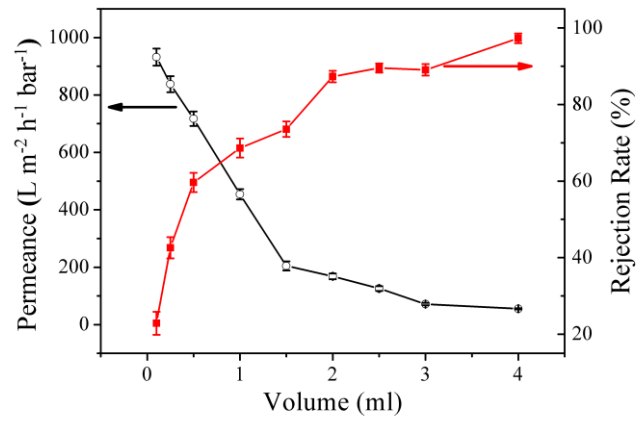
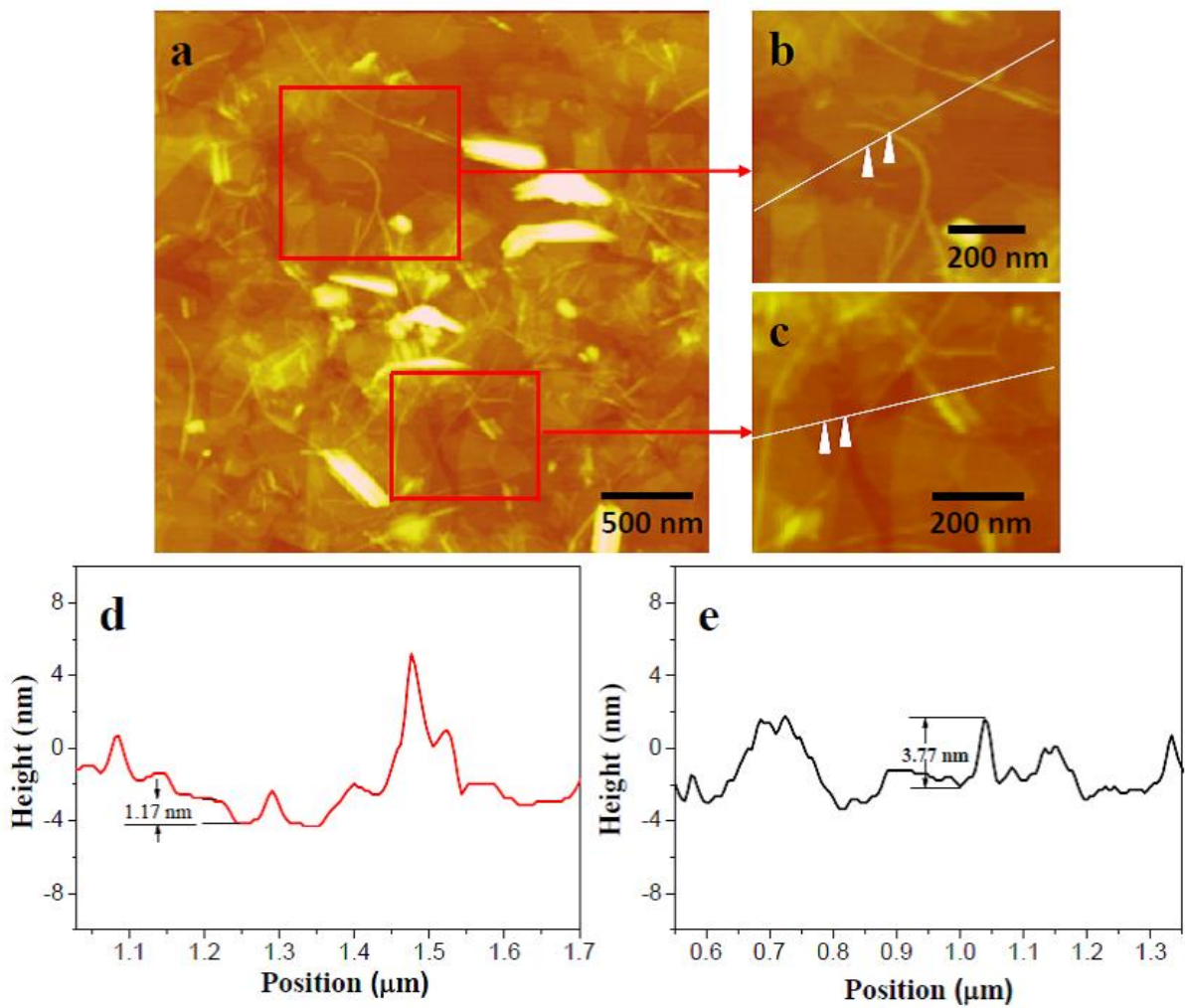


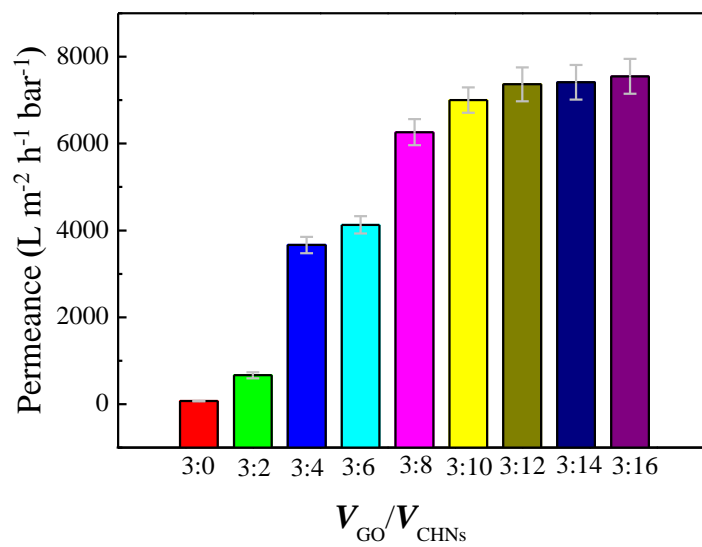
Supplementary Figure S1 | Morphologies of GO sheets and GO membranes. a, A TEM image of GO sheets. **b,** SEM image of the surface of GO membranes.



Supplementary Figure S2 | Dependence of separation performance of GO membranes on membrane thicknesses. The applied pressure is fixed as 1 bar.

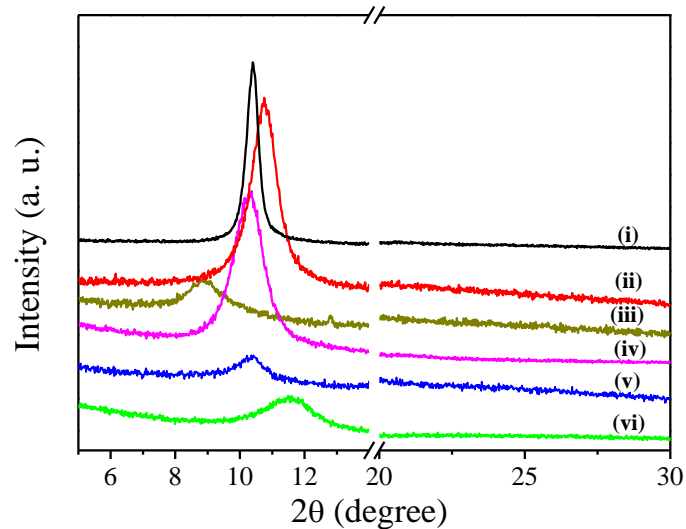


Supplementary Figure S3 | AFM images of GO/CHNs composites. **a**, Low-magnification image of GO/CHNs composites. **b-c**, high-magnification images of GO/CHNs composites. **d** and **e** are the height plots along the lines marked in **b** and **c** respectively.

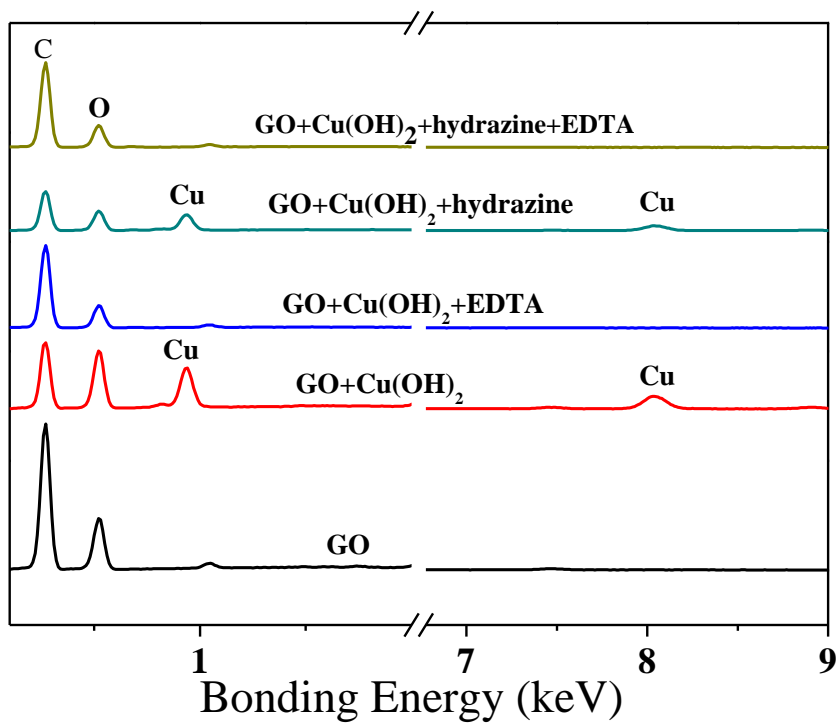


Supplementary Figure S4 | The water permeance of GO/CHNs membranes with various

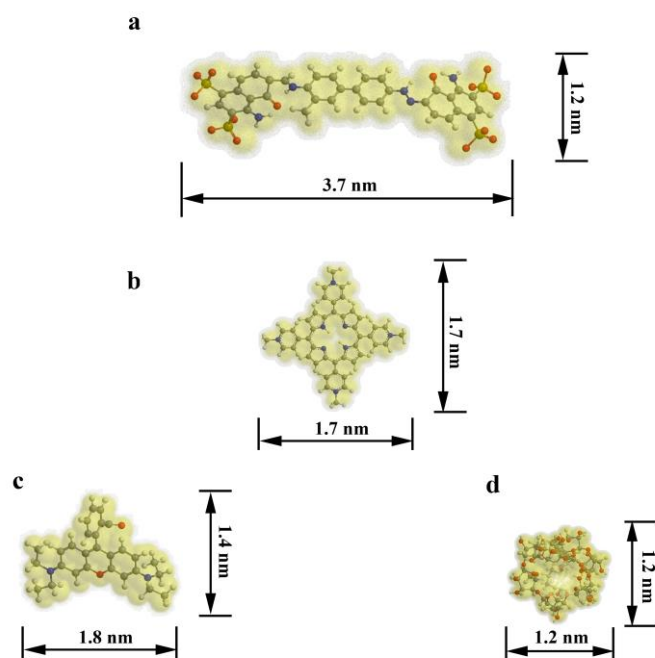
$V_{\text{GO}}/V_{\text{CHNs}}$.



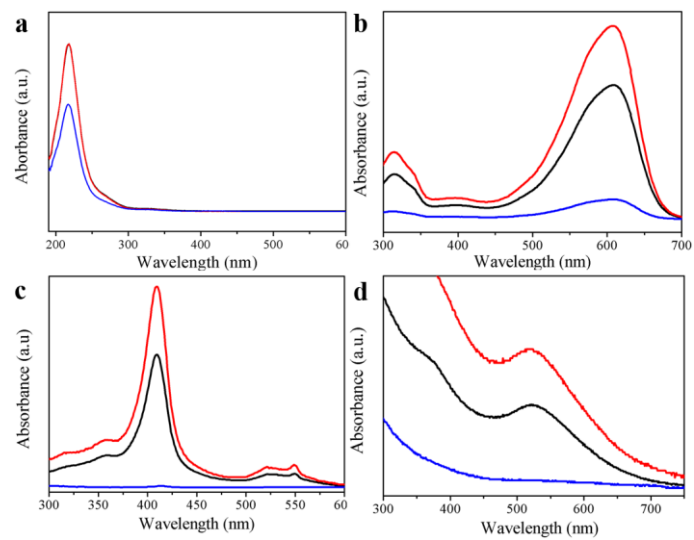
Supplementary Figure S5 | XRD patterns of GO-based membranes. i, GO membrane. **ii**, GO membrane after N_2H_4 treatment for 15 mins. **iii**, GO/CHNs composite film. **iv**, GO/CHNs composite film by direct EDTA treatment. **v**, GO/CHNs composite film treated by N_2H_4 for 15 mins. **vi**, NSCGO membrane. These results demonstrate that the spacing between restacked GO sheets is 8.49 Å for pure GO, 8.22 Å for GO treated with hydrazine for 15 min, 9.86 Å for GO/CHNs membranes, 8.55 Å for GO/CHNs membranes after ethylene-diamine-tetraacetic acid (EDTA) treatment, 8.50 Å for GO/CHNs membrane treated with hydrazine for 15 min and 7.68 Å for NSC-GO membranes, respectively. This partial hydrazine treatment could cause the GO stack to be more compact and further stabilize the channels as well as membranes themselves.



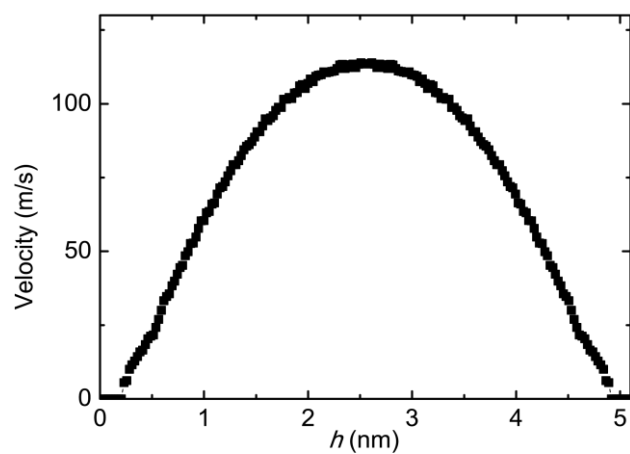
Supplementary Figure S6 | EDS spectrum of GO-based membranes.



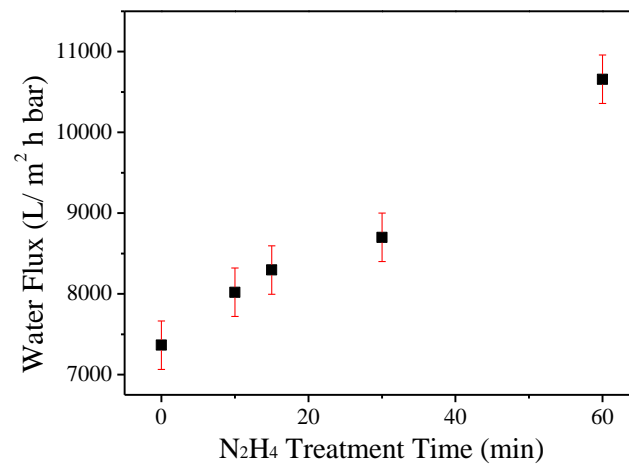
Supplementary Figure S7 | Structures and molecular size of dyes and molecules. a, EB dye molecule. b, TMPyP. c, RB. d, γ -CD filled with adamantane (γ -CD/Ad).



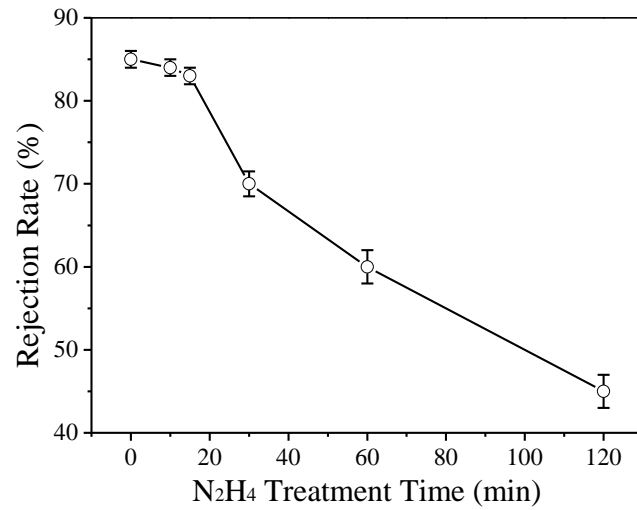
Supplementary Figure S8 | Typical UV-vis absorption spectra of the feed, the permeate and the retentate. a, $[\text{Fe}(\text{CN})_6]^{3-}$. b, EB. c, Cyt.c. d, gold nanoparticle.



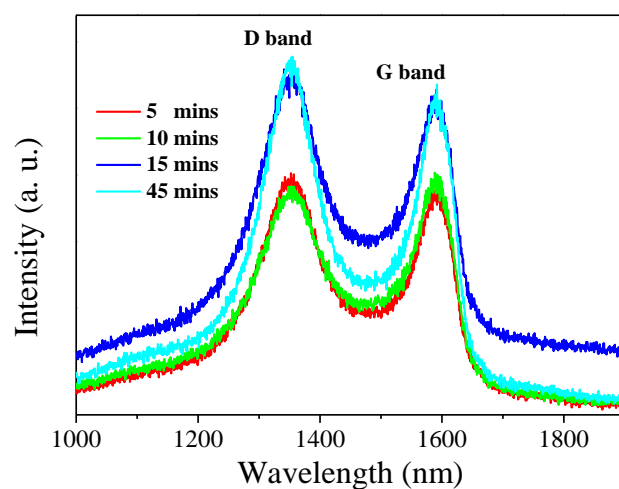
Supplementary Figure S9 | Velocity profile of water flow across a 5 nm GO channel with 20% oxygen-containing groups.



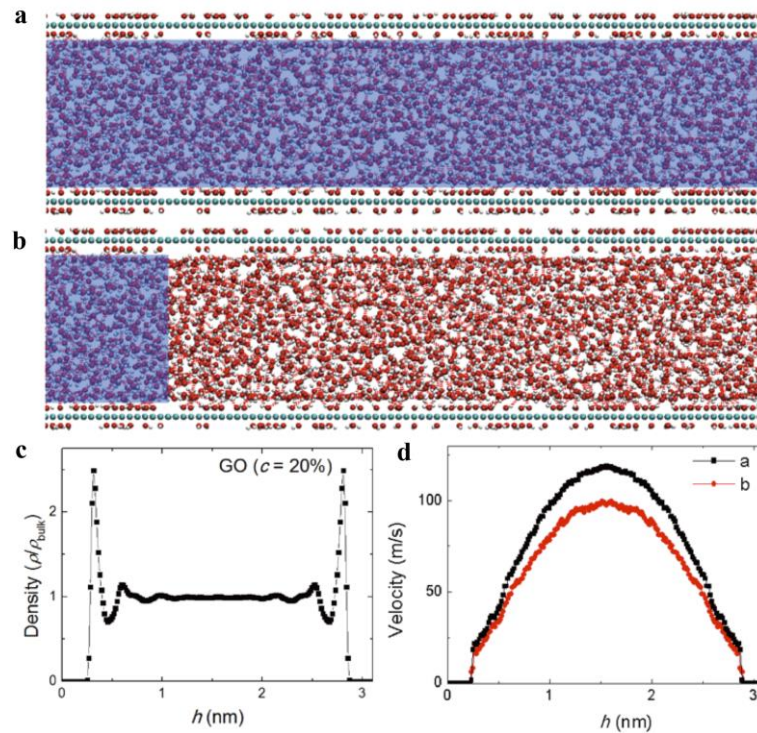
Supplementary Figure S10 | Water permeance of GO/CHNs membranes treated with N₂H₄ for various durations.



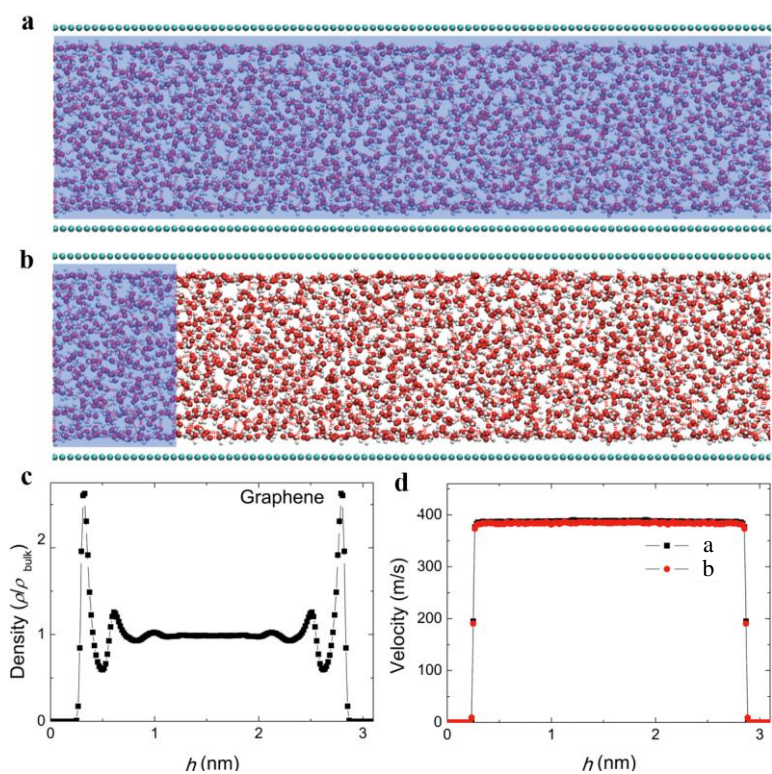
Supplementary Figure S11 | Rejection rate of EB molecules of NSC-GO membranes prepared from GO/CHNs treated with N₂H₄ for different durations.



Supplementary Figure S12 | Raman spectra of GO/CHNs membranes treated with hydrazine for different durations. The I_D/I_G ratios at 5, 10, 15, 45 min are 0.956, 0.961, 1.038 and 1.154, respectively, as calculated by integrating the peak areas of D-band and G-band peaks.



Supplementary Figure S13 | The effect of the implementation methodology of pressure gradient in MD simulations. a-b, Setup of the system for the transport of water molecules transport in a GO channel with a size of 3.1 nm, where the pressure gradient was established by applying forces to **a** all of the water molecules and **b** the water molecules in a 2 nm selected region (shaded region). **c** and **d** The density distribution and velocity profile of water along the GO surface normal for model **a** and **b**, respectively.



Supplementary Figure S14 | The same effect as shown in Figure S13 for a graphene channel. a-b, Setup of the system for the transport of water molecules transport in a graphene channel with a size of 3.1 nm, where the pressure gradient was established by applying forces to **a** all of the water molecules and **b** the water molecules in a 2 nm selected region (shaded region). **c** and **d** The density distribution and velocity profile of water along the graphene surface normal for model **a** and **b**, respectively.

Supplementary Table S1 | Performance of membranes. Water flux and rejection rate (EB) of GO membranes, GO/CHNs membranes, GO/CHNs membranes by direct EDTA treatment, GO/CHNs membranes treated with N₂H₄ and NSC-GO membranes.

Membranes	Pure water flux (L/h·m ² ·bar)	Flux of EB solution (L/h·m ² ·bar)	EB rejection rate (%)
GO	71 ± 5	50 ± 2	85.0 ± 1
GO/CHNs	7365 ± 340	7013 ± 320	44.4 ± 2
GO/CHNs +EDTA	451 ± 25	344 ± 20	78.3 ± 1
GO/CHNs +hydrazine	8296 ± 390	7345 ± 400	36.6 ± 3
NSCGO	695 ± 30	573 ± 28	83.5 ± 1

¹The hydrazine treatment duration was fixed as 15 minutes. The effective filtration area is 2.83 cm².

All of the permeance values were calculated after considering the 10% porosity of the PC support, which is reasonable because the water permeance of the nanostrand-channeled GO membranes supported on anodic alumina oxide membranes with 200 nm pores and 50% porosity was 4.3 times greater than that supported on PC with 200 nm pore and 10% porosity.