Emerging Membrane Technologies for Sustainable Water Treatment: A Review of Recent Advances

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Table S1. Nanocomposite membranes used for desalination and heavy metals removal in 2023-2024.

Membrane matrix	Average surface roughness (nm)	Charge (mV)	Pore size (nm)	NP	Loading	Permeability		Improvement /Reduction (%)	Pollutant	Rejection (%)		Improvement/ Reduction (%)	Ref.
						Before NP	After NP			Before NP	After NP		
PSF/PA	66	-60	0.686	AlPO-5	11.3 (μg/cm^2)	13.10	23.20	77.01	Na_2SO_4	-	97.5	-	(1)
PSF/PA	14.6	-28	~0.3	β-cyclodextrin nano-sheets	0.02	8.79	21.46	144.14	Na_2SO_4	97.93	98.18	0.26	(2)
PSF/PA	13.5	-30	-	Sulfonated-MoS_2	0.019	~5.00	6.80	36.00	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	~96, ~94, ~29, ~15	98.8, 95.5, 31.4, 13.2	2.92, 1.60, 8.28, -12	(3)
Poly(m-phenylene isophthalamide)/PA	18.5	-	-	MOF-808	0.02	13.50	17.63	30.59	Na_2SO_4	94.64	97.67	3.20	(4)
PSF hollow fiber/PA	8.4	-38	1.06	CuBTC	0.2	4.41	16.61	276.64	Arsenate	84.9	85.8	1.06	(5)
PSF hollow fiber/PA	-	-13	0.3	4-sulfocalix (4) arene	5	1.95	4.17	113.85	NaCl	97.6	98.8	1.23	(6)
PES/PA	18.6	-	0.34	ZIF-8	0.15 w/v%	1.26	2.52	100	NaCl	98.38	98.3	-0.08	(7)
PES/PA	-	-	-	Graphene oxide	0.3	~4.5	~8.2	82.22	Na_2SO_4, NaCl, Cr^{2+}, Ni^{2+}	76.67, 21.65, 80.15, 68.7	98.94, 34.8, 97.5, 83.37	29.05, 60.74, 21.65, 21.35	(8)
PES/PA	-	-	-	AlFu MOF	0.5	~3.5	~7.5	114.29	Na_2SO_4, NaCl, Cr^{2+}, Ni^{2+}	76.67, 21.65, 80.15, 68.7	87.74, 29.56, 89.8, 78.5	14.44, 36.54, 12.04, 14.26	(8)
PES	28.8	-	103.60	GO-ZnO	1	575	550	-4.35	NaCl, $MgSO_4$	8, ~9	~14, ~17	75, 88.89	(9)

PVP	31.2	-	127.40	GO-ZnO	1	700	937.5	33.93	NaCl, $MgSO_4$	~9, ~11	~13, ~16	44.44, 45.45	(9)
PSF/PVA	2.9	-25.90	-	GO	1	1	14.3	1330	As^{3+}, NaCl, $MgSO_4$, Na_2SO_4	~47.1, 46.1, 67, 89.1	88.4, 60, 74.5, 92	87.69, 30.15, 11.19, 3.25	(10)
PSF/PA	73.5	-	0.27	Ag	14.3 ($\mu g/cm^2$)	3.8	4.2	10.53	NaCl	98.1	98.1	0	(11)
PSF/PA	19.5	-(22-25)	0.52	Acyl chloride@MoS_2	0.0125	9.3	27.1	191.40	Na_2SO_4	97	98.6	1.65	(12)
PSF/PA	66.56	-32.10	-	N-doped graphene QD	0.01	~4.2	~5.6	33.33	Na_2SO_4	~96	~98	2.08	(13)
PSF/PA	~45	-	-	GO assembled with 1,3-diamino-2-propanol	50 mg/l	~1.94	~2.13	9.79	NaCl	99	99.3	0.30	(14)
PES/PA	7.89	-24	-	g-C_3N_4/$CuFe_2O_4$	0.01	3.8	9.2	142.11	Na_2SO_4, Cd^{2+}	49, 51	94, 96	91.84, 88.24	(15)
PVDF-grafting-PAA/PA	~30	-28	0.67	UiO-66-NH_2	-	15.33	43.60	184.41	Mo(VI), NaCl, Na_2SO_4	~65, 28.6, 95.5	98.1, 30.8, 96.5	50.92, 7.69, 1.05	(16)
PSF/PA	87.9	-38	-	Tannic acid-ZIF-8	0.01	2.06	3.55	72.33	NaCl	97	99.5	2.58	(17)
PSF/PA	-	-40	-	ZIF-8	0.02	7.78	9.91	27.38	Na_2SO_4	97	97.89	0.92	(18)
Poly (vinyl butyral)	21.32	-14	5.74	SA-grafted ε-MnO_2	-	254.37	394.62	55.14	Cd^{2+}	-	98.55	-	(19)
PSF/PA	56.2	-26	0.64	UiO-66-OH	10 ($\mu g/cm^2$)	53.5	37.4	-30.09	$MgCl_2$, $MgSO_4$, Na_2SO_4	90, 97.7, 98.3	95, 99.2, 99.5	5.56, 1.54, 1.22	(20)

PSF/PA	18.8	~-65	11.79	O–MoS_2	0.09	156.59	287.81	83.80	NaCl, $MgCl_2$, $MgSO_4$, Na_2SO_4	~20, ~3, ~80, ~82	~19, ~15, ~82, ~98	-5, 400, 2.50, 19.51	(21)
PES/PA	1.82	-	-	(ZnFeCe) layered double hydroxide	0.01	~11	~22	100	$MgSO_4$, Na_2SO_4, $MgCl_2$, NaCl	~88, ~95, ~50, ~20	88.3, 98.3, 77.4, 22.1	0.34, 3.47, 54.80, 10.50	(22)
PSF/PA	56.4	-38	-	Arg-doped polydopamine	-	2.59	3.89	50.19	NaCl	~70	98.8	41.14	(23)
PES/PA	53.2	-30	0.39	Cyclodextrin metal-organic framework	3 g/cm^2	~4	24.4	510	Na_2SO_4	95	97.12	2.23	(24)
PSF/PA	-	-22	-	Silica	0.8	~1	3.65	265	NaCl	95	98.5	3.68	(25)
PSF/PA	-	-(16-24)	-	Poly(amido amine)-halloysite nanotubes	0.025-0.1	~5.75	4.6-5.65		Na_2SO_4, $MgCl_2$, NaCl	97, 82, 40	97-98, 82-90, 25-40		(26)
PES/PA	37.83	-	0.45	Zn-PDA-MCF-5	0.25	4.20	6.40	52.38	Na_2SO_4, $MgCl_2$, NaCl	92, 77, 66	95, 88, 86	3.26, 14.29, 30.30	(27)
PES	-	-	-	MoO_2@GO	-	-	410	-	NaCl, $MgCl_2$, $Ni(NO_3)_2$, $PbCl_2$	40, 66, 90, 85	79, 82, 99, 98	97.5, 24.24, 10, 15.29	(28)
PES	-	-	-	WO_3@GO	-	-	445	-	NaCl, $MgCl_2$, $Ni(NO_3)_2$, $PbCl_2$	40, 66, 90, 85	70, 75, 99, 98	75, 13.64, 10, 15.29	(28)
CA	-	-	-	Titanate nanowire	5	1.3 L/m^2.h	2.3 L/m^2.h		NaCl	95	65	-31.58	(29)
PES/PA	9.42	-28	0.54	MoS_2	0.001	8.07	10.45	29.49	Na_2SO_4	97.10	98.4	1.34	(30)

Pre-cast PS20 PSf/PA	60	-	-	ZIF-8	0.15	~2.1	~2.7	28.57	NaCl	~98	~97	-1.02	(31)
PSF/PA	38.56	-	0.6	CNTs	0.015	0.94 $m^3/m^2.day$	0.93 $m^3/m^2.day$		NaCl	99.5	99.77	0.27	(32)
Polyphenylsulfone/ Sulfonated polyphenylsulfone HF	21	-	-	TiO_2	2	2.5	5.4	116	$MgSO_4$	58	95	63.79	(33)
PSF/PA	5	-20	0.3	Amine-carbon dot	0.05	~16.26	30.9	90.04	Na_2SO_4	~99	99.4	0.40	(34)
PES/TA-C_3N_4 nano-sheets	34.9	-65	0.58	g-C_3N_4 nano-sheets	-	21.03	34.25	62.86	Na_2SO_4	92.04	98.53	7.05	(35)
PES/PA	4.4	-	0.53	Exfoliated protonated MMT nano-clay	0.03	~1.62	~2.62	61.73	Na, Mg, SO_4, Cl	~37.5, ~50, ~39, ~40	80.8, 96.3, 85.7, 82	115.47, 92.60, 119.74, 105	(36)
PES/PA	-	-	-	Ethylenediamine-GO impregnated	0.05	-	~1.65	-	$MgSO_4$, Na_2SO_4, NaCl	~85, ~87, ~38	98, 97, 63	15.29, 11.49, 65.79	(37)
PSF/PEI	4.42	28.46	0.41	SiO_2	-	~37 p	~48		$MgCl_2$	~33	95.2	188.48	(38)
PA66/Piperazine	-	-9	-	NH_2-nano-diamonds	-	8.44-10	9.97-12.88		$MgSO_4$, Na_2SO_4, $MgCl_2$, NaCl	~97, ~95, ~43, ~38	98.14, 97.1, 55.31, 44.9	1.18, 2.21, 28.63, 18.16	(39)
PES/PVP	4.05	-	3.4	Graphite	0.5	~0.64	~1.4	118.75	-	82	91.79	11.94	(40)
PVDF	-	0.5	-	Ionic liquid-reduced GO	0.5	58.62	85	45.00	Cu^{2+}, Cd^{2+}, Zn^{2+}, Mn^{2+}, As^{3+}	~28, ~30, ~17, ~30, ~28	67, 96, 51, 65, 70	139.29, 220, 200, 116.67, 150	(41)
PSF/PEI	46.56-87.03	-	-	Ag_2S	0.005–0.05	1.50	1.90	26.67	NaCl	97.7	98	0.31	(42)

Cellulose diacetate	-	-	-	Cellulose NCs	0.50	0.6	4	566.67	NaCl	88	96	9.10	(43)
Polyphenylsulfone & PVP	20.95	-	1.61	MXene	0.6	0.91	3.7	306.59	Cu^{2+}, Cd^{2+}, Pb^{2+}	97.7, 93.7, 92	97.4, 93.2, 93	-0.31, -0.53, 1.09	(44)
P-carboxy phenyl amino maleimide with CA	-	-	-	ZrO_2	2	157	316.15	101.40	NaCl	57.94	65.80	13.57	(45)
PSF/PA	38.38	-	-	MCM-41	0.05	3.05	4.05	32.79	Cu^{2+}, Na^{+}	100, 96.88	100, 96.46	0, -0.43	(46)
PSF/PA	27.3	-	-	MXene	-	~12	~21	75	Na_2SO_4	~95	~97	2.11	(47)
PAN	-	-17	23.85	Hyperbranched PEI-GO	1	-	-	-	Au^{3+}	-	88.57	-	(48)
PAN/PVA/PA	50.6	-	0.36	Polyvinyl alcohol/attapulgite	3	15.6	22	41.03	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	78, 64, 56, 12	99.5, 99.5, 94, 25	27.56, 55.47, 67.86, 108.33	(49)
PSF/PA	59.26	-50	-	Chicken egg white albumin	0.3	1.47	1.76	19.73	NaCl	99.61	99.66	0.05	(50)
PE/PA	52.3	-18	-	TiO_2	0.01	2.22	5.00	125.23	NaCl, $MgSO_4$, Na_2SO_4, As^{5+}	97.60, 98.00, 99.20, 67.50	98.80, 99.50, 99.80, 100	1.23, 1.53, 0.60, 48.15	(51)
PSF	-	-	-	Amine, thiol-SiO_2	0.50	-	6.70		Cd^{2+}, Pb^{2+}	-	82.00, 99.00	-	(52)
PSF/PA	-	-	86	GO-silver	0.15	0.60	2.40	300	Salt	93.50	99.20	6.10	(53)
PSF/PA	-	-13.2	-	Cellulose NCs	0.10	>6.50	>18.80	189.23	Cd^{2+}, Pb^{2+}	94.00, 88.80	98.00, 95.00	4.26, 6.98	(54)

PSF/PA	-	-7.38	0.62	N-doped graphene QDs	-	4.78	17.30	261.92	Na_2SO_4	92.00	99.70	8.40	(55)
PSF/PA	9.2	-12	0.2	Cellulose NCs	0.10	6.00	16.00	166.67	Na_2SO_4, $MgCl_2$, NaCl Cu^{2+}, Pb^{2+}	~98, ~73, ~42, ~96, ~92	~99, ~74, ~43, ~97, ~96	1.02, 1.40, 2.38, 1.04, 4.35	(56)
PES/Polyester	19.95	-70	0.47	Carboxymethyl cellulose-MIL-53 (Fe)	-	~22	39.83	81.05	Na_2SO_4, NaCl	~68, ~21	61.49, 17.22	-9.57, -18	(57)
PES/Polyester	33.9	-38	-	Tannic acid-MXene	0.01	9.2	16.6	80.43	Na_2SO_4, $MgSO_4$	~96, ~94	96.6 ~94	0	(58)
Poly(m-phenylene isophthalamide)/PA	17	-62	-	2D boron nitride nanosheets	10 v/v%	15.98	18.18	13.77	Na_2SO_4	97.86	97.5	-0.37	(59)
Polyphenylsulfone	1.93	-14	1	Polyaniline	0.50	~2.00	~4.25	112.50	Pb^{2+}, Cu^{2+}	~60, ~62	~95, ~98	58.33, 58.06	(60)
Polyphenyl sulfone	8-16.44	-	130	SiO_2	2.00	~7	~40.73	481.86	NaCl	~95	94.90	-0.11	(61)
PU	316	-	2.8 μm	Laponite/GO	15	7.25	132.85	1732.41	Pb^{2+}, As^{5+}	~22, ~18	98, 95	345.45, 427.78	(62)
PSF	40	-	-	Sepiolite	4.5	0.232	0.472	103.45	NaCl	~40	~74	85	(63)
PVDF	26	-	150	Perfluorocty lamine-Graphene	0.7	5 $L/m^2.h$	~9 $L/m^2.h$	80	NaCl	~99.7	~99.86	0.16	(64)

				nanosheets								
PVDF	44	-	190	Octylamine-Graphene nanosheets	0.7	5 L/m^2.h	~8.5 L/m^2.h	70	NaCl	~99.7	~99.88	0.18	(64)
PSF/PA	16.3	-21.01	0.36	Imine-based covalent organic frameworks nanosheet	0.007	6	8.54	42.33	Na_2SO_4	97.1	~98.1	1.03	(65)
PES/PA	31.8	-38	-	Tannic acid-Fe^{3+}-MCNT	30 µg/cm^2	1.1	3.2	190.91	NaCl	~97	~99	2.06	(66)
PVA/CA	-	-17	-	MIL-100 (Fe)	5	9.25	11.25	21.62	Na_2SO_4, $MgSO_4$, Pb^{2+}, Cd^{2+}	~68, ~60, ~90, ~83	~78, ~65, 93, 92	14.71, 8.33, 3.33, 10.84	(67)
PAN/PEI	16.1	-8	0.6	rGO@Au	0.025	~94	~10	-89.36	NaCl, Na_2SO_4, $MgSO_4$, $MgCl_2$	~54, ~60, ~85, ~81	91.5, 92, 96.5, 96.2	69.44, 53.33, 13.53, 18.77	(68)
PVP, PSF	22.2	-	650	ZIF-8	1	0.98	2.22	126.53	NaCl, Na_2SO_4	~87, ~97	94.2, ~97.5	8.28, 0.52	(69)
PES/PA	29.5	-70	0.56	MoS_2	20.1 µg/cm^2	~37	33.5	-9.46	Na_2SO_4	~65	97.5	50	(70)
PSF/PA	8.15	-1.28	-	Titania nanosheet	-	~0.98	1.57	60.20	Cs^+	99	100	1.01	(71)
PSF/PA	-	-	-	Ag@Sodium alginate@ch	-	~5.8	~6	3.45	NaCl	~98	~98	0	(72)

				itosan									
PSF	5.93	-	4.45	Chitosan/MWCNT	0.1/0.75	16.29	20.46	25.60	Na_2SO_4	54.7	95.5	74.59	(73)
PVDF/PVP	-	-	-	Montmorillonite	5	13.8	19.8	43.48	Pb^{2+}, Cd^{2+}	~39, ~52	83, 87	112.82, 67.31	(74)
PSF/PA	78.6	-54	-	Amine-multi walled carbon nanotube	0.02	2.33	2.47	6.01	NaCl	94	97.5	3.72	(75)
CA	-	-	-	Amine-SiO_2	40	-	-	-	As^{5+}, Cd^{2+}, Pb^{2+}	-	~99, ~99, ~90	-	(76)
CA	-	-	5-200	$MnFe_2O_4$-SWCNTS	4	0.67 $\times10^4$	1.01 $\times10^4$	50.75	Al^{3+}, Zn^{2+}	42, 37	98, 94	133.33, 154.05	(77)
PSF	61.9	-	-	TiO_2	0.05	12.5	9	-28	Pb^{2+}, Cu^{2+}, Co^{2+}, Sr^{2+}, NaCl, Na_2CO_3, KNO_3	~45, ~53, ~62, ~33, ~37, ~45, ~39	~73, ~86, ~88, ~57, ~68, ~83, ~72	62.22, 62.26, 41.94, 72.73, 83.79, 84.44, 84.62	(78)
PES	68.6	-65	1.41	TiO_2	1.5	7.59	14.32	88.67	NaCl, Na_2SO_4, $MgCl_2$, $MgSO_4$	~92, ~83, ~55, ~45	44.5, 91.2, 54.1, 82.8	-51.63, 9.88, -1.64, 84	(79)
PSF/PA	-	-	-	Ag	4 mg/ml	11 $L/m^2.h$	33 $L/m^2.h$	200	Na_2SO_4	~97	96.11	-0.92	(80)
PLA	-	-	-	MIL-140	3	0.27	0.54	100	NaCl	99.87	99.83	-0.04	(81)

PSF/PA	62	-40	-	Sulfonated porous organic polymers	0.005	1.5	3.5	133.33	NaCl	>95.5	>97.5	2.09	(82)
PSF/PA	18	-5	-	Cellulose nanocrystals (CNC)	5 µL CNC suspension	~100	~220	120	$MgCl_2$, $MgSO_4$, Na_2SO_4, NaCl, LiCl	~97, ~92, ~70, ~82, ~75	~94, ~92, ~78, ~80, ~78	-3.09, 0, 11.43, -2.44, 4	(83)
PSF/PA	171.56	-31	-	Palygorskite	1.3 mg/ml	1.98	5.02	153.54	NaCl	99.3	99.1	-0.20	(84)
PSF/PA	16.5	-47.5	0.56	Mesoporous silica nanosheet	0.1% w/v	~9.5	22.5	136.84	Na_2SO_4, $MgSO_4$, $CaCl_2$, $MgCl_2$, NaCl	~98, ~95, ~58, ~48, ~30	97.8, ~92 ~42, ~35, ~18	-0.20, -3.16, -27.59, -27.08, -40	(85)
PSF/PA (Trimesoyl chloride, Piperazine) (second layer)	52	-70	0.67	MOF-801	3.4 µg/cm^2	10.6	20.90	97.17	Na_2SO_4	99.1	97.5	-1.61	(86)
PSF 3500-P Udel/ PA (Trimesoyl chloride, Piperazine)	33.49	-	-	TiO_2/Ag	0.05	~0.27	~0.4	48.15	$Cr(NO_3)_3$	~94	~99	5.31	(87)
PSF/PA	74	-	-	β-	0.1	-	2.68	-	NaCl	-	99.40	-	(88)

(Trimesoyl chloride, m-phenylenediamine)	cyclodextrin-modified Mg_2Al layered double hydroxide	

Table S2. Thin-film composite membranes used for desalination and heavy metals removal in 2023-2024.

Membrane matrix	Average surface roughness (nm)	Charge (mV)	Pore size (nm)	Thin film	Permeability			Pollutant	Rejection (%)		Improvement/ Reduction (%)	Ref.
					Support	Composite	Improvement /Reduction (%)		Support	TFC		
PES	11.71	-28	-	Polyamide	~1.1-1.8	1.89		NaCl	~86-97	97.4	~8.22	(89)
Poly(ethylene terephthalate)	-	-	-	Polyamide	86.27	73	-15.38	NaCl	25.89	33	27.46	(90)
Polyacrylonitrile	10.1	-70	0.6	Stevioside/ trimesoyl chloride	>81.2	~20	-75.40	Na_2SO_4	<~82	~90	9.76	(91)
PES	-	-	-	Polyamide	-	1.51		NaCl	-	97.8	-	(92)
Polyethylene	63.33	-12.5	-	Polyamide	13.4	~4	-70.15	NaCl, $MgCl_2$, $MgSO_4$, Na_2SO_4	~6, ~8, ~12, ~19	~37, ~38, ~49, ~72	516.67, 375, 308.33, 278.94	(93)
Sulfonated graphene oxide embedded PSF	-	-9.25	44	Polyamide	~0.49	~0.84	71.43	NaCl	~98	~95	-3.06	(94)
PSF	45	-	0.48	Polyamide (m-phenylene diamine, 1,3,5-benzenetriacyl chloride)	~1.5	~3.2	113.33	NaCl	~95	~99	4.12	(95)
PES	-	-11.2	-	Polyamide, dipeptide of zwitterionic	0.7	18.93	2604.29	NaCl	96.25	98	1.82	(96)

				amino acid L-arginine								
PES	-	-	-	Polyamide	-	0.57		NaCl	-	99.2	-	(97)
PSF	-	-	-	Polymethyl acrylate grafted silica nanoparticles	2-5	2-5	0	NaCl	~20	>99	395	(98)
PSF	-	-	-	UiO-66-SO_3H-incorporated polyamide	~1	~3.4	240	NaCl	~96	94.7	-1.35	(99)
PSF	45.62	-28	0.34	EMT-NH_2 zeolite (interlayer), Polyamide (Piperazine, Trimesoyl chloride)	~130	~13.8	-89.30	$MgCl_2$, $MgSO_4$, Na_2SO_4	-	97.4, 98.4, 98.65	-	(100)
Polyacrylonitrile	10.4	-55.1	-	BaAlg hydrogel interlayer, Polyamide (piperazine, triethylamine, tricarbonyl chloride)	-	27.25	-	Na_2SO_4	-	98.7	-	(101)
PES	52.5	-18	0.38	Polyamide (Polyethylene oxide, trimesoyl chloride,	-	12.59	-	Na_2SO_4, $MgCl_2$, $MgSO_4$,	-	96, ~84.4, ~92.51	-	(102)

				piperazine)								
PSF	19.6	-45	-	MXene-TiO_2 interlayer, Polyamide (piperazine, trimesoyl chloride)	-	11.10	-	$MgSO_4$	-	98.29	-	(103)
NF90	70.84	-	-	Polypyrrole, Carbon nanotubes	-	0.63	-	NaCl	-	53.00	-	(104)
NF270	63.46	-	-	Polypyrrole, Carbon nanotubes	-	3.68	-	NaCl	-	38.40	-	(104)
PES	5.48	-75	0.54	Piperazine, 1, 3, 5-benzenetricarbonyl trichloride	-	23.70	-	Na_2SO_4, $MgSO_4$, NaCl	-	95.40, 75.90 5.80	-	(105)
PES	-	-15	-	Polyamide (Piperazine, 1, 3, 5-benzenetricarbonyl trichloride) Tröger's base	-	18.5	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	98.3, 93.9, 47.3, 23.9	-	(106)
PSF (first layer), Polycarboxylic acid/ZIF-8 (interlayer)	20.50	-38	-	Polyamie (1,3,5-Benzenetricarbonyl trichloride, 1, 3-	-	4.2	-	NaCl	-	98.8	-	(107)

				phenylenediamine)								
Commercial PA-TFC BWRO	-	-54	-	Poly(acrylic acid)-polyamide	2.9	1.69	-41.72	Nitrate, Boron, As (III), As(V)	-	98, 90.7, 96, 99.6	-	(108)
PSF/polyester terephthalate	8.95	-1.50	-	Polyamide layer (terephthaloyl chloride, 1,2-bis(3-aminopropylamino) ethane)	-	~6	-	$MgCl_2$, Na_2SO_4, $MgSO_4$, NaCl, $CaCl_2$	-	92.7, ~75, ~90, ~78, ~73	-	(109)
PES	-	-48	-	Polyamide (Piperazine, Trimesoyl chloride)	-	43.3	-	Na_2SO_4	-	99.3	-	(110)
PES	9.6	-18	1.21	Poly (sodium 4-styrenesulfonate , polyethyleneimine)	-	74.5	-	Na_2SO_4	-	99.20	--	(111)
Commercial ceramic membrane	-	-	-	Polyamide (Piperazine, 1,3,5-benzenetricarbonyl trichloride)	-	42.9	-	Na_2SO_4	-	93.40	-	(112)
Polyacrylonitrile modified	20.7	-	-	Polyamide (M-phenylenediami	-	0.87	-	Na_2SO_4, NaCl	-	99, 98.1	-	(113)

polydopamine				ne, Trimesoyl chloride)								
PES	98.2	-20	0.33	Polyamide (M-phenylenediamine, Trimesoyl chloride, Sulfonated polyaniline (SPANI) nanofibers)	-	35.35	-	Na_2SO_4, $MgSO_4$	-	98.95, 95.37	-	(114)
PSF	89.2	-	-	Polyamide (poly(TMC-co-MPD-co-poly(DADMAC-co-DADA)))	~0.38	1.29	239.47	NaCl	~88	93.10	-	(115)
PES/sulfonated PSF (first layer), Polydopamine-piperazine-halloysite nanotubes (second layer)	197	-16	0.36	Polyamide	15.87	45.3	185.44	Na_2SO_4	98.3	97.1	-	(116)
Hydrolyzed polyacrylonitrile	-	-13	1.13	Carbo-cationic microporous poly(triaminoguanidinium-amide)	-	19	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	98.6, 99.1, 21.5-85, 41.6-85	-	(117)

Poly(vinylidene fluoride)/Carboxylic multiwalled carbon nanotubes (first layer) Tannic acid/Fe (second layer)	26.7	-25	0.37	Polyamide (Amino-functionalized graphene quantum dots, trimesoyl chloride)	-	~8	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	65.68, 63.59, 21.64, 14.72	-	(118)
PSF	6.80	-16.9	-	1,3,5-benzenetricarbonyl trichloride, m-phenylenediamine, Silver nitrate	-	~1.37	-	NaCl	96.52	98.05	-	(119)
PSF	-	-25	-	Polyamide (trimesoyl chloride, m-phenylenediamine, nonionic surfactant TW)	-	~1.4	-	NaCl	-	~92	-	(120)
PSF	3.8	-68.7	-	Polyamide (Piperazine, Trimesoyl chloride, Triaminoguanidine hydrochloride)	-	~12	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	99, ~97, ~43, ~42	-	(121)
Single-walled carbon nanotube	3.2	-6	0.47	Polyamide (tris (4-	-	0.7	-	NaCl, $MgCl_2$,	-	96.80, 95.70,	-	(122)

				aminophenyl) amine, 1,3,5-trimesoyl chloride, N, N′-dimethylacetamide, piperazine)				Na_2SO_4		97.70		
PSF	-	41.6	-	β-Cyclodextrin, Terephthaloyl chloride, Tannic acid	-	~4.4	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, $CaCl_2$	-	93, 92, 91, 84	-	(123)
PSF	-	7.16	-	β-Cyclodextrin, Trimesoyl chloride, Tannic acid	-	~1	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, $CaCl_2$	-	~79, ~80, ~80, ~80	-	(123)
PSF	-	-4.5	0.42	Polyamide (Polyethyleneimine, Terephthaloyl chloride, Piperazine)	-	11	-	Na_2SO_4, Heavy metals	55-82, 98-99	97.5, 98-99	-	(124)
PSF	-	-40	-	Polyamide (Terephthaloyl chloride, Triethylamine, Piperazine, N-(3-Dimethylamino propyl)-N′-ethylcarbodiimi	-	5.87	-	Cr (VI), Na_2SO_4, NaCl	-	97, 97.7, 23.4	-	(125)

				de hydrochloride, Hydroxysuccinimide, Ethylenediamine, Graphene oxide)								
GO-PVDF nanofibrous membrane	-	-0.3	-	Chitosan	-	157.3	-	Mn (II)	~12	90.7	655.83	(126)
PSF	-	-4	0.41	Polyamide (Trimesoyl chloride, Poly(2-dimethylaminoethyl)methacrylate, α,α'-dichloro-p-xylene, Piperazineamide)	-	8	-	Na_2SO_4, $MgCl_2$, NaCl, Co (II)	-	~98, 92, 44, 98	-	(127)
PES	10.3	-38	0.61	Polyamide (Trimesoyl chloride, Piperazine) Post treatment	-	~10.5	-	$MgCl_2$, NaCl, $MgSO_4$, Na_2SO_4	-	~54, ~25, ~95, ~98	-	(128)
PSF	-	-	-	Polyamide (m-phenylenediamine, Trimesoyl	1.77 (without Fe-TA)	3.58	102.26	Boron	~99 (without Fe-TA)	98.37	-	(129)

				chloride), Fe-TA complex								
Polyacrylonitrile	-	-	0.2-0.4	Polyamide (Trimesoyl chloride, Piperazine, Triethylamine)	-	13.30	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	98.2, 97.6, 80.7, 15.2	-	(130)
PSF	-	-58.1	-	Polyamide (Triethylamine, m-phenylenediamine, cyclopentanecarbonyl chloride)	-	4.84	-	NaCl	-	98.28	-	(131)
PES (first layer), Dopamine and $C_{19}H_{39}NO_2$-g-C_3N_4 (second layer)	-	-18	0.49	Polyamide (Polyethyleneimine, Trimesoyl chloride)	-	12.33	-	Mg (II)	-	98.41	-	(132)
PSF	-	-10.97	-	Copolymer poly(vinyl alcohol-co-styrenesulfonic acid) /Glutaraldehyde	-	3.22	-	$MgSO_4$, NaCl	-	79.2, 54	-	(133)
PSF	7.06	-	-	Polyamide (Piperazine, Trimesoyl chloride,	-	7.09	-	$MgSO_4$	-	97.5	-	(134)

				Triethylamine, Phytic acid-modified graphene oxide)								
PSF	10.31	-40	0.2	Polyamide (2-methylimidazole, Piperazine, Trimethyl chloride)	-	6.98	-	Na_2SO_4, NaCl	-	99.5, 42.8	-	(135)
PSF	9.82	25	0.46	Polyamide (Polyethyleneimine, 1,3,5-benzenetriacyl chloride)	-	3	-	NaCl, LiCl, Na_2SO_4, $MgSO_4$, $CaCl_2$, $MgCl_2$	-	~65, ~60, ~64, ~95, ~98, 97.8	-	(136)
Polyethylene	30.4	25	0.5	Polyamide (Polyethyleneimine, 1,3,5-benzenetriacyl chloride)	-	10.50	-	NaCl, LiCl, Na_2SO_4, $MgSO_4$, $CaCl_2$, $MgCl_2$	-	~54, ~62, ~43, ~92, ~96, ~97	-	(136)
PES	-	-	-	Polyamide (Meta-phenylene diamine, Trimesoyl chloride, Graphene oxide, Chitosan)	-	0.86	-	NaCl	-	88.58	-	(137)

Polydopamine coated zeolite anchored on PSF	50	-38	-	Polyamide (Piperazine, 1,3,5-benzenetriacyl chloride)	-	22.50	-	NaCl, $MgCl_2$, $MgSO_4$, Na_2SO_4	-	48.60, 91.30, 99.10, 99.50	-	(138)
Polyethylene	33.4	-1	0.27	Polyamide (Piperazine, 1,3,5-benzenetriacyl chloride, Isopropyl alcohol)	-	3.5-4.8	-	Na_2SO_4, $MgCl_2$	-	95, 94.30	-	(139)
PSF	6.74	-3	-	Polyamide (Pyromellitic acid, Cyanuric chloride, Branched polyethyleneimine)	-	9.8-20.40	-	Na_2SO_4	-	95.10	-	(140)
NF270	-	-31.3	-	$BaCl_2$ and Na_2SO_4 aqueous solution	14.38	16.13	12.17	Na_2SO_4	94.7	97	2.43	(141)
Nylon membrane disc filters	-	-	-	Polyamide (m-phenylene diamine, Trimesoyl chloride)	-	16	-	Na_2SO_4, NaCl	-	92.5, 65	-	(142)
PES	3.25	-11.4	-	Polyamide	-	1.25	-	$MgCl_2$,	-	99.70,	-	(143)

				(Branched polyethylenimine, 1,4-phenylene diisocyanate, Cyanuric chloride)				$MgSO_4$, $CuCl_2$, NaCl, LiCl, Na_2SO_4		99.1, 99.30, 98.90, 98.80, 98.80		
Sulfonic acid functionalized graphene oxide and PES	140.83	-40	7.55	Polyamide (m-phenylene diamine, Trimesoly chloride)	0.68	3.09	354.41	Cr(VI), As(V), Na_2SO_4, $MgCl_2$, NaCl	~76, ~90, ~77, ~62, ~58	~89, ~99, ~79, ~72, ~68	17.11, 10, 2.60, 16.13, 17.24	(144)
Poly(p-phenylene terephthamide)/ Poly(ethylene glycol)	-	-38	-	Polyamide (Piperazine, 1,3,5-benzenetricarbonyl trichloride, UiO-66-NH_2)	-	~2.8	-	Na_2SO_4, $MgSO_4$, $MgCl_2$, NaCl	-	96.30, 85.40, 53.20, 18.40	-	(145)
Polyacrylonitrile	-	-	-	Polyamide (M-phenylenediamine, trimesoylchloride)	-	1	-	NaCl	-	98.6	-	(146)
Polycarbonate TE	-	-	-	Polyamide (m-phenylenediamine, 1,3,5-benzenetricarbonyl trichloride)	-	1.1	-	NaCl	-	97	-	(147)

PES	-	-12	<0.5	Polyamide (piperazine, 1,3,5-benzenetricarbonyl trichloride)	-	15.80	-	Na_2SO_4, $MgSO_4$, NaCl	-	99.5, 99.30, 47.80	-	(148)
Polyacrylonitrile-PX, XL-poly(epoxyether) (PEE)	-	-	-	Polyamide (N,N,N',N'-tetramethyl-1,6-hexanediamine, Tetraphenolethane tetraglycidyl ether)	-	0.5-3	-	NaCl	-	20-85	-	(149)
PSF	5.3	-45	0.5	Polyamide (Piperazine, 1,3,5-benzenetricarboxylic trichloride, 7,7′–OH-BINOL)	-	17.01	-	Na_2SO_4	-	98	-	(150)
PSF	64.7	-	-	Polyamide (Piperazine, Trimesoyl chloride, m-phenylenediamine)	-	2.96	-	NaCl	-	99.40	-	(151)
PSF	-	18.2	-	Polyamide (Piperazine, Trimesoyl	-	12.62	-	$MgCl_2$	-	94.60	-	(152)

				chloride, Branched polyethyleneimine)								
PES	28.6	-28	0.59	Polyamide (Piperazine, Trimesoyl chloride, 2-acrylamido-2-methyl-1-propanesulfonic acid	-	30.5	-	Na_2SO_4	-	99.70	-	(153)
Commercial polyamide-based reverse osmosis membrane	129.72	-35	-	Diazotization reagent reaction	14.20	~15.50	9.15	NaCl	96.50	~98	1.55	(154)
Flat-sheet polyamide-based reverse osmosis membrane	-	5	-	Polyamide (Cellulose derivative polyquaternium-10, Polyvinyl alcohol, Glutaraldehyde)	6.03	4.32	-28.36	NaCl	98.14	98.58	0.45	(155)
PES	-	-28	0.38	Polyamide (Piperazine, Trimesoyl chloride)	~8	~12	50	Na_2SO_4, $MgCl_4$, $CaCl_2$, NaCl	~98, ~97, ~95, ~45	~98, ~96.5, ~93, ~30	0, -0.52, -2.11, -33.33	(156)
Nanofibrous mat	-	-	180	Polyamide	-	25.50	-	Na_2SO_4,	-	97.40,	-	(157)

from sulfonated PVDF	(Meta phenylenediamine, 1,3,5-benzene tricarbonyl chloride)	L/m^2.h	$MgSO_4$, $CaCl_2$, NaCl	98.40, 97.40, 88.80	

Table S3. Biomimetic membranes used for desalination and heavy metals removal in 2023-2024.

Membrane matrix	Biomimicry	Feature	Charge (mV)	Roughness (nm)	Pore size (nm)	Permeability (L/m^2.h.bar)	Pollutant	Rejection (%) Support	Ref.
TFC RO PAN-PEI/PAA/PA	Sharklet pattern	Biofouling reduction	-	-	25	1.47	NaCl	98.2	(158)
Polycarbonate tracketched membrane (PCTE)-Peptide-GO	Artificial ion channels	Selective ion transport	-	-	30-40	-	NaCl, KCl, $MgCl_2$, $CaCl_2$	~48, ~45, ~37, ~47	(159)
PAN-Peptoid added PA	Biomimetic antimicribial peptoid	Antimicrobial & antibiofoulong	12.5	132.5 µm	-	2.21	NaCl	99.4	(160)

PSF-PA-SWCNT-liposomes	Artificial water channel	Enhanced water permeability	-32.23	124	-	43.2 L/m^2.h	NaCl	97.6	(161)
Water channel-based biomimetic membrane (Nanovesicle-containing m-phenylenediamine, Trimesoyl chloride	Biomimetic water channels	Water permeability enhancement and breaking the permselectivity trade-off	-65	-	-	8.2	NaCl	96.4	(162)
CTA-RO	Pore mechanism of frozen tofu	Long Lifetime	-67	9.92	~18	17.2	NaCl	89.9	(163)
PA-BNP-Ag	Incorporation of biomimetic NPs	High perm-selectivity & Antifouling/bacterial property	-28	57.5	0.27	4.2	NaCl	98.1	(11)
Artificial water channel-polyamide	Artificial water channel	Enhanced water-salt permselectivity	-35	-	0.26	3.9	Cl^-, NO_3^-, F^-, SO_4^{2-} Na^+, K^+, Ca^{2+}, Mg^{2+}	80-96	(164)
Lecithin incorporated PESH-PA NF	Lecithin incorporation	Enhanced perm-selectivity for dye/salt separation	-105	24.1	0.85	48.3	NaCl	17.5% for NaCl, 7.2% for $MgCl_2$	(165)
Polydopamine/cystamine coated PSF-PA RO	Redox-responsive	Anti-fouling	-	37.8	-	0.54	NaCl	99.11	(166)

	coatings								
Catechol /tetraethylenepentamine/Ag coated commercial ESPA1	Co-deposition of catechol /tetraethylenepentamine	Anti-biofouling	-32	74.5	-	~73p	NaCl	~97	(167)
GSNA	Guanidinefunctionalized sericin/nanocellulose aerogel (GSNA) with a biomimetic skeletal architecture	Hybrid water disinfection and heavy metal removal	-40	-	47	2900	Cu (II), Co (II), Ni (II)	~85, ~75, ~78	(168)
PLA fibers-polydopamine assisted PEI grafting	Green modification method	Biodegradability	15	-	-	-	Cr (VI)	64.79	(169)

Table S4. Forward osmosis membranes used for desalination and heavy metals removal in 2023-2024.

FO Membrane Material	Draw Solute	Osmolality (mOsm/kg)		Feed Solution	Mode	DI Water Flux (LMH)	Solution Water Flux (LMH)/Specific Salt Flux (g/L)	Reverse Salt Flux (gMH)	Ref.
Hydration Technologies Inc. TFC FO Membrane	Tributyl-4-vinylbenzylphosphonium alkanesulfonate ionic liquid	2 wt.%	80	2000 ppm NaCl	AL-DS	11.4	8.01	6	(170)
		4	170						
		6	230		AL-FS	5.5	4.5	2.5	
		8	310						
Porifera TFC FO Membrane	Poly(amidoamine) dendrimer	10 g/L	344	DI	AL-DS	12.9	--	--	(171)

	coated magnetic NPs (PAMAM-MNPs)	20	561						
		30	636						
		40	721						
Support-free assembled molecular layer-by-layer (SF-mLbL) HPAN FO	0.5,1,1.5 & 2 M NaCl	--	DI	0.5,1,1.5 & 2 M NaCl	AL-DS	~ 49	0.17	~ 7	(172)
					AL-FS	43.52 ± 0.89	0.17	~ 6.2	
IP-PA					AL-DS	~ 16	0.78	~ 12	
					AL-FS	10.34 ± 0.48	0.75	~ 7.7	
Commercial Cellulose Triacetate					AL-DS	~ 14	0.85	~ 11.5	
					AL-FS	7.41 ± 0.18	0.82	~ 6	
PES-PA Aquaporin TFC FO (A/S, Denmark)	Zinc sulfate	83700 ppm	12 bar	0.5, 1 & 1.5 M NaCl	AL-DS	6.5	6.5	4	(173)
					AL-FS		11.5	4.5	
		167400	21.6		AL-DS	8.2	8.1	4.6	
					AL-FS		14	5	
		251100	30		AL-DS	8.8	8.8	5.8	
					AL-FS		21.5	6.6	
In-house made TFC-HF FO with a PA selective layer	PEO2-PPO16-PEO2 (L31)	30	20	NaCl 1%,	AL-DS	11	5	-	(174)
		50	22						
		65	23	NaCl 3.5%,			3		
		75	35						
	PEO11-PPO16-PEO11 (L35)	30	28	NaCl 10%			2		
		40	35						
		65	100						
		75	130						
	PEO2-PPO30-PEO2 (L61)	65 wt.%	10 bar	SWRO brine			2.5		
	PEO13-PPO30-PEO13 (L64)	--	--						
Chitosan Nanofibers/PA	NaCl	0.5	-	DI water	AL-DS	-	95	~ 7	(175)

		mol/L							
		1					107.53	~ 28	
		1.5					125	~ 37	
		2					131.13	~ 42	
Ag@NH_2-UiO-66/PAES-COOH	NaCl	0.4 M	-	DI water	-	-	5.5	2.6	(176)
		0.6					8	~ 3.75	
Ag@NH_2-UiO-66/PAES-COOH	NaCl	0.8	-	DI water	-	-	11	~ 6.2	
		1					13.78	~ 7	
		1.2					15.8	~ 7.9	
		1.4					19	~ 9.2	
Perylene diimide/PES/PA	NaCl	1 M	-	DI water	AL-DS	TFC-0	11.41	0.265	2.92	(177)
						TFC-10	10.7	0.07	0.77	
						TFC-20	9.22	0.065	0.54	
						TFC-30	10.05	0.05	0.49	
					AL-FS	TFC-0	7.6	0.190	1.5	
						TFC-10	7.1	0.065	0.4	
						TFC-20	7.1	0.05	0.35	
						TFC-30	6.8	0.055	0.4	
FO-TFC (Hydration Technology Innovations – HTI)	Ammonium Bicarbonate	3 M	--	DI Water	AL-FS	15.8	--		95852	(178)
CTA & CA FO	NaCl	1 M	--	DI Water	AL-DS	--	1464.21-1627.12		164.79-870.44	(179)
CF042A-FO, Sterlitech Corp., Kent, Auburn, WA, USA	$CaCl_2$	1 M	-	Sodium alginate	AL-DS	-	-		1.2	(180)
		2							0.8	
		3							0.55	
MIL-53(Fe)@γ-Al_2O_3/cellulose acetate	NaCl	1 M	--	DI	--	--	37.1		1.78	(181)
Cellulose triacetate (CTA) FO	NaCl	--	128.0	Raffinate	AL-DS	-	2.7		-	(182)

(Fluid Technology Solutions Inc., Albany, OR, USA, FTS H2O			bar					
	$MgCl_2.6H_2O$	--	54.4 bar	Mine Water	AL-FS	-	5.3	-	
PSF/PA TFC	NaCl	2 M		6000 ppm of greasy wastewater	AL-DS	-	9.1	0.02	(183)
PSA/PA/CNC TFN-1							18	0.28	
PSA/PA/CNC TFN-5							31	0.57	
PSA/PA/CNC TFN-7							38	0.88	
CTA FO (FTSH2O, Fluid Tech. Solutions, Albany, OR, USA)	NaCl	0.5 M		Synthetic salt/Dye effluent	AL-FS	--	5.1	1.5	(184)
		1					9.5	2.9	
		2					11	3.6	
		3					14.5	4.4	
	RO brine	--					--	--	
Porous Hydrophilic Polymer/PA (PFO-100)	NH_4^+ NO_3^- PO_4^- K^+	-		2500 ppm Synthetic brackish ground water	-	-	-	0.04 1.22 1.21 2.09	(185)
TFC FO, Hydration Technologies Inc. (Albany, Oregon, USA)	Thermosensitive magnetic ionic liquids	[BIM[$FeCl_4$	5 wt.%	--	Distilled water & simulated brackish water (2000 ppm NaCl)	AL-FS	17.5	--	52	(186)
						AL-DS	20.5	--	62.5	
			10	1707		AL-FS	21	--	76	
						AL-DS	22	--	76	
			15	--		AL-FS	21.66	--	87.5	
						AL-DS	26	--	93.6	
			20	--		AL-FS	22.16	15.1	92.29	
						AL-DS	27.61	--	95.63	
	Thermosensitive magnetic ionic liquids	[BPY[$FeCl_4$	5	--	Distilled water & simulated brackish water (2000 ppm NaCl)	AL-FS	17	--	49	
						AL-DS	18.2	--	60	
			10	1659		AL-FS	19.4	--	62.5	
						AL-DS	21	--	49	

				15	3850		AL-FS	20.43	--	75	
							AL-DS	23	--	87.5	
				20	--		AL-FS	21.43	--	87.33	
							AL-DS	24.91	--	92.00	
			[BMP[$FeCl_4$	5	675		AL-FS	11	--	37.5	
							AL-DS	14.7	--	39	
				10	1610		AL-FS	14.5	--	51	
							AL-DS	14.9	--	62	
				15	3032		AL-FS	14.7	--	60	
							AL-DS	15	--	77	
				20	--		AL-FS	15.74	--	76.33	
							AL-DS	20.07	--	89.67	
RGO Geopolymer/TiO_2 FO	GM1	NaCl		--		DI water	--	21	-	10.8	(187)
	GM2							10.5		8.2	
	GM3							6		4	
PSF/PA	PIP-TMC (PIP)	NaCl		--		DI water	--	--	9.29	4.21	(188)
	PIP-ST (ST)								22.6	2.94	
	PIP-ABSA (ABSA)								18	3.1	
	PIP-AESA (AESA)								16	3.6	
Cellulose triacetate (CTA) FO, Hydration Tech. Innovations		NaCl		1 M		DI	-	-	-	60.0 ± 6.7 mmol/m^2h	(189)

(HTI, Albany, USA).			SA				75
			HA				110
	$CaCl_2$		DI				33.0 ± 5.6
			SA				5.8 ± 1.6
			HA				7.1 ± 1.9
	NH_4Cl		DI				94.6 ± 18.3
			SA				129.2 ± 12.8
			HA				220.6 ± 26.1
	$NaHCO_3$		DI				36.9 ± 9.6
			SA				26.2 ± 5.7
			HA				41.2 ± 7.4
	NaH_2PO_4		DI				6.6 ± 4.0
			SA				15
			HA				25
PES TFC	NaCl	1 M	DI Water	AL-DS	13.1	0.3	~ 5
				Al-FS	9.2	0.5	~ 4.5
TFNi-0				AL-DS	52	0.30	~ 15
				Al-FS	25.5	0.35	~ 11
TFNi-4	NaCl	1 M	DI Water	AL-DS	47.5	0.4	~ 16
				Al-FS	24	0.35	~ 11
TFNi-8				AL-DS	48	0.25	~ 14
				Al-FS	23.5	0.38	~ 11
TFNi-12				AL-DS	56.6	0.4	~ 20
				Al-FS	25.8	0.4	~ 12
TFNi-16				AL-DS	43.5	0.66	~ 29
				Al-FS	22.8	0.63	~ 14

(190)

Toray				AL-DS	37	0.25	~ 14	
				Al-FS	24.3	0.3	~ 8	
HTI				AL-DS	45	1.2	~ 49.5	
				Al-FS	22	1.1	~ 24	
MWCNT10-PVA/PA	NaCl	1 M	DI water	FO	-	~ 14	~ 3	(191)
MWCNT20-PVA/PA		1 M		FO		~ 10.3	~ 2.5	
MWCNT30-PVA/PA		1 M		FO		~ 8.5	~ 2.7	
pCNT5-PVA/PA		1 M		FO		~ 21	~ 4	
pCNT10-PVA/PA		1 M		FO		~ 15.7	~ 2.5	
pCNT20-PVA/PA		1 M		FO		~ 13	~ 2.3	
pCNT30-PVA/PA		1 M		FO		~ 10.5	~ 2.2	
PVA1pCNT3-PA		1 M		FO		~ 22.5	~ 6.75	
PVA1pCNT5-PA		1 M		FO		~ 21.5	~ 7.3	
PVA1pCNT10-PA		1 M		FO		~ 16	~ 4	
PVA0.25pCNT3-PA		0.5 M		FO		22.57 (0.45)	10.12	
				PRO		30.72 (0.46)	14.22	
PVA0.25pCNT3-PA		1 M		FO		30.16 (0.3)	9.34	
				PRO		42.85 (0.39)	16.72	
		2 M		FO		55.53 (0.46)	25.37	
				PRO		81.48 (0.46)	37.84	
PVA0.5pCNT3-PA		1 M		FO		~ 27	~ 6.5	
PVA2pCNT3-PA				FO		17.47	~ 7.2	
PSF/PA-Sulfonated GO TFC	NaCl	2 M	DI water	-	7.29	Specific Salt Flux= 0.036	0.27	(192)
PSF/PA-Sulfonated GO TFN TFC-GO1					22.84	--	--	
TFC-SGO1					25.28	0.012	0.24	
TFC-SGO2					32.53	0.0075	0.19	

TFC-SGO3							38.12	0.004	0.17	
Cu@FO-0.0		NaCl	2 M	DI water	-	-	26	--	(193)
Cu@FO-0.1							~ 37	--	
Cu@FO-0.2							~ 50	--	
Cu@FO-0.3							~ 58	--	
Cu@FO-0.4							~ 58	--	
Cu@FO-0.5							58.13	0.57	
GO/pDA		Dextrose	0.5 M	0.1 M NaCl	AL-FS	-	33	6.07	(193)
PEI:rGO/pDA							25.5	0.91	
PEI:rGO							22.3	1.61	
CTA-FO							7.03	7.59	
PES/SA @Mxene/PA TFN FO	PES-PA	NaCl	0.5 M	DI Water	AL-FS	--	0.26	2.2	(194)
					AL-DS	--	0.36	6	
			1 M		AL-FS	13.0	0.34	4.4	
					AL-DS	23.0	~ 0.49	11.5	
			2 M		AL-FS	21.6	0.4	8.5	
					AL-DS	40.8	0.58	23.5	
PES/SA @Mxene/PA TFN FO	SCMP-1		0.5 M		AL-FS	--	--	--	
					AL-DS	--	--	--	
			1 M		AL-FS	17.0	--	5.7	
					AL-DS	30.0	--	12.5	
			2 M		AL-FS	--	--	--	
					AL-DS	--	--	--	
	SCMP-2		0.5 M		AL-FS	--	--	--	
					AL-DS	--	--	--	
			1 M		AL-FS	19.2	--	4.2	
					AL-DS	33.5	--	13.0	
			2 M		AL-FS	--	--	--	

					AL-DS	--	--	--
			0.5 M		AL-FS	--	--	--
					AL-DS	--	--	--
	SCMP-3				AL-FS	25.5	--	4.3
			1 M		AL-DS	40.5	--	10.4
					AL-FS	--	--	--
			2 M		AL-DS	--	--	--
					AL-FS	--	0.16	2.5
	SCMP-4		0.5 M		AL-DS	--	0.19	5.0
					AL-FS	30.4	~ 0.17	5.2
			1 M		AL-DS	45.6	~ 0.2	9.0
					AL-FS	45.4	0.19	8.8
			2 M		AL-DS	66.6	0.24	16.0
					AL-FS	--	--	--
PES/SA @Mxene/PA TFN FO		NaCl	0.5 M	DI Water	AL-DS	--	--	--
	SCMP-5				AL-FS	30.2	--	5.9
			1 M		AL-DS	44.0	--	8.5
					AL-FS	--	--	--
			2 M		AL-DS	--	--	--
TFC-FO						6	0.55	3.6
PTFE@TFC						5.5	0.66	3.7
PDA@TFC		NaCl	1 M	DI Water	AL-DS	7	0.35	2.5
A-TiO_2/PDA@TFC						10.5	0.8	0.8
A-TiO_2/PTFE@TFC						9.5	0.8	0.7
PES (16 wt. %) - PA	M4	NaCl	1 M	DI Water	AL-FS	6.02	-	2.85
PES (17 wt. %) - PA	M5					5.74		2.82

PES (18 wt. %) - PA	M6						4.71	2.75	
PES (16 wt. % - MAX Phase 0.025 wt. %) – PA	M11						7.57	0.88	
PES (16 wt. % - MAX Phase 0.05 wt. %) – PA	M12						9.47	1.48	
PES (16 wt. % - MAX Phase 0.075 wt. %) – PA	M13						12.82	2.09	
PES (16 wt. % - MAX Phase 0.1 wt. %) – PA	M14						14.17	3.6	
PES –PA (MPD 2%, MAX Phase 0.025)	M15						6.83	2.49	
PES –PA (MPD 2%, MAX Phase 0.05)	M16	NaCl	1 M	DI Water	AL-FS	-	8.62	4.86	(196)
PES –PA (MPD 2%, MAX Phase 0.075)	M17						9.47	5.09	
PES –PA (MPD 2%, MAX Phase	M18						12	5.77	

0.1)									
PES –PA (TMC 15%, MAX Phase 0.025)	M19					6.63		1.41	
PES –PA (TMC 15%, MAX Phase 0.05)	M20					8.42		3.63	
PES –PA (TMC 15%, MAX Phase 0.075)	M21					8.84		4.14	
PES –PA (TMC 15%, MAX Phase 0.1)	M22					10.09		5.97	
PMIA-PA	PMIA 10%	NaCl	1 M	DI Water	AL-FS	7.1	-	0.117	(197)
	PMIA 11%					7		0.115	
	PMIA 12%					5.4		0.1	
PMIA-PA	PMIA 13%					5.25		0.97	
	PMIA 14%					5	-	0.95	
	PMIA 15%					4.9		0.9	
T_1 FO (Toray Chemical Korea Co.)		NaCl	1 M	DI Water	AL-FS	9.65	0.0215	0.208	
T_2 FO (FTS H_2O Co.)						6.71	0.0146	0.098	
TFC		NaCl	2 M	DI Water	AL-FS	12.5±0.5	-	2.56 ± 0.08	(198)
PSF-PA-MoS_2 (0.01) TFN						~ 14		3.2	
PSF-PA-MoS_2 (0.02) TFN						14.3 ± 1.2		3.5	
PSF-PA-MoS_2 (0.05) TFN						8.5		6.5	
PSF-PA-MoS_2 (0.1) TFN						4.2		16	
PSF-PA-MoS_2-Ag (0.01) TFN						~ 14.2		2.56 ± 0.08	

PSF-PA-MoS_2-Ag (0.02) TFN						16.9 ± 0.6		3	
PSF-PA-MoS_2-Ag (0.05) TFN						14.3		3.7	
PSF-PA-MoS_2-Ag (0.1) TFN						7.5		13.4	
PVDF-PA TFC		$(NH_4)_2SO_4$	1 M	NaF (300 mg/L)	AL-FS	27.8	0.56	15.5	(199)
TFC/CNC					AL-FS	40.7	0.36	14.5	
TFC/BA-CNC					AL-FS	46.0	0.22	9.9	
TFC/APTES-CNC					AL-DS	43.1	0.3	13	
Hydrogel-Impregnated Membranes (HIM)-PA	LTFC-0.25	NaCl	1 M	DI Water	AL-FS	~ 42.5	~ 0.15	6.25	(200)
					AL-DS	~ 47.5	`~ 0.16	7.4	
	LTFC-0.5				AL-FS	56.60 ± 2.99	~ 0.09	~ 5.6	
					AL-DS	61.33 ± 2.85	0.087 ± 0.004	~ 5.7	
	LTFC-1				AL-FS	~ 32.5	0.090 ± 0.011	2.82 ± 0.32	
					AL-DS	~ 34.7	~ 0.11	3.55 ± 0.45	
	LTFC-2				AL-FS	13.50 ± 1.74	0.355 ± 0.033	~ 4.75	
					AL-DS	16.76 ± 1.87	0.286 ± 0.027	~ 4.8	
CTA membrane		poly(styrene sulfonate) (PSS)-3,4-ethylenedioxythiophene (EDOT) - mPSS	175 g/L	Pure Water	AL-FS	4.2	-	0.19	(201)
				Brackish Water, 3.67 g/L		4.1		--	
		NaCl	28.2 g/L	Pure Water		3.6		4.13	
				Brackish Water, 3.67 g/L		3.2		--	
Hydration Technologies Inc. (HTI, Albany, OR, USA)		[P4444 [MBS	5 wt.%	~ 5	AL-FS	1.65	-	1.14	(202)
				Distilled water	AL-DS	1.67		1.36	
			10	~ 11	AL-FS	2.8		1.25	

			wt.%			AL-DS	3.27		1.47	
			15 wt.%	~ 17		AL-FS	3.45		2.45	
						AL-DS	4.64		3.77	
			20 wt.%	~ 25		AL-FS	4.85		2.67	
						AL-DS	7.36		5.89	
PSF-PA/PDA@SDS-HNTs	TFC	NaCl: Flux $MgSO_4$: Reverse salt flux	2 M	DI Water	--		7.29	0.03567 M	0.26 mMH	(203)
	TFC-H1						12.46	--	--	
	TFC-S-H0.5						18.72	0.01071	0.2	
	TFC-S-H1						30.3	0.00482	0.18	
	TFC-S-H1-PDA						32.57	0.00184	0.06	
	TFC-S-H2						27.27	0.0055	0.15	
	TFC-S-H3						24.95	0.00561	0.14	
HTI-CTA FO, Hydration Technologies Inc. (HTI; Albany, USA)		Deep eutectic solvent, reline	0% Dilution		DI Water	AL-FS	17.6	-	1.19	(204)
						AL-DS	29.8		2.48	
			200% Dilution			AL-FS	~ 10.5		~ 0.35	
						AL-DS	~ 16.5		~ 0.77	
			500% Dilution			AL-FS	3.1		0.15	
						AL-DS	12.8		0.81	
ZSM-5 (Si/Al=18.6)		NaCl	5 wt.%		DI Water	--	1.52	-	15.3	(205)
silicalite-1 (Si/Al = ∞)							< 0.0 L		< 2.0	
CA-PA		NaCl	1 M		DI Water	AL-FS	26.1	0.15	3.5	(206)
						AL-DS	35	0.16	5	
CA-PA-PDA/PEI						AL-FS	33.1	0.115	3.5	
						AL-DS	44	0.125	5	
CA-PA-PDA/PEI/Uio66 (0.05)						AL-FS	37	0.1	3.5	
						AL-DS	50	0.105	5	

CA-PA-PDA/PEI/Uio66 (0.1)					AL-FS	40	0.085	3.5	
					AL-DS	54.5	0.9	5	
CA-PA-PDA/PEI/Uio66 (0.15)					AL-FS	35.5	0.95	3.5	
					AL-DS	47	0.12	5	
PVDF-PA-Surfactant	TFC-0				AL-FS	7.2	0.5	3	
					AL-DS	12	0.62	6.5	
	TFC-Tween80				AL-FS	9	0.68	6	
PVDF-PA-Surfactant					AL-DS	16	0.55	10	
	TFC-SDS	NaCl	1 M	DI Water	AL-FS	12	0.32	3	(207)
					AL-DS	21	0.29	6	
	TFC-CTAC				AL-FS	14.5	0.14	2	
					AL-DS	22.5	0.12	2.5	
	TFC-CTAT				AL-FS	21.7	0.04	0.9	
					AL-DS	31.8	0.05	1.6	
PSF-PA	TFC-0		0.5 M			12.5	0.135		
			1			16.86	0.136		
			1.5			20	0.14		
			2			23	0.14		
	TFC-1 (n-hexane rinse of the active layer)	NaCl	0.5	DI Water	AL-FS	16	0.145	-	(208)
			1			21.16	0.16		
			1.5			24.5	0.165		
			2			27.5	0.165		
CTA-PDA/GO-Fe (III)-TA-PA	DMSO				AL-FS	7.5	3.1	22.5	
					AL-DS	9.8	1.6	16	
	DMSO-s	NaCl	1 M	DI Water	AL-FS	25.5	0.3	10	(209)
					AL-DS	34.4	0.27	10.9	
	NMP				AL-FS	12.5	4.8	57.5	

					AL-DS	17.783	2.2	39.4	
	NMP-s				AL-FS	22	0.9	22.5	
					AL-DS	27.7	0.7	19.9	
	Dioxane				AL-FS	3.5	0.3	2	
					AL-DS	3.79	0.7	3.36	
CTA-PDA/GO-Fe (III)-TA-PA	Dioxane-s				AL-FS	2	0.8	3	
					AL-DS	2	0.8	1	
	DMAC				AL-FS	9	2.75	27.5	
					AL-DS	16	1.65	29.5	
	DMAC-s				AL-FS	15.5	3.75	56	
					AL-DS	21.75	3.7	77.5	
TFN1		NaCl	1 M	DI Water	AL-FS	21	0.35	7.7	
					AL-DS	25.5	0.32	8.2	
TFN2					AL-FS	22.5	0.275	6.4	
					AL-DS	31	0.28	8.8	
TFN3					AL-FS	22.5	0.19	4.5	
					AL-DS	35.8	0.155	5.84	
TFN4					AL-FS	22.5	0.27	6.2	
					AL-DS	28.75	0.23	7	
PES-PA/WS2-Cys-MOF	TFC	NaCl	0.5 M	DI Water	AL-FS	14.63	--	3.5	(210)
					AL-DS	40	--	13	
			1 M		AL-FS	18.91	0.32	5.96	
					AL-DS	48	0.39	18	
			1.5 M		AL-FS	25.1	--	10	
					AL-DS	54	--	23	
	TFN-0.05		1 M		AL-FS	24	0.3	7	
					AL-DS	51	0.385	21	
	TFN-0.1		0.5 M		AL-FS	29.42	--	8	

					AL-DS	58	--	17	
			1 M		AL-FS	38.91	0.26	10.39	
					AL-DS	67.1	0.34	23	
			1.5 M		AL-FS	45.6	--	12	
					AL-DS	75	--	27	
PES-PA/WS2-Cys-MOF	TFN-0.25		1 M		AL-FS	32	0.28	9	
					AL-DS	57	0.355	20.5	
No interlayer	TFC				AL-FS	17	0.32	5.9	
					AL-DS	23	0.44	10.2	
	M-SU2				AL-FS	26	0.15	4	
					AL-DS	36	0.22	7.9	
SA/UiO-66-NH_2 interlayer	M-SU4	NaCl	1 M	DI Water	AL-FS	28	0.1	2.8	(211) Li^+ rejection
					AL-DS	44.5	0.16	7	
	M-SU5				AL-FS	19	0.19	3.9	
					AL-DS	39.8	0.23	9.2	
UiO-66-NH_2 interlayer	M-U				AL-FS	24.5	0.17	4.4	
					AL-DS	32	0.255	8.2	
PAN-Dopamine-PSSMA/PDADM		NaCl	1 M	DI Water	--	3	--	3.9	(212)
PSF/PA: PA-I		NaCl	1 M	DI Water	AL-DS	125.2 ± 10.0	--	44.7 ± 8.1	(213)
PSF/PA-APTMS-TiO_2: APTMS-TFN0.05		NaCl	1 M	DI Water	AL-FS	18.14	0.40	--	(214)
PSF/PA Sulfonamide: ST		NaCl	1 M	DI Water	AL-FS	22.6	0.13	2.94	(188)
Commercial Sterlitech CF042 Delrin FO cell - Porifera		Poly(amidoamine) dendrimer coated magnetic nanoparticles	30 g/L	DI Water	AL-FS	12.9	--	--	(171)

PMIA/PA TFC FO: M2	NaCl	1 M	DI Water	AL-FS	32.35	--	5.38	(197)
CTA-ES FO (HTI Company, Albany, OR, USA)	NaCl + Polyethylene glycol tert-octylphenyl ether surfactant (TX114)	0.3 M + 0.6 mM	Synthetic & Real Seawater	AL-DS	21.26	1.82	37.04	(215)
CA-PDA/PEI/UiO-66(0.1)	NaCl	1 M	DI Water	AL-FS	40.0	--	3.2	(206)
PEI:rGO/pDA	dextrose	0.5 M	NaCl 0.1 M	AL-FS	25.5	--	0.91	(216)
CA HF-25-3:2-4.0-A	NaCl	0.5 M	DI Water	AL-FS	2.8	0.61	1.7	(217)
PES-Polyvinylamines-poly(allylamine hydrochloric): PVAm(50) & PSS(70), pH=7-AAV	$MgCl_2$	0.5 M	DI Water	AL-FS	33	1/13.4	2.3	(218)
SF-mLbL PA-GO	0.05-TFN	NaCl	0.5 M	DI Water	AL-FS	52	0.065	3.5	(219)
			0.75 M		AL-FS	61	0.07	4.2	
			1 M		AL-FS	68	0.074	5	
			1.5 M		AL-FS	83	0.069	5.8	
	0.1-TFN		0.5 M		AL-FS	53	0.067	3.6	
			0.75 M		AL-FS	65	0.07	4.3	
			1 M		AL-FS	70	0.073	5.1	
			1.5 M		AL-FS	84	0.07	5.95	
	0.3-TFN		0.5 M		AL-FS	55	0.069	3.7	
			0.5		AL-DS	--	--	--	
			0.75 M		AL-FS	64	0.073	4.7	
			0.75		AL-DS	--	--	--	
			1 M		AL-FS	72	0.074	5.35	
			1		AL-DS	--	--	--	
			1.5 M		AL-FS	84.5	0.074	6.2	
			1.5		AL-DS	--	--	--	
	0.05-TFNi		0.5 M		AL-FS	73	0.061	4.5	

SF-mLbL PA-GO	0.1-TFNi	NaCl	0.75 M	DI Water	AL-FS	83.5	0.065	5.6	(219)
			1 M		AL-FS	100	0.066	6.6	
			1.5 M		AL-FS	125	0.063	7.8	
	0.3-TFNi		0.5 M		AL-FS	73.5	0.055	4.1	
			0.75 M		AL-FS	100	0.056	5.55	
			1 M		AL-FS	118	0.055	6.5	
			1.5 M		AL-FS	132	0.057	7.4	
	0.5-TFNi		0.5 M		AL-FS	75	0.058	4.45	
			0.75 M		AL-FS	108	0.054	5.9	
			1 M		AL-FS	125	0.053	6.7	
			1.5 M		AL-FS	135	0.059	8.05	
	0.7-TFNi		0.5 M		AL-FS	85	0.059	5.04	
			0.75 M		AL-FS	117	0.051	6	
			1 M		AL-FS	135	0.053	7.4	
			1.5 M		AL-FS	161	0.056	8.8	
			0.5 M		AL-FS	87.18 ± 0.15	0.058	5.06 ± 0.11	
			0.5		AL-DS	--	--	--	
			0.75		AL-FS	119	0.051	5.55	
			0.75		AL-DS	--	--	--	
			1		AL-FS	135	0.054	7.5	
			1		AL-DS	--	--	--	
			1.5		AL-FS	162	0.056	8.85	
			1.5		AL-DS	--	--	--	
Hydration Technologies Inc.		Tributylalkylphosphonium 3-sulfopropyl Methacrylate ([P_{4446}][C_3S ILs	258 mOsm kg-1/7.5 wt%	DI Water	AL-DS	4.49	--	1.64	(220)

Hydration Technologies Inc. (Albany, Oregon, USA)	Imidazolium-based magnetic ionic liquids (MILs), C_8-$FeCl_4$	20 wt.%	DI Water	AL-FS	10.04	-	-	(221)
				AL-DS	17.3			
PES/PA: TFC-PEG-diamine-0.2	NaCl	1 M	DI Water	AL-FS	23.3	0.07	1.6	(222)
CA/PA: CA/PA-DMF4-ME1	$Na2_SO_4$	1 M	DI Water	AL-FS	9.2	1/2000	--	(223)
PES/PSF/PEG: PEG1	NaCl	1 M	DI Water	AL-FS	136	0.014	1.94	(224)
PSU/PEG-*b*-PSU-*b*-PEG/PA: TFC/PEG-1	NaCl	1.5 M	DI Water	AL-FS	22.29	0.11	2.45	(225)
N-C-dots/PEI-M	NaCl	2 M	UP water	AL-FS	26	--	8.25	(226)
PES/STA: TFC-STA	NaCl	1 M	DI Water	AL-FS	27.4	0.047	1.3	(227)
PES-$Na_{14}(P_2W_{18}Co_4O_{70})\cdot 28H_2O$-LDH (POM-LDH)/PA: TFN-$PL_2$	NaCl	1 M	DI Water	AL-FS	46.6	0.23	10.8	(228)
PES-PAM-grafted ZnO NPs/PA: TFN-ZP400	NaCl	1 M	DI Water	AL-FS	20.7	0.12	2.5	(229)
PSF-ZnO-PA: TFN 1% in-situ	NaCl	1 M	DI Water	AL-FS	33	0.085	2.9	(230)
PES-CNF-*g*-PSBMA/PA: TFN100	NaCl	1 M	DI Water	AL-FS	16.3	0.12	2	(231)
Diazotized PE-PA TFC: TFC5-N	NaCl	2 M	DI Water	AL-FS	57	0.35	--	(232)
PAN-PA/BWD-NCQDs: TFC-0.05	NaCl	1 M	DI Water	AL-DS	35.3	0.15	5.5	(233)
Chitosan nanofiber-PA	Na_2SO_4	--	DI Water	AL-FS	128	0.24	--	(175)
PES-PA: PES-250	NaCl	0.5	DI Water	AL-FS	1.0	0.07	0.07	(234)
PSF- MIL-53(Fe)/PA	NaCl	2 M	DI Water	AL-FS	11.4	0.45	5.08	(235)
PES- alginate/Ca (II) interlayer/PA: TFC-LbL.5	NaCl	1 M	DI Water	AL–FS	23.3	0.02	0.6	(236)
PES-tetra-(4-carboxyphenyl)porphyrin (Al-MOF)/PA: iTFC-0.2	NaCl	2 M	DI Water	AL-FS	21.26	0.04	0.93	(237)
PAN/PA: PAN-C3 (90 ^{0}C)	NaCl	1 M	DI Water	AL-FS	103.0 ±	0.35	37	(238)

					8.2			
PSF/chitosan	EDTA-2Na+Triton X100	1 M + 0.5 M	DI Water	AL-FS	9.5	0.008 ± 0.002	0.08	(239)
PES-PDA/GO/PA: TFC4	NaCl	0.5 M	DI Water	AL-DS	36	0.56	21.5	(240)
MoS_2@NH_2-UiO-66 TFN with interlayer (TFNi)/PA: M2 (MoS_2@NH_2-UiO-66 load was 0.002 wt%)	NaCl	2 M	DI Water	AL–FS	38.13 ± 0.8	0.038	1.48 ± 0.06	(241)
Asymmetric cellulose acetate hollow fiber FO: HF-25-3:2-4.0-A	NaCl	0.5 M	DI Water	AL-DS	2.8	0.61	1.7	(217)
MoS2@Zeolite X Nanocomposite (PES/PA)-Modified TFN FO: TFN-MZ2	NaCl	1 M	DI Water	AL-FS	50.37	--	22.85	(242)
PSF/PMMA-b-PSF-b-PMMA triblock copolymer-modified/PA TFC FO: TFC20	NaCl	1 M	DI Water	AL-FS	17.5	0.15	2.0	(243)
PAN NF/Dopamine/poly diallyl dimethyl ammonium and poly(4-styrenesulfonic acid-co-maleic acid) sodium salt: MMM-0.1-LbL5	NaCl	1 M	DI Water	AL-DS	3	--	3.9	(212)
PES-PA/NH2-GOQDs: TFC100	NaCl	0.5 M	DI Water	AL-FS	58.32 ± 4.05	0.21	11.00 ± 1.25	(244)
Aquaporin flat sheet membrane	Temperature-sensitive hydrogel modified with sewage sludge ash (SSA): (SSA-TSH)	--	Potassium dichromate ($K_2Cr_2O_7$), glucose monohydrate	AL-FS	1.992-2.044	--	--	(245)

				(C6H12O6·H2O), potassium dihydrogen phosphate (KH2PO4), and ammonium chloride (NH4Cl)					
TFC PVDF/chitosan-tannic acid$_{0.5}$-60 min		$(NH_4)_2SO_4$	1 M	NaF, 300 mg/L	AL-DS	38.2	--	0.151	(246)
Support-free IP on macroporous substrate	SFIP-PVDF1	NaCl	0.5 M	DI water	AL-FS	7	--	6.5	(247)
			1 M		AL-FS	12	--	10	
			1.5 M		AL-FS	13	--	14	
			2 M		AL-FS	16	--	15	
	SFIP-PVDF2		0.5 M		AL-FS	8.5	--	3.75	
			1 M		AL-FS	14	--	7	
			1.5 M		AL-FS	13.5	--	7.5	
			2 M		AL-FS	17.5	--	8.5	
	SFIP-PVDF3		0.5 M		AL-FS	16	--	5	
			1 M		AL-FS	21	--	6.5	
			1.5 M		AL-FS	23	--	7.5	
			2 M		AL-FS	26	--	9	
Vanadium pentoxide (VO)-aSiO-rGO		NaCl	1 M	DI Water	AL-DS	45	0.13	6.1	(248)
NTFC-FO: PANI@PAN/PVDF electrospinning nanofibers (PPESNF)/PA: NTFC1		NaCl	1 M	DI Water	AL-FS	40	0.12	4.8	(249)
				DI Water, synthetic	AL-FS	12.08	1.38	17	

	surfactant (TX114)			seawater, TDS= 36 000 ppm and real seawater collected at Ninh Thuan province of Vietnam				
CTA-FO	Na-CQDs	0.3 to 0.5 g/mL		DI Water	AL-FS	13.92	0.0018	0.0253	(250)
	K-CQDs			3.5 wt% NaCl solution					
PVC/PA: TB1	KCl	1 M		DI Water	AL–FS	14.68	0.210	3.08	(251)
	NaCl					11.94	0.278	3.32	
TFC/sPSUH-3	NaCl	1 M		DI Water	AL-FS	34.27	0.16	--	(252)
TFC/sPSUH-4						34.94	0.16	--	
Cellulose triacetate (CTA) flat sheet membrane (Hydration Technology Inc., HTI, Oregon, USA)	*Rhamnolipid* bio-surfactant	200 mg/L		Synthetic Caspian seawater salinity of ~13 ppt	AL–FS	7.7	-	0.088	(253)
	NaCl	70 mg/L				8.6	-	4.8	
FTS H_2O CTA FO flat sheet (Sterlitech)	l-PDMAAm	50 wt.%	> 170 bar	NaCl 0.2 wt.%	AL-FS	89	-	-	(254)
				1.75 wt.%		81			
				3.5 wt.%		77			

Table S5. Hybrid organic-inorganic membranes used for desalination and heavy metals removal in 2023-2024.

Membrane matrix	Feature	Pollutant	Permeability ($L/m^2.h.bar$)	Rejection (%)	Ref.
PA-NF incorporated with amino-functionalized $Ti_3C_2T_x$ nanoparticles	High harness removal	$MgSO_4$	PA-NF incorporated with amino-functionalized Ti_3C_2Tx nanoparticles	High harness removal	(255)
Graphene oxide hybrid membrane - Fe_3O_4@amyloid fibrils nanoclusters intercalated into the GO sheets	Heavy metals removal	As (III), Pb (II), Cd (II), Hg (II), Cu (II), Zn (II), Ni (II), Co (II) & Cr (III)	---	> 99.9	(256)
PSF/ hydroxyapatite dual-layer hollow fiber membrane	Lead Removal	Pb (II)	5-115	141.2 mg/g absorption capacity	(257)
PVDF/rGO nanocomposite membrane	Heavy metals removal	Cu (II), Cd (II), Zn (II), Mn (II) & As (III)	175.86-412.20 L/m^2 h	Up to 90 for divalent cations and 90 for As (III)	(41)
ZIF-67/PP hybrid membrane	U (VI) extraction technology	U (VI)	--	--	(258)
UiO-66-AO-based adsorption-	Uranium	U (VI)	1358.8 / m h	84.5	(259)

filtration hybrid membranes	extraction				
surface coating of metal-phenolic networks on activated carbon	Selective Separation of Pb (II)	Pb (II)	--	60-100	(260)
Cellulose acetate-ZnO	Lead removal	Pb (II)	--	Up to 97	(261)
MIL-101(Cr) and MIL-101(Cr)@GO doped PVA	Desalination by pervaporation	NaCl	9.7 kg/m^2 h	> 99.99	(262)
Carboxyl Functionalization of Hybrid Organosilica RO	Desalination	NaCl, $MgCl_2$, $MgSO_4$	~ 3.5, 3.2, 3 ($\times 10^{-13}$ $m^3m^{-2}s.Pa$)	~ 97-99	(263)
UiO-66-NH_2/PVDF hybrid fibrous membrane	Bifunctional adsorption and photo-catalysis	Cr(VI)	--	~ 95	(264)
SiO_2/PVDF-TMC	Membrane distillation	NaCl	16.08 kg/(m^2·h)	> 99.9 %	(265)
UiO-66-$(OH)_2$ @Fe_2O_3/CFs	Phosphate removal	Phosphate, sulfate, carbonate, chloride, nitrate	--	333.3 mg/g adsorption capacity	(266)
PVDF/SMA@ polyvinylamine (PVAM)-tannic acid (TA)-metal ion	High permselectivity	Mg (II) & Ca (II)	53.4	> 99	(267)
PSF -GO/hydrotalcite	Treatment of lead ion from battery industrial effluent	Pb (II)	182.6-193.5 L/m^2 h	96	(268)
TPU-Laponite/GO	Selective adsorption of water	Pb (II) & As (V)	53.4	54-99 % & 16-94 %	(62)

	contaminants				
PAN nanofibers-Tb-based MOF	efficient phosphate removal	Phosphate	---	111.3 mg/g adsorption capacity	(269)
Hydrophilic nylon/Ag-rGO	desalination	NaCl, Na_2SO_4, $MgCl_2$, and $MgSO_4$	1.2	70, 97, 30, 72	(270)
PES-Na-A zeolite/oxycut residue NF	Cr (III) removal	Cr (III)	--	98	(271)
PTL/PES	Antifouling properties	Cu (II), Ni (II), Cd (II), Pb (II)	39.5	> 99	(272)
PVDF/PVP/MMT MMM	Heavy metal ions removal	Pb (II) and Cd (II)	13.8-19.8 L/m^2 h	83 & 87	(74)
ANF/MoS_2	Pb (II) removal	Pb (II)	~ 160	75	(273)
PET-PAN Electrospun-LDHs	Cr(VI) & methyl orange removal	Cr (VI)	---	80	(274)
ZIF-8/TA	Improved permeation	NaCl	56 L/m^2 h	~ 99	(275)
PPG-UiO-66@PTFE	Efficient mercury extraction	Hg (II)	--	98	(276)

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