Fig. 1 MD module schematic for DCMD and VMD configurations
Fig. 2 Schematic diagram of local heat and mass transfer MD heat and mass transfer adjacent to the membrane surface and across the membrane.
Fig. 3 Computational flow chart for Aspen simulations of DCMD and VMD system
Fig. 4 Flow sheets of MD systems in Aspen simulations (a) DCMD; (b) VMD
Fig. 5 Comparison of permeation flux and outlet temperatures from simulation results and experimental data for DCMD module ($A_m = 180.9 \, \text{cm}^2$, $T_{1,0} = 39.3-64.1 \, \text{°C}$ and $T_{2,0} = 23.5 \pm 0.5 \, \text{°C}$; $W_1 = 0.4 \, \text{L} \cdot \text{min}^{-1}$ and $W_2 = 3 \, \text{L} \cdot \text{min}^{-1}$).
Fig. 6 Effects of lumen- and shell-side flow conditions ($Re_1$ & $Re_2$) in simulated DCMD module on (a) Permeation flux; (b) Specific energy consumption (steady-state operation, feed: NaCl solution with initial feed concentration of 7.0 wt%, $T_{1,0} = 80$ °C and $T_{2,0} = 30$ °C)
Fig. 7 Specific energy consumption of simulated VMD system with varying vacuum pressure $p_{2,0}$ and lumen-side flow condition ($Re_1$) (steady-state operation, feed: NaCl solution with initial feed concentration of 7.0 wt%, $T_{1,0} = 80 \, ^\circ\text{C}$, $p_{2,0} = 2.3\sim7.5 \, \text{kPa}$)
Fig. 8 Specific energy consumption and permeation flux with varying $Re_1$ in simulated DCMD and VMD flowsheets (a) $J_M$ and $e$ vs. $Re_1$, (b) $e$ vs. $J_M$ (steady-state operation, feed: NaCl solution with initial concentration of 7.0 wt%, $Re_2 = 456$, $T_{1,0} = 80^\circ$C and $T_{2,0} = 30^\circ$C for DCMD; $p_{2,0} = 4.25$ kPa for VMD)
Fig. 9 Simulated temperature profiles along the fiber length in the DCMD (a) and VMD (b) modules (steady-state operation, feed: NaCl solution with initial concentration of 7.0 wt%, $Re_1 = 1482$, $Re_2 = 456$, $T_{1,0} = 80^\circ C$ and $T_{2,0} = 30^\circ C$ for DCMD; $p_{2,0} = 4.25$ kPa for VMD)
Fig. 10 Simulated profiles of local driving force $\Delta p$ along the fiber length in DCMD and VMD modules (steady-state operation, feed: NaCl solution with initial feed concentration of 7.0 wt%, $Re_1 = 1482$, $Re_2 = 456$, $T_{1,0} = 80 \, ^{\circ}\text{C}$ and $T_{2,0} = 30 \, ^{\circ}\text{C}$ for DCMD; $p_{2,0} = 4.25 \, \text{kPa}$ for VMD)