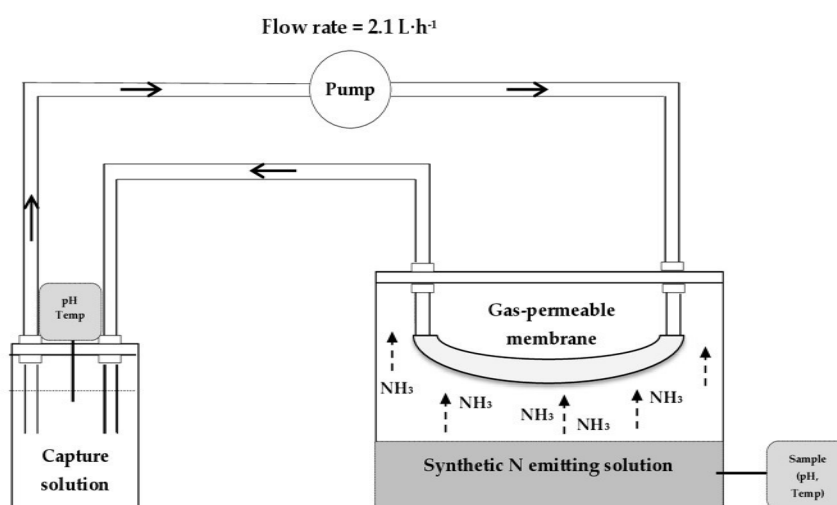


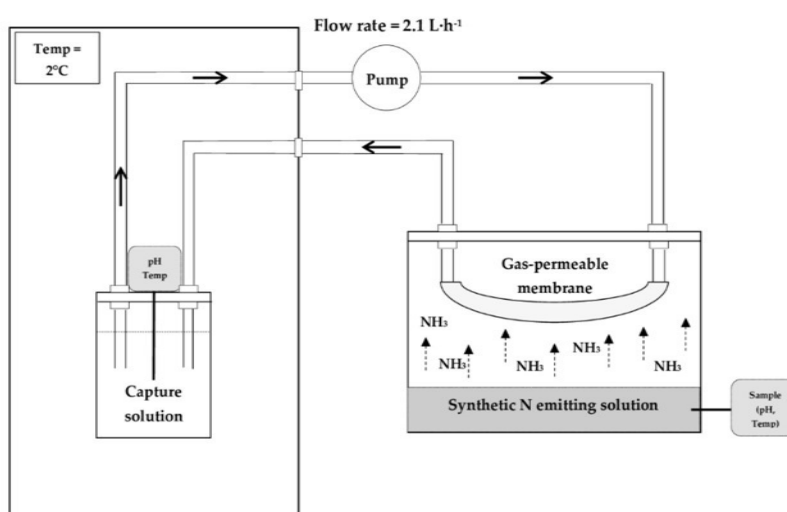
# Evaluation of different adsorbents for ammonia recovery in suspended gas permeable membrane systems

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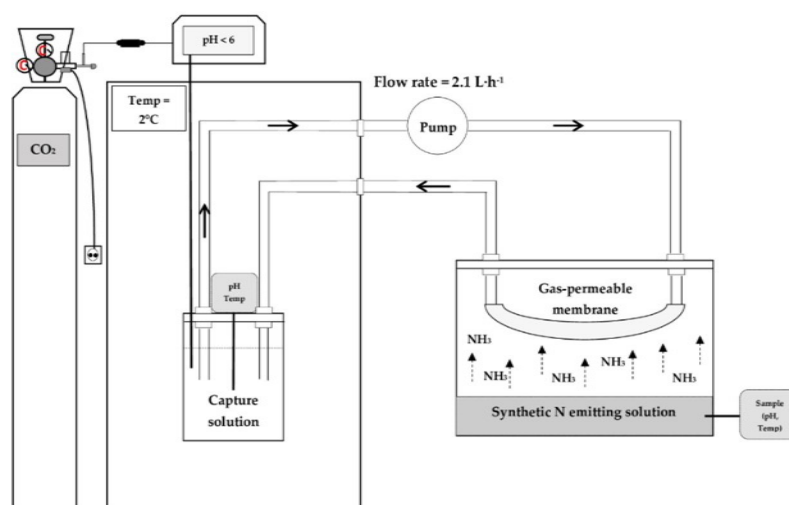
## SUPPLEMENTARY MATERIALS



**Figure S1.** Scheme of the  $\text{NH}_3$  capture process by the suspended gas-permeable membrane system in a closed circuit using different trapping solutions at  $25^\circ\text{C}$ . Reproduced from [Membranes, 2021, 11(7):538; DOI: 10.3390/membranes11070538] under CC BY 4.0 license.



**Figure S2.** Scheme of the  $\text{NH}_3$  capture process by the suspended gas-permeable membrane system in a closed circuit using different trapping solutions at  $2^\circ\text{C}$ . Adapted from [Membranes, 2021, 11(7):538; DOI: 10.3390/membranes11070538] under CC BY 4.0 license.



**Figure S3.** Scheme of the  $\text{NH}_3$  capture process by the suspended gas-permeable membrane system in a closed circuit using carbonic acid as the ammonia trapping solution at 2 °C. Reproduced from [Membranes, 2021, 11(7):538; DOI: 10.3390/membranes11070538] under CC BY 4.0 license.

**Table S1.** Characteristics of the e-PTFE membrane used in the experiments.

Length (cm)	100
Outer diameter (mm)	5.2
Width of the wall (mm)	0.64
Polymer density ( $\text{g}/\text{cm}^3$ )	0.95
Porosity (%)	< 60
Average pore size length ( $\mu\text{m}$ )*	$12.7 \pm 5.9$
Average pore size width ( $\mu\text{m}$ )*	$1.3 \pm 0.9$
Absorption surface ( $\text{cm}^2$ )	163.4

\* Pore sizes are average values across 10 membrane samples characterized by Scanning Electron Microscopy (SEM).

**Table S2.** Summary of operation and chemical costs, as well as end-product market prices, for the eight ammonia trapping solutions under analysis.

<b>Operation costs</b>	
<i>Pumpdrive 5001 peristaltic pump</i>	
Electrical consumption (kWh)	0.1
Cost (€/kWh)	0.3
Weekly electrical consumption (kW/7d)	16.8
Weekly cost (€/7d)	5.0
<b>Chemical costs</b>	
<i>Acid consumption</i>	
Sulphuric acid (g)	51.3
Phosphoric acid (g)	38.3
Nitric acid (g)	96.6
Carbonic acid (g)	59.1
Acetic acid (g)	60.1
Citric acid (g)	64.0
Maleic acid (g)	58.6
<i>Acid cost</i>	
Sulphuric acid (€/L) / (€/kg)	47.6 / 87.1
Phosphoric acid (€/L) / (€/kg)	44.9 / 80.4
Nitric acid (€/L) / (€/kg)	37.4 / 52.0
Carbonic acid (€/L) / (€/kg)	- / 89.5
Acetic acid (€/L) / (€/kg)	46.4 / 48.7
Citric acid (€/kg)	- / 81.2
Maleic acid (€/Kg)	- / 105.8
<b>Fertilizer bulk prices</b>	
Ammonium sulphate 21% (€/kg)	0.69 <sup>[1]</sup>
Diammonium Phosphate (DAP) 18-46-0 (€/kg)	1.09 <sup>[1]</sup>
Ammonium nitrate 34,5% (€/kg)	1.08 <sup>[2]</sup>
Ammonium bicarbonate 99-100% (€/kg)	0.93 <sup>[3]</sup>
Ammonium acetate 99% (€/kg)	1.11 <sup>[3]</sup>
Ammonium citrate > 90% (€/kg)	1.06 <sup>[3]</sup>
Ammonium maleate (€/Kg)	2.76 <sup>[4]</sup>
NH <sub>3</sub> ·H <sub>2</sub> O 25% (€/kg)	1.30 <sup>[3]</sup>

The prices of the end products have been obtained from the suppliers listed below:

<sup>1</sup> North Carolina Dept of Ag-USDA Market News Service, 2022. Available online at:

[https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3159/2022-04-14/579600/ams\\_3159\\_00112.txt](https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3159/2022-04-14/579600/ams_3159_00112.txt) (accessed 14 April 2022).

<sup>2</sup> Almacenes Antonio Guerrero. Agricultura y Ganadería-Convencional y Ecológica, 2022. Available online at: <https://www.almacenesantonioguerrero.es/productos/nitrato-345-25kg/%0A.Best-price-In-stock/2051660.html> (accessed 16 April 2022).

<sup>3</sup> Various suppliers, 2022. Available online: <https://www.made-in-china.com/> (accessed 14 April 2022).

<sup>4</sup> Hangzhou LookChem Network Technology Co. Ltd. Available online at: [https://www.lookchem.com/product\\_Ammonium-hydrogen-maleate-Manufacturer-High-quality-Best-price-In-stock/2051660.html](https://www.lookchem.com/product_Ammonium-hydrogen-maleate-Manufacturer-High-quality-Best-price-In-stock/2051660.html) (accessed 16 April 2022).