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Tunable molecular separation and in-situ fouling control using smart polyaniline membranes

The development of new smart membranes where the selectivity and flux can be tuned by external stimuli during operation have the potential to overcome two major limitations in the current state-of-the art in membranes: (i) fouling, (ii) our inability to precisely fine tune flux and selectivity during operation. Herein, a simple, scalable method for fabricating electrically tunable polyaniline (PANI) composite membranes which can have their selectivity controlled whilst in operation as well as having improved fouling-resistance has been developed.

Both pure polymer and composite membranes were prepared using a 0, 10, 25 and 50wt% loading of expanded graphite (EG), blended into a mixture of PANI and poly(2-acrylamido-2-methyl-1-propanesulfonic-acid; PAAMPSA). Results shows electrically tunable membranes were produced. Both pure polymer and composite membranes showed tunable properties when electrically-stimulated in dynamic contact angle measurements. These membranes showed an increase in permeability and MWCO under applied potential in PEG cross-flow filtrations, with the 50wt% membrane showing the greatest increase at 30V. The composite membranes successfully removed BSA fouling layer with applied voltage to the membranes, confirmed by increased BSA solution concentration and loss of BSA on membranes via confocal microscopy. Extended cross-flow filtrations of these membranes demonstrated that they are stable, less brittle, with minimal leaching and reduction of conductivity during use compared to mineral acid doped PANI membranes.

This work therefore indicates that PANI-PAAMPSA/EG membranes are extremely promising candidate membranes for in-situ fouling control. Overall this work helps to open a “smart” window for the production of more universally applicable electrically tunable membranes.