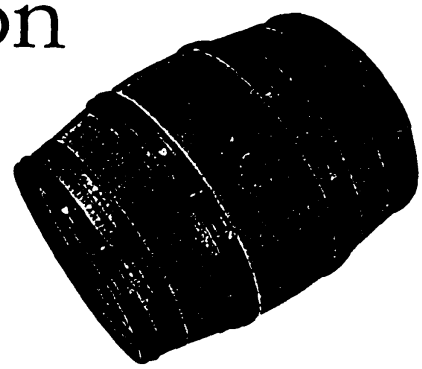
Racking of red wines nurtured in barrels

A tentative classification of racking techniques



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Racking is an operation which separates or withdraws the clear wine from the layer of coarse sediments or lees formed at the bottom of the barrel or vat.

The composition of the sediments varies with time:
- When the alcoholic and malolactic fermentation processes are over, the lees consist of yeasts and bacteria undergoing autolysis, remnants of skin, stalks and seeds from the harvest, acidic polysaccharides (grape polysaccharides) and proteins precipitated with the tannins.
- At the end of the first winter, the lees contain the yeast and bacteria biomass, acidic polysaccharide deposits, colloidal colouring substances and acidic potassium tartrate.
- By the end of the first summer, the lees are considerably leaner, consisting mainly of yeast wall and colour substance precipitates.

Besides the elimination of deposits due to natural decanting the effects of the racking process are completed by the introduction of oxygen and removal of carbon from the wine. The amount of oxygen dissolved during the racking process greatly influences the future development of the wine whose quality and aging potential will depend very much on how the oxygen dissolution process is envisaged and planned (frequency, quantity).

To our knowledge, there is no previous comparative study of various racking techniques and their effects on the dissolution of oxygen. This article looks at both questions.

Classification of racking techniques

We based our classification on a) the method used to displace and collect the wine and b) whether aeration was performed.

Displacement modes:

a) Gravimetry: the wine flows out naturally from the barrel and is collected below.
b) Pumping: the wine is pumped from the barrel into a container.
c) Pressure: a "blower" or compressed air system expels the wine very quickly from the barrel into a container.

Reception containers:

a) Barrel: handling operations are reduced to a minimum. When transferring the wine, the barrel can be filled from the top (bunghole) or the bottom ('escape hole') according to the amount of aeration wanted.
b) Temporary container: this may be a small container used to collect the wine before transferring it directly into a barrel. This method necessitates a faucet under the barrel.
c) Container for aeration: a very large container is used that can hold the contents of a whole barrel (190 to 230l) in order to aerate the wine. The surface area/volume ratio is adjustable.

Aeration techniques:

a) Limited Aeration: in this case, the wine is transferred from one barrel to another through a series of pipes, without passing through a temporary container. A flow of nitrogen can also be used to push the wine from one barrel to another, avoiding the risk of aerating the wine by pumping it.
b) Forced Aeration: the wine column can be broken by placing a horizontal barrier perpendicularly to the wine flow. A layer of wine 2 to 6 mm thick is formed, facilitating the rapid penetration of oxygen. A pump emulsifying the wine and oxygen also allows extensive oxygen penetration. Lastly, oxygen saturation is ensured by pouring the wine into the top of an empty vat or barrel.

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Evolution of dissolved oxygen content and oxydo-reduction potential after racking

The analysis of a large number of similar profiles obtained with various Bordeaux appellations from several grape varieties (merlot noir, cabernet sauvignon, cabernet franc, malbec, petit verdot) and several vintages (1991, 1992, 1993 and 1994) yields comparable results.

The oxygen dissolved in the course of a racking operation (6mg/*l*) is absorbed by the wine constituents in 8 to 10 days, depending on the temperature of the wine cellar and the phenolic content of the wine. The oxydo-reduction potential (EH in mV) requires 10 to 15 days to return to its initial level. But the EH evolution goes through three different stages of varying intensity according to the wine concerned:
- A short phase of increase and decrease of the EH value, related to the oxygen concentration, directly in relation with Nernst's law;
- A phase of varying intensity during which the EH drops below its initial level, indicating a reduced medium;
- A third phase, with a longer EH increase, independent of the oxygen concentration, that brings oxydo-reduction nearly back to its initial level. However, the final value of EH depends on the wine's degree of oxidation. During the first racking operations in young wines, EH at equilibrium is higher after racking than before racking. EH at equilibrium becomes stable when wines have been racked 2 to 4 times.

Laboratory tests in a temperature-controlled chamber show that oxygen saturated wine evolves in a similar way. Moreover, these observations are confirmed by catechine hydroalcoholic or ascorbic solutions.

Effect of racking on the composition of wine and bacteria populations

Tests showed that racking had little effect on total acidity, pH and alcohometry titer. ▶

The volatile acidity increases slightly to 0,02g H2SO4/l on average (extreme values <0,01 g H2SO4/l and 0,05g H2SO4/l).

On the other hand, there was a marked increase in the quantity of acetic acid, measured with the enzyme method. Ethanol has a similar evolution, though to a lesser degree. Furthermore, in some cases, we noted that a few days after racking, the ethanol content decreased at the same time as the acetic acid content increased. The increase in total SO2 is related to the filling of sulpherized barrels after racking.

We also noted an increase of lactic and acetic bacteria populations during the first days after the wine was aerated. When there is no longer any dissolved oxygen, the number of bacteria decreases regularly, then levels out.

Influence of the temperature of wine on the dissolution of oxygen

Oxygen penetration is faster at low temperatures; simultaneously the saturation rate of the wine is higher: at 10°C the wine is saturated at 9,7 mg oxygen/l, whereas at 30°C it is saturated at 5,5 mg oxygen/l. Yet the oxygen is consumed at a much slower rate at lower temperatures (3 to 4 times more slowly), thus limiting any risk of oxidation.

Influence of racking techniques on the penetration of oxygen

Table 2 groups together the main results obtained in the Médoc and Libourne areas for 1991, 1992 and 1993. Results represent the mean values of dissolved oxygen for each racking method. Measurements were made with a Clarck electrode.

It must be specified that the dissolution of oxygen during racking apparently does not depend on the composition of the wine. Some recent studies (VIVAS *et al*, 1993) show that the capacity of wine to dissolve oxygen does not differ significantly from that of a model medium (hydroalcoholic medium at 12% volume and 5g of tartaric acid per litre). It thus appears that the racking method and the temperature are the two main factors to be considered to determine the degree of oxygenation of wine.

Measuring the dissolved oxygen content after using various racking methods shows, on the one hand, that the aeration induced by the racking process allows a large amount of oxygen to pass through (3,5 to 8 mg/l) and on the other, that "air-tight" racking methods do let in a far from negligible quantity of oxygen (2 to 3 mg/l).

Conclusion

These results on the influence of racking techniques on the dissolution of oxygen have enabled us to better understand the effects of various racking techniques on the degree of oxygenation of wine.

Studying the kinetics of dissolved oxygen and the oxydo-reduction potential after racking has allowed us to determine that wine needs 15 to 20 days to reach a new equilibrium after an intake of oxygen (2,5 to 7,5 mg/l). Studies currently in progress, in conditions of practice, should help find different ways by which racking operations can be adapted according to this new information. In the long term, we believe that raking frequency and the nurturing period could be rationalized by measuring the oxydo-reduction potential at regular intervals.

The deliberately synthetic presentation in table form of our results also helps to provide objective indications as to the effect of any given technique on the amount of air introduced into wine. With this knowledge, rationalizing and adjusting the racking process can be contemplated.

De Solla visits Demptos

Peter Peck and Darryl Simpson of De Solla Agencies with Jérôme Francois of Demptos Cooperage in St Caprais, Bordeaux. At the restructuring of the 200 year old firm in 1970 the first 225 litre barriques were brought to South Africa. In 1980 the firm also established a production facility in California. After the death of a proprietor in 1989, the cooperage was sold to the prestigious Burgundian coopers, Francois Frére, which makes the Francois family one of the biggest purchasers of wood in France, although each cooperage retains its identity. Demptos maintains a close relationship with the Institute of Oenology at Bordeaux University. Nicolas Vivas, the author of the accompanying article on racking, is responsible for research and development. One finding: wood should not be seasoned in the open for longer than 24 months; too much is then leached out of the wood.

Table 1: Effect of racking on evolution of bacteria populations and composition of wine

Times (days)	t0	t+3 days	t+15 days	t+60 days
Free SO2*	19	25	20	22
Total SO2*	58	70	68	64
Volatile acidity**	0,45	0,45	0,46	0,49
Acetic acid (g/l)***	0,53	0,55	0,59	0,62
Acetaldehyde (mg/l)***	17	12	18	20
Lactic acid bacteria****	4.10e3	2.10e4	2.10e3	1.10e1
Acetic acid bacteria****	1.10e3	3.10e3	1.10e4	8.10e2

*mg H2SO4/1 - ** Method CAZENAVE-FERRE (gH2SO4/l - *** Enzimatic method - **** nbr viable bacteria cell/ml

Table 2: Incidence of racking techniques and temperature on oxygen dissolved

Displacement of wine flow	Reception containers			Aeration technic	Temperature (°C)	Dissolved oxygen content	
	Intermediate container	Blending	Barrel			Before	After racking
Gravity	–	–	+	–	15	0,5	2,7
	–	–	+	Filling through bunghole	15	0,3	3,4
	+	–	+	–	15,5	0,4	4,5
	+	–	+	Barrier perpendicular to the flow	16	0,3	5,5
	+	+	+	–	12	0,4	7,8
	+	+	+	–	18	0,4	6,2
Pumping	–	–	+	–	8	0,3	3
	–	–	+	–	12	0,3	2,4
	+	–	+	–	8	0,5	4,1
	+	–	+	–	16	0,2	3,5
Pressure	+	–	+	Barrier perpendicular to the flow	15	0,4	5,5
	–	–	+	–	16	0,3	3,1
Pumping with Nitrogen	+	–	+	–	16	0,4	4,8
	–	–	+	–	8	0,3	2,2
	–	–	+	–	15	0,2	2,1
	–	–	+	–	17	0,3	2,4