Role of membrane processes in wine making and stabilisation

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Winemaking belongs to the industries that relies on centuries old traditional techniques in the manufacturing process. However, even this industry has been considerably modernised in last decades. In the phase of stabilisation and filtration of wine, membrane separation processes are becoming more and more important. The main argument for introducing membrane processes in winemaking is reducing the operating costs – to save time and energy. In our research, we primarily focused on using membrane separation processes in two steps of wine making: wine stabilization – to reduce of potassium bitartrate if it's needed, and final filtration - to provides microbiological stability of wine before the bottling

Electrodialysis

Electrodialysis is the membrane separation process that has been certified for use and achieved a certain success in winemaking. It's used to provide a tartrate stability and is an alternative to the cold stabilisation of wine (removal of cream of tartar) where applied. Unlike filtration, elektrodialysis significantly affects the composition of wine – it affects mineralization of wine partially removing electrolytes (potassium, calcium, organic acids, sulfates etc.), it affects pH, acidity and slightly the alcohol content as well. Demineralization of wine by elektrodialysis expressed by decrease in conductivity is limited, typically to less than 20 %, more preferably to less than 10 %, due to the possible impact of the process on the organoleptic properties of wine such as color, aroma and taste. It is obvious, that preferential removal of potassium and (bi)tartrates is required to achieve the desired tartrate stability at a minimum demineralization degree, although potassium content also affects the taste of wine. However, this requirement is limited by the selectivity of commercially available ion-exchange membranes.

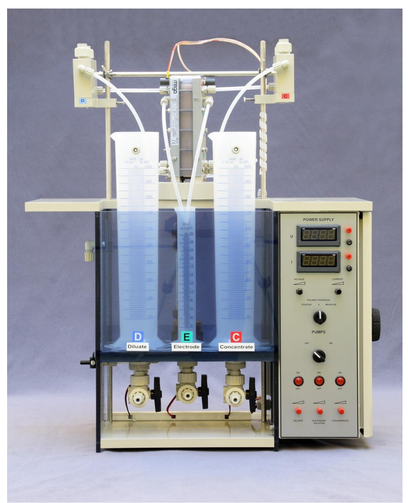

Figure 1: Photo of electrodialysis equipment ED-Z

Figure 2: Photo of heterogeneous ion-exchange membranes

Due to these reasons, the kinetics of removal of the individual species from several kinds of wine was extensively studied using a lab-scale ED system. Commercially available ED-Z stack from MemBrain s.r.o. and heterogeneous RALEX® CM-PES and AM-PES ion-exchange membranes from MEGA a.s. were used. Diluate (wine) samples were periodically taken for analysis (conductivity, pH, composition, saturation temperature).

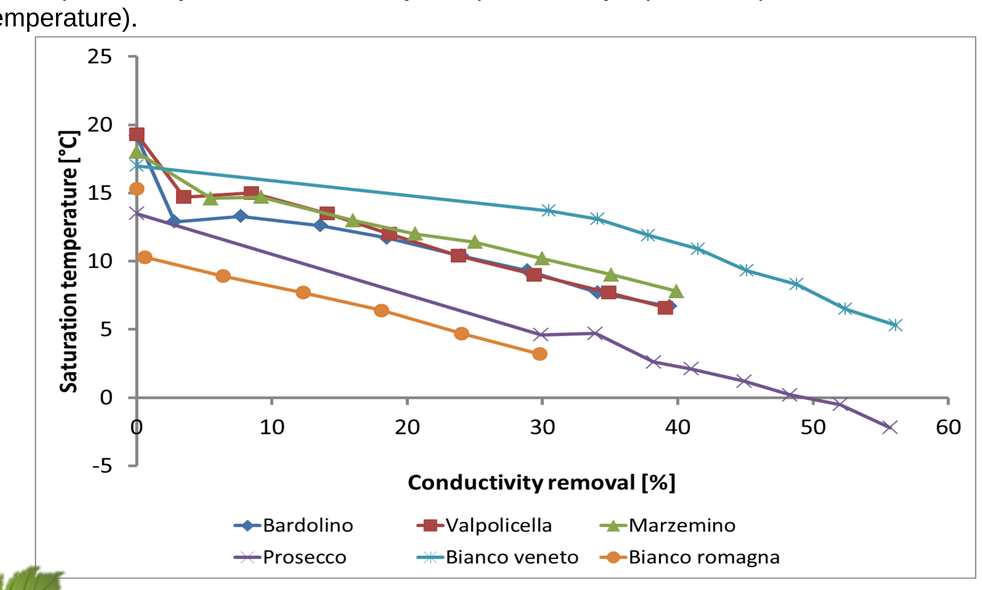

Figure 3: Saturation temperature vs. conductivity removal from wine

Conclusion: From the results of the experiments we can see, that it is necessary to remove 40 to 60 % of conductivity from an unstable wine to achieve an absolutely stable product (the saturation temperature close to the freezing point of wine, that is in the range of -4 to 0 °C). Although wine is usually stable due to the slow kinetics of potassium bitartrate precipitation even if the temperature is substantially below the saturation temperature, typically by 10°C, it is still necessary to remove 10 to 30 % of conductivity from an unstable wine by ED to provide the desired tartrate stability, which significantly limits applicability of ED for wine stabilization.

The experimental data obtained in this work, if treated properly, can be useful to decide, whether ED is suitable for stabilization of a given kind of wine or not.

Cross-flow microfiltration

Cross-flow microfiltration was primarily tested in winemaking in the 80's of last century. The process was not accepted by the market from many reasons in those days, especially due to the undesirable hydro-mechanical and heat effects on wine, rejection of some components affecting the quality of wine and high cost. In last decade, a significant progress has been reached in this field; novel microfiltration membranes and devices have been developed specially for use in winemaking, as well as other issues have been eliminated. Recently, microfiltration began to be more and more popular in winemaking and it`s used mainly as a final filtration step as an alternative to diatomaceous earth filtration.

We performed a series of pilot-scale microfiltration tests for filtration of white wines from Moravia using a polymeric membrane. The main purpose was to remove colloidal particles from wine and to eliminate microbiological contamination.

Figure 4: Photo of cross-flow microfiltration equipment

Figure 5: Photo of microfiltration module with polymeric membrane

Before and after the test, each wine was analysed both chemically and microbiologically. After two months, the microfiltered wines were evaluated by oenologists. Totally seven kinds of white wine, five kinds of red wine and one rose wine were tested:

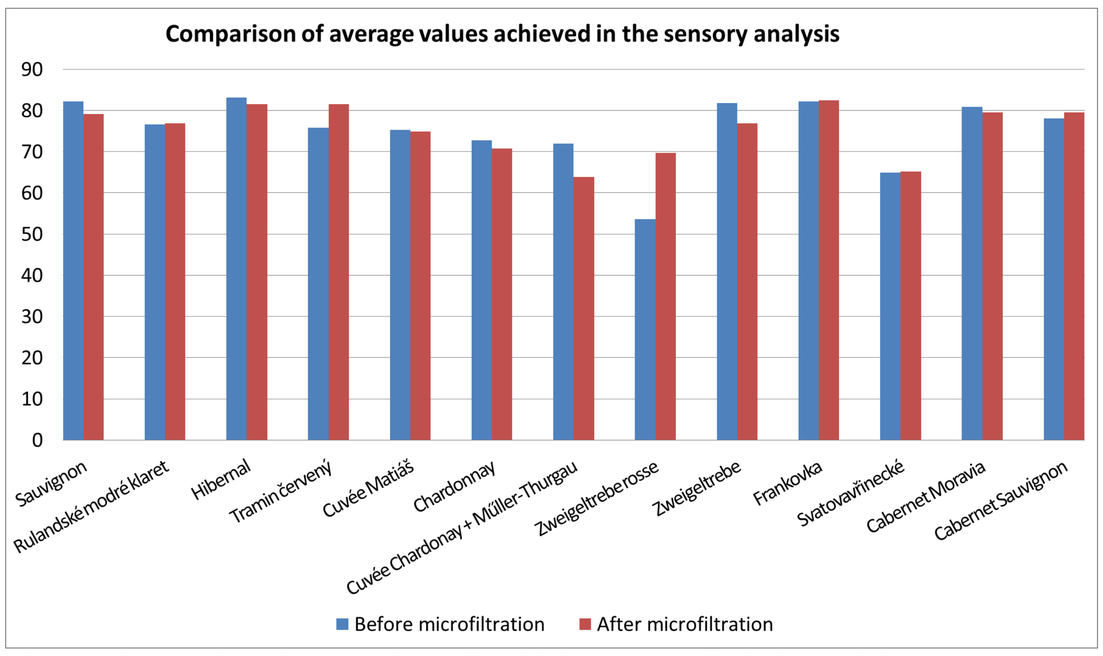

Figure 6: The comparison of average values achieved in the sensory evaluation by oenologists

Conclusion: The results of chemical, microbiological and sensory analysis were found to be satisfactory and the winemakers evaluated microfiltration as an excellent method for wine clarification. Due to results of chemical and sensorial analysis, the cross-flow microfiltration slightly changes the content of aromatic and extractive substances, but on the other hand, prevents problems caused by microorganisms. Original samples were therefore better outcomes (7 of 13) than wine after cross-flow filtration, but in the remaining cases (6) wines has problems with microbiological stability. Cross-flow filtration proved to be a convenient solution for wine, produced from blue grapes, especially for claret from Pinot Noir and Rosé varieties of Zweigeltrebe, where the difference between filtered and unfiltered wine most pronounced in favor of. For white wines, the most proven for microfiltration is the variety of Gewürztraminer.

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