Wydział Chemiczny

Zakład Inżynierii Chemicznej

„ Separation of volatile aroma compounds from water solutions with use of pervaporation”

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The aim of this PhD study was to develop an effective and efficient method of volatile aroma compounds concentration from model aqueous solutions as well as from real fruit juice hydrolates with use of pervaporation process. Pervaporation has a high potential for recovering of natural and natural identical aroma compounds, highly diluted in complex aqueous media, due to its high selectivity, modular design, ability to operate under mild conditions and low energy consumption.

Flavors are one of the most important parameters that determine the quality of food products, therefore they decide on the acceptance of the product by the consumer. Nowadays aroma compounds are mostly separated in thermal processes: distillation under reduced pressure, steam distillation, solvent extraction process or adsorption processes. The main disadvantage of thermal processes is large losses of aroma compounds or their degradation caused by number of isomerization or cyclization reactions. This situation requires use of innovative methods that would allow for separation of fragrance ingredients under mild conditions but with the high efficiency. Pervaporation, as one of the clean technology, can become the innovative and economic alternative technique for conventional processes.

Pervaporation (PV) is a membrane separation process where some components from a liquid mixture permeate selectively through a dense membrane and evaporate on a downstream side of the membrane. In order to accurately describe the pervaporation process, it is essential to identify the exact mechanism of mass transfer through the selective layer of the membrane as well as optimal process parameters and membrane properties.

The present PhD thesis describes four main investigation stages. In the first step one of the most important objective was to evaluate the effect of membrane properties and thickness on the aroma compounds recovery from model aqueous solutions by pervaporation process. In order to accurately describe the exact mechanism of the aroma compounds mass transfer through the selective layer of the membrane the main aim of the second stage of the present study was to investigate the applicability of the original Flory Huggins theory and its two modifications, proposed by Hildebrand and Mulder in the modeling of the sorption equilibria in the pervaporation of binary and multicomponent aroma systems. A better understanding of the mass transfer mechanism is essential for e.g. improving the process of designing new pervaporation membranes or for scale-up studies. In the next stage the effect of operating parameters such as feed concentration (composition), temperature and flow rate on flux and selectivity in PV of model, multicomponent fruit juice solution was determine. The three-factor Box−Behnken design (BBD) coupled with RSM was used in order to evaluate the optimal operational conditions and to analyze the interactions between independent factors

and system responses. In the last step of this investigation, pervaporation of real apple, cherry and black currant hydrolate fruit juices were performed in semi-technical scale.

Presented in this PhD study results clearly demonstrated the great potential of pervaporation for recovering aroma compounds from diluted model and natural aqueous solutions. Pervaporation can be directly applied in industry, especially due to the growing demand of various branches of the economy on clean and highly economic technologies and its great selectivity towards volatile organic compounds.