Contribution ID: **1074** Type: **Poster Presentation**

Swelling of oak wood in water-ethanol mixtures : impact of the liquid composition on the material deformation.

Wednesday, 24 May 2023 16:10 (1h 30m)

Aging is a key milestone of spirits production during which mass exchanges occur between brandies and the external environment. The barrel is a complex porous media made of oak wood and acting as a container [1]. During aging, the liquid present in a barrel partially impregnates the wood and migrates as liquid state. In the outer, non-impregnated part of the stave, vapour concentration gradients trigger diffusion. These mechanisms are responsible for a volume loss from 1% to 3% per year, depending mainly on environmental conditions [2]. In addition, wood is not an inert interface since the presence of water and ethanol modifies its physical properties.

The hygroscopic nature of wood is responsible for adsorption as bound phase when in contact with aqueous solutions or liquid ethanol. Such adsorption causes swelling of the wood due to its sub parietal macromolecular structure. In the case of barrels, the mechanical assembly of the staves hinders the free swelling of the wood and thus creates mechanical constraints that improve the sealing between staves. However, the coupled effects of water, ethanol and time on the cell wall are not fully understood. Because of the diversity of alcohol content of the brandies, it appears relevant to study the effect of the liquid composition on the wood swelling. Previous studies highlighted dimensional changes in pure ethanol to be lower than in pure water [3][4]. This work focuses on oak wood dynamics and equilibria when soaked in pure water, pure ethanol or binary mixtures. A custom device has been developed to determine the evolution of swelling in both transversal directions as a function of the liquid composition, through image processing. Eight ethanol concentration values have been tested from 0% to 100% (vol/vol). As shown in the attached figure (a), a synergic effect is evidenced for a wide range of concentration from 20% to 80% of ethanol (vol/vol). This is in accordance with previous studies that have reported a higher swelling than with pure solvents [3][5]. This suggests a collaborative action of sorption sites when both solvents are in sufficient quantity. To complete these experiments, we studied sequential scenarii namely pure water followed by pure ethanol and vice versa (b). Results show that wood slightly shrinks when put in ethanol after having swelled in water. Thus, it seems that only a part of the previously bound water remains adsorbed onto wood while another part is desorbed due to its affinity with ethanol. On the contrary, when the chronology of pure liquids is inverted, the previously mentioned synergic effect is observed leading to the same swelling values as for mixtures between 20% and 80% of ethanol (vol/vol). Such results emphasize the influence of the history between wood and liquids.

To complete the study, a Dynamic Vapour Sorption device will be used to obtain sorption isotherms of oak wood for both water and ethanol in gas phase. This equipment allows also to study the reversibility of interactions between wood and vapours.

Participation

In-Person

References

[1] del Alamo-Sanza, M., & Nevares, I. (2018). Oak wine barrel as an active vessel: A critical review of past and current knowledge. In Critical Reviews in Food Science and Nutrition (Vol. 58, Issue 16, pp. 2711–2726). Taylor and Francis Inc. https://doi.org/10.1080/10408398.2017.1330250

[2] Mosedale J.R., & Puech J.L. (1998). Wood maturation of distilled beverage. In Trends in Food Science & Technology (Vol. 9, 95–101).

[3] Meier, P., Kaps, T., & Kallavus, U. (2005). Swelling of Pinewood (Pinus Sylvestris) in Binary Aqueous Solutions of Organic Substances. In MEDŽIAGOTYRA (Vol. 11, Issue 2). https://www.researchgate.net/publication/228473291

[4] Mantanis, G. & Young, R.A. & Rowell, R. (1994). Swelling of Wood. Part II. Swelling in Organic Liquids. In Holzforschung (Vol. 48, 480-490). 10.1515/hfsg.1994.48.6.480.

[5] Bossu, J., le Moigne, N., Corn, S., Trens, P., & di Renzo, F. (2018). Sorption of water-ethanol mixtures by poplar wood: swelling and viscoelastic behaviour. Wood Science and Technology, 52(4). https://doi.org/10.1007/s00226-018-1022-1ï

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

France

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary authors: Mr DUSSAUT, Cédric (Laboratoire Génie des Procédés et Matériaux); COLIN, Julien (CentraleSupélec); Mr CASALINHO, Joel (Laboratoire Génie des Procédés et Matériaux); Mr LITOUX-DESRUES, François (Chêne & Cie); Mr TEISSIER DU CROS, Rémi (Chêne & Cie); Mrs ABADIE, Charlotte; Mr PERRÉ, Patrick (Laboratoire Génie des Procédés et Matériaux)

Presenter: Mr DUSSAUT, Cédric (Laboratoire Génie des Procédés et Matériaux)

Session Classification: Poster

Track Classification: (MS04) Swelling and shrinking porous media