Supporting Information

*Reduced Graphene Oxide – metal nanoparticles composite membranes for environmental separation and chloro-organic remediation*

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1 Scanning electron microscope (SEM) images of polyvinylidene fluoride (PVDF) commercial membrane:

![SEM images of PVDF substrate](image1.png)

**Figure S1**: SEM images of PVDF substrate used in this study. PVDF substrate was obtained from Nanostone Water Co. Trade name: PV200. The substrate consisted of thin PVDF active layer (110 um thick) coated on polysulfone substrate and had a pore size of 90-120 nm.

2 Experimental setup:

![Experimental setup](image2.png)

**Figure S2**: Experimental setup for filtration experiment operated in a) dead-end and b) Cross-flow. Dead-end filtration cell: Sterlitech HP4750. Crossflow filtration cell: Sterlitech CF016D.
3 Optical images of GO membranes:

Figure S3: Optical images of graphene oxide-based membranes at various stages of synthesis. a) Air-dried GO membrane, b) GO membrane after thermal incubation at 90 °C for 24 hours, and c) Iron palladium nanoparticles embedded nanocomposite GO membranes.

4 Energy dispersive spectra of nanocomposite GO layer

Figure S4: Energy dispersive spectrum of nanocomposite rGO layer functionalized with Fe/Pd nanoparticles obtained for functionalized GO layer in TEM.
X-ray photoelectron spectra for the top surface of the nanocomposite GO membrane:

Figure S5: XPS spectra of the functionalized layer and underneath the rGO layer of the nanocomposite rGO membrane embedded with Fe-Pd nanoparticles. (a,b,c,d,e,f,g) and (h,i,j,k,l,m,n) shows the spectra for binding energies at the membrane surface and underneath GO layer for Survey, carbon, oxygen, nitrogen, fluorine, iron, and palladium, respectively.
6 BET characterization of nanoparticles:

**Figure S6:** BET surface area analysis of lab-made iron nanoparticles (zerovalent) and commercial magnetite nanoparticles. Commercial magnetite nanoparticles were purchased from Sigma Aldrich.
7  Persulfate decomposition by zerovalent iron:

![Graph showing persulfate decomposition by zerovalent iron with conversion (%) on the y-axis and time (seconds) on the x-axis. The graph includes data points for ZVI: PS- 1:1 (molar), ZVI: PS- 0.5:1 (molar), and ZVI: PS- 1:1 (reused ZVI).]

**Figure S7:** Persulfate activation by zerovalent (ZVI) iron in solution phase (with dispersed nanoparticles) and batch mode operation. [persulfate feed]=2 mM, Initial pH: 7, Temp: 23°C

8  Persulfate decomposition by iron-based nanoparticles:

![Graph showing persulfate conversion (%) for Fe-Pd and Fe nanoparticles with runs on the x-axis and conversion (%) on the y-axis.]

**Figure S8:** Persulfate decomposition by iron and iron-palladium bimetallic nanoparticles. [Persulfate feed]=2 mM, [Fe]=2 mM, for Fe-Pd bimetallic nanoparticle, Pd wt% = 10, initial pH: 7, temp: 23°C.
The flux of nanocomposite membranes during persulfate activation

Figure S9: Flux of nanocomposite rGO membranes at 1.4 bar pressure during filtration of persulfate solution shown in figure 5

FTIR and Raman spectra of rGO before and after persulfate exposure.

Figure S10: FTIR spectra of rGO before and after 72 hrs of persulfate exposure (7.2 mM) at 50°C
Figure S11: Raman spectra of rGO before and after 72 hrs of persulfate exposure (7.2 mM) at 50°C
11 Analysis of intermediates during TCE oxidation

Chloroacetic acid

Figure S12: Analysis of TCE oxidation intermediates by GC-MS analysis.
Salt retention by nanocomposite rGO membranes

Figure S13: Salt retention by rGO and nanocomposite rGO membranes. Salt retention was measured for 7 mM salt feed at an operating pressure of 6.9 bars and average flux of 15 LMH.