LX. On the analysis of wine

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LX. *On the Analysis of Wine.* By C. CHAPTAL.

[Concluded from p. 134.]

NOW that we are acquainted with the faults in the construction of the distilling apparatus, let us try to make an application of it in order to improve the knowledge we have acquired in regard to distillation, and the art of managing the fire.

It appears to me that the whole art of distilling may be reduced to the three following principles :

1st, To heat at once, and in an uniform manner, all the points of the mass of the liquid.

2d, To remove all those obstacles which may confine the ascent of the vapours.

3d, To effect the condensation as speedily as possible.

To fulfil the first condition, it will be necessary that the mass of the liquid should have little depth ; and this requires that the bottom of the boiler should present a very large surface, that the fire may be applied in a great many points.

The bottom of the still ought to be a little bent inwards. This form is attended with two advantages : the first is, that by these means the fuel is at an equal distance from every point of it, and that the heat is uniform throughout ; the second is, that by this construction the bottom of the boiler has more strength, and the matters which may be deposited at the bottom of the liquor are thrown to the angles which rest on the mason work, and where, consequently, it is less dangerous. When this deposit falls upon parts immediately exposed to the direct action of the heat, it forms a crust, which prevents the liquor from being in contact with the part of the boiler covered by it, and the fire then burns the metal. This inconvenience is not to be feared, if the deposit by the curved form of the bottom is thrown into the angles, where it is withdrawn from the direct action of the heat.

The fire must be made to circulate around the boiler by means of a spiral chimney ; in which case none of the heat will be lost, as the whole liquid is surrounded by it, and exposed to its action in an uniform manner.

That the column of steam which rises may experience no obstacle in its ascent, the sides of the boiler ought to rise in a perpendicular direction ; and the steam must be maintained at the same degree of expansion till it has reached the refrigerator. But the steam rising freely, and being condensed by coming into contact with the cool sides of the capital, would fall back into the boiler or body of the still, if the sides were

not inclined in such a manner as to make the drops of the liquid, which attach themselves to them, trickle down into the gutter which conveys them into the worm. I have found by calculation that this inclination ought to be at least 75 degrees to the horizon. It is also necessary that the water of the refrigeratory should be frequently renewed; otherwise it will soon acquire the temperature of the steam, and be no longer able to condense it.

Though these principles in regard to distillation are incontestable, some modifications must be made in them for the purpose of facilitating the operation: by giving to the aperture of the boiler a diameter equal to that of the base, the capital becomes very wide; it is consequently necessary to give it a considerable height, that its sides may have the inclination of 75 degrees. This construction is attended with two great inconveniences: the first is, that it renders the capital heavy, clumsy, and expensive; the second, that it makes it difficult to give to the upper edges of the boiler that strength necessary to withstand the effort of the capital. These considerations induced me to make some changes in the above construction. These changes all relate to the form of the boiler: I make the sides to project a little as they rise, and then bring them nearer to each other towards the top, in such a manner that the diameter of the aperture may correspond to that of the bottom. This form removes the two effects above mentioned, and has the advantage of presenting a border at the upper part, against which the bubbles arising from too strong an ebullition may be broken, and thrown back to the centre of the boiler.

Besides this change in the form of the boiler, I thought it proper to take away the refrigeratory with which the capital was covered, and which was attended with the inconvenience of cooling the steam, and forming a cloud of vapour in the inside, which opposes its further ascension.

It may be observed, that in distilling by means of a retort in a sand-bath, it will be sufficient to apply a cool body to the retort to produce this effect: striæ are immediately seen formed on the sides, and the liquor falls to the bottom of the retort.

If I at first proposed to preserve the refrigeratory, it was because I ascribed to it a part of the effects which depended on a proper construction of the furnace. I, however, afterwards found that a still greater effect was obtained by suppressing the refrigeratory. Besides, this change was more economical, and occasioned less embarrassment.

After this I conceived that the great art of condensing the vapours was confined to enlarging the beak of the capital,

and carefully cooling the worm. By these means the vapours escape from the still with greater facility, as they are admitted into the worm by the speedy condensation of those which preceded them.

These different improvements began to be introduced into Languedoc about fifteen years ago. The brothers Argand greatly contributed to make them be adopted. They first established stills according to these principles, and found them attended with so much saving, in regard to time and fuel, that from the results of comparative experiments it has been estimated at four-fifths.

I have myself superintended several establishments of this kind, where the same principles were adopted. In my opinion, it is hardly possible to carry improvement any further; and it is to be wished that this method of distillation should become general.

But it is not so much to the form of the apparatus as to the construction of the fire-place, and the proper management of the fire, that these extraordinary effects are to be ascribed. The posterior edge of the grate ought to correspond to the middle of the bottom of the boiler, that the flame may fall upon and heat the whole bottom in an uniform manner. The distance between the boiler and the grate ought to be from 16 to 18 inches when coals are employed; and the chimney ought to be spiral.

Besides saving in regard to time, fuel, labour, &c. this form of apparatus has an influence on the quality of the spirit. It is far sweeter than any other, and has no empyreumatic taste; which is a fault almost inseparable from the common spirits used in commerce: this quality, which renders spirits of this kind so superior to others, had almost become cause of their being rejected, because the inhabitants of the north, whose principal beverage this liquor is, found it too sweet. It was therefore necessary to mix it with *burnt* spirit, in order to give it a good name. This fiery taste may be easily communicated to it by maintaining the distillation beyond the usual time. The liquor which passes over towards the end of the operation has evidently a burnt taste.

In the arts, it is necessary to humour the taste and even the caprice of the consumer; and what among us is rejected in consequence of its bad taste, may appear exquisite and delicious to an inhabitant of the north. Burning liquors, which in the north might be accounted weak, are too powerful for the sensible nerves of the inhabitants of the south. Montesquieu has observed with great ingenuity, that to give a Muscovite sensibility you must flay him.

By

By the comparative experiments I have been able to make I am convinced that a little more spirit is obtained by this method than by the old one; the cause of which is, that the spirit issues cool from the apparatus, and sustains no loss by evaporation. The distilleries therefore in which this improved apparatus is employed have no sensible smell of the spirit.

When wines are distilled, the operation is carried on till the moment when the liquor which passes is no longer inflammable.

Wines furnish more or less spirit, according to their degree of strength. Very generous wine furnishes a third of its weight. The mean term of the product of our wines in the south is a fourth of the whole: there are some which furnish a third.

Old wines give better spirit than the new; but they furnish a less quantity, especially when the decomposition of the saccharine body has been terminated before the distillation.

What remains in the boiler after the spirit is extracted is called *vinasse*: it is a confused mixture of tartar, colouring matter, dregs, &c. This residuum is thrown away as useless; yet by drying it in the air, or in a stove, very pure alkali might be extracted from it by combustion.

In some distilleries the *vinasse* is acidified, in order to be distilled, and to extract from it the little vinegar that has been formed in it.

The spirit is stronger according as it is mixed with a greater or less quantity of water; and as it is of importance in commerce to be able to ascertain easily the degrees of strength, many researches have been made to discover the means of determining it.

The distiller judges of the strength of the spirit by the number, size, and permanency of the bubbles which are formed when the liquor is shaken: for this purpose he pours it from one vessel into another, lets it fall from a certain height, or, what is more common, puts it into a long flask, which is filled two-thirds, and then shakes it violently, keeping the mouth shut with his finger. This last apparatus is called in French *la sonde*.

The proof by combustion, in whatever manner performed, is very defective. The regulation of 1729 prescribes putting gunpowder into a spoon, covering it with liquor, and setting fire to it. The spirit, if it inflame the powder, is considered to be of the first quality: when the contrary happens, it is bad. But liquor of the same quality inflames, or does not in-

flame, according to the proportion employed. A small quantity always inflames; a large one never, because the water which the liquor leaves is then sufficient to moisten the gunpowder, and to secure it from inflammation.

Recourse has been had to salt of tartar (carbonate of potash) for trying the strength of spirits. This alkali dissolves in water, but not in alcohol, so that the latter floats on the solution which is formed.

These methods, more or less defective, have rendered it necessary to try other means capable of determining the strength of spirit, by ascertaining the specific gravity.

A drop of oil poured upon alcohol fixes itself on the surface, or is precipitated to the bottom, according to the degree of the strength of the liquor. This method was proposed, and adopted by the Spanish government in 1770: it formed the object of a regulation; but it is liable to error, since the effect depends on the height of the fall, the gravity of the oil, the size of the drop, the temperature of the atmosphere, the dimensions of the vessels, &c.

In 1772 this important object was resumed by two able philosophers, Borie and Poujet, of Cette, who made known to the distillers of Languedoc a new areometer, which they adopted. They applied to it a thermometer, the different degrees of which indicate at every instant the corrections that ought to be made in the graduation of the areometer, in consequence of the very variable temperature of the atmosphere.

By the help of this areometer, not only may the degree of strength be ascertained, but the spirit may be carried to any point required; for this purpose different weights are provided. The heaviest is marked *Dutch proof*, the lightest *three-sevenths*: if the weight marked Dutch proof be therefore screwed to the lower extremity of the shank, and if the instrument be immersed in liquor of *three-sevenths*, it will sink a great deal too much, but it may be brought back to Dutch proof by adding four-sevenths of water.

On the other hand, if the weight *three-sevenths* be screwed to the shank, and if the areometer be then immersed in liquor Dutch proof, it will rise above the last term, and may be easily brought back to that degree by adding stronger alcohol.

When spirit is distilled for the purpose of extracting alcohol from it, a *balneum marie* is commonly employed: the heat is then more gentle, and more uniform, and the product of the distillation is of a better quality: this product is the common spirit of wine used in commerce.

3d, *Tartar*.

3d, *Tartar*. Tartar exists in verjuice: it is found also in must: it concurs to facilitate the formation of alcohol, as we have already observed from the experiments of Bullion. It deposits itself on the sides of the casks in consequence of rest, and forms there a crust of greater or less thickness, rough, with crystals very badly determined. Some time before the vintage, when the vessels are getting ready for receiving it, the casks are opened, and the tartar is taken out, to be employed in commerce and for various other purposes.

Tartar is not furnished by all wines in the same proportion. Red wines give more than the white. The highest coloured and thickest generally give the most.

The colour of the tartar also varies very much, and it is called *red* or *white*, according as it is produced from either of these wines.

This salt is very little soluble in cold water: it is much more so in boiling water. It scarcely dissolves in the mouth, and resists the pressure of the teeth.

It is freed from its colouring principle by a simple process, and is then known under the name of *cream of tartar*. For this purpose it is dissolved in boiling water, and, when the water is saturated, the solution is put into earthen vessels to cool: as it cools, it precipitates a stratum of crystals which are already almost free from colour. These crystals are again dissolved in boiling water: four or five per cent. of an argillaceous and sandy kind of earth, found at Murviel, near Montpellier, is diffused through the solution, and it is then evaporated to a pellicle. On cooling, it precipitates white crystals, which being exposed in the open air on cloths for some days, acquire that whiteness which belongs to cream of tartar. The mother-waters are reserved for being employed in new solutions. Such is the method practised at Montpellier and in its environs, where the principal part of the manufactories of cream of tartar are established.

The tartar is employed also as a flux: it is attended with the double advantage of furnishing the carbon necessary for the deoxygenation of the metals, and also alkali, which is one of the best fluxes known.

Tartar is purified also by calcination. Its acid is decomposed and destroyed by this process, and there remains then nothing but the alkali and the charcoal: the alkali is dissolved in water, the liquor is filtered, and, being then concentrated, that salt known in the shops under the name of *salt of tartar*, or *carbonate of potash*, is obtained.

The alkali furnished by tartar amounts only to one-fourth of its weight.

4th, *Extractive matter*. The extractive principle abounds in must. It appears to be dissolved in it by the help of the sugar; but when the fermentation changes the nature of the saccharine principle, the extractive matter sensibly decreases. A portion brought back then almost to the state of fibrine matter is precipitated: the deposit is the more sensible as the fermentation slackens, and as the alcohol is more abundant. This is what constitutes in particular the lees. These lees are always mixed with a pretty considerable quantity of tartar, which it envelops.

There always exists in wine a portion of extractive matter which is in perfect solution, and from which it may be freed by evaporation. It is more abundant in new wines than in old. The older they grow, they seem to be the more completely freed from it.

These lees, after being dried in the sun or in a stove, are well pressed, and then burnt, to extract that sort of alkali called in commerce *wood ashes*. The combustion is effected in a furnace, the sides of which are raised in proportion as it takes place: the residuum is a porous mass, of a greenish gray colour, which forms about the thirtieth part of the lees burnt.

Wines are freed from these lees by drawing them off, in order to preserve them from acid degeneration.

5th, *Aroma*. All natural wines have an odour more or less agreeable. There are some, even, which are indebted for a great part of their reputation to the agreeable odour they exhale. This is the case with Burgundy wine. This perfume is lost by too tumultuous a fermentation: it becomes stronger by age. It rarely exists in very generous wines; either because it is concealed by the strong odour of alcohol, or because the strong fermentation which has been necessary to develop the spirit has extinguished or dissipated it. This aroma does not appear susceptible of being extracted, to be communicated at pleasure to other substances. Heat even seems to destroy it; for, except the first liquid which passes over by distillation, and which retains a little of the odour peculiar to wine, the spirit which comes after has no longer the characters that essentially belong to it.

6th, *The colouring principle*. The colouring principle of wine exists in the pellicle of the grapes. When the must is fermented without the skins, the wine is white. This colouring principle does not dissolve in the vintage but when the alcohol is developed in it; and it is only then that the wine becomes coloured. The colour is stronger according as the fermentation has been more tumultuous, or as it has been left longer in the vat. Mere pressure of the grapes by treading

treading them, if done with care, may mix with must a quantity of colouring matter sufficient to make the mass assume a very intense colour. When it is required to obtain wine free from colour, the grapes are collected while the dew is upon them, and they are trod as little as possible.

The colouring principle is in part precipitated in the casks along with the tartar and the lees; and when the wine is old, it is not uncommon to see it entirely free from colour. The colour then deposits itself in pellicles on the sides of the vessels, or at the bottom: it is seen floating in the liquid like films, which render it turbid.

If bottles filled with wine be exposed to the sun, a few days will be sufficient to precipitate the colouring matter in large pellicles; and the wine loses neither its perfume nor its qualities. I have often made this experiment on the old highly coloured wines of the south.

To precipitate the principle of the colour, nothing is necessary but to pour lime water into the wine. In this case, the lime combines with the malic acid and forms a salt, which appears in the liquor under the form of light flakes. These flakes gradually deposit themselves, and carry with them all the colouring principle. The deposit is black or white, according to the colour of the wine employed for the operation. It often happens that wine is susceptible of forming a precipitate, though it has been completely freed from its colour by a first deposit; which proves that the principle of the colour has strong affinity to malate of lime. The coloured precipitate is insoluble both in cold and in warm water. This liquid even produces no change in the colour. Alcohol has scarcely any effect upon it, only it acquires from it a slight tint of brown.

The nitric acid dissolves the colouring principle of this precipitate.

When wine has been reduced to the state of extract, the alcohol poured over it becomes strongly coloured, as well as the water, though in a less degree. But, besides the colouring principle which is then dissolved, there is also a saccharine extractive principle which facilitates the solution.

The colouring principle, then, does not appear to be of the nature of resins; it presents all the characters belonging to a very numerous class of vegetable products, which approach very near to feculæ, without having all their properties. The greater part of colouring principles are of this kind: they are soluble by the assistance of extractive matter, and when freed from this medium they become fixed in a lasting manner,