**Nanocellulose Based, facilitated transport membranes for carbon capture applications**

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**Highlights**

* Nanofibrillated cellulose was used to prepare facilitated transport membrane for CO2 capture
* PVAm – Naocelllulose membrane showed interesting separation performance close to the 2008 upper bound for CO2/N2 separation.
* Arginine-Nanocellulose membranes were able to overcome 2008 upper bound for CO2/N2 separation.

**1. Introduction**

Carbon capture and storage (CCS) technologies represent an interesting medium-term solution to tackle climate change and CO2 emissions, removing the greenhouse gas before its release in the atmosphere. In order to make it a viable solution, high performance separation techniques must be applied, and gas separation membranes are a strongly investigated solution.

Within this work a new family of facilitated transport membranes (FTM) has been investigated that uses nanofibrillated cellulose (NFC) has matrix for the CO2 carriers. Thanks to its high hydrophilicity, the high mechanical resistance and the already interesting separation performances showed [1] this materials seems indeed a very interesting candidate to obtain high performing and stable Hybrid Facilitated transport membranes (HFTM).

A series of membranes loaded with different amounts amine based carriers such as L-Arginine and polyvinylamine (PVAm) were prepared and tested under humid conditions for CO2 and N2 permeability in order to assess their potential for post combustion carbon capture applications.

**2. Methods**

Two different types of nanocellulose were produced at inofib starting from the raw materials, namely the Carboxymethlated nanocellulose (NFC-CMC) where some of the idroxyl group on the fiber surface were substitute with carboxilyc acids and aminosilane modified Nanocellulose (NFC-AEAPTMS. L-Arginine was purchased from sigma adrich, while PVAm was obtained through a three step purification form the commercial product Lupamin® 9095 kindly provided by BASF Italia.

The membranes were produced by solvent casting from an aqueous solution obtained by adding the amine compound solution in a water dispersion of nanocellulose. Permeation test were carried out in humid condition in order to exploit the facilitated transport mechanisms which needs water to be fully active. To that aim a purposely built apparatus was used [1] able to use well known barometric technique for gas permeability evaluation ls in presence of water vapor.

**3. Results and discussion**

The data obtained from the different experiments are shown in figure 1 a and b for the NFC-Arginine and for amonosilane treated NFC. It can be seen that the addition of the amino acid resulted in a significant increment of both permeability (from 29 to 220 Barrer) and ideal selectivity (from 56 to 185). Introduction of PVAm determined the formation of strong interactions with the NFC matrix, which reduced permeability respect to a pure mobile carrier, but improved stability at high relative humidity. Lastly, a chemically modified NFC, with amine-bearing moieties grafted onto the surface (NFC-AEAPTMS) was tested with a content of 20 wt% PVAm, also showing promising performances.



a) b)

**Figure 1** a) CMC-NFC permselectivity at different loadings of L-Arginine and relative humidity and b) of aminated NFC plus polyvinylamine at 100 RH% with respect to Robeson’s Upper Bound [2]

**4. Conclusions**

In the present works a new type of nanocellulose based facilitated transport membranes were investigated for their use in post combustion carbon capture application. The general results showed that nanocellulose thanks to its hydrophilicity is a good candidate to be sed in facilitated transport membranes and is coupled with mobile carrier such as L-arginine it allows to obtine mebrane with separation performance well above the 2008 Robeson’s Upper Bound.

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**References**

[1] D. Venturi, D. Grupkovic, L. Sisti, M.G. Baschetti, Effect of humidity and nanocellulose content on Polyvinylamine-nanocellulose hybrid membranes for CO2capture, J. Memb. Sci. 548 (2018) 263–274.

[2] L.M. Robeson, The upper bound revisited, J. Memb. Sci. 320 (2008) 390–400.