Supporting Information

Determination of Volume Properties of Aqueous Vanadyl Sulfate at 283.15 to 323.15 K

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Table S1. The values of the parameters in eq. (1) with the correlation coefficients *r* and standard deviation, s

m/mol·kg	A_0	10^5A_1	10^6A_2	r	10^5s/ g·cm^{-3}
0	1.00047	-2.59991	-4.47446	0.9999	5.0
0.05003	1.00823	-4.03571	-4.38571	0.99995	4.9
0.07006	1.01126	-4.52706	-4.36494	0.99995	4.9
0.1000	1.01571	-5.3016	-4.32251	0.99996	4.7
0.2001	1.03053	-7.86026	-4.17662	0.99997	4.4
0.2997	1.04498	-10.3226	-4.0368	0.99998	4.0
0.3990	1.05926	-12.6812	-3.89091	0.99998	3.7
0.5003	1.07349	-14.9219	-3.7658	0.99998	3.6
0.7996	1.115	-20.9687	-3.41688	0.99999	2.7
0.9995	1.14197	-24.5761	-3.21342	1	2.1
1.200	1.16836	-27.9146	-3.01645	1	1.7
1.500	1.20657	-32.1684	-2.77749	1	1.6
1.801	1.24332	-35.7552	-2.5697	1	1.3
2.003	1.26713	-37.4727	-2.52511	1	1.4
2.198	1.28958	-39.3803	-2.36883	1	0.8
2.493	1.32282	-41.5168	-2.2255	1	1.0
2.791	1.35394	-43.0285	-2.1697	1	0.8
3.002	1.37657	-44.1227	-2.09177	1	0.7

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Table S2. The values of the coefficient of thermal expansion for aqueous $VOSO_4$, $10^4\alpha$/K^{-1} at temperature in the range (283.15 to 323.15) K

m/mol·kg	Coefficient of thermal expansion($10^4\alpha$/K^{-1})								
	283.15 K	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K
	1.16	1.60	2.05	2.50	2.96	3.41	3.87	4.33	4.79
0.05003	1.27	1.71	2.15	2.58	3.03	3.47	3.91	4.36	4.81
0.07006	1.31	1.75	2.18	2.62	3.05	3.49	3.94	4.38	4.83
0.1000	1.37	1.80	2.23	2.66	3.09	3.53	3.96	4.40	4.84
0.2001	1.58	1.98	2.39	2.80	3.21	3.63	4.04	4.46	4.88
0.2997	1.76	2.15	2.54	2.93	3.33	3.72	4.12	4.52	4.92
0.3990	1.93	2.31	2.68	3.05	3.42	3.80	4.18	4.56	4.95
0.5003	2.10	2.45	2.80	3.16	3.52	3.88	4.24	4.61	4.98
0.7996	2.50	2.81	3.12	3.44	3.75	4.07	4.39	4.71	5.03
0.9995	2.72	3.01	3.30	3.58	3.88	4.17	4.46	4.76	5.06
1.200	2.91	3.18	3.44	3.71	3.98	4.25	4.52	4.79	5.06
1.500	3.14	3.37	3.61	3.85	4.09	4.33	4.57	4.82	5.06
1.801	3.30	3.51	3.73	3.94	4.16	4.38	4.60	4.82	5.04
2.003	3.37	3.57	3.78	3.99	4.20	4.41	4.62	4.83	5.05
2.198	3.43	3.62	3.81	4.01	4.20	4.40	4.59	4.79	4.99
2.493	3.49	3.66	3.84	4.02	4.19	4.37	4.55	4.74	4.92
2.791	3.51	3.68	3.85	4.02	4.19	4.36	4.53	4.70	4.88
3.002	3.52	3.68	3.84	4.00	4.16	4.33	4.49	4.65	4.82

Table S3. The values of the parameters in eq. (5) with the correlation coefficients, r, and standard deviations, s

m/mol·kg	B_0	B_1	B_2	r	s
0.05003	7.96451	0.27332	-0.00219	0.9988	0.11
0.07006	9.00282	0.26887	-0.00211	0.9998	0.04
0.1000	10.48001	0.26544	-0.00208	0.9998	0.04
0.2001	12.43216	0.25235	-0.00196	0.9999	0.04
0.2997	13.95983	0.24285	-0.00188	0.9998	0.04
0.3990	14.80486	0.23615	-0.00186	0.9998	0.04
0.5003	15.90775	0.22733	-0.00178	0.9999	0.03
0.7996	17.73484	0.20562	-0.00163	0.9998	0.03
0.9995	18.76515	0.19329	-0.00153	0.9998	-0.00
1.200	19.8163	0.18171	-0.00145	0.9998	0.03
1.500	21.23482	0.16607	-0.00134	0.9998	0.02
1.801	22.651	0.15149	-0.00123	0.9999	0.02
2.003	23.59375	0.14202	-0.00115	0.9998	0.02
2.198	24.38334	0.13488	-0.00111	0.9998	0.02
2.493	25.47576	0.12383	-0.00104	0.9999	0.02

2.791	26.84207	0.11365	-9.544× 10^{-4}	0.9999	0.02
3.002	27.39803	0.10727	-9.109× 10^{-4}	0.9998	0.01

Table S4. Values of the apparent molar expansibility of the solute, $10^2\phi_E$·/cm^3·mol^{-1}·K^{-1}, from 283.15 to 323.15 K

m/mol·kg	Apparent molar expansibility($10^2\phi_E$·/cm^3·mol^{-1}·K^{-1})								
	283.15 K	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K
0.05003	22.95	20.76	18.57	16.38	14.19	12.00	9.81	7.62	5.43
0.07006	22.67	20.56	18.45	16.34	14.23	12.12	10.01	7.90	5.79
0.1000	22.38	20.30	18.22	16.14	14.06	11.98	9.90	7.82	5.74
0.2001	21.32	19.36	17.40	15.44	13.48	11.52	9.56	7.60	5.64
0.2997	20.53	18.65	16.77	14.89	13.01	11.13	9.25	7.37	5.49
0.3990	19.90	18.04	16.18	14.32	12.46	10.60	8.74	6.88	5.02
0.5003	19.17	17.39	15.61	13.83	12.05	10.27	8.49	6.71	4.93
0.7996	17.30	15.67	14.04	12.41	10.78	9.15	7.52	5.89	4.26
0.9995	16.27	14.74	13.21	11.68	10.15	8.62	7.09	5.56	4.03
1.200	15.27	13.82	12.37	10.92	9.47	8.02	6.57	5.12	3.67
1.500	13.93	12.59	11.25	9.91	8.57	7.23	5.89	4.55	3.21
1.801	12.69	11.46	10.23	9.00	7.77	6.54	5.31	4.08	2.85
2.003	11.90	10.75	9.60	8.45	7.30	6.15	5.00	3.85	2.70
2.198	11.27	10.16	9.05	7.94	6.83	5.72	4.61	3.50	2.39
2.493	10.30	9.26	8.22	7.18	6.14	5.10	4.06	3.02	1.98
2.791	9.46	8.50	7.55	6.59	5.64	4.68	3.73	2.78	1.82
3.002	8.91	7.99	7.08	6.17	5.26	4.35	3.44	2.53	1.62

Table S5. The values of the apparent molar expansibility of the solute, $10^2\phi_E$(Cal.)/cm^3·K^{-1}, calculated according to eq. (8) from 283.15 to 323.15 K

m/mol·kg	Apparent molar expansibility($10^2\phi_E$(Cal.)/cm^3·K^{-1})								
	283.15 K	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K
0.05003	23.36	21.02	18.72	16.42	14.12	11.83	9.51	7.19	4.86
0.07006	22.56	20.45	18.37	16.29	14.22	12.15	10.07	7.97	5.87
0.1000	22.10	20.06	18.04	16.03	14.02	12.02	10.00	7.97	5.94
0.2001	21.23	19.26	17.32	15.38	13.44	11.50	9.55	7.60	5.63

0.2997	20.56	18.66	16.78	14.90	13.03	11.15	9.27	7.37	5.47
0.3990	19.87	18.01	16.15	14.30	12.45	10.60	8.74	6.87	4.98
0.5003	19.17	17.38	15.60	13.83	12.05	10.27	8.48	6.68	4.87
0.7996	17.30	15.67	14.05	12.43	10.81	9.18	7.54	5.89	4.23
0.9995	16.23	14.70	13.18	11.65	10.12	8.59	7.04	5.49	3.92
1.200	15.28	13.82	12.37	10.93	9.47	8.02	6.55	5.07	3.58
1.500	13.92	12.59	11.26	9.93	8.59	7.25	5.90	4.54	3.17
1.801	12.70	11.47	10.25	9.02	7.79	6.55	5.30	4.04	2.77
2.003	11.88	10.75	9.61	8.48	7.34	6.20	5.05	3.88	2.71
2.198	11.24	10.14	9.04	7.94	6.84	5.72	4.60	3.47	2.33
2.493	10.28	9.26	8.23	7.20	6.17	5.12	4.08	3.02	1.95
2.791	9.42	8.48	7.54	6.60	5.65	4.70	3.73	2.76	1.78
3.002	8.88	7.98	7.08	6.18	5.27	4.36	3.44	2.51	1.57

Table S6. The fitting parameters, C_i, with the correlation coefficients *r* and the standard deviations, s, at different temperatures

Parameter	283.15K	288.15K	293.15K	298.15K	303.15K	308.15K	313.15K	318.15K	323.15K
C_0	3.554	4.158	5.816	6.440	7.172	8.167	8.284	8.703	9.210
C_1	40.107	42.597	39.749	40.895	41.062	39.410	41.612	41.797	41.487
C_2	-44.074	-48.441	-44.508	-46.722	-47.451	-45.071	-48.984	-49.456	-49.197
C_3	26.531	29.199	26.566	27.898	28.340	26.676	29.231	29.465	29.230
C_4	-5.585	-6.168	-5.551	-5.836	-5.932	-5.531	-6.119	-6.161	-6.094
r	0.9998	0.9998	0.9998	0.9997	0.9997	0.9998	0.9996	0.9997	0.9996
s	0.12	0.13	0.12	0.13	0.13	0.12	0.14	0.14	0.14

Table S7. The values of $\overline{V}_B^0$ and Pitzer's parameters with the correlation coefficients *r* and the standard deviations, *s*, at different temperatures

Parameter	283.15K	288.15K	293.15K	298.15K	303.15K	308.15K	313.15K	318.15K	323.15K
$\overline{V}_B^0$	7.50	8.40	9.58	10.29	10.97	11.62	11.98	12.33	12.68
$10^4\ \beta_{M,X}^{(0)V}$	-1.949	-3.076	-2.990	-3.643	-3.965	-4.010	-4.567	-4.803	-4.953

$10^3\ \beta^{(1)V}_{M,X}$	7.36	7.35	6.43	6.19	5.74	5.12	4.97	4.59	4.13
$10^4\ C^V_{MX}$	0.764	0.829	0.779	0.808	0.807	0.780	0.808	0.805	0.796
s	0.27	0.29	0.26	0.28	0.28	0.25	0.28	0.28	0.27
r^2	0.995	0.993	0.993	0.991	0.988	0.987	0.979	0.974	0.964
A_v	1.643	1.72	1.7930	1.88	1.962	2.06	2.153	2.2625	2.372

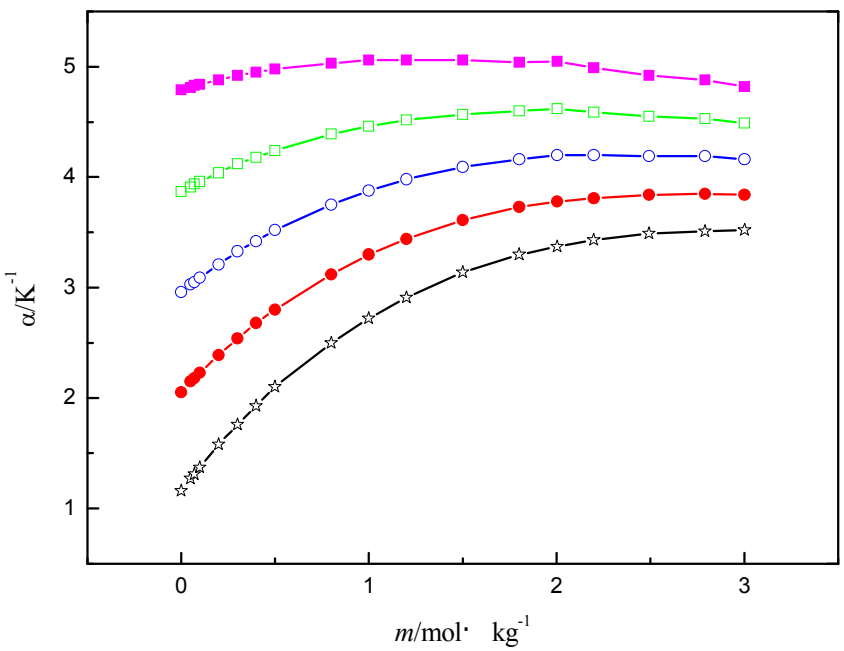

Figure S1. Plot of the coefficient of thermal expansion of aqueous $VOSO_4$ *vs* the molality at the different temperatures

From top to bottom: ■ 323.15 K, □ 313.15 K, ○ 303.15 K, ● 293.15 K, ☆ 283.15 K

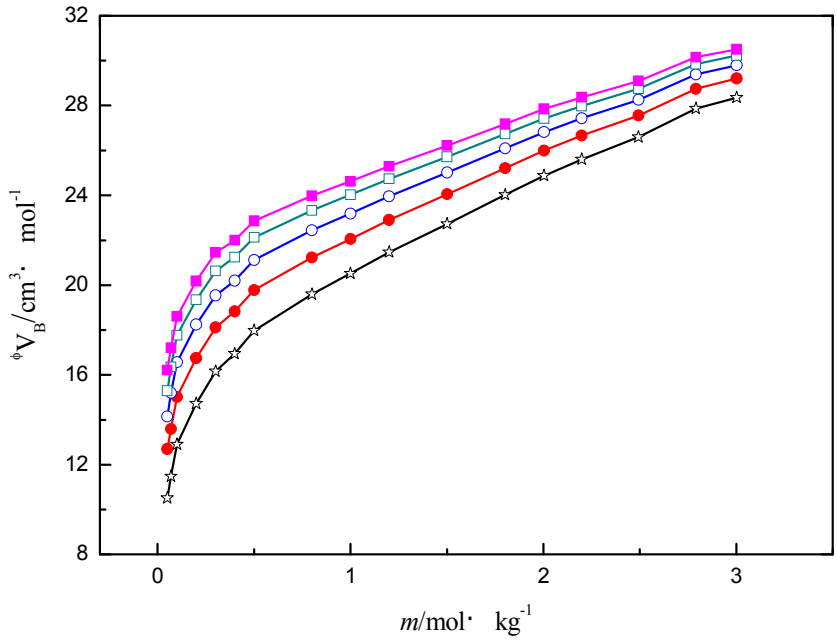

Figure S2. Plot of the apparent molar volume, $^{\varphi}V_B$, against the molality m at the different temperatures

From top to bottom: ■ 323.15 K, □ 313.15 K, ○ 303.15 K, ● 293.15 K, ☆ 283.15 K

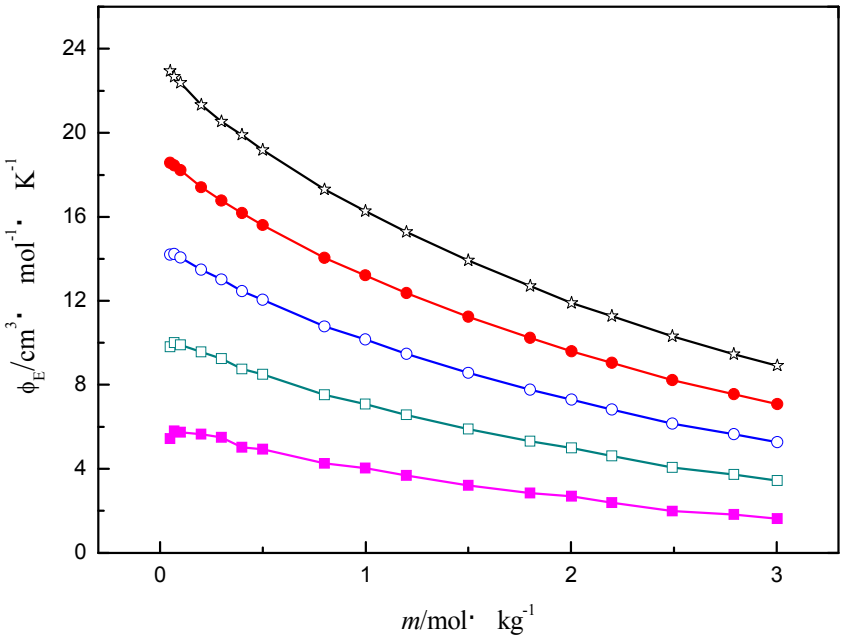

Figure S3. Plot of the apparent molar expansibility of the solute, ϕ_E, against the molality m at the different temperatures

From top to bottom: ■ 323.15 K, □ 313.15 K, ○ 303.15 K, ● 293.15 K, ☆ 283.15 K

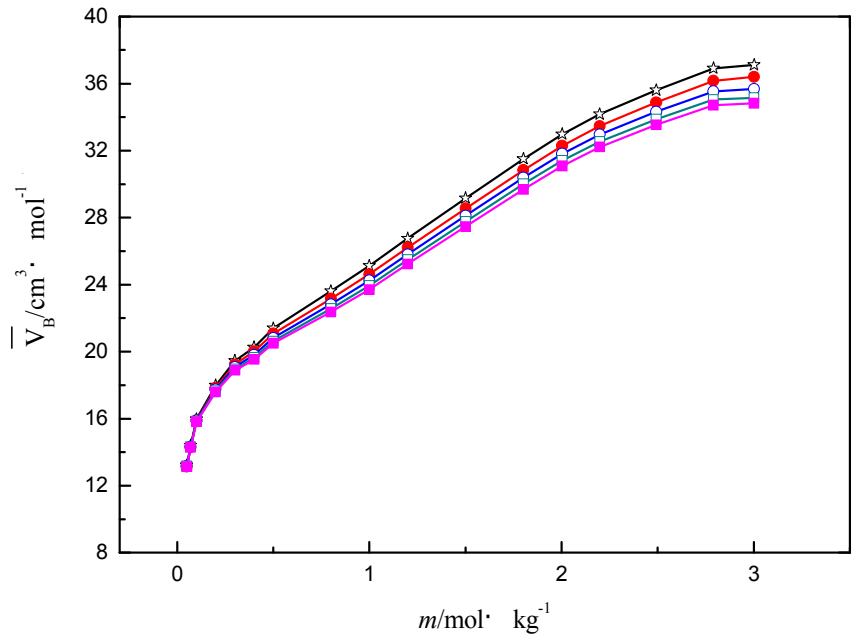

Figure S4. Plot of the partial molar volume of the solute, $\overline{V}_B$, against the molality m at the different temperatures

From top to bottom: ☆ 283.15 K, ● 293.15 K, ○ 303.15 K, □ 313.15 K, ■ 323.15 K