Supplementary methods

Chemicals

All salts, including sodium fluoride (NaF, ≥99.0%), sodium chloride (NaCl, ≥99.5%), sodium bromide (NaBr, ≥99.0%), and sodium iodide (NaI, ≥99.0%) were purchased from Sigma-Aldrich. All organic chemicals, including ethylene glycol (≥99.0%), erythritol (≥99%), xylose (≥90%), and N,N-dimethylformamide (DMF, anhydrous, 99.8%) were also procured from Sigma-Aldrich. Both sulfuric acid (H$_2$SO$_4$, >95.0%) and potassium hydroxide (KOH, >99.0%) were purchased from J.T. Baker Chemicals.

Membrane characterization

The average pore radius of the polyamide active layer was estimated using the pore hindrance transport model where membranes are assumed to have a bundle of cylindrical pores with uniform pore size (details are given in next subsection). This pore radius can be calculated using the membrane rejection of neutrally charged organic solutes (i.e., ethylene glycol, erythritol, and xylose in this study) in separate experiments. Prior to solute rejection tests, membrane coupons (filtration area of 20 cm$^2$) were first compacted at 31.7 bar for over 8 hours. After compaction, one of the organic solutes was dissolved in the feed solution to obtain a concentration of 50 mg/L (as total organic carbon, TOC) and separate permeate samples were collected at operating pressures of 13.8, 20.7, 27.6, and 34.5 bar. Water flux at each applied pressure was also recorded. Solute concentrations for both feed and permeate samples were analyzed by a TOC analyzer (TOC-VCSH, Shimadzu, Japan) to determine the rejection of the organic solute.

The isoelectric point of the polyamide layer was determined by inspecting the dependence of NaCl rejection on feed solution pH (9, 26). Membrane coupons were first compacted for over 8 hours under a pressure of 31.7 bar, and filtration was performed at a pressure of 27.6 bar to obtain the NaCl rejection (10 mM NaCl in feed solution) at pH 5.5, 5.0, 4.5, 4.0, 3.5, and 3.0. The solution pH was adjusted by 0.1 M sulfuric acid (H$_2$SO$_4$). The membrane system was equilibrated for more than 30 minutes after each pH adjustment. Permeate samples were then collected for Na$^+$ analysis by ion chromatography (IC; ICS-1000, Dionex, Sunnyvale, CA) to determine the NaCl rejection by the membrane.
Pore hindrance transport model

The membrane average pore radius was estimated based on the pore hindrance transport model where membranes are considered to have a bundle of cylindrical pores with the same radius (73, 74). The membrane real (intrinsic) rejection of neutral organic solutes, $R_r$, can then be described as

$$R_r = 1 - \frac{\Phi K_c}{1 - \exp(-Pe)(1 - \Phi K_c)}$$  \hspace{1cm} (S1)

where $K_c$ is the hydrodynamic hindrance coefficient for convective flow and $Pe$ is the Peclet number. The partition coefficient, $\Phi$, describes the solute distribution at the pore mouth when only steric interactions are considered:

$$\Phi = \frac{< c' >}{c} = (1 - \lambda)^2 = \left(1 - \frac{r_s}{r_p}\right)^2$$  \hspace{1cm} (S2)

where $< c' >$ is the average solute concentration within the pore, $c$ is the concentration just outside the pore, and $\lambda$ is the ratio of the solute radius, $r_s$, to the pore radius, $r_p$.

According to the thin-film theory, the real rejection can be related to the observed rejection, $R_o$, by accounting for the concentration polarization (75):

$$\ln \frac{1 - R_r}{R_r} = \ln \frac{1 - R_o}{R_o} - \frac{J_v}{k_f}$$  \hspace{1cm} (S3)

where $k_f$ is the mass transfer coefficient and $J_v$ is the membrane permeate water flux.

To estimate the average pore radius, we first utilized Equation S3 to calculate the membrane real rejections of each organic solute (erythritol, xylose, and ethylene glycol) from the experimentally obtained observed rejections. The parameters $\Phi K_c$ and $Pe$ were then solved by fitting the real rejection data to Equation S1 using an optimization process (Solver, Microsoft Excel). The obtained parameter $\Phi K_c$, which is only a function of the ratio of the solute to pore radius, enables us to calculate the average pore radius. Additional details on this process can be found in our previous work (76).

Ion transport in an electro-driven process
The overall membrane conductance for ion transport in an electro-driven process can be described as (77)

\[ G = \frac{A_m e N_A \sum (J_i | z_i |)}{\Delta \Phi} = \frac{A_m F \sum (J_i | z_i |)}{\Delta \Phi} \]  

(S4)

where \( A_m \) is the membrane area, \( e \) is the elementary charge, \( N_A \) is the Avogadro number, \( \Delta \Phi \) is the voltage across the membrane, \( F \) is the Faraday constant, and \( J_i \) and \( z_i \) are the flux and the valence of ionic species \( i \), respectively. For the 1:1 electrolytes considered in this study,

\[ J_{\pm} = \frac{d_m}{A_m F} G_{\pm} \frac{\Delta \Phi}{d_m} = \frac{d_m}{A_m F} G t_{\pm} \frac{\Delta \Phi}{d_m} \]  

(S5)

where \( d_m \) is the membrane thickness and \( t_{\pm} \) is the transport number for cations or anions.

According to Nernst-Plank equation, the ionic flux for an electro-driven process is given by (78)

\[ J_{\pm} = D_{\pm} \frac{e K_{\pm} C \Delta \Phi}{k_B T d_m} = D_{\pm} \frac{F K_{\pm} C \Delta \Phi}{R T d_m} \]  

(S6)

where \( D \) and \( K \) are the diffusion coefficient inside the membrane and partition coefficient at membrane-solution interface, respectively, \( C \) is the electrolyte molar concentration in the bulk solution, and \( k_B \) is the Boltzmann constant. The subscript \( \pm \) indicates a parameter assigned for either anions or cations.

Combining Equations S5 and S6 gives

\[ P_{\pm} = D_{\pm} K_{\pm} = \frac{R d_m}{A_m F^2 G} G t_{\pm} T = \alpha G t_{\pm} T \]  

(S7)

where \( P \) is the ion permeability, \( T \) is the absolute temperature (K), and \( \alpha \) is a temperature-independent parameter.

The overall energy barrier for ion transport through the membrane (\( E_{P_{\pm}} \)) can be calculated using an Arrhenius-type equation:

\[ P_{\pm} = P_{\pm,0} e^{\left( \frac{E_{P_{\pm}}}{R T} \right)} \]  

(S8)

where \( P_{\pm,0} \) is a pre-exponential factor and \( R \) is the gas constant. Substituting Equation S7 into Equation S8 yields:
\[ G(T)t_{\pm}(T)T = B_{\pm}e^{-\frac{E_{p_{\pm}}}{R}T} \]  

(S9)

where \( B_{\pm} \) is the pre-exponential factor.

**Determination of overall ion conductance**

The membrane ion conductance was obtained using a linear sweep voltammetry (LSV) technique. A membrane coupon was assembled into a homemade two-chamber diffusion cell and an Ag/AgCl reference electrode (CHI111, CH Instruments, Austin, TX) was inserted in each chamber (Fig. 1C). During the LSV measurement, current was recorded while sweeping the voltage difference between the two reference electrodes from -50 to 50 mV at a scan rate of 2 mV s\(^{-1}\). Reciprocal of the slope of the obtained \( I-V \) curve indicates the charge transfer resistance of the system with the membrane. The LSV measurement was repeated after removing the membrane coupon for the estimation of charge transfer resistance of the system without the membrane (Fig. S3A). The difference between the two obtained resistances is the resistance for ion transport through the membrane (i.e., reciprocal of the overall ion conductance).

**Determination of ion-pore interaction energy using density functional theory (DFT) simulation**

In the DFT simulation, we used a continuum solvation model to probe the interaction energy changes between ions and the pore during their transport through a pristine 0.8 nm carbon nanotube (CNT) and an in-pore oxygen (O\(^{\cdot-}\)) functionalized CNT (CNT-O) to simulate a negatively charged pore. The interaction energy, \( E_{int}(y,z) \), was computed along the specified intercalation coordinates (Y and Z axis; Fig. S7) and the ion transport pathway was obtained by the minimum interaction energies in our calculation:

\[ E_{int}(y,z) = E_{ion-pore}(y,z) - E_{pore} - E_{ion} \]  

(S10)

where \( E_{ion-pore}(y,z) \) is the total energy of the ion-pore system with ion location at \((y,z)\), and \( E_{pore} \) and \( E_{ion} \) refer to the energy of an isolated pore and an isolated ion in solution, respectively. \( E_{int}(y,z) \) can be used as the potential energy surface (PES) of ion entering the pore along the Y and Z coordinates.

**Impact of oxygen (O\(^{\cdot-}\)) functionalization on simulated ion transport**
As shown in Fig. S7, the minimum energy pathway calculated by DFT indicates that the intra-pore diffusion pathway for both Na\(^+\) and F\(^-\) ions was significantly affected by the -O\(^-\) group in the sub-nanometer pore. After entering the pore, both ions are preferably translocated along the pore center in pristine, unfunctionalized pore. However, in the presence of intra-pore -O\(^-\) functionalization, an off-centered path near the -O\(^-\) group is observed for both ions due to the steric repulsion of the -O\(^-\). Importantly, when ions leave the -O\(^-\) group and the steric effect is diminished, it is clearly shown that Na\(^+\) and F\(^-\) ions are electrostatically attracted and repelled by the O\(^-\) group, respectively.

The effect of the -O\(^-\) group on the PES of ion transport is shown in Fig. S8. For the pristine, unfunctionalized sub-nanometer pore (grey filled squares), the PES of both Na\(^+\) and F\(^-\) showed a monotonically increasing trend when the ion enters the pore (Z coordinate = 12 Å), and no further energy barrier can be observed during the intra-pore diffusion process. In comparison, after anchoring an -O\(^-\) group on the inner pore wall (Z coordinate = 6 Å in Fig. S8), the energy barrier for Na\(^+\) ions to enter the pore was lowered to 9.8 kcal mol\(^{-1}\) (the barrier near pore entrance in the red line of Fig. S8A) compared to the energy barrier for unfunctionalized pore (12.8 kcal mol\(^{-1}\)). This decrease in the energy barrier of Na\(^+\) is accompanied by a sharp decrease of the PES at 6 Å due to electrostatic attraction to the -O\(^-\) group. For the diffusion of Na\(^+\) ions inside the -O\(^-\) functionalized pore (from coordinate 6 Å to 0 Å), an energy barrier of over 15 kcal mol\(^{-1}\) is observed as Na\(^+\) ions have to overcome the strong electrostatic attraction with the -O\(^-\) group (Fig. S8A). Such results suggest that the contribution of intra-pore diffusion to the overall energy barrier could be significant in the presence of strong ion-pore attraction. Unlike Na\(^+\) ions, F\(^-\) ions are electrostatically repulsed by the -O\(^-\) group during the intra-pore diffusion process. As a result, for F\(^-\) ions to permeate through the -O\(^-\) functionalized pore, after overcoming an energy barrier of 13.7 kcal mol\(^{-1}\) at the pore entrance, only a small energy barrier (3.9 kcal mol\(^{-1}\)) is observed as F\(^-\) ions bypass the -O\(^-\) group (red line of Fig. S8B).

**Contribution of partition and intra-pore diffusion to the overall energy barrier for salt transport.**

In the solution-diffusion model, intrinsic salt permeability (\(P\)) is defined as the product of partition coefficient (\(K\)) and diffusion coefficient (\(D\)):
For salt transport through the membrane, the salt needs to overcome energy barriers both during partitioning into pores and diffusion inside the pores:

\[ P = KD \]  \hspace{1cm} \text{(S11)}

\[ D = D_0 e \left( \frac{-E_D}{R \tau} \right) \]  \hspace{1cm} \text{(S12)}

\[ K = K_0 e \left( \frac{-\Delta E_K}{R \tau} \right) \]  \hspace{1cm} \text{(S13)}

where \( E_D \) and \( \Delta E_K \) are the energy barriers for intra-pore diffusion and the energy change in the partition step, respectively, and \( D_0 \) and \( K_0 \) are the pre-exponential factors. Substituting Equations S8, S12, and S13 into Equation S11 yields:

\[ P_0 e \left( \frac{-E_P}{R \tau} \right) = K_0 e \left( \frac{-\Delta E_K}{R \tau} \right) D_0 e \left( \frac{-E_D}{R \tau} \right) = K_0 D_0 e \left( \frac{-\Delta E_K + E_D}{R \tau} \right) \]  \hspace{1cm} \text{(S14)}

Therefore, the overall energy barrier for salt transport in sub-nanometer pores in the polyamide layer is the sum of the contributions from both the energy change in the partition step and the energy barrier of intra-pore diffusion:

\[ E_P = E_D + \Delta E_K \]  \hspace{1cm} \text{(S15)}

**QCM sample preparation**

The protocol for isolating the polyamide layer from the RO membrane is well described in the literature (53, 79, 80). Specifically, the polyester support layer of the RO membrane was first peeled off using tweezer, leaving a composite of the polysulfone and polyamide layers. Next, the polysulfone and polyamide composite was placed on the QCM sensor with the polyamide layer facing the surface of the sensor. Following this step, the polysulfone layer was dissolved by dropwise addition of dimethylformamide (DMF), leaving only the polyamide layer on the QCM sensor. Last, the QCM sensor coated with the polyamide layer was air dried, rinsed with DI water, and dried again with nitrogen gas.

**Determination of the volume of polyamide layer**

To determine the volume of the polyamide layer on the QCM sensors, the mass of the polyamide layer was first measured by running QCM tests with the sensors before and after being coated with the polyamide layers in air. With the resulting resonance frequency change in the QCM tests, \( \Delta f_p \), the mass of the polyamide layer (\( m_p \)) can be calculated by the Sauerbrey relationship (54, 55):
\[ m_p = \frac{C}{n} \Delta f_p \]  

(S16)

where \( n \) is the overtone number (\( n = 3 \) in this study) and \( C \) is the crystal constant (17.7 ng Hz\(^{-1}\) cm\(^{-2}\)). With the mass \( (m_p) \) and density \( (\rho) \) of the polyamide layer, the volume of the polyamide layer \( (V_p) \) can be determined:

\[ V_p = \frac{m_p}{\rho} \]  

(S17)

The experimental results are summarized in Table S2.

**Determination of the partition coefficient**

By definition, the partition coefficient \( (K) \) can be calculated as

\[ K = \frac{c_m}{c_b} \]  

(S18)

where \( c_m \) and \( c_b \) are the salt concentrations in the membrane (polyamide layer) and bulk solution, respectively. Since the bulk solution concentration \( c_b \) is known, \( K \) can be obtained by determining \( c_m \). As the volume of the polyamide layer \( (V_p) \) has been determined, \( c_m \) can be determined after the mass of salt partitioning into the membrane \( (m_{s,p}) \) is measured:

\[ c_m = \frac{m_{s,p}}{M_{W_s} V_p} \]  

(S19)

where \( M_{W_s} \) is the molecular weight of the salt.

The mass of the partitioned salt, \( m_{s,p} \), was measured using a QCM (Fig. 3B) with protocols adopted from the literature (53, 81). In the QCM test, three coated sensors (i.e., samples) and one uncoated sensor (i.e., control) were used in four parallel modules, resulting in three replicate experimental results. As the pump is continuously drawing solution from the feed tank and evenly distributing the solution to the modules, all the sensors were exposed to the same solution throughout the test. The resonance frequency of each sensor was in-situ monitored and recorded by a computer connected to the QCM instrument.

During the QCM tests, the sensors were first exposed to DI water for about 2 hours to establish stable baselines of the resonance frequencies. Then, the sensors were exposed to the test salt solution (or solutions with increased concentrations) for about 20 minutes to achieve new
stabilized frequency readings. The changes of resonance frequency between DI water and the test solution can be obtained for both the sample sensor ($\Delta f_s$) and the control sensor ($\Delta f_c$). After running the test solution (or solutions), DI water was used again to rinse the system for another two hours and check the frequency baselines. Representative QCM results with increased NaCl solutions can be found in Fig. S9.

For data analysis, as the control sensor served to account for the frequency change resulting from the change of the physical properties of salt solutions (e.g., density and viscosity), the frequency change resulting from the salt partitioning into the polyamide layer ($\Delta f_{s,p}$) can be obtained as the difference between $\Delta f_s$ and $\Delta f_c$ (i.e., $\Delta f_{s,p} = \Delta f_s - \Delta f_c$). Based on the Sauerbrey relationship, $m_{s,p}$ can be calculated from $\Delta f_{s,p}$. Thus, knowing $m_{s,p}$, the partitioning coefficient $K$ can be determined by Equations S18 and S19.

In our QCM experiments, we have used 0.5 M as the solution concentration of the investigated salts for the determination of $E_K$. Such high concentration was applied because low solution concentration (i.e., < 0.1 M) can lead to large variations (>50 %) in the QCM measurements due to the limited resolution of the instrument (Table S3). Notably, $K$ remains constant as the solution concentration changes (Fig. S9 and Table S3), as also observed in a previous study (53).
Figure S1. Example of concentration increase in the middle chamber as cations (Na+) and anions (I−) diffuse from the side chambers over time.
Figure S2. Arrhenius plots for salt transport through membranes with three electrolytes: (A) NaF, (B) NaBr, and (C) NaI. Two membrane coupons, with their active polyamide layers facing the solution chambers, were assembled into a custom-made three-chamber diffusion cell (Fig. 1A). The two side chambers were filled with a single salt solution ($C_s=10$ mM) and middle chamber was filled with DI water. Salt flux ($J_{salt}$) was measured at five different temperatures (22, 26, 30, 33, 37 °C) by monitoring the conductivity change in the middle chamber over time. Solution pH was maintained at 5.7 in all experiments. Error bars represent standard deviations from duplicate measurements.
Figure S3. Electrochemical characterization of ion transport. (A) I-V curves obtained using linear sweep voltammetry (LSV; at a scan rate of 2 mV s⁻¹) for the calculation of membrane resistance for ion transport with 10 mM NaF. Resistances of systems with (blue line) and without (red line) membrane were determined from the slope of the curves. (B) Measurement of membrane potential ($\Delta\Phi_{\text{mbr}}$) across a cation-exchange membrane (CEM; CMI-7000, Membrane International) using LSV from -100 to 100 mV; the membrane potential is the intersect between the I-V curves and the voltage (x) axis. NaCl concentration was maintained constant in one chamber ($C_h=10$ mM), and the concentration in the other chamber ($C_l$) was gradually increased from 0.5 to 1, 2, 5, and 10 mM to obtain concentration ratios of 20:1, 10:1, 5:1, 2:1, and 1:1, respectively. (C) Dependence of membrane potential on the concentration ratio between the two chambers. The fitted slope is 0.0257 V and the transport number of Na⁺ was estimated to be 1.0 for this CEM according to Equation 6. Considering the highly linear dependence of membrane potential on concentration ratio ($R^2 = 0.999$), only concentration ratios of 5:1, 2:1, and 1:1 were used for transport number measurements with the RO membrane.
Figure S4. Transport number of Na$^+$ ions with RO membranes. (A) Transport number of Na$^+$ ($t_{Na^+}$) with RO membranes for four electrolytes (NaF, NaCl, NaBr, and NaI) at pH 5.7 as calculated from the measured membrane potentials. (B) Dependence of membrane potential on the concentration ratio between the two chambers (Fig. 1C) for NaF at pH 9.5, 5.7, and 4.5. The slopes of the curves were used to calculate the corresponding transport numbers of Na$^+$ and F$. Experimental conditions: salt concentration was maintained constant in one chamber ($C_h=10$ mM), and the concentration in the other chamber ($C_l$) was gradually increased from 2 to 5 and 10 mM to obtain concentration ratios of 5:1, 2:1, and 1:1, respectively. Solution pH was adjusted using 0.1 M H$_2$SO$_4$ and 0.1 M KOH. Error bars represent standard deviations from triplicate measurements.
Figure S5. Arrhenius plots for decoupled anion and cation transport through membranes with three electrolytes: (A) NaF, (B) NaBr, and (C) NaI. The overall membrane conductance was obtained using linear sweep voltammetry (-50 – 50 mV) with 10 mM of electrolytes in both chambers (Fig. 1C) at temperatures of 22, 26, 30, 33, and 37 °C. The transport number (t±) was calculated using the membrane potential (ΔΦmbr) measured at the same temperatures mentioned above. For membrane potential measurement, at each temperature salt concentration was maintained constant in one chamber (C1=10 mM), and the concentration in the other chamber (C2) was gradually increased from 2 to 5 and 10 mM to obtain concentration ratios of 5:1, 2:1, and 1:1, respectively. Solution pH was maintained at 5.7 in all experiments. Error bars represent standard deviations from duplicate measurements.
Figure S6. Point of zero charge characterization and average pore radius estimation for the RO membrane. (A) Salt rejection of the RO membrane at different feed solution pH. The filtration experiment was conducted using a bench-scale crossflow system under pressure of 27.6 bar. The concentration of the feed solution was 10 mM and solution pH was adjusted using 0.1 M H₂SO₄. The lowest salt rejection was observed at pH 4.5, indicating that the point of zero charge of polyamide layer is around 4.5. We note that, although the salt used in the measurement is NaCl, the measured point of zero charge should be independent of the salt species being used (9). (B) Dependence of membrane real retention of neutral organic tracers on membrane permeate water flux. Experiments were conducted using the same crossflow filtration system. In each experiment, a different organic tracer was used at a feed concentration of 50 mg/L (as TOC). Permeate samples were collected under pressures of 13.8, 20.7, 27.6, and 34.5 bar. Fitting is based on the membrane hindrance transport model (Equation S1). In both (A) and (B), temperature was maintained at 22.0 ± 0.5 °C and crossflow velocity was set at 21.4 cm/s. Error bars represent standard deviations from triplicate measurements.
Figure S7. DFT simulation of ion transport trajectory. Minimum energy pathway of (A) Na$^+$ (yellow spheres) and (B) F$^-$ (purple spheres) ions permeating through pristine and oxygen (O$^-$; red sphere) functionalized carbon nanotubes (CNT and CNT-O, respectively) from density functional theory (DFT) simulations. The diameters of the CNT and CNT-O were ~8 Å.
**Figure S8.** DFT simulation of potential energy change during ion permeation. Potential energy surface of (A) Na\(^+\) and (B) F\(^-\) ions as a function of intercalation coordinate from DFT simulations. In panels (A) and (B), the grey and red curves represent the permeation of ions in CNT and CNT-O, respectively. In all DFT simulations, the diameters of the CNT and CNT-O were ~8 Å. The entrances of CNT and CNT-O were located at the coordinate of 12 Å (average position of H atoms on the edge), and the O\(^-\) group in CNT-O was anchored at the coordinate of Z = 6 Å.
Figure S9. Representative QCM results. Frequency changes of sensors with different NaCl concentrations for (A) sensor coated with polyamide layer and (B) bare (control) sensor. The frequency change was measured at 6 different NaCl concentrations (i.e., 0.001, 0.01, 0.05, 0.1, 0.5, and 1.0 M). At each concentration, once the frequency change was stabilized (~20 min), the salt concentration was increased. At last, DI water was applied to rinse the sensors and verify the baseline. The Solution pH was maintained at 5.7 in all experiments. In panel (A), the frequency change ($\Delta f_s$) increases with solution concentration as more salts partition into the sensor. In panel (B), the frequency change ($\Delta f_c$) also increases with solution concentration because solution properties (e.g., density and viscosity) vary with concentration. The real frequency change caused by salt partitioning ($\Delta f_{s,p}$) is the difference between the frequency changes in panels (A) and (B) (i.e., $\Delta f_{s,p} = \Delta f_s - \Delta f_c$). With the calculated $\Delta f_{s,p}$, the mass of salt partitioning in the polyamide layer can be determined by the Sauerbery relationship.
Figure S10. Arrhenius plots for partition coefficients of three different salts: (A) NaF, (B) NaBr, and (C) NaI. The partition coefficients were measured with QCM (Fig. 3B) at five different temperatures (22, 26, 30, 33, and 37 °C). The salt concentration in the measurement was maintained at 0.5 M. Solution pH was maintained at 5.7 in all experiments. Error bars represent standard deviations from triplicate measurements.
**Table S1.** Molecular weight, diffusivity, and Stokes radius of organic tracers and the pore radius of RO membranes estimated from organic tracer experiments.

| Organic tracer | MW (g/mol) | Diffusivity<sup>a</sup> (10<sup>-10</sup> m<sup>2</sup>/s) | Stokes radius<sup>b</sup> (r<sub>s</sub>, nm) | λ = r<sub>s</sub>/r<sub>p</sub> | Pore radius<sup>b</sup> (r<sub>p</sub>, nm) |
|----------------|------------|----------------------------------|----------------------------------|------------------|----------------------------------|
| Xylose         | 150        | 7.4                              | 0.290                            | 0.925            | 0.314                            |
| Erythritol     | 122        | 8.3                              | 0.260                            | 0.882            | 0.295                            |
| Ethylene Glycol| 62         | 11.8                             | 0.204                            | 0.774            | 0.264                            |
| **Average**    |            |                                  |                                  | **0.291**        |                                  |

<sup>a</sup>Calculated using the Wilke and Chang Equation.

<sup>b</sup>Calculated using the Stokes-Einstein Equation.
Table S2. Characteristics of polyamide layers on the sensors

| Sensor no. | Mass of the polyamide layer (ng) | Volume of the polyamide layer\(^a\) (× 10\(^{-9}\) L) | Thickness of the polyamide layer (nm) |
|------------|----------------------------------|-----------------------------------------------------|--------------------------------------|
| 1          | 10.34                            | 9.11                                                | 115.99                               |
| 2          | 9.97                             | 8.74                                                | 111.31                               |
| 3          | 10.41                            | 9.13                                                | 116.24                               |
| 4          | 11.74                            | 10.30                                               | 131.17                               |
| 5          | 9.90                             | 8.68                                                | 110.56                               |
| 6          | 11.00                            | 9.65                                                | 122.81                               |
| **Average** | **10.76 ± 0.82**              | **9.27 ± 0.61**                                     | **120.18 ± 9.13**                    |

\(^a\)The density of the polyamide layer used in the calculation was 1.14 g/cm\(^3\) (82–84).
Table S3. Partition coefficient of NaCl at different concentrations

| NaCl concentration (M) | Measured partition coefficient with error, K |
|------------------------|---------------------------------------------|
| 0.001                  | N/A                                         |
| 0.01                   | 0.351 ± 0.8                                 |
| 0.05                   | 0.377 ± 0.477                               |
| 0.1                    | 0.375 ± 0.214                               |
| 0.5                    | 0.342 ± 0.029                               |
| 1                      | 0.368 ± 0.053                               |
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