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Micro-oxygenation of wine in presence of dissolved carbon dioxide

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Abstract

Techniques for micro-oxygenation of wines are now accepted practices in wine manufacturing. But, at present time, only wine tasting and empirical know-how are used to control the oxygen input. Our work aims at a better control of oxygen input in wine, where oxygen plays a role through its solubilization and its consumption by various substrates in the wine. This work aims at implementing concepts from conventional chemical engineering, i.e., mass transfer between two fluid phases, to rationalize, quantify and master the oxygen input during or just after vinification, in respect to the quantities demanded by the wine processing. In particular, the work presented here concerns the incidence of dissolved carbon dioxide in wine on oxygen transfer. This parameter must be considered when the micro-oxygenation is applied during or after alcoholic fermentation. This study shows that the presence of dissolved carbon dioxide affects strongly the efficiency of the transfer of oxygen to the liquid: it almost decreases one order of magnitude when carbon dioxide concentration changes from 0 to 1.4 g/L. For convenience and reproducibility, experiments were performed on synthetic solutions, but part of the results was validated on real wine. An explanation based on a simplified physical description is proposed.

Keywords: Absorption; Aeration; Bubble columns; Mass transfer; Micro-oxygenation; Wine

1. Introduction

All along vinification and ageing, as well as during ageing of the bottled wine, oxygen is a major actor in the wine transformation. It has a beneficial role in many steps of the wine making process (increase of the yeast population, colour stabilization, etc.), but oxygen may also be detrimental when present during specific steps (oxidation, growth of micro-organisms, etc.).

Solubilization of oxygen into broths or wines occurs when gaseous oxygen is brought into contact with the liquid. This is on purpose, as when aerated withdrawals are operated, (where oxygen concentration from 3 mg/L up to saturation can be obtained, (Moutounet and Mazauric, 2001)), or when hyper-oxygenation or micro-oxygenation are operated. This may also be an unavoidable side effect of filtration, cooling or bottling operations (Castellari et al., 2004).

Oxygen of the surrounding air may easily dissolve into grape broths and wines. But, in contrast with nitrogen or carbon dioxide, oxygen, when dissolved, is quickly consumed, as it is involved in numerous mechanisms of oxydo-reduction reactions. Phenolic components from the grape are the main consumers of oxygen (around 60%) (Fabre, 1994). Therefore, red wines exhibit faster consumption kinetics than white wines (Moutounet and Mazauric, 2001). Other components may be involved in this consumption, like ethanol (around 20%), resulting in the formation of ethanal, and sulfur dioxide (around 12%).

Oxygen input to wine, and therefore its consumption, may vary all along the vinification. White wine broths are very oxidation sensitive, because of their low antioxidant content. To insure better stability for these wines, hyper-oxygenation, a technique using vigorous oxygen bubbling, is operated to induce browning reactions due to polyphenol oxidation (Getaz and Fabre, 1990; Schneider, 1991, 1998). The consequences of this technique upon the vinification process, used only on white broths, has been described (Artajona et al., 1990; Blanck, 1990; Dubourdieu and Lavigne, 1990; Meistermann, 1990).

During alcoholic fermentation, oxygen input improves fermentation kinetics and decreases the risks for fermentation failure, by increasing cell viability at the end of the fermentation

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