

提取率与扩散系数一览表

一、使用不同提取剂提取 DGT 固定膜中目标离子的提取率

目标离子	固定膜类型	提取剂	提取率	参考文献
磷	Zr-Oxide	1M NaOH	0.950	[1]
砷	Zr-Oxide	1.0M NaOH (淡水)	0.877	[2]
		1.0 M NaOH-1.0 M H ₂ O ₂ (海水)	0.917	
阴离子同步	Zr-Oxide	0.2 M NaOH-0.5 M H ₂ O ₂	V: 0.754	[3]
			Cr: 0.948	
			As: 0.741	
			Se: 0.963	
			Mo: 0.981	
			Sb: 0.512	
			W: 0.780	
阳离子同步	Chelex	1.0 M HNO ₃	P: 0.862	[4]
			Mn: 0.967	
			Co: 0.975	
			Ni: 1.05	
			Cu: 1.03	
			Zn: 0.88	
			Cd: 0.938	
阴阳离子同步	ZrO-Chelex	第一步 1.0 M HNO ₃	阳离子同 Chelex	[6]
		第二步 水洗	阴离子同	
		第三步 0.2 M NaOH-0.5 M H ₂ O ₂	Zr-Oxide	
稀土元素	Chelex	2M HCl	La:0.865; Dy:0.896	[7]
			Ce:0.872; Ho:0.913	
			Pr:0.887; Er:0.916	
			Nd:0.902; Tm:0.911	
			Sm:0.916; Yb:0.918	
			Eu:0.90; Lu:0.924	
			Gd:0.891; Y:0.894	
无机汞与甲基汞	Tulsion® CH-95	2%硫脲-0.1M HCl	Tb:0.938	[8]
			CH ₃ Hg ⁺ : 1 Hg ²⁺ : 0.536	

二、氧化型阴离子在不同温度下的扩散系数($\times 10^{-6} \text{ cm}^2 \text{ s}^{-1}$)_{a,b,c}

温度(°C)	V	Cr	As	Se	Mo	Sb	W	P
1	4.03	3.71	3.06	3.15	3.22	3.12	3.49	3.20
2	4.18	3.85	3.18	3.27	3.34	3.24	3.62	3.32
3	4.34	4.00	3.30	3.39	3.47	3.36	3.75	3.45
4	4.50	4.14	3.42	3.52	3.60	3.49	3.89	3.57
5	4.67	4.29	3.54	3.64	3.73	3.61	4.03	3.70
6	4.83	4.45	3.67	3.78	3.86	3.74	4.18	3.84
7	5.00	4.60	3.80	3.91	3.99	3.87	4.32	3.97
8	5.18	4.76	3.93	4.04	4.13	4.01	4.47	4.11
9	5.35	4.93	4.06	4.18	4.27	4.14	4.63	4.25
10	5.53	5.09	4.20	4.32	4.42	4.28	4.78	4.39
11	5.72	5.26	4.34	4.47	4.57	4.43	4.94	4.54
12	5.90	5.43	4.48	4.61	4.71	4.57	5.10	4.69
13	6.09	5.61	4.63	4.76	4.87	4.72	5.27	4.84
14	6.29	5.79	4.77	4.91	5.02	4.87	5.44	4.99
15	6.48	5.97	4.92	5.07	5.18	5.02	5.61	5.15
16	6.68	6.15	5.08	5.22	5.34	5.18	5.78	5.31
17	6.89	6.34	5.23	5.38	5.50	5.33	5.96	5.47
18	7.10	6.53	5.39	5.54	5.67	5.49	6.13	5.63
19	7.31	6.72	5.55	5.71	5.83	5.66	6.32	5.80
20	7.52	6.92	5.71	5.87	6.01	5.82	6.50	5.97
21	7.74	7.12	5.87	6.04	6.18	5.99	6.69	6.14
22	7.96	7.32	6.04	6.22	6.36	6.16	6.88	6.32
23	8.18	7.53	6.21	6.39	6.53	6.34	7.07	6.50
24	8.41	7.74	6.38	6.57	6.72	6.51	7.27	6.68
25	8.64	7.95	6.56	6.75	6.90	6.69	7.47	6.86
26	8.87	8.17	6.74	6.93	7.09	6.87	7.67	7.05
27	9.11	8.38	6.92	7.12	7.28	7.06	7.88	7.23
28	9.35	8.61	7.10	7.31	7.47	7.24	8.09	7.43
29	9.60	8.83	7.29	7.50	7.66	7.43	8.30	7.62
30	9.84	9.06	7.47	7.69	7.86	7.62	8.51	7.82
31	10.10	9.29	7.66	7.89	8.06	7.82	8.73	8.02
32	10.35	9.52	7.86	8.09	8.27	8.01	8.95	8.22
33	10.61	9.76	8.05	8.29	8.47	8.21	9.17	8.42
34	10.87	10.00	8.25	8.49	8.68	8.42	9.40	8.63
35	11.13	10.24	8.45	8.70	8.89	8.62	9.62	8.84
36	11.40	10.49	8.66	8.91	9.10	8.83	9.86	9.05
37	11.67	10.74	8.86	9.12	9.32	9.04	10.09	9.27
38	11.95	10.99	9.07	9.33	9.54	9.25	10.33	9.48

39	12.22	11.25	9.28	9.55	9.76	9.46	10.57	9.70
40	12.50	11.51	9.49	9.77	9.99	9.68	10.81	9.93

^a 扩散层为琼脂糖+PVDF, 厚度 0.90mm; ^b 离子价态为 P(V), As(V), Cr(VI), Mo(VI), Sb(V), Se(VI), V(V)和 W(VI); ^c 参考文献: [4].

三、金属阳离子在不同温度下的扩散系数($\times 10^{-6} \text{ cm}^2 \text{ s}^{-1}$)^{a,b,c}

温度(°C)	Mn	Co	Ni	Cu	Zn	Cd	Pb	Fe
1	2.76	3.05	3.05	3.07	3.21	2.98	3.92	2.99
2	2.86	3.16	3.17	3.19	3.34	3.09	4.07	3.10
3	2.97	3.28	3.29	3.31	3.46	3.21	4.23	3.22
4	3.08	3.40	3.41	3.43	3.59	3.32	4.38	3.33
5	3.19	3.53	3.53	3.56	3.72	3.45	4.54	3.46
6	3.31	3.65	3.66	3.69	3.85	3.57	4.70	3.58
7	3.42	3.78	3.79	3.82	3.99	3.69	4.87	3.71
8	3.54	3.91	3.92	3.95	4.13	3.82	5.04	3.83
9	3.66	4.05	4.05	4.08	4.27	3.95	5.21	3.96
10	3.78	4.18	4.19	4.22	4.41	4.09	5.39	4.10
11	3.91	4.32	4.33	4.36	4.56	4.22	5.56	4.23
12	4.04	4.46	4.47	4.50	4.71	4.36	5.75	4.37
13	4.17	4.61	4.61	4.65	4.86	4.50	5.93	4.51
14	4.30	4.75	4.76	4.80	5.01	4.64	6.12	4.66
15	4.44	4.90	4.91	4.95	5.17	4.79	6.31	4.80
16	4.57	5.05	5.06	5.10	5.33	4.94	6.51	4.95
17	4.71	5.21	5.21	5.25	5.49	5.09	6.71	5.10
18	4.85	5.36	5.37	5.41	5.66	5.24	6.91	5.26
19	5.00	5.52	5.53	5.57	5.83	5.40	7.11	5.41
20	5.14	5.68	5.69	5.74	6.00	5.55	7.32	5.57
21	5.29	5.85	5.86	5.90	6.17	5.71	7.53	5.73
22	5.44	6.01	6.02	6.07	6.35	5.88	7.75	5.89
23	5.60	6.18	6.19	6.24	6.52	6.04	7.96	6.06
24	5.75	6.36	6.37	6.41	6.71	6.21	8.19	6.23
25	5.91	6.53	6.54	6.59	6.89	6.38	8.41	6.40
26	6.07	6.71	6.72	6.77	7.08	6.55	8.64	6.57
27	6.23	6.89	6.90	6.95	7.27	6.73	8.87	6.75
28	6.40	7.07	7.08	7.13	7.46	6.91	9.10	6.93
29	6.56	7.25	7.26	7.32	7.65	7.09	9.34	7.11
30	6.73	7.44	7.45	7.51	7.85	7.27	9.58	7.29
31	6.91	7.63	7.64	7.70	8.05	7.45	9.83	7.48
32	7.08	7.82	7.83	7.89	8.25	7.64	10.07	7.67
33	7.26	8.02	8.03	8.09	8.46	7.83	10.32	7.86
34	7.43	8.21	8.23	8.29	8.67	8.03	10.58	8.05

35	7.61	8.41	8.43	8.49	8.88	8.22	10.84	8.25
36	7.80	8.62	8.63	8.70	9.09	8.42	11.10	8.44
37	7.98	8.82	8.83	8.90	9.31	8.62	11.36	8.65
38	8.17	9.03	9.04	9.11	9.53	8.82	11.63	8.85
39	8.36	9.24	9.25	9.32	9.75	9.03	11.90	9.05
40	8.55	9.45	9.46	9.54	9.97	9.23	12.17	9.26

^a 扩散层为琼脂糖+PVDF, 厚度 0.90 mm; ^b 离子价态为 Fe(II), Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Pb(II)和 Cd(II); ^c 参考文献: [4].

四、S(-II)在不同温度下的扩散系数($\times E-6 \text{ cm}^2 \text{ s}^{-1}$)^a

温度(°C)	S	温度(°C)	S	温度(°C)	S	温度(°C)	S
1	8.41	11	11.92	21	16.14	31	21.06
2	8.73	12	12.31	22	16.60	32	21.59
3	9.06	13	12.71	23	17.07	33	22.12
4	9.39	14	13.11	24	17.54	34	22.67
5	9.73	15	13.52	25	18.02	35	23.22
6	10.08	16	13.94	26	18.51	36	23.78
7	10.43	17	14.37	27	19.00	37	24.34
8	10.80	18	14.80	28	19.51	38	24.92
9	11.16	19	15.24	29	20.02	39	25.49
10	11.54	20	15.69	30	20.53	40	26.08

^a 由于准确测定 S(-II)扩散系数难度较大, 一般直接采用水体扩散系数代替[5].

参考文献:

1. Ding SM, Xu D, Sun Q, et al. Measurement of Dissolved Reactive Phosphorus Using the Diffusive Gradients in Thin Films Technique with a High-Capacity Binding Phase. Environmental Science & Technology, 2010, 44(21): 8169-8174.
2. Sun Q, Chen J, Zhang H, et al. Improved diffusive gradients in thin films (DGT) measurement of total dissolved inorganic arsenic in waters and soils using a hydrous zirconium oxide binding layer. Analytical Chemistry, 2014, 86(6): 3060-3067.
3. Ding SM, Xu D, Wang YP, et al. Simultaneous Measurements of Eight Oxyanions Using High-Capacity Diffusive Gradients in Thin Films (Zr-Oxide DGT) with a High-Efficiency Elution Procedure. Environmental Science & Technology, 2016, 50(14): 7572-7580.
4. Wang Y, Ding SM, Gong MD, et al. Diffusion characteristics of agarose hydrogel used in

- diffusive gradients in thin films for measurements of cations and anions. *Analytica Chimica Acta*, 2016, 945: 47-56.
5. Li YH, Sandra G. Diffusion of ions in seawater and deep sea sediments. *Geochim Cosmochim Acta* 1974, 38: 703-714.
 6. Wang Y, Ding SM, Shi L, et al. Simultaneous measurements of cations and anions using diffusive gradients in thin films with a ZrO-Chelex mixed binding layer. *Analytica Chimica Acta*, 2017, 972: 1-11.
 7. Yuan YM, Ding SM, Wang Y, et al. Simultaneous measurement of fifteen rare earth elements using diffusive gradients in thin films. *Analytica Chimica Acta*, 2018, 1031, 98-107.
 8. Ren MY, Wang Y, Ding SM, et al. Development of a new diffusive gradient in the thin film (DGT) method for the simultaneous measurement of CH_3Hg^+ and Hg^{2+} . *New Journal of Chemistry*, 2018, 42(10), 7976-7983.