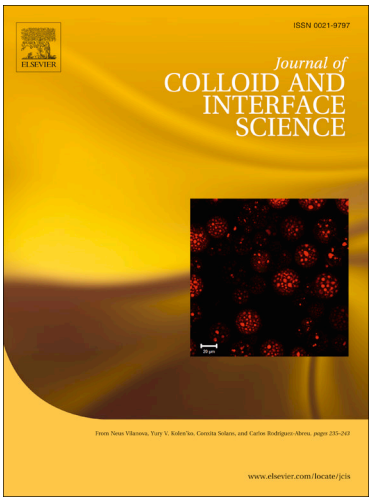

Enhanced selectivity and performance of heterogeneous cation exchange membranes through addition of sulfonated and protonated Montmorillonite

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Enhanced selectivity and performance of heterogeneous cation exchange membranes through addition of sulfonated and protonated Montmorillonite

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Abstract

Novel heterogeneous cation exchange membranes, based on poly (ether sulfone) and cation exchange resin, were prepared with the addition of protonated and sulfonated Montmorillonite (MMT) nanoparticles. Detailed investigations were then carried out studying the morphology, physical properties and the performance of membranes. It is observed that addition of MMT, leads to a substantially better distribution of ion exchange resin in the polymer matrix. This leads, at low loadings of MMT (0.5 wt%), to membranes that are more hydrated, more hydrophilic and with higher ion exchange capacities. Especially at these low MMT loadings, substantially better membrane performance is observed, with higher permselectivities, lower areal resistances and increased ion transport during electrodialysis. A very surprising effect is that the addition of MMT has a strong effect on the selectivity of the membranes, especially towards Mg^{2+}. A high affinity of the nanoclay towards Mg^{2+}, selectively slows down Mg^{2+} transport through the nanoclay containing membrane. At low MMT loadings this leads to a much higher areal resistance for Mg^{2+}, while for Na^{+} and Ca^{2+} the areal resistance is decreased. This leads to resistance based selectivities of 5.5 for Na^{+}/Mg^{2+} and 4.5 for Ca^{2+}/Mg^{2+}. Under more challenging electrodialysis operation selectivities become lower, but persist at 2.6 for Na^{+}/Mg^{2+} and 2.04 for Ca^{2+}/Mg^{2+}, outperforming commercial Ralex membranes. Overall, the protonated clay leads to slightly better membrane performances and selectivities than the sulfonated clay, likely due to a better compatibility with PES.

Keywords: Electrodialysis, Heterogeneous, cation exchange membrane, Montmorillonite, Ion selective