

Carbon Dioxide Absorption with Aqueous Biphasic Absorbent in a Rotating Zigzag Bed

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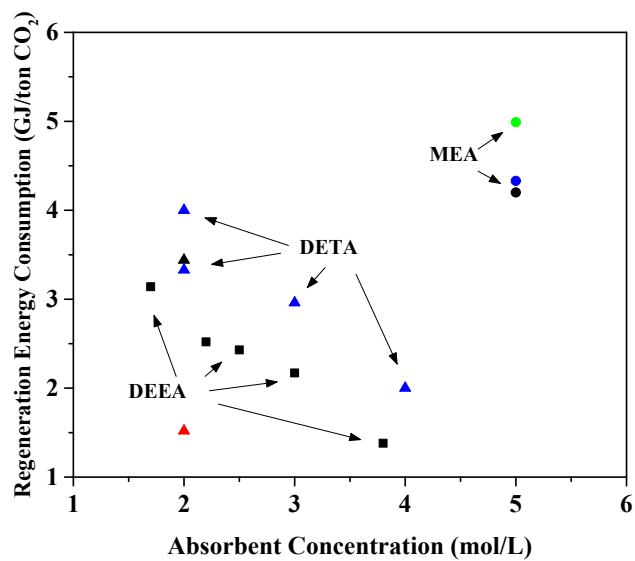


Figure S1. Regeneration energy consumption of different amine solutions. (The symbols in black, red, blue and green are from references 15, 36, 37 and 38, respectively. The square, triangle and circle symbols represent DEEA, DETA, and MEA, respectively.)

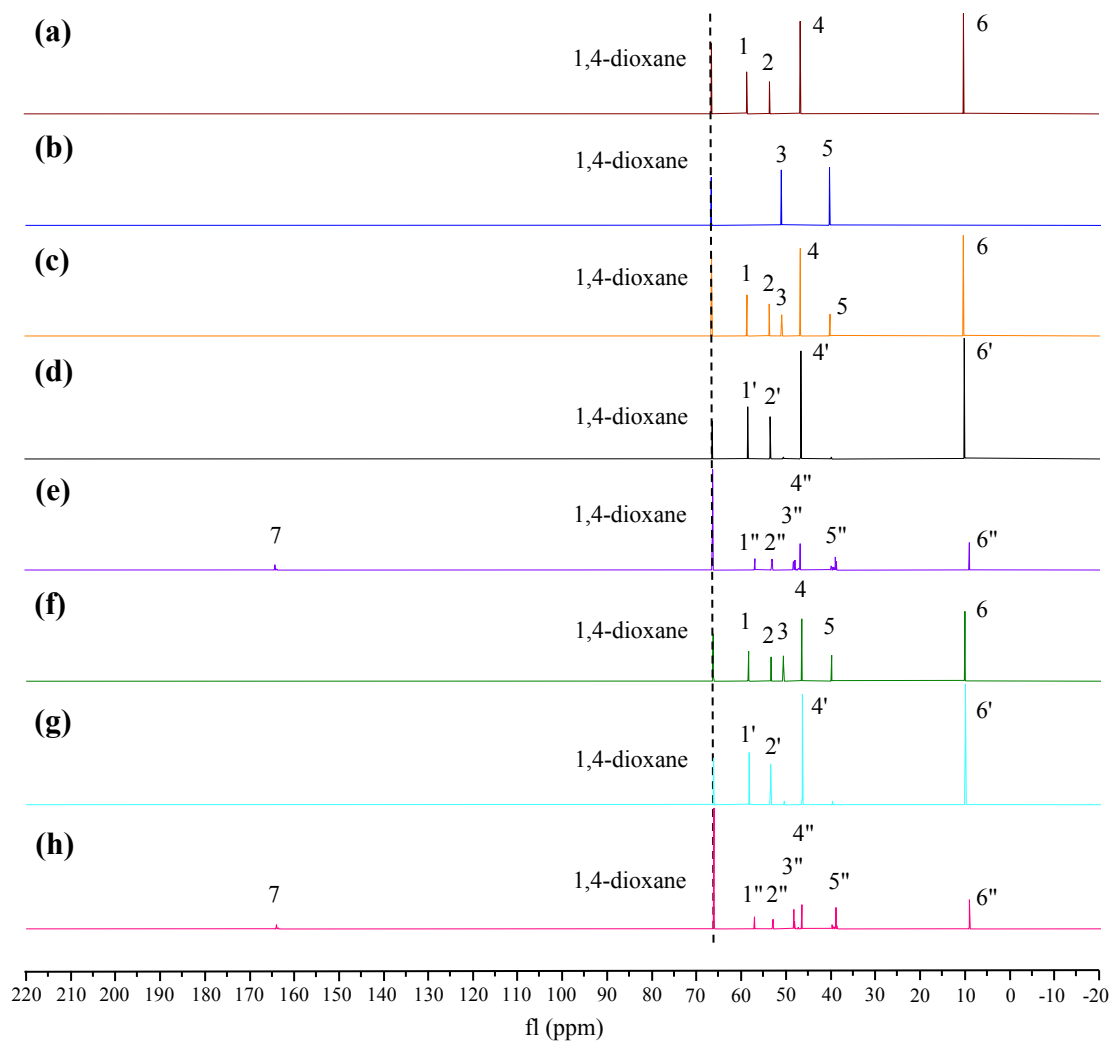


Figure S2. ^{13}C NMR spectrums of different absorbents and their components. (a) 5 mol/L DEEA; (b) 5 mol/L DETA; (c) 4 mol/L DEEA + 1 mol/L DETA, $\alpha = 0.02$ mol/mol; (d) top layer of 4 mol/L DEEA + 1 mol/L DETA, $\alpha = 0.21$ mol/mol; (e) bottom layer of 4 mol/L DEEA + 1 mol/L DETA, $\alpha = 0.21$ mol/mol; (f) 3.5 mol/L DEEA + 1.5 mol/L DETA, $\alpha = 0.02$ mol/mol; (g) top layer of 3.5 mol/L DEEA + 1.5 mol/L DETA, $\alpha = 0.23$ mol/mol; (h) bottom layer of 3.5 mol/L DEEA + 1.5 mol/L DETA, $\alpha = 0.23$ mol/mol.

Table S1. Parameters of the Motor Used in this Study

Parameter	
model number	YB3-80M2-2
power consumption (kW)	1.1
efficiency (%)	82.8

Table S2 Data Employed for ANN Model Development

Run	c (mol/L)	L (L/h)	N (rpm)	G (m ³ /h)	T (°C)	$y_{\text{CO}_2\text{-in}}$ (%)	α (mol/mol)	Predicted K_{Ga} (kmol/kPa m ³ h)	Experimental K_{Ga} (kmol/kPa m ³ h)	Predicted η (%)	Experimental η (%)
1	1	8	1000	3	40	10.04	0.02	2.66	2.63	78.68	78.79
2	1.5	8	1000	3	40	9.71	0.02	3.94	3.61	89.47	88.21
3	2	8	1000	3	40	9.48	0.02	4.39	4.27	92.45	92.01
4	2.5	8	1000	3	40	10	0.03	4.84	4.65	94.24	93.63
5	1	4	1000	3	40	10.04	0.02	1.42	1.40	56.17	55.37
6	1	6	1000	3	40	10.04	0.02	2.06	2.01	69.85	69.14
7	1	10	1000	3	40	10.04	0.02	3.07	3.03	83.03	83.28
8	1	12	1000	3	40	10.04	0.02	3.29	3.29	85.50	85.78
9	1	14	1000	3	40	10.04	0.02	3.53	3.50	87.18	87.47
10	1	8	600	3	40	10.04	0.02	2.01	1.96	69.21	68.21
11	1	8	800	3	40	10.04	0.02	2.38	2.27	75.07	73.63
12	1	8	1200	3	40	10.04	0.02	2.90	2.75	81.74	80.36
13	1	8	1400	3	40	10.04	0.02	3.10	2.90	84.98	82.17
14	1	8	1000	1.4	40	10.04	0.02	2.60	2.58	96.22	96.32
15	1	8	1000	1.8	40	10.04	0.02	2.81	2.70	93.28	93.18
16	1	8	1000	2.2	40	10.04	0.02	2.84	2.80	89.81	89.73
17	1	8	1000	2.6	40	10.04	0.02	2.76	2.76	84.94	85.05
18	1	8	1000	3.4	40	10.04	0.02	2.58	2.60	73.26	73.93
19	1	8	1000	3	30	10.04	0.02	2.48	2.45	76.65	76.31
20	1	8	1000	3	50	10.04	0.02	2.83	2.84	80.34	81.28
21	1	8	1000	3	60	10.04	0.02	2.91	2.93	82.33	82.17
22	1	8	1000	3	70	10.04	0.02	2.95	2.95	86.31	82.31

23	1	8	1000	3	40	2.34	0.02	4.35	4.05	88.86	89.21
24	1	8	1000	3	40	4.37	0.02	3.89	3.87	87.70	88.59
25	1	8	1000	3	40	6.21	0.02	3.39	3.48	85.62	86.27
26	1	8	1000	3	40	8.12	0.02	3.08	3.09	82.93	83.43
27	1	8	1000	3	40	10.04	0.12	2.05	2.02	70.79	69.51
28	1	8	1000	3	40	10.04	0.20	1.56	1.46	59.85	57.22
29	1	8	1000	3	40	10.04	0.37	0.85	0.65	37.72	30.49
30	1	8	1000	3	40	10.04	0.42	0.66	0.54	30.87	25.93
31	1	8	1000	3	40	10.04	0.50	0.30	0.36	20.13	18.18
32	1.5	4	1000	3	40	9.71	0.02	1.97	1.94	68.57	67.98
33	1.5	6	1000	3	40	9.71	0.02	2.93	2.85	82.65	81.37
34	1.5	10	1000	3	40	9.71	0.02	4.28	4.00	91.37	90.68
35	1.5	12	1000	3	40	9.71	0.02	4.43	4.31	92.55	92.21
36	1.5	14	1000	3	40	9.71	0.02	4.70	4.68	93.41	93.79
37	1.5	8	600	3	40	9.71	0.02	2.80	2.64	81.31	79.06
38	1.5	8	800	3	40	9.71	0.02	3.40	3.22	86.43	85.20
39	1.5	8	1200	3	40	9.71	0.02	4.47	4.30	92.65	92.17
40	1.5	8	1400	3	40	9.71	0.02	4.92	4.81	95.84	94.26
41	1.5	8	1000	1.4	40	9.71	0.02	3.41	3.27	98.37	98.48
42	1.5	8	1000	1.8	40	9.71	0.02	3.64	3.42	96.78	96.70
43	1.5	8	1000	2.2	40	9.71	0.02	3.87	3.66	95.22	94.94
44	1.5	8	1000	2.6	40	9.71	0.02	4.04	4.04	93.05	93.85
45	1.5	8	1000	3.4	40	9.71	0.02	3.71	3.63	84.66	84.96
46	1.5	8	1000	3	30	9.71	0.02	3.49	3.33	86.53	86.03
47	1.5	8	1000	3	50	9.71	0.02	4.48	4.46	91.78	92.86
48	1.5	8	1000	3	60	9.71	0.02	4.71	4.94	93.98	94.67

49	1.5	8	1000	3	70	9.71	0.02	4.82	5.11	94.76	95.14
50	1.5	8	1000	3	40	2.23	0.02	4.76	4.56	92.72	91.83
51	1.5	8	1000	3	40	4.18	0.02	4.57	4.32	92.93	91.10
52	1.5	8	1000	3	40	6.17	0.02	4.36	4.38	92.78	91.80
53	1.5	8	1000	3	40	8.24	0.02	4.19	4.22	91.12	91.51
54	1.5	8	1000	3	40	9.71	0.13	2.75	2.77	81.25	80.70
55	1.5	8	1000	3	40	9.71	0.20	2.04	1.91	73.53	67.20
56	1.5	8	1000	3	40	9.71	0.37	1.15	1.12	49.34	47.20
57	1.5	8	1000	3	40	9.71	0.46	0.78	0.67	34.86	31.34
58	1.5	8	1000	3	40	9.71	0.52	0.50	0.47	25.19	22.96
59	1	8	1000	3	40	10.04	0.02	2.66	2.55	78.68	77.77
60	1.5	8	1000	3	40	9.71	0.02	3.94	3.81	89.47	89.57
61	2	8	1000	3	40	9.48	0.02	4.39	4.31	92.45	92.20
62	2.5	8	1000	3	40	10	0.03	4.84	4.75	94.24	94.02
63	1	4	1000	3	40	10.04	0.02	1.42	1.44	56.17	56.54
64	1	6	1000	3	40	10.04	0.02	2.06	2.09	69.85	70.59
65	1	10	1000	3	40	10.04	0.02	3.07	3.09	83.03	83.94
66	1	12	1000	3	40	10.04	0.02	3.29	3.38	85.50	86.43
67	1	14	1000	3	40	10.04	0.02	3.53	3.54	87.18	87.70
68	1	8	600	3	40	10.04	0.02	2.01	2.05	69.21	69.96
69	1	8	800	3	40	10.04	0.02	2.38	2.42	75.07	75.82
70	1	8	1200	3	40	10.04	0.02	2.90	2.96	81.74	82.66
71	1	8	1400	3	40	10.04	0.02	3.10	3.22	84.98	85.06
72	1	8	1000	1.4	40	10.04	0.02	2.60	2.65	96.22	96.66
73	1	8	1000	1.8	40	10.04	0.02	2.81	2.81	93.28	93.95
74	1	8	1000	2.2	40	10.04	0.02	2.84	2.90	89.81	90.57

75	1	8	1000	2.6	40	10.04	0.02	2.76	2.79	84.94	85.28
76	1	8	1000	3.4	40	10.04	0.02	2.58	2.58	73.26	73.73
77	1	8	1000	3	30	10.04	0.02	2.48	2.48	76.65	76.87
78	1	8	1000	3	50	10.04	0.02	2.83	2.79	80.34	80.84
79	1	8	1000	3	60	10.04	0.02	2.91	2.89	82.33	81.92
80	1	8	1000	3	70	10.04	0.02	2.95	2.92	86.31	82.17
81	1	8	1000	3	40	2.24	0.02	4.35	4.33	88.86	90.73
82	1	8	1000	3	40	4.23	0.02	3.89	3.70	87.70	87.42
83	1	8	1000	3	40	6.31	0.02	3.39	3.25	85.62	84.34
84	1	8	1000	3	40	7.96	0.02	3.08	2.93	82.93	81.75
85	1	8	1000	3	40	10.04	0.12	2.05	2.09	70.79	70.77
86	1	8	1000	3	40	10.04	0.20	1.56	1.65	59.85	61.75
87	1	8	1000	3	40	10.04	0.37	0.85	0.96	37.72	42.14
88	1	8	1000	3	40	10.04	0.42	0.66	0.69	30.87	32.29
89	1	8	1000	3	40	10.04	0.50	0.30	0.42	20.13	20.69
90	1.5	4	1000	3	40	9.71	0.02	1.97	1.99	68.57	68.71
91	1.5	6	1000	3	40	9.71	0.02	2.93	2.94	82.65	82.34
92	1.5	10	1000	3	40	9.71	0.02	4.28	4.11	91.37	91.29
93	1.5	12	1000	3	40	9.71	0.02	4.43	4.41	92.55	92.77
94	1.5	14	1000	3	40	9.71	0.02	4.70	4.56	93.41	93.36
95	1.5	8	600	3	40	9.71	0.02	2.80	2.87	81.31	81.66
96	1.5	8	800	3	40	9.71	0.02	3.40	3.58	86.43	87.91
97	1.5	8	1200	3	40	9.71	0.02	4.47	4.56	92.65	93.30
98	1.5	8	1400	3	40	9.71	0.02	4.92	4.76	95.84	94.04
99	1.5	8	1000	1.4	40	9.71	0.02	3.41	3.43	98.37	98.77
100	1.5	8	1000	1.8	40	9.71	0.02	3.64	3.81	96.78	97.74

101	1.5	8	1000	2.2	40	9.71	0.02	3.87	3.89	95.22	95.82
102	1.5	8	1000	2.6	40	9.71	0.02	4.04	4.03	93.05	93.75
103	1.5	8	1000	3.4	40	9.71	0.02	3.71	3.62	84.66	84.80
104	1.5	8	1000	3	30	9.71	0.02	3.49	3.50	86.53	87.51
105	1.5	8	1000	3	50	9.71	0.02	4.48	4.48	91.78	93.07
106	1.5	8	1000	3	60	9.71	0.02	4.71	4.50	93.98	93.15
107	1.5	8	1000	3	70	9.71	0.02	4.82	4.63	94.76	93.59
108	1.5	8	1000	3	40	2.23	0.02	4.76	4.76	92.72	92.73
109	1.5	8	1000	3	40	4.2	0.02	4.57	4.69	92.93	92.80
110	1.5	8	1000	3	40	6.3	0.02	4.36	4.36	92.78	91.76
111	1.5	8	1000	3	40	7.94	0.02	4.19	3.98	91.12	90.20
112	1.5	8	1000	3	40	9.71	0.13	2.75	2.72	81.25	79.98
113	1.5	8	1000	3	40	9.71	0.20	2.04	2.05	73.53	69.98
114	1.5	8	1000	3	40	9.71	0.37	1.15	1.18	49.34	49.03
115	1.5	8	1000	3	40	9.71	0.46	0.78	0.77	34.86	35.40
116	1.5	8	1000	3	40	9.71	0.52	0.50	0.53	25.19	25.47
117	1	8	1000	3	40	10.04	0.02	2.66	2.73	78.68	80.08
118	1.5	8	1000	3	40	9.71	0.02	3.94	4.09	89.47	91.14
119	2	8	1000	3	40	9.48	0.02	4.39	4.63	92.45	93.56
120	2.5	8	1000	3	40	10	0.03	4.84	5.12	94.24	95.18
121	1	4	1000	3	40	10.04	0.02	1.42	1.41	56.17	55.77
122	1	6	1000	3	40	10.04	0.02	2.06	2.08	69.85	70.38
123	1	10	1000	3	40	10.04	0.02	3.07	2.99	83.03	82.85
124	1	12	1000	3	40	10.04	0.02	3.29	3.29	85.50	85.73
125	1	14	1000	3	40	10.04	0.02	3.53	3.55	87.18	87.79
126	1	8	600	3	40	10.04	0.02	2.01	2.02	69.21	69.26

127	1	8	800	3	40	10.04	0.02	2.38	2.45	75.07	76.33
128	1	8	1200	3	40	10.04	0.02	2.90	3.02	81.74	83.26
129	1	8	1400	3	40	10.04	0.02	3.10	3.18	84.98	84.68
130	1	8	1000	1.4	40	10.04	0.02	2.60	2.70	96.22	96.91
131	1	8	1000	1.8	40	10.04	0.02	2.81	2.79	93.28	93.81
132	1	8	1000	2.2	40	10.04	0.02	2.84	2.82	89.81	89.91
133	1	8	1000	2.6	40	10.04	0.02	2.76	2.78	84.94	85.23
134	1	8	1000	3.4	40	10.04	0.02	2.58	2.60	73.26	73.93
135	1	8	1000	3	30	10.04	0.02	2.48	2.52	76.65	77.35
136	1	8	1000	3	50	10.04	0.02	2.83	2.85	80.34	81.50
137	1	8	1000	3	60	10.04	0.02	2.91	2.93	82.33	82.30
138	1	8	1000	3	70	10.04	0.02	2.95	2.99	86.31	82.94
139	1	8	1000	3	40	2.44	0.02	4.35	4.71	88.86	92.46
140	1	8	1000	3	40	4.29	0.02	3.89	4.09	87.70	89.87
141	1	8	1000	3	40	6.2	0.02	3.39	3.44	85.62	85.99
142	1	8	1000	3	40	8.24	0.02	3.08	3.13	82.93	83.73
143	1	8	1000	3	40	10.04	0.12	2.05	2.15	70.79	71.71
144	1	8	1000	3	40	10.04	0.20	1.56	1.57	59.85	59.79
145	1	8	1000	3	40	10.04	0.37	0.85	0.96	37.72	42.14
146	1	8	1000	3	40	10.04	0.42	0.66	0.75	30.87	34.37
147	1	8	1000	3	40	10.04	0.50	0.30	0.42	20.13	20.69
148	1.5	4	1000	3	40	9.71	0.02	1.97	1.99	68.57	68.64
149	1.5	6	1000	3	40	9.71	0.02	2.93	3.00	82.65	82.89
150	1.5	10	1000	3	40	9.71	0.02	4.28	4.17	91.37	91.57
151	1.5	12	1000	3	40	9.71	0.02	4.43	4.57	92.55	93.41
152	1.5	14	1000	3	40	9.71	0.02	4.70	4.86	93.41	94.47

153	1.5	8	600	3	40	9.71	0.02	2.80	2.88	81.31	81.65
154	1.5	8	800	3	40	9.71	0.02	3.40	3.52	86.43	87.66
155	1.5	8	1200	3	40	9.71	0.02	4.47	4.56	92.65	93.31
156	1.5	8	1400	3	40	9.71	0.02	4.92	4.67	95.84	93.72
157	1.5	8	1000	1.4	40	9.71	0.02	3.41	3.50	98.37	98.89
158	1.5	8	1000	1.8	40	9.71	0.02	3.64	3.69	96.78	97.48
159	1.5	8	1000	2.2	40	9.71	0.02	3.87	3.81	95.22	95.56
160	1.5	8	1000	2.6	40	9.71	0.02	4.04	4.06	93.05	93.94
161	1.5	8	1000	3.4	40	9.71	0.02	3.71	3.70	84.66	85.53
162	1.5	8	1000	3	30	9.71	0.02	3.49	3.50	86.53	87.51
163	1.5	8	1000	3	50	9.71	0.02	4.48	4.50	91.78	93.16
164	1.5	8	1000	3	60	9.71	0.02	4.71	4.69	93.98	93.89
165	1.5	8	1000	3	70	9.71	0.02	4.82	4.73	94.76	93.97
166	1.5	8	1000	3	40	2.42	0.02	4.76	4.96	92.72	93.48
167	1.5	8	1000	3	40	4.27	0.02	4.57	4.68	92.93	92.77
168	1.5	8	1000	3	40	6.18	0.02	4.36	4.36	92.78	91.73
169	1.5	8	1000	3	40	8.23	0.02	4.19	4.35	91.12	92.12
170	1.5	8	1000	3	40	9.71	0.13	2.75	2.80	81.25	80.92
171	1.5	8	1000	3	40	9.71	0.20	2.04	2.11	73.53	70.95
172	1.5	8	1000	3	40	9.71	0.37	1.15	1.24	49.34	50.86
173	1.5	8	1000	3	40	9.71	0.46	0.78	0.80	34.86	36.44
174	1.5	8	1000	3	40	9.71	0.52	0.50	0.54	25.19	26.00