











$$\text{Mass balance (\%)} = \left( \frac{V_p \cdot C_p + V_r \cdot C_r}{V_f \cdot C_f} \right) \times 100 \quad (3)$$

Where  $C_f$ ,  $C_p$  and  $C_r$  represent concentrations of feed, permeate and retentate and  $V_f$ ,  $V_p$  and  $V_r$  are volumes of feed, permeate and retentate, respectively.

The results of the NaCl rejection test are reported in **Table 1** for the not cross-linked membranes as well as for the cross-linked membranes. Cross-linked membranes with 1, 5-Diamino-2-methylpentane (DAMP) has great impact on improving transport properties of membranes (Table 1). These results were due to the positive charge of the cross-linked membranes which rejected the Na<sup>+</sup> cation (ions with a lower mobility than Cl<sup>-</sup>) more efficiently than the not cross-linked membrane with having a negative charge. Moreover, the presence of the MWCNT increased the rejection of all the hybrid samples respect to the corresponding polymeric samples, but, in the case of the cross-linked membranes containing 0.5 wt% of MWCNTs, also the fluxes were improved together with a relevant increase of the rejection.

**Table 1. Experimental conditions and transport properties of hybrid PI membranes.**

Exp. No.	Membrane composition	Flux [l/hr*m <sup>2</sup> ]	Rejection %
1	PI, 5.5 g THF, 11.2g DMF, 11.2 g	3.5	32.0
2	PI, 5 g THF, 13 g DMF, 13 g CNTs, 0.05 g, 0.16 % Cross-linked by DAMP	12.5	61.3
3	PI, 3 g THF, 6 g DMF, 6 g CNTs, 0.075 g, 0.5 % Cross-linked by DAMP	51.5	56
4	PI, 5 g THF, 10 g DMF, 10 g CNTs, 0.125 g, 0.5 %	6.5	35
5	PI, 5.0 g DMF, 11.2 g THF, 11.2 g CNTs, 0.1 g, 0.37 %	3.5	10.0

NaCl, 1800 ppm concentration, membrane thickness 250 um.

#### 4. CONCLUSIONS

- 1) Mixed matrix membranes (MMM) containing different percentages (from 0.1 to 0.5 wt. %) of MWCNTs were prepared using three different PI polymers.
- 2) Poly imide (PI) membrane is ideal for high-pressure driven membrane process, like NF and RO, because the presence of a thin and dense skin layer allows achieving higher flux, in comparison with symmetric dense membranes. Moreover, the sponge like structure guarantees a high mechanical resistance versus compacting phenomena under high pressure
- 3) The dense asymmetric PI membranes, cross linked with DAMP, given better performance than the un-cross linked PI membranes in the rejection of salts (NaCl), because of charge effect (Donnan exclusion). The cross-linked PI membrane containing 0.5 wt. % MWCNTs was individuated as the most promising among the PI-based membranes prepared.

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