SUCCESS STORY

**Wood K plus**
**WOOD: next generation materials and processes – from fundamentals to implementations**

Program: COMET – Competence Centers for Excellent Technologies

Program line: COMET-Center (K1)

Type of project: Advanced Biomass Utilisation: Processes for sustainable Biorefineries, 2020; multi-firm


# MORE EFFICIENT MEMBRANE SEPARATION THROUGH BETTER UNDERSTANDING OF MOLECULAR INTERACTIONS

MOLECULAR LEVEL INTERACTIONS CAN STRONGLY INFLUENCE MEMBRANE SEPARATION PROCESSES. WOOD K PLUS HAS INVESTIGATED HOW THEY AFFECT INDUSTRIAL MEMBRANE FILTRATION PROCESSES IN THE CELLULOSE BASED BIO-REFINERY.

The biorefinery plants of Lenzing AG produce pulp and various cellulose fibers such as viscose, lyocell or modal. Acetic acid and furfural with high purity are obtained as co-products from the waste liquor of pulp production. Several membrane separation processes are used along the entire value chain.
Membrane separation processes separate the individual components of a solution mainly based on their size and consequently, their diffusion coefficients. Pressure driven membrane processes show great potential for the separation of process streams and especially the thickening of diluted solutions, since this technology is less energy-intensive than thermal separation processes (e.g. rectification). In the field of seawater desalination for drinking water production, membrane technology (reverse osmosis) has already almost completely replaced its thermal counterpart (distillation). In the field of complex mixtures with numerous different components, as they occur in pulp and fiber production, the application of membrane plants has not been implemented to such great extent so far. To increase the presence of membrane technology in this industrial field, it is necessary to be able to predict the behaviour of the membrane performance as accurately as possible, based on the composition of the feed solution. The separation behaviour of a membrane process is mainly dependent on two influencing factors, on the one hand the interaction between membrane and the dissolved molecule and on the other hand the interaction between the dissolved molecules

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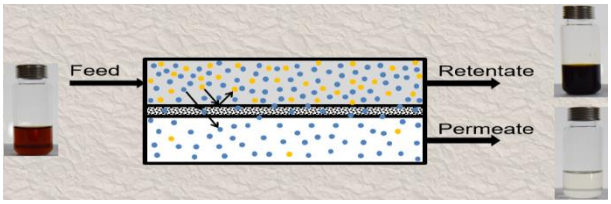
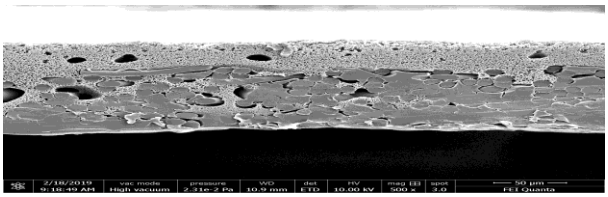
themselves. For simple systems, these interactions have been well known for decades. However, the influence of intermolecular interactions in multi-component solutions on the membrane separation behaviour has been insufficiently investigated up to now.




*Sketch of a cross-flow nanofiltration plant (©Schlackl)*

**The impact of intermolecular interactions**

Within the COMET project "Advanced Biomass Utilisation: Processes for sustainable Biorefineries" two representative process streams of pulp and fiber production were selected and the effects of the intermolecular interactions were systematically studied. In the field of pulp production, experiments were carried out with sulfite lye and corresponding synthetic model solutions. By using model solutions, it was possible to show, for the first time, which interactions are responsible for molecules migration in a direction opposite to their original diffusion direction. Such behaviour has been observed and published several times by other research groups, but an explanation in the particular chemical system has not yet been successfully delivered. In addition, interactions of model substances with lignosulfonate - a polymeric structure of phenolic components - were investigated in detail. Both types of interactions were found, increasing and some decreasing the process efficiency. In viscose fiber production, membrane processes can be used to purify caustic soda solutions enabling their reuse in the process. The investigations carried out showed that interactions between organic acids and dissolved xylan have a high influence on the performance of the membrane separation unit.



*SEM measurement of the cross section of a used membrane (©Schlackl)*

**Benefits of the results for industrial processes**

Due to the application oriented experimental setup, the results can be directly applied to industrial membrane filtration plants. The efficiency of one studied application within a production unit could be increased by approx. 50 % due to changes in process design and the use of more suitable membranes. The corresponding production plant trials have already started at the industrial site and the first results are expected in the first half of 2021. Furthermore, the findings will be used for the planning and design of new bio-refinery and decarbonisation concepts. Due to the gained insights, membrane technology is increasingly considered a key technology.

**Project coordination (Story)**
Klaus Schlackl, PhD
Project Leader
Wood K plus

T +43 (0) 7672 – 701 2088
k.schlackl@wood-kplus.at

**Wood K plus**
**Kompetenzzentrum Holz GmbH**
Altenbergerstraße 69
4040 Linz
T +43 (0) 732 2468 – 6750
zentrale@wood-kplus.at
www.wood-kplus.at

**Project partner**

- Lenzing AG, Austria
- Johannes Kepler University, Austria

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