**Adsorption of uremic toxins onto Mixed Matrix Membranes Adsorbers (MMMAs)**

Matilde De Pascale1\*, Maria Grazia De Angelis1, Monica Faria2, Maria Norberta de Pinho2, Cristiana Boi1

*1**Department of Civil, Chemical, Environmental and Materials Engineering (DICAM), University of Bologna, via Terracini 28, Bologna, Italy; 2* *Instituto Superior Técnico, Chemical Engineering Department, Lisbon, Portugal*

*\*Corresponding author: matilde.depascale2@unibo.it*

**Highlights**

* Preparation of Cellulose Acetate-zeolite (HEU) Mixed Matrix Membranes Adsorbers (MMMAs).
* MMMAs removal efficiency is enhanced compared to the one of the pristine adsorbent.
* MMMAs permeability increases with respect to the one of pure polymeric membrane.

**1. Introduction**

Renal failure is a debilitating and chronical condition in which kidneys are no longer able to remove toxins and excess fluid from the body. For patients with terminal kidney disease, that were approximately 3.2 million at the end of 2017 [1], haemodialysis is the primary support treatment. Two of the main drawbacks of the therapy are the massive use of water, about 120 L per patient per treatment, and the uncomplete removal of uremic toxins from blood. Our work is focused on the preparation and characterization of novel porous Mixed Matrix Membranes Adsorbers (MMMAs) to remove the toxic compounds present in the spent dialysate. The purified water might be reused, to produce new dialysis fluid for the same patient, in order to reduce substantially the amount of pure water required for a single dialysis treatment.

**2. Methods**

Porous MMMAs based on Cellulose Acetate (Sigma Aldrich®) and ZUF (HEU) zeolite (Zeolith-Bentonit-Versand.de®) were prepared through the phase inversion casting technique [2], [3]. MMMAs with different amounts of ZUF were fabricated and characterized to investigate the removal of uremic toxins (urea, creatinine and uric acid) from aqueous solutions. Adsorption tests were performed in batch and in continuous mode (Fast Protein Liquid Chromatography). MMMAs removal capacity from aqueous solution was evaluated for the single uremic toxin and for a mixture of them.

**3. Results and discussion**

Results of the permeation tests showed the increase of the hydraulic permeability with the filler (ZUF) loading: the water permeability coefficient B0 (m2) is enhanced from 6.6E-16 m2 to 1.2E-15 m2 going from the pure cellulose acetate membrane to the MMMAs (30% ZUF). In Figure 1 is reported the urea and uric acid percentage removed from aqueous solution as a function of the ZUF wt%. The results are obtained in batch adsorption mode.



**Figure 1.** Percentage of uremic toxin removed as a function of ZUF wt%.

The removal of uric acid is easy, and it is almost independent on the loading of zeolite present in the membrane while for urea the percentage of ZUF plays and important role in the adsorption process. From the results shown in Figure 1, is also understandable that the membrane itself is actively involved in the adsorption mechanism.

**4. Conclusions**

MMMAs with ZUF were successfully prepared and tested to evaluate their removal capacity and their hydraulic permeability. The preliminary results indicate the potentiality of porous materials and MMMAs in toxin removal for the hemodialysis process and justify the future investigation of other combinations of polymers and fillers.

**References**

1. G. Lesaffer, R. De Smet, N. Lameire, P. Duym, R. Vanholder, Nephrol. Dial. Transplant 15 (2000) 50-57.
2. E. Salijoughi, M. Sadrzadeh, T. Mohammadi, J. Memb. Sci. 326 (2013) 252-258.
3. J.T. Chen, C.C. Shih, Y.J. Fu, S.H. Huang, C.C Hu, K.R. Lee, J.Y. Lai, Ind. Eng. Chem. Res 53 (2014) 2781-2789.