**Towards the recovery of refrigerant gases from end-of-life equipment: study of the separation performance of polymer membranes**

Fernando Pardo\*, Gabriel Zarca, Ana Urtiaga

*Department of Chemical and Biomolecular Engineering, Universidad de Cantabria,*

*Av. de Los Castros s/n. Santander 39005, Spain*

*\*Corresponding author: pardof@unican.es*

**Highlights**

* Two fluorinated gases have been considered for this study (R-32 and R-134a).
* Gas permeability and gas pair selectivity were compared for material discrimination.
* Rubbery polymers have shown promising properties for the recovery of fluorinated gases.
* Fluorine in the hydrocarbon chains has a remarkable effect on membrane performance.

**1. Introduction**

Hydrofluorocarbon gases (HFCs) are the third generation of fluorine-based refrigerants. The absence of chlorine atoms in their molecular structures makes HFCs to be considered as ozone-friendly gases. Despite this fact, HFCs are powerful greenhouse gases and the new regulations (EU No 517/2014 and Kigali Amendment to the Montreal Protocol in 2016) are looking for an 85% reduction in their production and consumption by 2047. In this context, research efforts should be dedicated to the development of new separation technologies to facilitate the reuse and recycling of these compounds. Therefore, the application of membrane technology, a cost-effective alternative to cryogenic distillation and pressure swing adsorption, is envisaged to play an important role in the reduction of HFCs emissions.

Membrane technology has reached a state of maturity in the recovery of several gases, such as H2 from ammonia purge gas or from refinery flue gases, or the recovery of CO2 from natural gas mixtures, etc [2]. Nevertheless, there is a lack of research data in the separation of fluorinated-based refrigerant gases. In this sense, this work aims at providing novel information about the permeation properties of some of the most used refrigerant gases, R32 and R134a.

Therefore, this work shows the permeation properties of the aforementioned fluorinated-based gases in different membranes (glassy and rubbery polymers) for the first time.

**2. Methods**

The polymeric films were synthetized by the solvent casting method. The resulting films had an average thickness below 100 µm. Single and mixed gas permeation tests were performed with H2, N2, R32 and R134a at several temperatures (303 - 353 K) and feed pressures (1 - 5 bar). The experimental setup, based on continuous permeation of gases, is described in previous works [3].

**3. Results and discussion**

This work reports on the effect of pressure and temperature on the refrigerant permeation properties through rubbery polymeric membranes (different PEBAX grades and PVDF-HFP). The experimental results show a linear increase of the permeability of all gases with pressure, a common effect of organic vapors and condensable gases. The activation energy of permeation of the different gases on the polymers which offered the best separation performances was also calculated. This work also presents the study of the effect of the fluorine substitution in the molecular structure by comparing the permeability of the fluorinated gases with their respective hydrocarbon analogues (CH4, C2H6 and C3H6).

**4. Conclusions**

In light of these results, polymer membranes are presented as potential candidates with exceptional properties for the recovery of fluorinated gases.

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**References**

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