Densities of Carbon Dioxide + Nitrogen from 225 K to 450 K at Pressures up to 70 MPa

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This paper reports *PVT* measurements for five gravimetrically prepared mixtures of CO_2 + N_2 from 225 K to 450 K at pressures up to 70 MPa. These results have been determined using a continuously-weighed pycnometer. A detailed error analysis indicates that the accuracy of the densities is better than ±0.1%. Additional *PVT* data for CO_2 + N_2 mixtures have been measured by Netherlandse Gasunie, Ruhrgas, and Gaz de France as reported by Jaeschke and Humphreys (1990).

Introduction

This paper reports experimental results for the densities of CO_2 + N_2 mixtures from 225 K to 450 K at pressures up to 70 MPa using a continuously-weighed pycnometer. Burnett data and derived virial coefficients at 300 K and 320 K for this system have been reported previously by Brugge *et al.* (1989). Esper *et al.* (1989) report Burnett-isochoric measurements from 205 K to 320 K and pressures from 0.1 MPa to 48 MPa. Isochoric *pVT*, vapor pressures and saturation densities have been reported by Esper *et al.* (1989) and Duarte-Garza *et al.* (1995a).

Standard thermodynamic procedures permit evaluation of other properties from the densities. GPA/GRI Research Report RR-140 authored by Duarte-Garza *et al.* (1995b) contains: energies (internal, Helmholtz, and Gibbs), enthalpies, and entropies obtained from the data reduction method described by Duarte-Garza *et al.* (1997); second and third virial coefficients for both the pure compounds and the mixture.

Experimental Section

Materials. The carbon dioxide was Ultra Pure grade from Scientific Gas Products, Inc., with a purity better than 99.995 mol % with 40 ppm nitrogen and 40 ppm oxygen maximum contaminant concentration. The sample was degassed by evacuating a frozen sample for a least 30 min. The nitrogen was Research Grade from Air Products, with a specified purity of better than 99.9995%. No further purification was performed.

Measurements. The pycnometer consists of a sample cell of known volume suspended from an electronic balance that has been described in detail by Lau (1986) and Lau *et al.* (1997). Pressures are measured using pressure transducers that have been calibrated *in-situ* against an automatic dead-weight gauge pressure standard. The accuracy

of the pressure measurements is estimated to be ±0.006 MPa. Temperatures are measured with a four-lead platinum resistance thermometer, which is adjacent to the sample cell on the inside surface of the compartment. The temperature is controlled to ±0.002 K and measured to an accuracy of ±0.005 K on ITS-90. The mixtures are prepared gravimetrically with mole fractions accurate to ±0.000 05, excluding the effects of sample impurity. The uncertainties in the pycnometric density measurements arise from the uncertainties in the mass determinations and the cell volume calibration. The error in the cell volume calibration, which includes random errors introduced by uncertainties in the temperature and pressure measurements, uncertainties from using a calibrating fluid whose equation of state is known, and errors from mass determinations, is about ±0.04%. The estimated accuracy (at 95 % confidence limit) provided by Hwang *et al.* (1997) in the pycnometric density measurements is

$$\Delta\rho = \{(0.15)^2 + (0.0004\rho)^2\}^{1/2}$$

or

$$\frac{\Delta\rho}{\rho} = \left\{\left(\frac{0.15}{\rho}\right)^2 + 1.6 \times 10^{-7}\right\}^{1/2}$$

where the units of density are $kg \cdot m^{-3}$.

Results and Conclusions

Table 1 contains densities measured with the pycnometer and derived compressibility factors for the five mixtures of CO_2 + N_2. These data cover temperatures from 225 K to 450 K and pressures up to 70 MPa.

The experimental data in this project are state-of-the-art measurements and generally accurate within ±0.1%. These results are suitable for both stringent testing and development of models and correlations. These results formed a significant contribution to the development of the American Gas Association Standard AGA-8.

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Table 1. Experimental *pVT* Results for CO$_2$ (A) + N$_2$ (B) at Various Mole Fractions Determined by Pycnometer. $M_{r,A}$ = 28.0134, $M_{r,B}$ = 44.0098

p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z
					x_A = 0.105 60, M_r = 29.7026						
					T = 225.00 K						
68.759	21 922	1.676 61	51.819	19 990	1.385 67	34.553	16 978	1.087 88	17.334	10 929	0.847 81
62.510	21 286	1.569 78	45.955	19 136	1.283 70	28.832	15 503	0.994 13	11.565	7 405	0.834 84
57.402	20 706	1.481 88	40.271	18 158	1.185 51	23.073	13 561	0.909 48	5.789	3 470	0.891 78
					T = 245.00 K						
68.953	20 751	1.631 22	34.424	15 394	1.097 76	18.586	10 022	0.910 40	8.579	4 647	0.906 28
57.208	19 395	1.447 99	29.447	14 066	1.027 71	15.875	8 698	0.895 97	6.223	3 302	0.925 17
49.629	18 325	1.329 51	25.196	12 702	0.973 77	13.324	7 341	0.891 00	3.806	1 967	0.949 87
40.517	16 735	1.188 53	21.643	11 356	0.935 60	10.939	6 004	0.894 41	1.265	631	0.984 15
					T = 265.00 K						
68.980	19 656	1.592 75	34.460	14 069	1.111 66	17.697	8 484	0.946 71	8.288	3 996	0.941 33
59.626	18 547	1.459 09	30.257	12 956	1.059 92	15.189	7 356	0.937 14	6.015	2 867	0.952 20
51.662	17 418	1.346 15	26.580	11 838	1.019 05	12.832	6 240	0.933 32	3.740	1 754	0.967 75
45.014	16 304	1.253 06	23.281	10 708	0.986 76	10.538	5 118	0.934 49	1.408	647	0.987 68
39.419	15 204	1.176 70	20.372	9 599	0.963 22						
					T = 285.00 K						
69.124	18 656	1.563 62	38.736	13 916	1.174 68	21.802	9 171	1.003 23	10.090	4 433	0.960 54
61.286	17 705	1.460 78	34.711	12 989	1.127 75	19.227	8 227	0.986 26	7.932	3 472	0.964 10
54.492	16 756	1.372 41	30.952	12 027	1.086 05	16.819	7 286	0.974 16	5.792	2 524	0.968 41
48.534	15 806	1.295 82	27.610	11 071	1.052 45	14.481	6 326	0.966 03	3.650	1 576	0.977 36
43.343	14 858	1.231 06	24.590	10 124	1.025 01	12.256	5 378	0.961 72	1.477	630	0.989 37
					T = 300.00 K						
69.055	17 936	1.543 52	39.817	13 396	1.191 62	22.642	8 840	1.026 85	10.413	4 272	0.977 21
61.675	17 032	1.451 73	35.681	12 476	1.146 58	19.933	7 919	1.009 13	8.196	3 363	0.977 05
55.165	16 118	1.372 13	31.967	11 568	1.107 87	17.400	7 007	0.995 54	5.999	2 456	0.979 25
49.506	15 219	1.304 11	28.534	10 638	1.075 34	14.971	6 088	0.985 87	3.767	1 534	0.984 50
44.370	14 306	1.243 41	25.493	9 743	1.048 99	12.682	5 188	0.980 01	1.537	620	0.993 86
					T = 320.00 K						
34.747	11 381	1.147 50	23.668	8 451	1.052 61	14.819	5 542	1.005 00	6.805	2 580	0.991 34
30.700	10 405	1.108 95	20.550	7 484	1.032 03	12.114	4 567	0.996 95	4.181	1 583	0.992 69
27.037	9 428	1.077 84	17.649	6 522	1.017 08	9.397	3 558	0.992 65	1.740	658	0.993 89
					T = 350.00 K						
69.189	15 932	1.492 33	42.587	11 927	1.226 99	24.756	7 884	1.079 02	11.366	3 857	1.012 64
62.799	15 130	1.426 30	38.449	11 112	1.189 02	21.856	7 081	1.060 65	8.925	3 047	1.006 54
57.018	14 327	1.367 58	34.625	10 298	1.155 40	19.062	6 271	1.044 55	6.550	2 246	1.002 14
51.735	13 520	1.314 94	31.132	9 499	1.126 23	16.417	5 471	1.031 15	4.182	1 439	0.998 67
46.821	12 700	1.266 88	27.855	8 693	1.101 11	13.867	4 670	1.020 38	1.840	635	0.995 73
					T = 400.00 K						
68.655	14 254	1.448 24	51.633	11 939	1.300 36	34.122	8 837	1.161 01	17.385	4 950	1.056 03
63.076	13 559	1.398 75	45.922	11 018	1.253 21	28.750	7 698	1.122 96	11.889	3 463	1.032 28
57.528	12 807	1.350 63	40.264	10 025	1.207 64	22.860	6 331	1.085 70	5.747	1 708	1.011 72
					T = 450.00 K						
68.588	12 929	1.417 87	45.745	9 819	1.245 17	28.416	6 734	1.127 83	11.263	2 901	1.037 67
57.394	11 523	1.331 23	40.044	8 884	1.204 71	22.867	5 582	1.094 89	5.828	1 532	1.016 75
51.431	10 685	1.286 48	34.451	7 895	1.166 28	17.279	4 336	1.065 08			
					x_A = 0.251 47, M_r = 32.0360						
					T = 225.00 K						
68.723	23 105	1.589 93	54.635	21 756	1.342 38	40.832	19 946	1.094 28	26.560	16 925	0.838 85
63.995	22 691	1.507 56	50.028	21 224	1.259 99	36.052	19 127	1.007 55	22.097	15 426	0.765 71
59.486	22 264	1.428 22	45.559	20 642	1.179 79	31.521	18 196	0.925 99	17.324	13 188	0.702 19
					T = 245.00 K						
68.896	21 883	1.545 56	30.934	16 208	0.936 93	16.575	10 536	0.772 28	8.167	4 858	0.825 28
55.480	20 476	1.330 12	26.204	14 812	0.868 47	14.379	9 182	0.768 76	6.059	3 439	0.864 90
45.088	19 053	1.161 71	22.498	13 442	0.821 63	12.171	7 694	0.776 56	3.737	2 005	0.914 97
37.041	17 617	1.032 17	19.130	11 922	0.787 71	10.182	6 283	0.795 55	1.182	594	0.976 85
					T = 265.00 K						
68.657	20 675	1.507 16	31.649	14 752	0.973 71	16.383	8 881	0.837 24	8.034	4 141	0.880 53
58.009	19 489	1.350 91	27.743	13 606	0.925 43	14.202	7 695	0.837 64	5.906	2 954	0.907 41
49.373	18 309	1.223 89	24.334	12 429	0.888 58	12.108	6 499	0.845 56	3.669	1 772	0.939 73
42.394	17 145	1.122 24	21.323	11 229	0.861 84	10.055	5 307	0.859 91	1.242	576	0.978 63
36.542	15 953	1.039 61	18.758	10 070	0.845 43						
					T = 285.00 K						
69.088	19 624	1.485 71	36.619	14 619	1.057 08	20.577	9 619	0.902 76	9.840	4 598	0.903 12
60.329	18 620	1.367 31	32.596	13 623	1.009 74	18.220	8 615	0.892 51	7.824	3 602	0.916 65
52.977	17 622	1.268 68	29.030	12 611	0.971 44	15.997	7 605	0.887 69	5.730	2 589	0.933 99
46.679	16 625	1.184 90	25.912	11 614	0.941 54	13.903	6 607	0.888 02	3.582	1 581	0.956 12
41.260	15 618	1.114 87	23.106	10 611	0.918 94	11.843	5 594	0.893 43	1.354	584	0.978 42
					T = 300.00 K						
69.107	18 739	1.478 49	38.228	13 978	1.096 43	21.667	9 189	0.945 31	10.244	4 408	0.931 69
60.931	17 774	1.374 35	34.097	13 006	1.051 03	19.169	8 232	0.933 53	8.099	3 448	0.941 69
54.037	16 828	1.287 37	30.514	12 054	1.014 87	16.816	7 276	0.926 56	5.937	2 496	0.953 60
48.072	15 886	1.213 17	27.295	11 104	0.985 48	14.565	6 319	0.924 07	3.713	1 533	0.971 02
42.827	14 930	1.150 01	24.350	10 142	0.962 54	12.396	5 368	0.925 79	1.436	581	0.990 88

Table 1 (Continued)

p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z
					$x_A = 0.251\ 47$, $M_r = 32.0360$						
					$T = 320.00$ K						
69.011	17 889	1.449 93	39.687	13 356	1.116 83	22.962	8 850	0.975 17	10.804	4 275	0.949 87
61.506	16 985	1.361 03	35.619	12 437	1.076 42	20.261	7 913	0.962 35	8.566	3 372	0.954 78
54.928	16 066	1.284 99	32.020	11 549	1.042 06	17.748	6 998	0.953 21	6.308	2 462	0.962 98
50.951	15 454	1.239 16	28.675	10 630	1.013 88	15.405	6 103	0.948 71	3.923	1 514	0.973 88
45.125	14 443	1.174 29	25.733	9 747	0.992 28	13.081	5 191	0.947 12	1.554	589	0.991 63
					$T = 350.00$ K						
69.195	16 641	1.428 87	41.551	12 414	1.150 18	24.223	8 189	1.016 47	8.875	3 119	0.977 80
62.429	15 801	1.357 68	37.578	11 589	1.114 25	21.446	7 354	1.002 12	6.486	2 275	0.979 70
56.348	14 958	1.294 50	33.822	10 735	1.082 67	18.790	6 513	0.991 39	4.097	1 430	0.984 53
50.943	14 118	1.239 96	30.428	9 895	1.056 71	16.208	5 661	0.983 86	1.687	586	0.989 27
46.046	13 270	1.192 39	27.254	9 049	1.034 97	13.711	4 814	0.978 72			
					$T = 400.00$ K						
68.727	14 796	1.396 65	51.693	12 454	1.248 04	34.456	9 299	1.114 12	16.675	4 918	1.019 49
63.061	14 085	1.346 20	45.922	11 501	1.200 58	28.669	8 006	1.076 72	11.547	3 455	1.004 91
57.436	13 316	1.296 93	40.281	10 470	1.156 80	23.064	6 634	1.045 36	5.867	1 767	0.998 35
					$T = 450.00$ K						
68.690	13 347	1.375 51	51.698	11 088	1.246 16	34.454	8 160	1.128 50	17.196	4 420	1.039 82
63.105	12 664	1.331 82	45.871	10 178	1.204 56	28.331	6 930	1.092 65	11.652	3 050	1.021 06
57.351	11 899	1.288 20	40.112	9 201	1.165 18	23.239	5 824	1.066 47	5.613	1 490	1.006 84
					$x_A = 0.503\ 65$, $M_r = 36.0700$						
					$T = 225.00$ K						
68.757	25 215	1.457 61	55.490	24 328	1.219 24	42.734	23 236	0.983 09	29.435	21 627	0.727 53
64.284	24 936	1.378 03	51.251	23 996	1.141 68	38.334	22 777	0.899 64	25.084	20 883	0.642 08
59.971	24 649	1.300 54	47.029	23 638	1.063 50	33.940	22 255	0.815 20			
					$T = 245.00$ K						
69.031	23 957	1.414 52	54.654	22 839	1.174 75	40.137	21 298	0.925 13	25.376	18 726	0.665 24
64.442	23 631	1.338 71	49.798	22 384	1.092 13	35.095	20 592	0.836 65	20.573	17 307	0.583 55
59.470	23 251	1.255 61	44.823	21 858	1.006 68	30.213	19 764	0.750 44			
					$T = 255.00$ K						
68.418	23 282	1.386 04	55.723	22 226	1.182 49	41.210	20 604	0.943 36	27.634	18 181	0.716 89
63.922	22 936	1.314 49	50.245	21 680	1.093 10	36.441	19 902	0.863 61	22.818	16 815	0.640 04
59.345	22 555	1.240 98	45.746	21 183	1.018 57	32.023	19 128	0.789 62	18.165	14 903	0.574 89
					$T = 265.00$ K						
69.001	22 729	1.377 83	24.410	16 191	0.684 25	12.784	9 667	0.600 20	7.181	4 428	0.736 03
55.649	21 552	1.171 90	20.995	14 913	0.638 95	11.373	8 341	0.618 84	5.511	3 132	0.798 60
43.359	20 111	0.978 51	18.245	13 585	0.609 54	10.049	7 048	0.647 11	3.500	1 816	0.874 72
35.192	18 811	0.849 08	16.080	12 265	0.595 03	8.649	5 731	0.684 94	1.140	538	0.961 70
29.030	17 505	0.752 67	14.235	10 905	0.592 45						
					$T = 275.00$ K						
69.014	22 139	1.363 36	26.449	15 778	0.733 14	13.921	9 416	0.646 60	7.643	4 332	0.771 63
55.386	20 861	1.161 17	22.837	14 506	0.688 53	12.286	8 098	0.663 54	5.790	3 063	0.826 73
45.081	19 595	1.006 19	19.987	13 241	0.660 17	10.850	6 889	0.688 82	3.684	1 807	0.891 65
37.149	18 322	0.886 76	17.566	11 921	0.644 45	9.299	5 612	0.724 69	1.152	522	0.965 19
31.129	17 054	0.798 31	15.661	10 692	0.640 61						
					$T = 285.00$ K						
69.189	21 561	1.354 22	30.659	16 028	0.807 23	16.990	10 479	0.684 22	9.050	4 948	0.771 86
57.633	20 450	1.189 32	26.842	14 917	0.759 37	15.270	9 375	0.687 37	7.376	3 837	0.811 24
48.491	19 343	1.057 93	23.732	13 814	0.724 99	13.678	8 273	0.697 72	5.543	2 732	0.856 22
41.194	18 238	0.953 18	21.142	12 705	0.702 25	12.150	7 173	0.714 82	3.502	1 627	0.908 34
35.359	17 137	0.870 73	18.932	11 599	0.688 80	10.616	6 055	0.739 89	1.192	522	0.963 66
					$T = 300.00$ K						
69.028	20 667	1.339 03	33.118	15 368	0.863 95	18.707	10 069	0.744 84	9.643	4 758	0.812 51
58.681	19 607	1.199 86	29.248	14 302	0.819 87	16.744	9 007	0.745 29	7.789	3 695	0.845 11
50.230	18 541	1.086 11	26.056	13 259	0.787 84	14.914	7 942	0.752 85	5.819	2 645	0.882 00
43.426	17 488	0.995 53	23.267	12 195	0.764 90	13.165	6 888	0.766 25	3.652	1 579	0.927 24
37.763	16 425	0.921 73	20.829	11 123	0.750 74	11.413	5 818	0.786 45	1.262	516	0.980 51
					$T = 320.00$ K						
69.044	19 595	1.324 33	35.685	14 568	0.920 66	20.472	9 547	0.805 95	10.290	4 535	0.852 81
59.508	18 570	1.204 42	31.758	13 560	0.880 25	18.276	8 532	0.805 09	8.230	3 525	0.877 52
51.900	17 566	1.110 48	28.435	12 565	0.850 56	16.233	7 546	0.808 53	6.074	2 518	0.906 64
45.580	16 571	1.033 81	25.458	11 549	0.828 50	14.233	6 542	0.817 71	3.800	1 518	0.940 86
40.180	15 562	0.970 42	22.859	10 551	0.814 29	12.261	5 537	0.832 27	1.353	518	0.981 71
					$T = 350.00$ K						
69.156	18 130	1.310 78	38.917	13 499	0.990 68	22.752	8 871	0.881 34	11.077	4 229	0.900 08
61.236	17 210	1.222 71	34.980	12 579	0.955 59	20.228	7 930	0.876 55	8.801	3 301	0.916 19
54.438	16 287	1.148 57	31.453	11 650	0.927 73	17.857	7 005	0.875 99	6.454	2 370	0.935 79
48.458	15 342	1.085 38	28.285	10 720	0.906 69	15.571	6 083	0.879 62	4.034	1 446	0.958 66
43.405	14 430	1.033 64	25.426	9 801	0.891 47	13.325	5 157	0.887 91	1.476	5 12	0.990 63
					$T = 400.00$ K						
68.619	15 943	1.294 13	51.725	13 625	1.141 48	34.424	10 252	1.009 62	17.447	5 539	0.947 10
63.139	15 271	1.243 18	45.830	12 615	1.092 36	28.635	8 807	0.977 63	11.530	3 641	0.952 17
57.289	14 473	1.190 19	40.049	11 490	1.048 04	22.930	7 212	0.955 99	6.060	1 884	0.967 16

Table 1 (Continued)

p/MPa	ρ/mol·m⁻³	Z	p/MPa	ρ/mol·m⁻³	Z	p/MPa	ρ/mol·m⁻³	Z	p/MPa	ρ/mol·m⁻³	Z
					$x_A = 0.503\,65$, $M_r = 36.0700$						
					$T = 450.00$ K						
68.770	14 241	1.290 66	51.741	11 920	1.160 14	34.390	8 760	1.049 25	17.215	4 659	0.987 57
63.009	13 527	1.244 95	45.854	10 950	1.119 22	28.731	7 513	1.022 09	11.855	3 221	0.983 70
57.446	12 774	1.201 95	40.196	9 923	1.082 66	23.022	6 148	1.000 83	5.842	1 581	0.987 60
					$x_A = 0.711\,05$, $M_r = 39.3876$						
					$T = 225.00$ K						
68.765	26 795	1.371 82	52.872	26 038	1.085 43	37.012	25 081	0.788 82	26.429	24 251	0.5825 5
63.528	26 562	1.278 46	47.575	25 745	0.987 80	31.663	24 690	0.685 51	20.934	23 708	0.472 00
58.351	26 316	1.185 25	42.444	25 438	0.891 90						
					$T = 245.00$ K						
69.042	25 577	1.325 14	54.941	24 802	1.087 45	39.256	23 681	0.813 78	24.157	22 096	0.536 70
64.182	25 327	1.244 02	49.385	24 441	0.991 92	34.043	23 217	0.719 81	18.997	21 291	0.438 01
58.841	25 034	1.153 85	44.239	24 074	0.902 10	29.624	22 763	0.638 87			
					$T = 265.00$ K						
68.931	24 364	1.284 06	34.035	21 489	0.718 83	18.559	18 633	0.452 05	13.579	16 527	0.372 90
57.785	23 656	1.108 65	28.869	20 782	0.630 47	16.504	17 937	0.417 60	13.579	16 527	0.372 90
48.415	22 939	0.957 91	24.672	20 072	0.557 87	14.781	17 194	0.390 16			
40.590	22 223	0.828 96	21.376	19 375	0.500 73						
					$T = 275.00$ K						
68.988	23 767	1.269 50	32.303	20 349	0.694 28	17.915	16 944	0.462 42	13.428	14 346	0.409 37
56.724	22 918	1.082 49	27.197	19 483	0.610 52	16.008	16 059	0.435 96	12.490	13 475	0.405 38
46.572	22 047	0.923 86	23.293	18 633	0.546 73	14.525	15 175	0.418 62	12.490	13 475	0.405 38
38.614	21 195	0.796 79	20.170	17 758	0.496 76						
					$T = 285.00$ K						
69.080	23 187	1.257 27	21.011	16 709	0.530 66	11.337	9 846	0.485 91	7.189	4 491	0.675 53
55.607	22 172	1.058 39	17.501	15 193	0.486 12	10.346	8 477	0.515 05	5.658	3 158	0.756 09
44.919	21 141	0.896 65	15.302	13 835	0.466 76	9.405	7 147	0.555 34	3.656	1 813	0.851 00
35.358	19 920	0.749 06	13.685	12 503	0.461 90	8.387	5 810	0.609 19	1.088	480	0.956 55
26.656	18 313	0.614 26	12.389	11 145	0.469 11						
					$T = 300.00$ K						
69.024	22 289	1.241 52	26.095	16 536	0.632 66	14.704	10 785	0.546 59	8.735	5 069	0.690 85
55.166	21 140	1.046 19	22.632	15 389	0.589 60	13.465	9 665	0.558 53	7.292	3 920	0.745 77
44.719	19 993	0.896 72	19.974	14 258	0.561 63	12.271	8 495	0.579 11	5.602	2 776	0.809 03
36.720	18 843	0.781 26	17.845	13 091	0.546 50	11.181	7 382	0.607 23	3.567	1 620	0.882 74
30.675	17 686	0.695 34	16.111	11 921	0.541 82	9.989	6 207	0.645 18	1.147	475	0.968 08
					$T = 320.00$ K						
68.951	21 146	1.225 54	29.742	15 577	0.717 63	16.988	10 025	0.636 90	9.068	4 460	0.764 17
56.959	20 044	1.068 05	26.138	14 465	0.679 15	15.338	8 906	0.647 29	7.231	3 343	0.812 97
47.500	18 927	0.943 25	23.221	13 356	0.653 46	13.797	7 791	0.665 59	5.144	2 228	0.867 76
40.063	17 804	0.845 75	20.797	12 248	0.638 19	12.287	6 684	0.690 91	2.761	1 113	0.932 37
34.288	16 696	0.771 87	18.747	11 132	0.632 96	10.719	5 567	0.723 68	1.224	472	0.974 66
					$T = 350.00$ K						
69.088	19 557	1.213 94	35.089	14 540	0.829 28	20.562	9 524	0.741 90	10.712	4 501	0.817 82
59.363	18 546	1.099 92	31.309	13 540	0.794 60	18.453	8 497	0.746 27	8.374	3 369	0.854 14
51.469	17 546	1.008 01	28.076	12 538	0.769 49	16.502	7 500	0.756 09	6.421	2 490	0.886 14
45.039	16 558	0.934 71	25.267	11 530	0.753 05	14.597	6 506	0.770 99	3.980	1 474	0.927 86
39.580	15 541	0.875 17	22.802	10 530	0.744 12	12.664	5 498	0.791 52	1.333	469	0.976 68
					$T = 400.00$ K						
68.723	17 122	1.206 85	51.834	14 909	1.045 37	34.480	11 432	0.906 88	17.097	5 912	0.869 54
63.024	16 465	1.150 93	45.987	13 915	0.993 70	28.678	9 833	0.876 94	11.537	3 866	0.897 30
57.544	15 751	1.098 49	40.123	12 749	0.946 29	22.998	8 013	0.862 98	5.890	1 881	0.941 52
					$T = 450.00$ K						
68.603	15 125	1.212 27	51.741	12 816	1.079 03	34.452	9 485	0.970 80	17.260	4 939	0.934 02
62.976	14 436	1.165 95	45.928	11 827	1.037 90	28.755	8 106	0.948 11	11.587	3 275	0.945 61
57.406	13 678	1.121 73	40.166	10 720	1.001 42	23.164	6 621	0.935 07	5.867	1 622	0.966 76
					$x_A = 0.909\,21$, $M_r = 42.5575$						
					$T = 225.00$ K						
68.831	28 071	1.310 72	49.927	27 446	0.972 39	34.971	26 858	0.696 01	23.482	26 326	0.476 80
63.930	27 922	1.223 88	44.731	27 252	0.877 39	30.735	26 672	0.615 97	15.997	25 923	0.329 86
59.307	27 772	1.141 51	40.095	27 071	0.791 71	25.841	26 445	0.522 33	11.238	25 636	0.234 33
54.341	27 605	1.052 26									
					$T = 245.00$ K						
68.926	26 926	1.256 64	52.013	26 268	0.972 04	34.971	25 446	0.674 66	17.497	24 311	0.353 31
63.374	26 722	1.164 24	46.110	26 007	0.870 37	29.357	25 125	0.573 59	11.846	23 827	0.244 06
57.687	26 505	1.068 44	40.397	25 728	0.770 80	23.315	24 738	0.462 67			
					$T = 265.00$ K						
68.251	25 744	1.203 24	41.002	24 360	0.763 92	22.907	22 978	0.452 45	13.391	21 862	0.278 00
61.833	25 466	1.101 99	36.809	24 091	0.693 45	20.145	22 696	0.402 84	11.756	21 611	0.246 89
56.018	25 189	1.009 34	32.721	23 801	0.623 95	17.673	22 420	0.357 76	9.953	21 301	0.212 07
50.756	24 919	0.924 43	29.107	23 523	0.561 60	15.450	22 147	0.316 62	8.547	21 030	0.184 46
45.612	24 633	0.840 39	25.874	23 250	0.505 08						

Table 1 (Continued)

p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z	p/MPa	ρ/mol·m^{-3}	Z
					$x_A = 0.909\ 21$, $M_r = 42.5575$						
					$T = 285.00$ K						
69.019	24 622	1.182 95	32.843	22 197	0.624 41	18.648	20 368	0.386 37	11.374	18 528	0.259 06
57.355	24 004	1.008 34	27.142	21 590	0.530 53	15.654	19 763	0.334 27	10.034	17 939	0.236 05
47.721	23 398	0.860 70	22.447	20 981	0.451 49	13.219	19 144	0.291 40	9.013	17 344	0.219 30
39.762	22 807	0.735 73									
					$T = 300.00$ K						
69.020	23 782	1.163 51	19.704	18 760	0.421 08	9.037	10 155	0.356 77	6.831	4 538	0.603 48
55.550	22 961	0.969 92	14.523	17 058	0.341 33	8.608	8 614	0.400 63	5.587	3 189	0.702 37
43.810	22 057	0.796 29	11.758	15 317	0.307 75	8.212	7 276	0.452 48	3.708	1 815	0.819 04
34.664	21 157	0.656 85	10.406	13 659	0.305 43	7.677	5 940	0.518 14	1.031	433	0.954 58
26.591	20 089	0.530 66	9.571	11 836	0.324 19						
					$T = 320.00$ K						
69.065	22 654	1.145 85	19.987	16 109	0.466 33	11.919	9 576	0.467 81	7.881	4 417	0.670 61
55.533	21 695	0.962 07	17.288	14 842	0.437 79	11.058	8 274	0.502 31	6.126	3 043	0.756 64
41.924	20 402	0.772 33	15.306	13 493	0.426 35	10.159	6 975	0.547 42	3.955	1 746	0.851 37
31.439	18 961	0.623 19	13.907	12 176	0.429 28	9.113	5 667	0.604 40	1.111	435	0.959 93
24.524	17 533	0.525 71	12.841	10 884	0.443 43						
					$T = 350.00$ K						
69.093	21 003	1.130 45	29.105	15 591	0.641 49	17.249	10 177	0.582 43	10.053	4 773	0.723 77
56.576	19 928	0.975 59	25.639	14 510	0.607 20	15.798	9 097	0.596 76	8.306	3 688	0.773 92
46.868	18 849	0.854 45	22.896	13 418	0.586 37	14.396	8 003	0.618 14	6.290	2 598	0.831 97
39.302	17 754	0.760 70	20.684	12 336	0.576 18	13.019	6 914	0.647 06	3.957	1 517	0.896 35
33.571	16 677	0.691 74	18.865	11 265	0.575 47	11.601	5 849	0.681 57	1.220	434	0.965 98
					$T = 400.00$ K						
68.626	18 399	1.121 50	51.935	16 437	0.950 04	34.588	13 100	0.793 89	17.344	6 764	0.770 99
63.073	17 828	1.063 77	45.955	15 496	0.891 70	28.277	11 221	0.757 72	11.728	4 263	0.827 21
57.472	17 176	1.006 10	40.612	14 494	0.842 50	23.033	9 253	0.748 47	6.627	2 218	0.898 38
					$T = 450.00$ K						
68.731	16 183	1.135 13	51.720	13 928	0.992 48	34.466	10 455	0.881 09	17.241	5 291	0.870 92
62.897	15 502	1.084 41	45.919	12 928	0.949 32	28.330	8 796	0.860 82	11.920	3 542	0.899 46
57.367	14 773	1.037 88	40.171	11 781	0.911 35	22.817	7 111	0.857 59	5.856	1 654	0.946 28

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