
rubbermallet
16-20 ozhammer

18-20-volt cordless drill with several bitsizes

Wooden spiles of varioussizes

Woodenwedges

Barrelwax

Optional (but recommended) itemsinclude:

Bungpuller

Hoopdriver

Awl

Headingtool

Flagging

Set of wood carvingtools

Let’s walk through all of these for amoment.

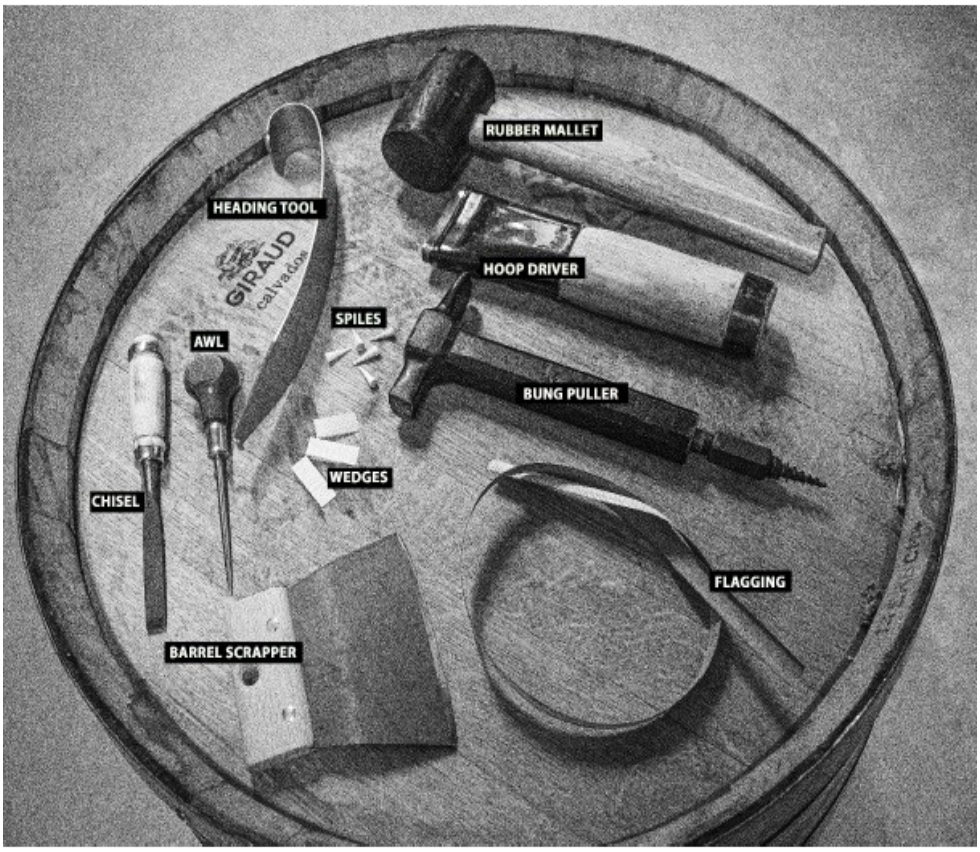


Figure 26 Barrel tools

I suggest purchasing a rubber mallet for the sole purpose of hammering in loose bungs. A standard 16 oz rubber mallet that you can find in most hardware stores will work fine. The rubber mallet is a lot kinder on the soft wood poplar bungs that are so common in many barrels and will not damage or break them aseasily.

However, I also like having a standard carpenter's hammer within easy reach. A size of 16-20 oz works well. I typically use one of these to gently hammer in small wood spiles or wedges during repairjobs.

Make sure you have a good cordless drill lying around. Something with a decent amount of power (18-20 volts is best) and good battery life is a must. You will want to make sure you have a few drill bits at your disposal. The most common sizes I use are 1/8" (for repairs) and 9/64" or 5/32" (for samplingholes).

Wooden spiles are simply small wooden cones that can be used to plug leaks and small holes. I also use them to plug in sampling holes. If you are careful with them, they can be pulled back out and put back in again with a pair of channel lock pliers to make an easy samplingport.

Wooden wedges are the siblings of spiles. They too are used for basic repairs. We will see in a bit exactly how to usethem.

Barrel wax has several uses and is handy stuff to have. It is most commonly used to smooth over and seal small leaks that may not necessitate the use of more invasivemeasures.

The following pieces of equipment are optional. You might find yourself rarely, if ever, using them. However, I keep all these items around and find that they all make my job easier from time to time. I have not regretted purchasing a single item on thislist.

Bung pullers are small iron hammers with a rod running through their center that terminates in a conical stepped screw. I purchased mine from GW Kent for about $300. These things make bung removal a cinch. I do not know how I would live without minenow.

A good hoop driver will come in handy more than you would think, especially if you are purchasing older used barrels. Hoop drivers are used to tighten down loose hoops and can help reseal a dried-out cask a lot faster by helping to reinforce the entire cask structure. I use mine on some of the older 25-30-year old ex-sherry casks that Ipurchase.

An awl is simply a metal spike with a wood handle that can be used to punch holes into wood. Yes, your drill will do the same thing, but honestly, I prefer the awl. It requires a bit more shoulder grease to work but avoids the potential for spirit getting into my expensive drill and eventually ruining my drill chuck (something that has happened more times than I care toadmit).

A heading tool is just a small curved piece of metal that aids in the removal and replacing of a barrel head. Heaven forbid you ever have a problem so bad that you need to remove the barrel head, but if you do, you'll be glad to have one or two of these little guys around for the job. Barrel Builders in Calistoga California sells them for $10 (see resources at the end of thebook).
Barrel flagging is handy stuff to have around. This is just dried water reed that can be inserted into the croze or between staves to tighten and plug gaps. It is cheap and incrediblyeffective.
Having a set of wood carving tools is nice because many of these tools can be used in a multitude of situations to better find, see, and repair leaks. I've use them to shim in wax and cellulose fibers around the croze. You can scrape away older worn wood to better see a leak and you can remove or alter older repairs that are not doing their jobsanymore.

A Few Words on Barrel Repairs

There are almost as many repair methods as there are leak types. I have repaired quite a few casks over the years and have tried all sorts of methods. I have used everything from the above tools to old-timer methods of melted paraffin wax and ryeflour.

Leak repairs require a bit of urgency but also some patience on the part of the warehouseman. Many leaks form as the warehouse climate changes and will eventually seal themselves. If the leak is not too bad, that is often the route I will

take. Just let mother nature handle it. However, some leaks require quite a bit more intervention. Some are so severe that it occasionally feels like nothing will everwork.

In the following sections we will cover some of the more common leak types and some suggested methods to repair them. But, as always, I suggest talking with other distillers and warehouse folks. My methods are not the only ones out there. Talk to and learn from as many people as you can to find the techniques that work best foryou.

Repairing Through Wood Leaks

Through wood leaks are exactly as they sound: leaks that emerge directly through the stave wood. This might be somewhere in the middle of a stave, at the end of a stave around the chime, or in one of the head pieces. Essentially if the leak is not coming from a stave or head joint, or from around the croze, we are talking about a “through wood” leak. These leaks are by far and away some of the fastest and easiest to repair. There are quite a few methods that work, and we will go through several of thembelow.

These easiest technique for repairing one of these leaks is what I call the “drill and plug” method. It is incredibly simple if you follow thesesteps:

Pinpoint and isolate the leak by wiping away any dirt and liquid with a clean paper towel. Use a small flashlight to better see the “shine” of the liquid and exactly where it is comingfrom.

Mark the leak point with a small amount ofchalk.

Take a 1/8” drill bit or awl and drill/punch a hole directly through theleak.

Gently hammer and tap in a wooden spile to plug thehole.

(Optional) Take a wood chisel and chip off the end of the spile so that it is flush with the surface of the barrelwood.

In my experience this fixes the problem almost every single time. It is a bit more invasive, but it does stop the leak dead in its tracks. There are other methods,however.

The following methods all require that you position the cask in some way that keeps liquid from flowing through the leak spot. So, if the leak is on a stave that is underneath the cask while its sitting on a rack, simply take it off the rack and roll it 180° so that the leak spot is facing upwards. Now you can tackle the problem with a dry workspace making all the following techniques much moreeffective.

We will start with some wax. Sometimes a quick rub over with barrel wax will close the leak noproblem.

No barrel wax? If you have some bottling or paraffin wax lying around you can heat some of that up and pour it melted over the leak. Let it cool andharden.

Two old-timer methods that you might think of trying are using rye flour or using garlic. Rye flour is rich in gummy compounds such as arabinoxylans and can sometimes make an effective liquid barrier. Mix up some rye flour with a small amount of water to form a paste and apply it to your dried leak spot. Let the flour dry completely before you position the cask to its originalorientation.

Garlic can also be used to seal small leaks. I know. It sounds weird but hear me out. Take a small clove of peeled garlic and rub it into the leak. Press it in with a stick of chalk so that it is thoroughly mashed into the leak spot. Let the mixture of garlic and chalk sit for a few hours before repositioning thecask.

Repairing Leaks Between Staves and Heading Pieces

These types of leaks are most commonly the result of a barrel that has dried out too much during storage. The best offense is a good defense here. Try not to let your casks dry out during storage. Fill them as soon as possible. Barring that swelling the cask with cold non-chlorinated water over several days should do thetrick.

But what if a leak develops between the staves or heading pieces after you have filled the cask? It happens. The leak can be repaired but it is going to take a little work on your part. (See figures28).

Identify exactly where the leak is coming from. Take a paper towel or cloth and dry the wet area as much as possible. Use a flashlight to find the exact spot of the leak and mark it with somechalk.

Empty the contents of the cask into a separatecontainer.

Stand the cask on the head that is farthest away from theleak.

Mark a spot on the head that tells you the correct orientation of the heading pieces in relation to the bung. If you remove the entire head, you will need to know exactly what position to return itlater.

Using a hoop driver and hammer, begin loosening the top two hoops by tapping the driver upwards against the hoop. If your hoops use hoop nails, you will need to remove those with a pair of vice grip pliers. (figure28a)

Remove the top two hoops completely, being careful to not let the head get too loose and fall into the barrel. (Figure28b)

You will need to gently tap on the staves at the chime to loosen them slightly from the heading pieces. Once again, try to keep the head from falling into the cask. This is a bit tricky and takes some practice.(Figure28c)

Loosen the two staves that are the source of the leak. Cut a piece of flagging and using a chisel, flat head screwdriver or knife blade, work the flagging in between the staves starting at the chime/croze and moving downwards. (Figure28d)

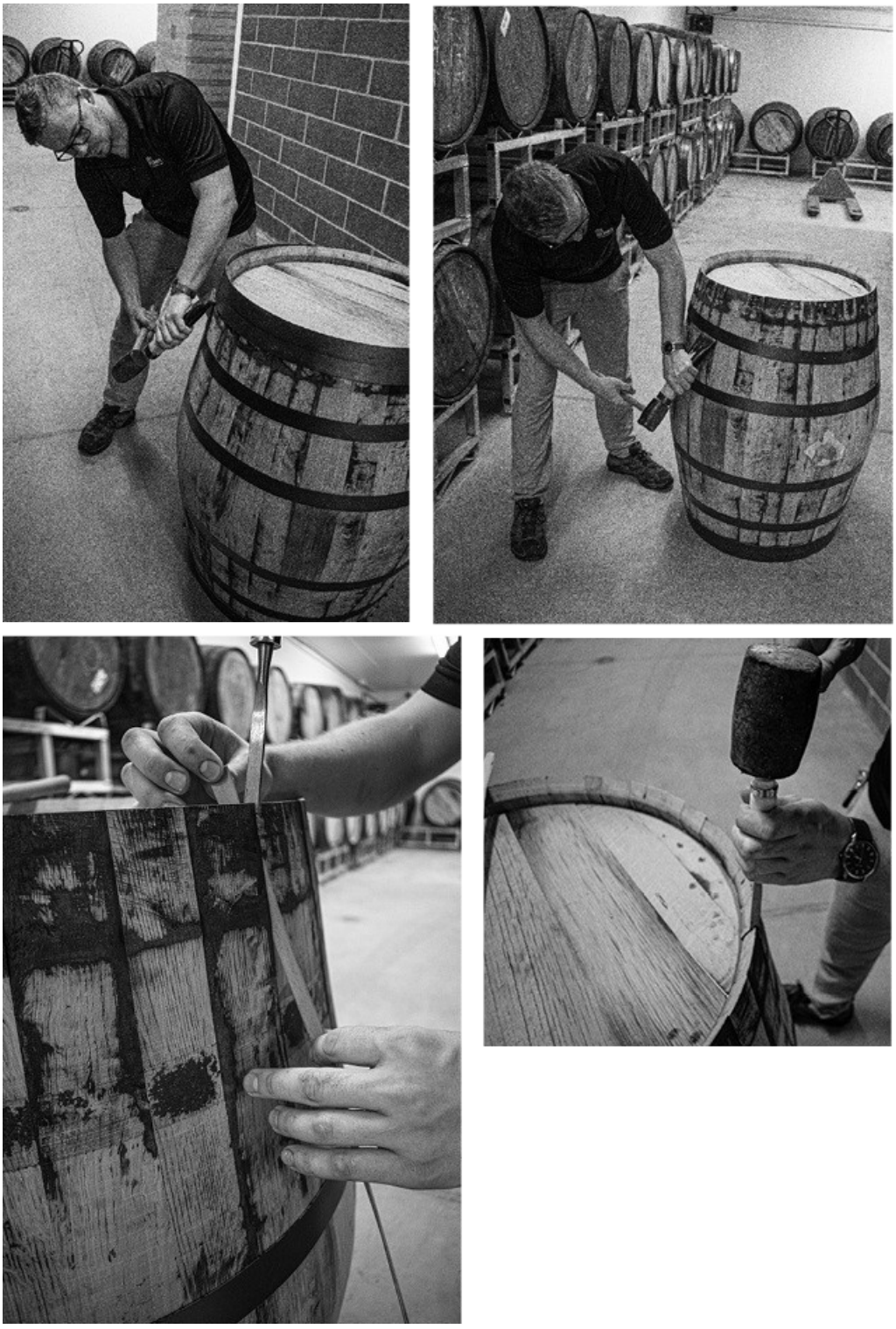
Make sure the heading pieces are set properly in the croze and aligned correctly with thebung.

Put the hoops back on, driving them down with a hammer and hoopdriver.

Fill the cask with a little bit of non-chlorinated water and roll it over onto where the leak was to ensure that you have sealed itcorrectly.

Refill the cask with yourspirit.

Now, what about if you have a leak between heading pieces? You can follow the same steps I have outlined above, but you may only need to remove the topmost hoop. Gently tap between the offending heading pieces with a chisel or flathead screwdriver to separate them slightly. Cut some flagging, insert, and close everything backup.



Figures 28 (clockwise from top left)— 28a, 28b, 28c, 28d

Fixing Leaks in the Croze

This type of leak is one of the most common and they can be incredibly frustrating to fix. Fortunately, many of them will often seal themselves over time, but far too often these leaks are bad enough to warrant physicalintervention.

The first thing I do as always is to pat dry the area and isolate the exact spot where the leak is coming from. Next, I will rotate the cask so that it is not leaking from that point anymore and let the area get completely dry. I will then try to rub some barrel wax or rye paste into the croze. You can use a chisel, flathead screwdriver, or knife blade to work the material deeper into the groove of the croze. Let everything dry or set for an hour or two and rotate the cask back into place to see if the leak has been repaired. Sometimes it takes a fewapplications.

If, after a few days, I can't get the leak to stop, the next step is for me to stand the cask on its head with the leaking croze on top. I will then take my hoop driver and try tightening the top two hoops. Usually I will make a few rounds on them, stop for a bit, come back, and tamp them down somemore.

If neither wax nor hoop tightening works then you have likely got yourself a poorly seated head. This is something that should have been notice in preparation for filling, but sometimes these things get by us. It is also possible in older used casks sitting in the lower tiers of metal racking systems to have this problem from bad weight positioning pushing on their heading from above. Regardless, the only way to fix this is too decant the cask, remove the top two hoops and use a heading tool to properly seat the head into the croze. It requires some elbow grease, but it is a lot better than losing precious spirit down thedrain.

Conclusion

Well, we have reached the end of our journey. Hopefully, you have found the contents in this book useful in some small way and perhaps some of it has inspired you to approach your cask program from a different angle.

I have never considered myself to be the end all, be all of knowledge on any subject and I certainly would not claim that here. I am always learning and constantly searching for new illuminations on all kinds of subjects that will hopefully make me better at my job. This constant and intrepid search for new knowledge is also what makes me love my job and this industry so much. I have always said that I never wanted the title of "Master Distiller" because in my mind, if I've "mastered" the art and science of distilling, then there is nothing more for me to learn. And if there is nothing more to learn then the rest is just boring, and it is time to find a new career. Fortunately for myself and everyone else, this industry is constantly growing, evolving, and offering new challenges. I think there is always going to be something new to learn and so my scholastic and professional journey down the distillation rabbit hole will forever be ongoing.

Our craft is the modern form of alchemy. Shrouded in a secrecy not of our own making, but of nature's. Maybe one day we will have all the answers surrounding the art of distillation, but I seriously doubt that time will come anytime soon.

I have always felt that distillers have it so much better than winemakers or brewers. We take their finished work and carry if forward a few more steps to produce something wholly our own. For many of us the cask provides an incredible opportunity to expand upon that uncanny uniqueness and opens a whole world of flavorful possibilities in the process.

Our products are the sum total of our materials, processes, techniques, climate, and personalities. How we mix those together; how we shape and mold these factors to our wills while maintaining humility in the eyes of mother nature… that is how we make produce a spirit of exceptional quality. And that is how we produce something that tells the story we want to tell.