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Membrane SF: Hybrid membrane process to remove emerging pollutants

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Introduction

The removal or/and recovery of volatile organic compounds (VOCs) from gas or liquid is a major issue in terms of minimizing the environment impact of numerous industrial processes. No destructive VOCs capture technologies are preferentially used to enable the recycling of a large ratio of the emitted compounds. Our work relates to new membrane processes "Membrane SF" for extraction of pollutants by multichannel tubular membrane coupled with ionics liquids (ILs) [1]. This process will find applications for the treatment of traces of pollutants in a liquid or gaseous fluid, for example, the removal of small pollutants from an aqueous stream in industrial waste water, separation of aromatic compounds from a hydrocarbon feed in petrochemical applications and the removal of water traces in products of high added value as pharmaceutical, cosmetic or bio-carburant. Moreover, this hybrid membrane process improves the membrane separation technology allowing specific separation (functions of the ILs used) and easy manufacture and regeneration. It provides a high-efficiency and environmentally friendly device and process to purify wastewater and industrial waste gas.

Material and Methods

The membrane we used is tubular multichannel ceramic membrane. At least one channel enables the fluid to go through and at least one channel is filled with ILs. Channels, which contain the ILs, were sealed by glue on each extremity to keep the ILs inside. The experimental devices and the structure of membrane SF are presented in *Figure 1*. There are several steps of processes to remove pollutants, including the step of extraction and the step of regeneration. Different pollutants were used (VOCs, water, CO_2) to demonstrate the feasibility of this new concept for gas

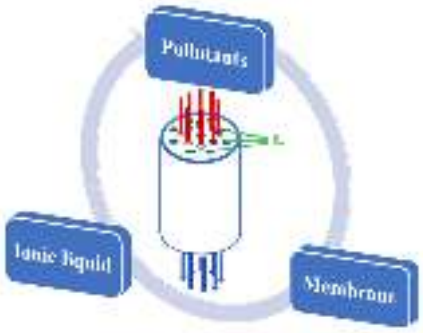

Figure 1. Steps of extraction with the Membrane SF Process

and liquid effluents. The influence of operating conditions including temperature, flow rate, and pressure was studied. Moreover, this new concept “membrane SF” was compared to adsorption or absorption processes for some applications. This new concept was also used to protect VOCs sensors [2] from humidity, which currently is one of the weaknesses of chemical sensors for low concentration detection

Results and Discussion

The removal of VOCs was estimated as a function of the mass of ILs from toluene, benzene, xylene and chloroform. For batch application, the removal factor decreased versus time due to the ILs saturation but the outlet concentration was very low during long time. For removal of humidity, it was demonstrated that “membrane SF” can remove a high quantity of water and a good reproducibility is obtained in terms of adsorption (error range lower than 10%) but also in terms of “membrane SF regeneration”. The operating conditions (temperature, pressure and flow rate) were studied to optimize this regeneration step. As can be seen in Figure 2, the response of a metal oxide gas sensor used to measure the concentration of BTEX was influenced by the environmental humidity. The "membrane SF" placed upstream has a double action, on the one hand it greatly reduces the humidity dependence of the sensor response, on the other hand it improves the sensor response stability. (Figure 2).

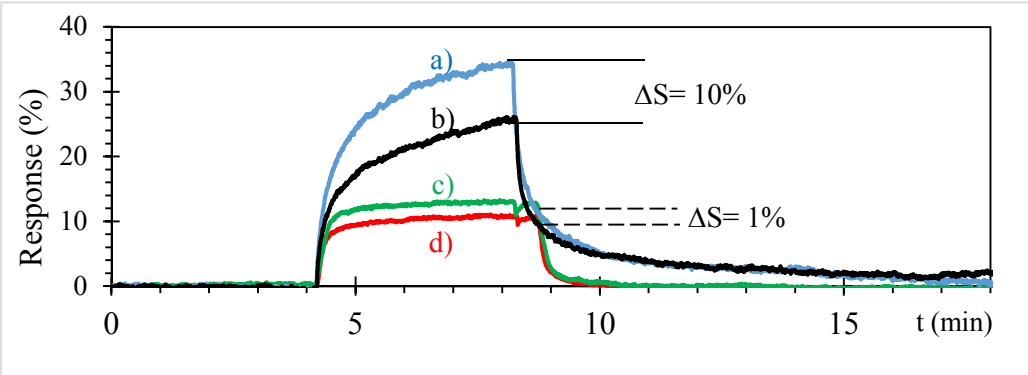

Figure 2. Sensor response for 500 ppb of BTEX without membrane SF a) in dry air b) in wet air (50% RH) and with membrane SF c) in dry air, d) in wet air (50% RH)

Conclusions

For membrane application, we have developed a new concept “membrane SF” which provides a membrane separation technology enabling specific separation, and improvement in the fabrication and regeneration processes.

References

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