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**CAPWA, water and energy recovery from flue gasses**

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Currently, many industrial processes in the food, paper, cement, energy and petrochemical sectors consume vast quantities of fresh water. At the same time, global water resources are steadily decreasing and the production of (demineralized ) water becomes more and more difficult. Therefore it is crucial to find sustainable ways to produce water and re-use the waste streams of industrial processes.

At the same time plants in fossil fuel-based power, pulp and paper industry consume large quantities of water which are emitted as vapor into the atmosphere. From these processes a significant amount of water could be recovered by water vapor capturing, appurtenant benefits are reduced energy costs. Water recovery would be especially beneficial for industrial plants located in arid areas.

Commercially available dehydration processes in industry are nowadays carried out by using condenser or desiccant systems. The use of membrane systems offers some technological and economic advantages above these conventional systems. Not only high-grade water from flue gases is recovered, but also the undesired presence of corrosive components in the water or the use of desiccant can be avoided. The system is easy to scale-up and operate, while a minimal energy is required.

Figure 1: Membrane test modules in an actual flue gas duct of a waste to energy plant for capturing water from flue gas

The objective of this research is to optimize and improve the recovery of water from gas streams using novel gas separation membranes, as well as transferring this technology from lab scale to industrial scale. Membrane modules will be placed in the flue gas ducts of power plants, in a cooling tower and in the hood outlet of a paper or board factory. For this purpose a thermally and chemically stable membrane with a low tendency to foul is needed.


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To achieve such a membrane a thermally and chemically stable dense layer was coated on a Polysulfone (PES) support. After satisfactory results in the lab-tests several modules with a membrane area of 0.94 $m^2$ each were constructed and tested in real flue gas streams. In Figure 1 the membrane modules for the pilot tests are shown. The first pilot tests were performed at a paperboard factory. The tests were carried out using a relative humidity (RH) of 100 % at 55 °C, a flow speed of 1 m/s and a vacuum pressure on the inside of the membranes of 97 mbar. Promising results of 2.2 $L \cdot m^{-2} h^{-1}$ water production were found. After some membrane optimization higher water production could be expected.

At the same time, new membrane materials were investigated to further improve the membrane performance. For the membrane optimization different hydrophilic polymers combining both a high water over nitrogen selectivity and a high water vapor permeability were selected and evaluated as potential candidates for the dehydration of gas streams.

The selected polymers were characterized by water vapor kinetic sorption isotherms. The newly developed composite membranes were characterized in terms of morphology by Scanning Electron Microscopy (SEM) and in terms by performance on their water vapor, nitrogen permeation and fouling characteristics.

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