Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Rocking Chair Electrochemical Deionization with Flow-through Electrodes

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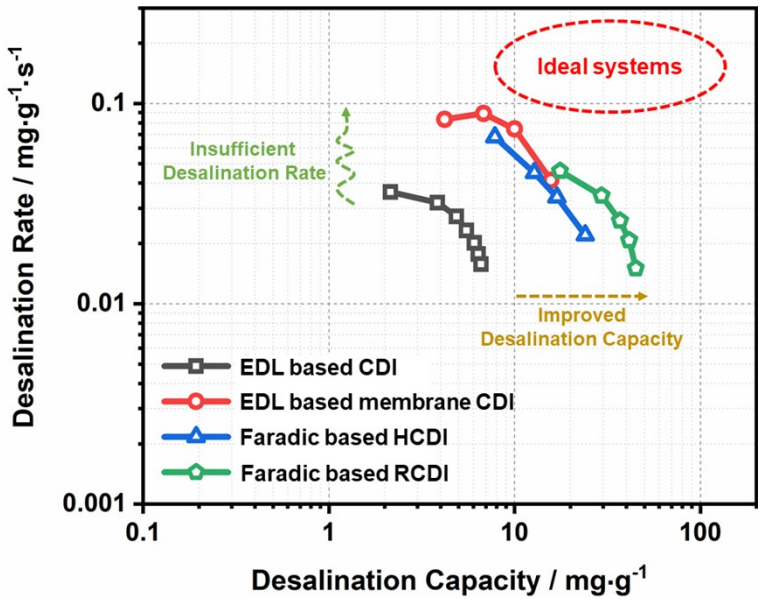

Figure S1. Comparison Kim-Yoon-Ragone plot of CDI, membrane CDI, HCDI and RCDI.[1-4]

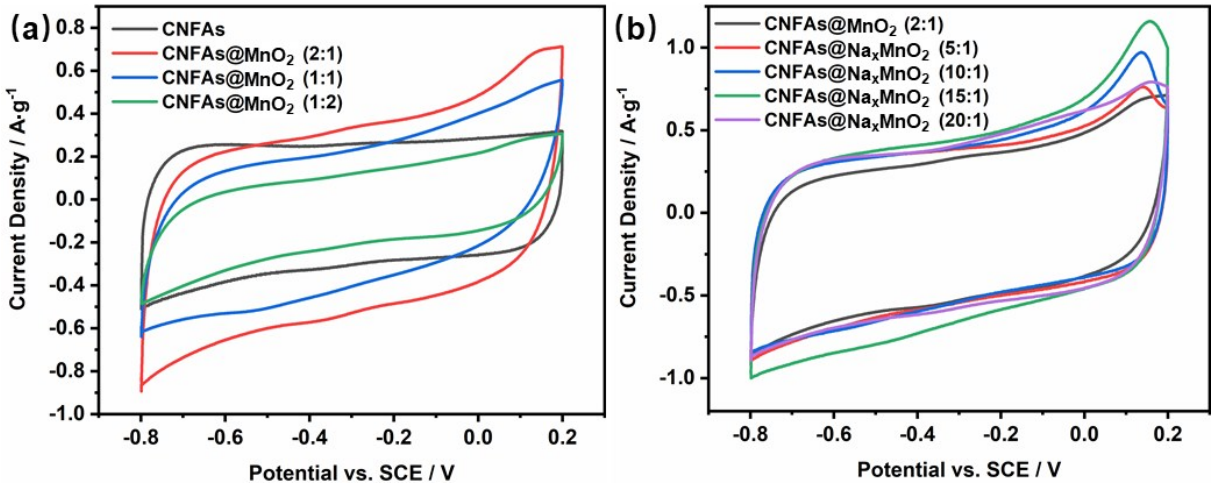

Figure S2. CV curves of (a) CNFAs@MnO_2 prepared with different C to Mn ratios and (b) CNFAs@Na_xMnO_2 prepared with different C to Na ratios.

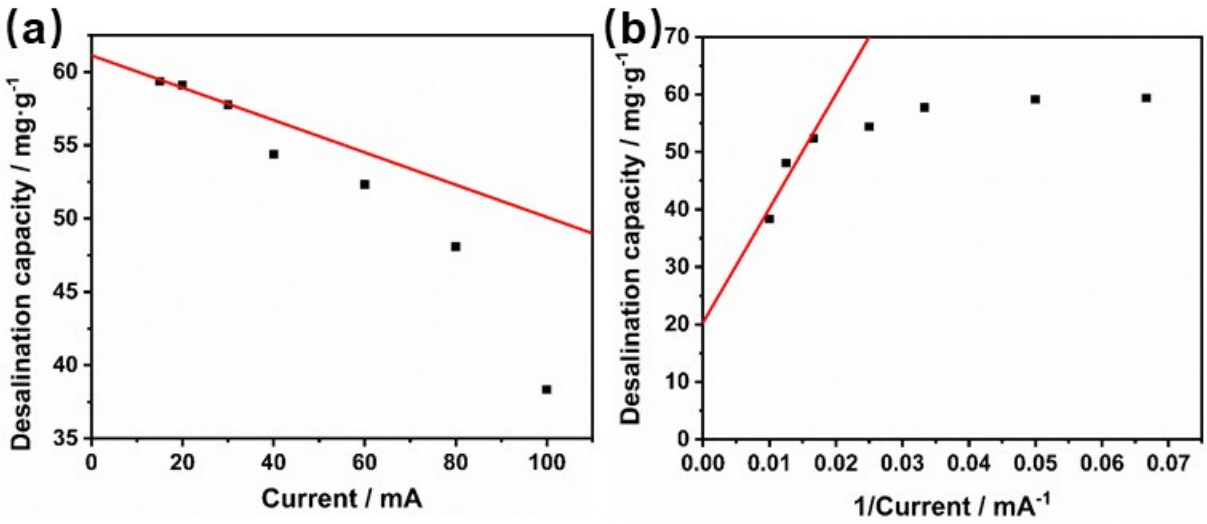

Figure S3. (a) the relationship of desalination capacity versus inverse current, (b) the relationship of desalination capacity versus the current for CNFAs@Na_xMnO_2-based FTE-RCDI.

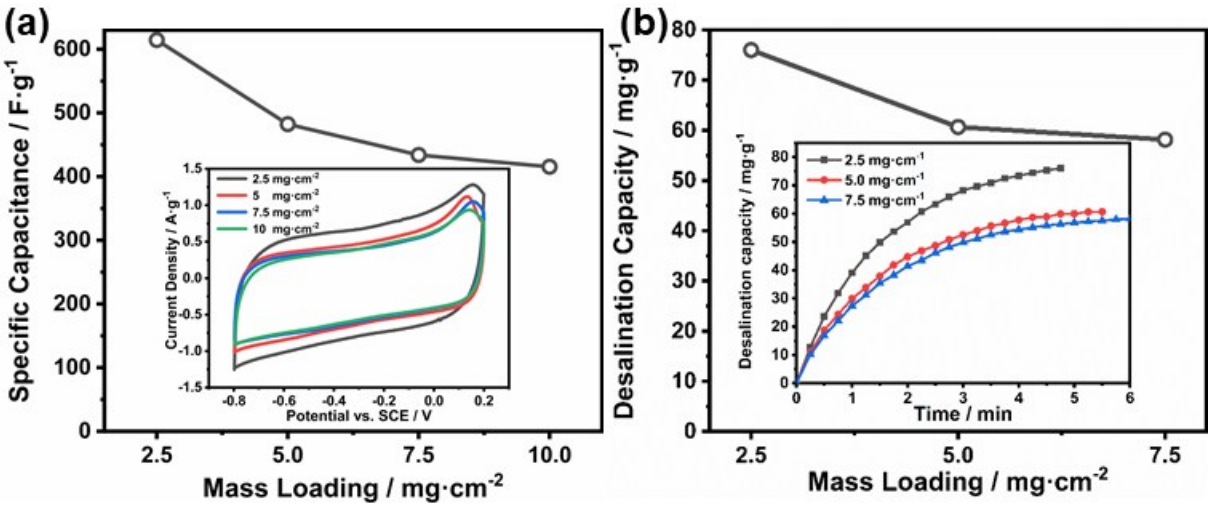

Figure S4. (a) Specific capacitances of CNFAs@Na_xMnO_2 in 1 M NaCl solution with the mass loading of 2.5, 5.0, 7.5, 10 mg·cm^{-2} (the inset shows the corresponding CVs); (b) desalination capacities of FTE-RCDI system at 12 mA constant current in 3000 mg·L^{-1} NaCl solution with the mass loading of 2.5, 5.0, 7.5, 10 mg·cm^{-2} (the inset shows desalination capacity transients).

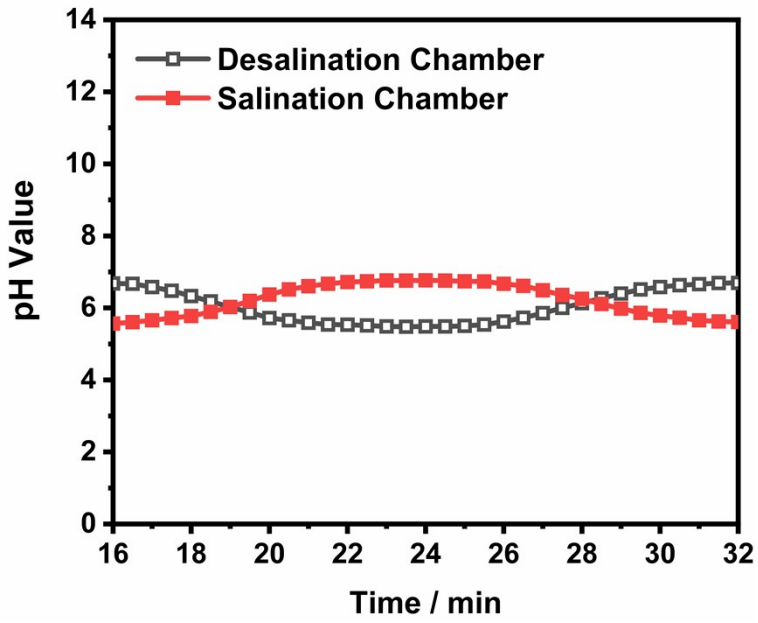

Figure S5. pH variations of the FTE-RCDI system throughout the desalination test with a constant current of 5 mA, cut-off voltage of 1.0 V, and the initial NaCl concentration of 3000 mg·L^{-1}.

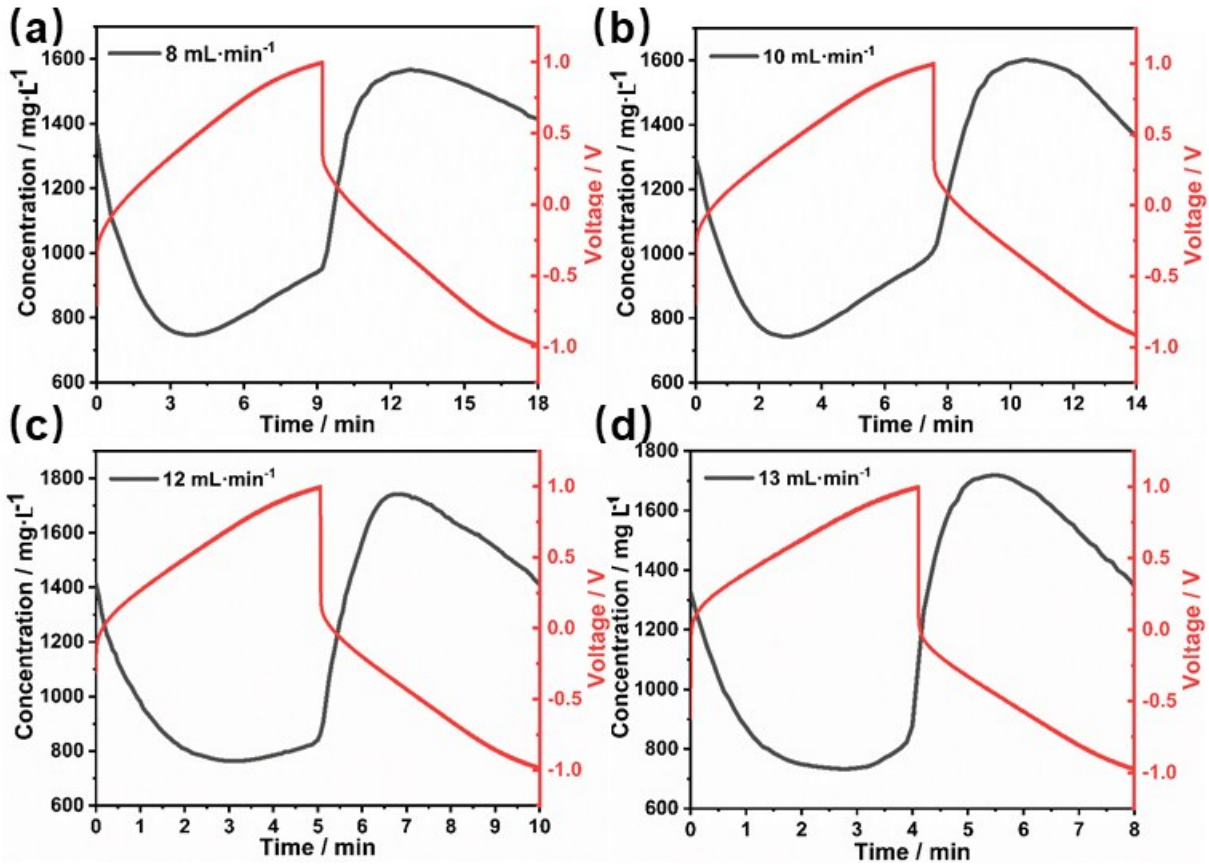

Figure S6. Concentration and voltage transients of the FTE-RCDI at the flowrate of (a) 8 mL·min^{-1}, (b) 10 mL·min^{-1}, (c) 12 mL·min^{-1}, (d) 13 mL·min^{-1} with the ΔC of 5 mM, feed concentration of 20 mM and water recovery of 50 %.

Table S1. Comparison of the desalination capacities and rates performance among various carbon, pseudo-capacitive, and faradic electrode materials reported in the literature.

Electrode Material	Cell architecture	Cycling Mode	Power Mode	Desalination Voltage/Current	Mass (mg)	Size (cm^2)	Thickness (μm)	C_0 ($mg \cdot L^{-1}$)	SDC ($mg \cdot g^{-1}$)	ADR ($mg \cdot g^{-1} \cdot s^{-1}$)	Ref
Porous Carbon	CDI	B.M.	C.V.	1.2 V/-	~50	16	-	50	2.2	0.0360	[1]
		B.M.	C.V.	1.2 V/-	~50	16	-	50	6.6	0.0160	
Activate Carbon	MCDI	S.P.	C.C.	1.2 V/2.0 mA	-	-	300	584.4	4.2	0.0830	[2]
		S.P.	C.C.	1.2 V/5.0 mA	-	-	300	584.4	6.8	0.0890	
		S.P.	C.C.	1.2 V/9.0 mA	-	-	300	584.4	10.0	0.0745	
		S.P.	C.C.	1.2 V/15.0 mA	-	-	300	584.4	15.7	0.0410	
$Na_2FeP_2O_7$	HCDI	B.M.	C.V.	1.2 V/-	-	3	-	584.4	30.2	0.0810	[4]
		B.M.	C.V.	1.2 V/-	-	3	-	5844.0	32.6	0.1430	
		B.M.	C.C.	1.2 V/3.0 mA cm^{-2}	-	3	-	584.4	7.8	0.0680	
		B.M.	C.C.	1.2 V/2.0 mA cm^{-2}	-	3	-	584.4	12.8	0.0450	
		B.M.	C.C.	1.2 V/1.5 mA cm^{-2}	-	3	-	584.4	16.9	0.0340	
		B.M.	C.C.	1.2 V/1.0 mA cm^{-2}	-	3	-	584.4	24.0	0.0220	
		B.M.	C.C.	1.2 V/3.0 mA cm^{-2}	-	3	-	5844.0	20.6	0.0688	
		B.M.	C.C.	1.2 V/2.0 mA cm^{-2}	-	3	-	5844.0	26.2	0.0458	
		B.M.	C.C.	1.2 V/1.5 mA cm^{-2}	-	3	-	5844.0	29.0	0.0344	
		B.M.	C.C.	1.2 V/1.0 mA cm^{-2}	-	3	-	5844.0	34.0	0.0230	
$Na_3V_2(PO_4)_3$@C	HCDI	B.M.	C.V.	1.0 V/-	10-20	16	-	5844.0	137.2	0.0760	[5]
PNDIE	HCDI	B.M.	C.V.	1.8 V/-	200/100*	32	-	1000.0	54.20	0.0383	[6]
$NaTi_2(PO_4)_3$/C	HCDI	B.M.	C.V.	1.8 V/-	125/73*	16	~200	1000.0	167.40	0.0930	[7]
Nafion-coated AC	RCDI	B.M.	C.C.	1.2 V/1.0 mA cm^{-2}	55.9	4	300	584.4	23.30	0.0294	[3]
		B.M.	C.C.	1.2 V/1.25 mA cm^{-2}				584.4	29.90	0.0251	

		B.M.	C.C.	1.2 V/1.5 mA cm^{-2}				584.4	35.00	0.0200	
		B.M.	C.C.	1.2 V/1.0 mA cm^{-2}				1168.8	19.10	0.0378	
		B.M.	C.C.	1.2 V/1.25 mA cm^{-2}				1168.8	25.90	0.0313	
		B.M.	C.C.	1.2 V/1.5 mA cm^{-2}				1168.8	30.40	0.0270	
		B.M.	C.C.	1.2 V/2.0 mA cm^{-2}				1168.8	35.60	0.0216	
		B.M.	C.C.	1.2 V/1.0 mA cm^{-2}				2922.0	17.50	0.0462	
		B.M.	C.C.	1.2 V/1.25 mA cm^{-2}				2922.0	29.10	0.0345	
		B.M.	C.C.	1.2 V/1.5 mA cm^{-2}				2922.0	36.70	0.0262	
		B.M.	C.C.	1.2 V/2.0 mA cm^{-2}				2922.0	41.10	0.0207	
		B.M.	C.C.	1.2 V/3.0 mA cm^{-2}				2922.0	44.50	0.0151	
AgCl| $Na_{0.44}MnO_2$	Dual-ion electrochemical desalination	B.M.	C.C.	1.5 V /100 mA g^{-1}	10/17*	7.84	-	890.0	57.40	0.0220	[8]
		B.M.	C.C.	1.5 V /200 mA g^{-1}				890.0	34.70	—	
		B.M.	C.C.	1.5 V /300 mA g^{-1}				890.0	27.20	—	
		B.M.	C.C.	1.5 V /500 mA g^{-1}				890.0	24.80	—	
		B.M.	C.C.	1.5 V /1000 mA g^{-1}				890.0	18.80	0.2090	
BiOCl| $Na_{0.44}MnO_2$	Dual-ion electrochemical desalination	B.M.	C.C.	1.5 V /100 mA g^{-1}	10.5/21.6*	7.84	40-50 /80-90	760.0	68.50	0.0210	[9]
		B.M.	C.C.	1.5 V /200 mA g^{-1}				760.0	37.5	0.0410	
		B.M.	C.C.	1.5 V /300 mA g^{-1}				760.0	22.40	0.0620	
		B.M.	C.C.	1.5 V /500 mA g^{-1}				760.0	9.20	0.0920	
$NaTi_2(PO_4)_3$| AgNPs	Dual-ion electrochemical desalination	B.M.	C.C.	1.4 V /100 mA g^{-1}	10-20	7.84	-	2500.0	105.00	—	[10]
		B.M.	C.C.	1.4 V /200 mA g^{-1}				2500.0	77.00	—	
		B.M.	C.C.	1.4 V /300 mA g^{-1}				2500.0	50.00	—	
		B.M.	C.C.	1.4 V /500 mA g^{-1}				2500.0	26.00	—	
		B.M.	C.C.	1.4 V /1000 mA g^{-1}				2500.0	15.00	—	
$Na_3V_2(PO_4)_3$@C|	Dual-ion	B.M.	C.C.	1.4 V /100 mA g^{-1}	10	-	-	1000.0	98.00	0.0400	[11]

AgCl	electrochemical desalination	B.M.	C.C.	1.4 V /500 mA g^{-1}				1000.0	34.0	0.3140	
$Na_3V_2(PO_4)_3$-rGO aerogel| AgCl	Dual-ion electrochemical desalination	B.M.	C.C.	1.4 V /100 mA g^{-1}	10			1000.0	103.75	—	[12]
		B.M.	C.C.	1.4 V /150 mA g^{-1}				1000.0	79.17	—	
		B.M.	C.C.	1.4 V /200 mA g^{-1}				1000.0	63.33	—	
		B.M.	C.C.	1.4 V /300 mA g^{-1}				1000.0	39.17	0.0940	
CNFAs@Na_xMnO_2 (This work)	FTE-RCDI	B.M.	C.C.	1.0 V /106 mA g^{-1}	~75	10	~2500	3000.0	59.36	0.1237	
		B.M.	C.C.	1.0 V /160 mA g^{-1}	~75	10	~2500	3000.0	59.10	0.1642	
		B.M.	C.C.	1.0 V /215 mA g^{-1}	~75	10	~2500	3000.0	57.76	0.2407	
		B.M.	C.C.	1.0 V /406 mA g^{-1}	~75	10	~2500	3000.0	54.39	0.3021	
		B.M.	C.C.	1.0 V /530 mA g^{-1}	~75	10	~2500	3000.0	48.08	0.4007	
		B.M.	C.C.	1.0 V /666 mA g^{-1}	~75	10	~2500	3000.0	37.34	0.4667	
		B.M.	C.C.	1.0 V /106 mA g^{-1}	~25	10	~800	3000.0	70.96	0.1711	
		B.M.	C.C.	1.0 V /160 mA g^{-1}	~25	10	~800	3000.0	68.75	0.2543	
		B.M.	C.C.	1.0 V /215 mA g^{-1}	~25	10	~800	3000.0	62.02	0.3576	
		B.M.	C.C.	1.0 V /406 mA g^{-1}	~25	10	~800	3000.0	55.45	0.4668	
		B.M.	C.C.	1.0 V /530 mA g^{-1}	~25	10	~800	3000.0	46.02	0.5031	
		S.P.	C.C.	1.0 V /106 mA g^{-1}	~370	50	~2500	3000.0	57.50	0.1102	
		S.P.	C.C.	1.0 V /160 mA g^{-1}	~370	50	~2500	3000.0	57.32	0.1512	
		S.P.	C.C.	1.0 V /215 mA g^{-1}	~370	50	~2500	3000.0	56.25	0.2211	
		S.P.	C.C.	1.0 V /406 mA g^{-1}	~370	50	~2500	3000.0	52.26	0.2805	
		S.P.	C.C.	1.0 V /530 mA g^{-1}	~370	50	~2500	3000.0	47.66	0.3603	
		S.P.	C.C.	1.0 V /666 mA g^{-1}	~370	50	~2500	3000.0	39.01	0.4307	

*mass of the cathode/anode.

Table S2. Cost factors for capital and operating costs of FTE-RCDI, Flow-through CDI and MCDI.

	FTE-RCDI (this work)	**Flow-through CDI**[*b]	**Flow-by MCDI**[*b]
Capital cost ($\$\cdot m^{-2}$)	72.17	64.00	104.26
Electrode cost	52.04	64.00	64.00
Membrane cost	20.13	-	40.26
Operational cost ($kWh\cdot m^{-3}$)			
Energy Consumption[*a]	0.12	0.98	0.35

[*a] conditions: productivity: 25 $L\cdot h\cdot m^{-2}$; concentration reduction: 500 $mg\cdot L^{-1}$;

[*b] the electrode material and the ion-exchange membrane used in flow-through CDI and MCDI in this Table are activated carbon cloth (S-7500, Zorflex) and heterogeneous ion exchange membrane (Shanghai Shanghua water treatment material Co., Ltd.), respectively.

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