TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

FricDiff: a novel and innovative separation process

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Abstract 1842 - FricDiff: a novel and innovative separation process

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FricDiff: a novel and innovative separation process

Multi-scale and/or multi-disciplinary approach to process-product innovation

Novel Separation Techniques (T3-8)

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One of the major disadvantages of the separation processes that are currently used in the (petro-)chemical industry is their high energy-consumption. This is particular the case for distillation, the most widely applied industrial separation technology. In addition, hazardous chemicals are often required to facilitate the separation. Over the past years, the interest for membrane separation processes, like pervaporation, vapor permeation and gas permeation has grown tremendously. The relatively low energy consumption and the fact that no additional chemicals are required, makes these processes interesting candidates to replace distillation. In spite of major efforts in universities and research institutes, membrane processes are still not suitable to replace distillation. The fluxes through the membranes are still too low, requiring large membrane areas. Furthermore, the ceramic membranes that are used are very fragile and expensive, whereas polymeric membranes have a low chemical and thermal stability. In order to find a solution for these drawbacks, an alternative separation technology called □FricDiff□ was developed at Eindhoven University of Technology.

FricDiff is a novel and energy-efficient separation process that can be used for the

separation of both gas and liquid mixtures. With this technology, a gas or vapor mixture (the liquid mixture is first evaporated to bring it in the vapor phase) is separated by letting it diffuse through a third component. This third component, which is called the enhancer, is a permanent gas (in case one wants to separate a vapor mixture) or a condensable vapor (when the mixture we want to separate is a gas mixture) that will show more friction with one component in the mixture. This component will, while interdiffusing, be more retained by the enhancer, leading to an enrichment of this component in the retentate. The separation process takes place inside a non-selective porous barrier (macro porous membrane) with the feed mixture and enhancer flowing at opposite sides of it. The advantage of using a macro porous barrier instead of a selective micro porous membrane, is that the fluxes through the barrier are much higher. Furthermore, the barrier can be made of a robust and relatively cheap material, like stainless steel.

In this project, the applicability of FricDiff for the separation of azeotropic mixtures of alcohols and water is studied. Experiments are performed with a lab scale experimental set-up and compared with results obtained with 2 computer models developed in the program Aspen Custom Modeler. The first model describes the mass transport in the tubes (at opposite sides of the porous barrier) with a plug flow and assumes that the mixtures are perfectly mixed in the radial direction. The second model is a more detailed model, which takes into account axial velocity profiles and radial concentration gradients and velocities. In this case, the effect of concentration polarization on the separation can be examined. In both models, the mass transport through the porous barrier is described with the Binary Friction Model. The influence of process conditions (e.g. absolute pressure, ratio of flow rates of feed mixture to enhancer) and the geometry and characteristics of the porous barrier (e.g. pore size, thickness of the porous barrier) on the separation are studied. In this way, the FricDiff-process can be optimized for the separation of a specific mixture.

Presentation time: Tuesday 18, 13:40 to **14:00**, in session *Novel Separation Techniques (T3-8)*.

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