Controlled barrel toasting: soon a reality!

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Introduction

Toasting is a vital stage in the production of a quality barrel. The research that Seguin Moreau has been pursuing for more than 10 years at the Faculté d’Oenologie in Bordeaux has made it possible to characterise the ideal conditions for heating wood to bring out the best aromas, at the optimal concentration for the different types of oak and wine.

We were the first to specify the thermal characteristics of traditional toasting and to identify the modifications in the structure and composition of the wood that are so important in the ageing of wines. We were also pioneers in innovation and in the control of barrel toasting. A automatic controlled toasting, using infrared heaters enabling the perfect reproduction of the traditional toasting cycle, was developed and patented in 1992. This principle makes it possible to guarantee optimal reproducibility through a perfect control of the heating temperature. The performance and value of this technique were assessed with both red and white wines. Certain producers now prefer to use this type of barrel rather than barrels traditionally toasted over a wood fire. This method of heating can be customised to meet the requirements of those who want a particularly precise toasting and perfect reproducibility. This is the only process capable of meeting that level of requirement. However, for both technical and economic reasons, it is neither desirable nor possible to toast all barrels in this way. The problem of the total mastery and precise control of toasting therefore remains.

The cooper today can guarantee to implement the best means of production and obtain the result required by the producer, thanks to all the research accomplished to date. At the current stage of our research, however, we can look forward to guaranteeing not only the implementation of means but also a commitment to the end result. The difference is enormous! Thanks to objective measurements, it should be possible to certify to the user that the wood and the toasting of the barrels ordered will correspond exactly to his demand.

The end user is not really concerned with knowing that the barrel has been heated to such or such a temperature and whether the speed of heating has been monitored. What matters most for him is the result of the development of a production process adapted to the quality of the wood and its effect on the wine.

Following analysis, in the laboratory, on reference samples (taken from staves toasted in the cooperage) to select the sturdiest and most efficacious sensors for discrimination of the various levels of toasting (results not presented), the classifications were then verified with the ‘electronic nose’ to ensure that they were identical to those given by the chemical analysis. The measurements were recorded after the end of toasting without ever in any way altering or interfering in the work of the master-coopers.

Development of control in industrial conditions

Definition of measurement conditions

Toasting is controlled after the drawing following the heating stage, during the rest phase and during the cooling of the barrels prior to trimming. An initial experimental phase made it possible to define the ‘optimal’ measurement conditions.

For each sensor, the response signal follows an identical curve. The intensity of the signal and the shape of the resultant curve are, however, specific to each individual sensor (Figure 1).

Necessity of rapidly closing the shell

The maximum time between the end of toasting and the drawing of a barrel is 8 minutes. Within that time, the temperature of the wood drops regularly. The volatile compounds escape the heated wood, as the shell is not closed. The intensity and the profile recorded by the electronic sensors evolve rapidly (Figure 2). It is therefore important to close the shell fairly rapidly to limit the loss of compounds through volatilisation.

The electronic nose is connected to the shell by a Teflon tube with an inside diameter of 2 mm connected to the pumping system (500 mL/min). The system is flushed with synthetic air (a mixture of 80% nitrogen and 20% oxygen) after each measurement. The shells are closed by a lid specially drilled for that purpose through which air is drawn into the middle of the shell. Air injection and analysis by the electronic sensors takes 30 seconds. The air is maintained at a relative humidity of 20% using CaCl₂.

Evolution of the response of the sensors during waiting prior to measurement

The maximum response from the sensors, for the same barrel, varies according to the time between the end of toasting, the closing of the barrel and the waiting time for the measurement. It is difficult to measure all the barrels coming from the press instantaneously. Whilst the experimental study identified that an injection of 20 or 30 seconds was enough to obtain a sufficiently strong and usable signal, it took much longer
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Figure 2. Evolution of the response of sensors (vertical axis) against time in seconds (horizontal axis) for a barrel left open for differing times (0, 7 and 14 minutes).

Figure 3. Mean evolution of the maximum response of sensors (mean of 6 measurements) and of the temperature (both vertical axis) against time in seconds (horizontal axis), for a closed barrel.

The time between the end of toasting and the closing of the barrel depends on the production of the workshop. There is little scope for reduction, as it is directly linked to the number of barrels reaching the end of toasting. We measured the evolution of the intensity and of the profile of various electronic sensors for a number of barrels closed immediately after drawing (i.e. 3 minutes on average as from their removal from the fire). Figure 3 describes the evolution of the maximum intensity measured and of the temperature of the wood against the waiting time once the barrel was closed.

It can be seen that the maximum signal intensity starts by rising up to 6 minutes, then slowly decreases. The possible measurement range thus spans a period from between approximately 6 and 15 minutes, whereas the temperature of the wood decreases slowly and regularly.

We then had to verify that the profiles measured were in fact identical between 6 and 15 minutes. Multi-dimensional statistical analysis in principal components (PCA) showed that the first measurements at 3 minutes were widely spaced and therefore considered to be heterogeneous. The other measurements were much more clustered. Discriminating factorial analysis made it possible to differentiate each measurement time (3, 6, 9, 12 and 15 minutes), but the last three practically overlap each other.

The acquisitions at 12 (N’ 4), 15 (N’ 5) and 18 (N’ 6) minutes easily overlap in a single cluster. The acquisitions at 6 (N’ 2) and 9 (N’ 3) minutes are not very different from this group. Consequently, it is possible to measure profiles that cannot be differentiated statistically between 6 and 18 minutes following the closure of the barrel coming from the press, which makes the work much more comfortable.
Controlling the quality and the level of toasting can thus be achieved either semi-automatically or entirely automatically.

**Control of quality and reproducibility of toasting in the workshop**

The results obtained are particularly interesting. Thanks to the constitution of a reference toasting database, to enable the ‘electronic nose’ to differentiate between light, medium and heavy toasting, it is now possible to test any barrel (with a prior unknown level of toasting) to check that its level of toasting does in fact match that ordered.

Measurement is fast (60 seconds), without immobilising the barrel, as the control is included in the normal flow of production. The ‘nose’ is reset in less than five minutes using synthetic air. The electronic nose can check approximately 200 barrels a day.

**Conclusions**

The use of the control system we have devised makes it possible to differentiate and control the various levels of toasting used by Seguin Moreau. The application devised by Excell for Seguin Moreau is covered by an international industrial protection. It is therefore now possible to envisage the practically perfect elimination of all the toasting accidents which were so difficult to detect in the past. The colour of the fired wood, often used to estimate toasting, is, in fact, a very poor indicator. The odour of the wood smelt immediately after toasting using a human nose is also ineffective. Insufficient, or worse, excessive toasting could consequently occasionally go unnoticed. In the absence of any outside control, only the strict observance of a precise toasting process and the professionalism of the coopers enabled work of regular quality to be obtained.

To enhance even further the toasting quality of Seguin Moreau barrels, it is now possible to envisage the addition of a new tool to the irreplaceable know-how of man. The industrial and economic feasibility study is currently ongoing and should enable in the near future the implementation of real controlled toasting, while keeping the ancestral method of fabrication developed over the centuries.