DISTILLATION - Spiritsfully

HOW DOES DISTILLATION WORK?

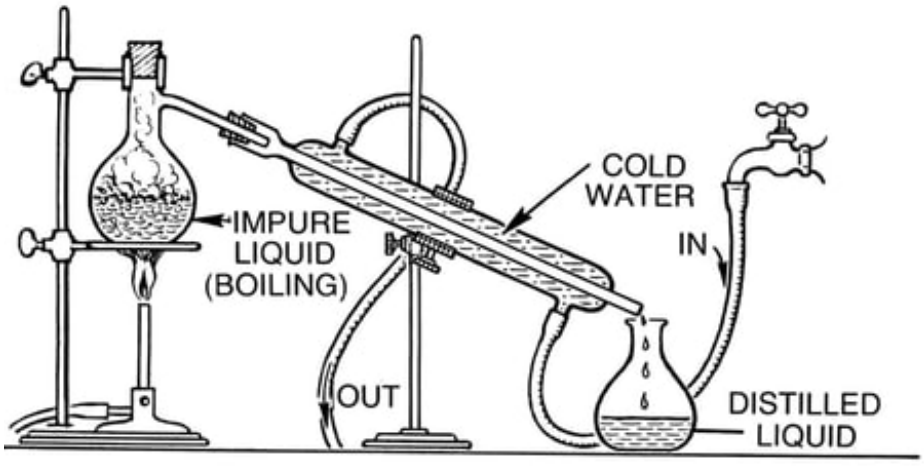
In the context of alcoholic beverage, the distillation process starts once the initial ferment that have different names according to the alcohol that is being made (wine, low wine, distiller's beer, wash, etc) has been obtained.

Distillation is a technique to make alcohol, but also perfume, essential oil, or to purify water. This is a complex process but based on a simple fact: water boils after ethanol. So ethanol will evaporate first in other words, this technique takes advantage of the different boiling points of different liquids that are composing the fermented liquid. Water boils at 100 degrees celcius whereas ethanol boils at 78 degree celcius. They then part from each other when heated. They will condensate into a liquid form when cooled down, at different times, and this is the moment the distiller will seize to collect them separately. The liquid that is getting out of the still first will have a higher concentration of ethanol than the initial water + ethanol mixture.
The notion of boiling point is important to understand if you want to understand how the different styles of stills are working. Indeed a liquid is actually starting to evaporate even before it has reached the boiling point. A boiling point of a liquid is the highest temperature a liquid can reach. At that temperature it can only evaporate. Think water: water evaporates anyway even when nothing happens. If heat is added, water evaporises more quickly. It is also important to understand that a liquid reacts differently according to the nature of the ingredients that is contained in it. For example the more water in a liquid, the higher the boiling point will be.

The distillate is usually collected in three moments starting with the foreshots (or the heads), followed by the heart and the tails (or feints). The different parts of the alcoholic liquid are called fractions. Each fraction has a different range of congeners. The heads and the tails are often whether discarded or redistilled for they are poisonous as such. Some keep them as cleaning agent. The distiller is "cutting" the heads from the heart at precise cut points. This is the experience that leads to the decision as the cut point change according to the type of spirits that is being made.
We mention the word congener some couple of lines ago. Congeners is the general word for everything that is in the distillate before distillation which is no water or alcohol types. They are giving flavours and styles to the spirit. Some spirits need to be very pure, such as vodka, and most of the congeners will be filtered out. For whiskies for example, the distiller pays attention to which one to keep or not to give the desired spirit its character. The boiling point of those congeners can be a way to keep them in or out, as well as their solubility.

Most spirits are double distilled to achieve the desired alcohol level and some are even triple distilled such as Irish whisky or many many times distilled like some vodkas.

Depending on the type of spirit, the producer can either use a pot still or a column still to process to distillation, bother often made with copper.



WHAT ARE THE MAIN STILLS IN USE?

POT STILLS

Pot distilling is the most traditional way of distilling.
The pot is heated underneath, with different techniques involved (see the different categories of spirits to understand the specific techniques). The pot still is like a pot on legs. It is most of the time made of copper (see below) but it can also be stainless still. The form of the pot, quite large at the bottom narrows and curves when getting to the top (swan's neck or lyne arm) over into a thin pipe called the worm. **The shape of the neck helps to separate the vapors. The worm is a coil that is then immersed into cold water. It is at this very moment that the alcohol vapour condensed back into a liquid.**
During the distillation a tool which looks like a little drawer located in the center of the process separates the heads (the first components evaporating) from the heart (good alcohol, also named ethanol) and the feints.

In other words, let's sum up the different parts of a pot still:

- the boiler in which the liquids to be distilled are located, is heated directly on a furnace or serves as a water bath ;
- the top (chapiteau in French) covers the boiler and is provided with a conical tube in which the vapours will rise;
- the swan neck, a tube which was originally conical and arc-shaped (hence the name), then cylindrical and straight on more modern apparatus, which brings the vapours into the condenser;
- the coil or condenser, a helical tube with a vertical axis on the walls of which the vapours condense due to the cooling effect of the liquid circulating around it. The oldest appliances had a rectilinear condenser more or less inclined.

Distillation with a pot still often requires two distillations to achieve a desired proof. The heart (and tails, if heavier congeneers are desired to give additional taste) are distilled again. This is leading us to say that the main characteristic of pot still distillation is the idea of batch process. A first batch is loaded into the still and heated, alcohol evaporates and the resulting end liquid is a low alcohol

distillate named low wine in whisky production of brouillis in Cognac production. After that first batch the still is cleaned, the head and tail discarded and that distillate is distilled again which would produce another distillate with a higher alcohol concentration. Even though that process can be repeated a lot of time it never reach a high level of alcohol concentration meaning also that the type of alcohol produced will have more congeners (which is impacting the taste).
The choice for this technique, pot still distillation, is determined by the desired spirit. And also by the law now given some alcohol category requires a specific pot still to use to keep the consistency and integrity of a category.

FROM A BUSINESS PERSPECTIVE ?

Pot still can have important size nowadays but it is never for industrial production, more for smaller operations. It is still used as it allows creating difference between batches (and what marketing focuses on).

COLUMN STILLS

Columnstills are sometimes also called Coffey Stills or Patent Still. They have been invented in the wave of the industrial revolution (18th century) and **are composed of two tall columns linked to one another.**
Basically it works like a pot still, but the process is never interrupted like it is with the pot still. The liquid-to-distill has to go through the two columns until it becomes a finished distillate which can reach up to 95% abv.

□

The liquid is heated by vapour/steam and then cooled down descending through a succession of perforated plates in the first column (rectifier). Rectification is the process of concentrating the alcohol content in a liquid by repeated distillation. And in a rectifying column, the presence of plates force the liquid to go through many distillations. The steam takes the alcohol out from the initial wash and carries it over to the second column (analyser) where it circulates until it can condense.

The succession of plates agglomerates certain types of congeneers at certain levels allowing the distiller to keep some to achieve a desired taste. The distiller is indeed able to judge in which trays different fractions of the distillation are and can run off the components he/she wants using a series of traps. Alternatively the distiller can continue the process until there isn't any fermented liquid anymore to feed in. Column stills allow more precision.

FROM A BUSINESS PERSPECTIVE ?

This distillation technique allows vast amount of alcohol to be manufactured from the same base, to a high precision and sometimes purity but you can’t have different “batches” with particlar sensibilites and taste. Here the marketing will insist on the purity reached by multiple distillations.

HYBRID STILLS

There are many shapes and sizes for an hybrid still. Basically an hybrid still takes on the characteristics of both column and pot still. It often consists of a rectifying columns seated on the pot still vessel. It

FROM A BUSINESS PERSPECTIVE ?

This type of stills offers more flexibility in terms of production for distilleries who can produce different types of spirits with the same still.

VACUUM DISTILLATION

The difference between the two physical separation methods is that atmospheric distillation occurs under atmospheric pressure, whereas vacuum distillation occurs at a significantly reduced pressure, thus reducing the boiling point of a substance.*
It allows to distilled at a lower temperature and then extract volatile and fragile essences in a way more precise and delicate way. this method allows you to obtain delicate flavours that often disappear with other techniques.

* source of the definition in italics: https://www.sciencedirect.com/topics/chemistry/vacuum-distillation

WHAT IS CALLED REFLUX IN THE DISTILLATION PROCESS AND HOW DOES IT INFLUENCE THE FINAL SPIRIT?

Water boils at 100 degrees Celsius and ethyl alcohol at 78.3 degrees Celsius, but there are lots of other alcohols and congeners that have different boiling points.
During distillation when the alcohols and congeners have vapourised they rise up into the still head and as they get further from the heat source they start to cool. As they condense they fall back down into the still. **These congeners that fall back are called reflux**.
Reflux also takes place in column stills in the rectifier with the heaviest components settling on the first tray and the lighter ones going further up the still and settling on a higher tray. **Reflux influences the final spirit by adding or removing flavour components (congeners) to the final spirit depending on how it is controlled.**
Producers can control the amount of reflux by the size and shape of the head of the still and by the length of the neck. Taller necks mean more congeners fall back into the still, shorter necks mean more congeners pass through the neck into the spirit. Higher temperatures also keep the congeners in vapour form so that they can pass into the spirit and not fall back into the still.
For example, in the case of whisky, the taller and slimmer a still is built, the more the heavier components are retained in the still instead of escaping to the condenser. This will then result in a smoother and milder whisky like for example at Glenmorangie. A short and sturdy shape is not much of an obstacle to heavier components, so here a more intensive full-bodied whisky is created, like Laphroaig.

WHY IS COPPER USED IN DISTILLATION'S APPARATUS?

Both pot and column still have a common point: they are made out of copper. Why ? The main reason is that copper is easy to shape, conducts heat well and reacts with sulphur, removing it from the final spirit. It is also very beautiful and beauty matters.
Or in other words, this metal is chosen for its physical properties (malleability, good heat conduction) and its chemical reactivity with certain components of the distillate.

HOW DOES THE SHAPE OF A STILL INFLUENCE THE FINAL SPIRIT?

There are several reasons for choosing a still. Sometimes they are simply there, inherited from the past. Sometimes they have been purchased second-hand for economic reasons so they may differ from other stills in case they complete an installation. They will influence the final result without having been chosen for it. Sometimes the shapes are also the result of experiments in this field (a good example is the still created by Industry City Distillery in Redhook Brookly that I describe here).
Research on the influence of stills on spirits was rather empirical until the 1980s. For example Charles

Doig is someone who has a lot of experience and is known for the pagoda roofs of his distilleries. You can find more information about him here for example. https://scotchwhisky.com/magazine/whisky-heroes/7007/whisky-heroes-charles-doig/
In the 1980s, we began to better measure the respective influence of the various factors. For example, the base of the still containing the liquid to be distilled has no influence on the result. What has influence is the reflux zone and the swan neck.

Reflux is a phenomenon that helps to determine the proportion of aromatic components in the distillate. Slim stills with a wide swan neck promote significant reflux. There will therefore be more aromatic compounds in the final distillate. On the other hand, in the sturdy stills with a narrow swan neck, there will be less reflux, which will give a more rustic distillate.
Size and height also play a role. Indeed, the temperature drops as you get higher. It will therefore be necessary to ensure the heating temperature to avoid that the heaviest, but also sometimes aromatic components do not remain at the bottom of the tank because they have not had enough heating time to evaporate. Of course, it means using the height is also a way to avoid them eventually. It is also a toll at the disposal of the distiller.

HOW SPEED AND HEAT ALSO INFLUENCE THE FINAL SPIRIT?

Moderate heating results in slow distillation. The vapours rise slowly and do not heat the swan neck. The swan neck remains cold which produces reflux. There will therefore be more light aromatic components in the distillate. On the other hand, a rapid distillation will increase the number of congeners. There will be more rich components in the end.
Another point that plays a role is the length and angle of inclination of the lye pipe connecting the swan neck to the condenser.
It is also possible to increase the reflux of a still by equipping it with a boil ball. A spherical compartment is built in between the shoulder of the kettle and the gooseneck. The vapours that rise from the heating tank expand in this wider and slightly cooler area. The lower temperature causes the condensation of the richest aromatic compounds that fall back into the distillate. Another means of action: a lamp glass. It can also be embedded between the shoulder and the swan neck. It allows to gather more aromatic components

WHAT IS TRIPLE DISTILLATION?

Triple distillation is associated with Irish whiskeys, along with the use of unpeated malt. It started with John Jameson created his triple distilled Irish Whiskey.
How does it work ?
Two of the pots still are used for the first wash distillation, a third distilled the feints, and a fourth one is the spirit still (where the 3 batches will run through distillation). In other words this a more selective process allowing refining the separation of heads, hearts and tails but this is more expensive.
Thanks to triple distillation Irish Whisky, gained market shares over the past 30 years, producing a distinguable style amongst the whiskies of the world.

In the production of Scotch Whisky it is rarely used. Scotch malt whisky is usually distilled twice but there are some exceptions: Auchentoshan and Hazelburn (produced in Springbank distillery) are distilled three times. Benrinnes and Springbank use their own partial triple distillation methods

In the production of Japanese Whisky it is rarely used, as it is modeled on the Scotch Whisky production process, and tn the production of Bourbon, the only producer using that process is Labrot & Graham.
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