Calculated values were also compared with the reviews of van Arsdell (*9*), Sherwood (*3, 16*), and Plummer (*12*). Comparison was made over the experimental range employed to obtain the present correlation and also over the entire range of conditions given by each of the listed reviews.

The comparison with the values given by van Arsdell in the International Critical Tables was superior to all other comparisons. The comparison over the experimental range had a relative error of ±3.5 %, and over the entire set of data a relative error of ±5.4 %. Similar comparisons with the data of Sherwood resulted in ±6.4 % and ±11.7 %. Plummer's correlation could be compared only in the region of experimental overlap, in which case the relative error was ±4.7 %.

In the region of very high dilution the correlation checks well (±5.0 % mean error) with the data of Johnstone and Leppla (*10*), which appears to be the only available data in the very low concentration range. Literature data available for high temperatures (*2, 7, 9*) are extremely erratic; values calculated from this correlation fall near the recommended values of van Arsdell (*9*).

NOMENCLATURE

a = activity
g = gaseous state
H = Henry's law constant
K = equilibrium constant
l = liquid state
m = molality of dissolved SO_2
P = pressure
$\gamma_{\pm}$ = mean molar activity coefficient

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Equations of State and Compressibilities for Gaseous Carbon Dioxide in the Range 0° to 600°C. and 0 to 150 Atm.

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Three volume-explicit equations of state are reported that fit the compressibility data of gaseous CO_2 with an average deviation of 0.09% and a maximum of 0.5% over the range 0° to 600° C. and 0 to 150 atm. The three equations were generated from the experimental data of Michels and Michels, MacCormack and Schneider, and Kennedy by a least squares program using an IBM650 digital computer. A table of compressibilities for CO_2 is presented.

COMPRESSIBILITY DATA for gaseous CO_2 were first obtained by the classic experiments of Andrews (*2*) in 1876, followed by the higher pressure work of Amagat (*1*) in 1892 and Keesom (*8*) in 1903. For an account of subsequent work on the P-V-T behavior of CO_2 up to 1959 the summary of Liley (*10*) should be consulted. The most extensive and accurate P-V-T measurements for CO_2 are those of Michels and coworkers (*13, 14, 16*) covering the range 0 to 150° C. and 16 to 3000 atm. and the data of MacCormack and Schneider (*11*) for the lower pressure region below 50 atm. and the temperature range 0° to 600° C. both sets of data having a precision of 0.01%. The more recent data of Kennedy (*9*) with a precision of 0.2% cover the range 0° to 1000° C. and 25 to 1470 atm. However, the data finally tabulated by Kennedy can differ from the experimental values by as much as 0.4% or 0.002 gram/cc., whichever is the greater.

With respect to equations of state for CO_2, Beattie and Bridgeman (*4*) have obtained a pressure-explicit equation up to the third power in $1/V$, based on the data of Andrews (*2*). Beattie (*3*) subsequently inverted this equation to obtain a volume-explicit form of lower accuracy. A pressure-explicit equation up to the eighth power in $1/V$, but omitting the fifth and sixth powers, has been presented by Michels and Michels (*15*) that represents their data along specific isotherms within 0.3% for pressures up to 3000 atm. MacCormack and Schneider (*11*) represent their data by a fourth power volume-explicit equation of state in which the second virial coefficient could be predicted within 3% and the experimental data within 0.02% along specific isotherms in the range 0° to 600° C. Houghton, McLean, and Ritchie (*7*) report a third power volume-explicit equation for the range 0° to 100° C. and 0 to 36 atm. that fits the data of Michels and Michels (*14*) with an average deviation of 0.17% (maximum 0.35%) and the data of Andrews (*2*) corrected for the compressibility of air with an average deviation of 0.38% (maximum 0.53%).

Houghton *et al.* (*7*) pointed out that more empirical constants are required for volume-explicit equations than for pressure-explicit equations to attain the same accuracy over a particular region of pressure and temperature. However volume-explicit equations are generally more useful than pressure-explicit equations for determining the effect of pressure on thermodynamic quantities such as enthalpy, entropy, and free energy. The work of Maron and Turnbull (*12*) indicates that in order for a volume-explicit equation to be useful in computing thermodynamic properties it must predict P-V-T data with an accuracy of better than 0.5%. Thus the purpose of the present work was to represent the combined data of Michels and Michels (*14*), MacMormack and Schneider (*11*), and Kennedy (*9*) by volume-explicit equations of state in the range 0° to 600° C. and 0 to 150 atm. with an accuracy of better than 0.5%. In this connection, a comparison of the three sets of data (*9, 11, 14*) in the region of overlap has shown that the largest error is 0.4%. In order to maintain the prescribed accuracy within 0.5% it was found necessary to use three separate equations of state, each operative over a certain temperature and pressure range; the reason for this is undoubtedly that the critical temperature (30.9° C.) and pressure (72.9 atm.) occur in the region covered by the equations.

EQUATIONS OF STATE

The volume-explicit of state used in the present work was of the general type

$$PV = \sum_{i=1}^{n} B_i P^{i-1} \tag{1}$$

The virial coefficients, B_i, in Equation 1 are solely a function of temperature:

$$B_i = \sum_{j=-p}^{m} b_j T^j \qquad m,p = \text{integers or zero} \tag{2}$$

Since the P-V-T data (*9, 11, 14*) were available in the form of isotherms, Equation 1 was programmed for an IBM650 digital computer to evaluate the virial coefficients, B_i, at each temperature by the method of least squares. The B_i were then plotted as a function of temperature and fitted to an equation of type 2. The powers i and j of the pressure and temperature, respectively, in Equations 1 and 2 were chosen to give a fit of better than 0.5%. To obtain the best correlation, it was necessary to sometimes use negative powers of T and sometimes positive powers in Equation 2, according to the nature of the temperature dependence of the particular B_i under consideration.

When applying Equations 1 and 2 to the data of Michels and Michels (*14*) and Kennedy (*9*), the second virial coefficients, B_2, thus obtained agreed remarkably well with those of MacCormack and Schneider (*11*) for pressures below 50 atm. Consequently, the second virial coefficients of MacCormack and Schneider have been used throughout the present work to ensure that the equations of state would also be accurate below 16 atm., where all the coefficients above the second gave negligibly small terms in Equation 1. The use of MacCormack and Schneider's second virial coefficients is unlikely to introduce much error into the P-V-T calculations but may lead to some error in the computation of thermodynamic properties which depend upon dB/dT. Since $B_1 = RT$ and the B_2 are taken from the data of MacCormack and Schneider, Equation 1 may be rearranged as follows:

$$\frac{PV - RT - B_2P}{P^2} = \sum_{i=3}^{n} B_i P^{i-3} \tag{3}$$

The method of least squares was then applied, using Equation 3, and the data of Michels and Michels (*14*) starting at 16 atm. or the data of Kennedy (*9*) beginning at 25 atm. to obtain the higher virial coefficients, B_3, B_4 and so on. Three separate equations of state, designated I, II, and III, were required to cover the temperature range 0° to 600° C. and the pressure range 0° to 150 atm. Because of the proximity of the two-phase region and the large curvature of the isotherms, the ranges over which the low temperature Equations I and II may be applied are restricted to the shaded areas in Figure 1. The equations of the lines AB and BC defining these areas are given below:

$$\text{AB: } P = \tfrac{5}{9}\,T - 120 \tag{4}$$

$$\text{BC: } P = T - 273 \tag{5}$$

The point of intersection, B, occurs at 71 atm. and 344° K. Equation III applies without restriction in the range 150° to 600° C. and 0 to 150 atm. The three equations of state and their coefficients B_i and b_j are summarized below:

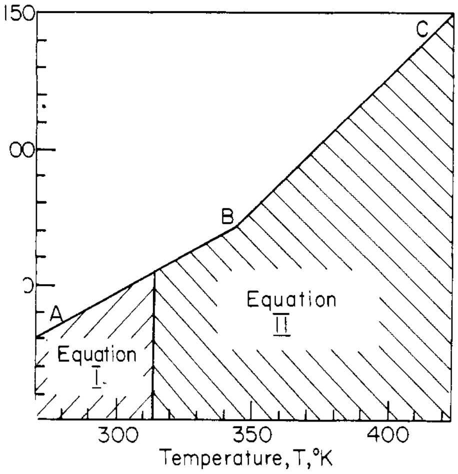

Figure 1. Regions of pressure and temperature for the application of equations of state I and II

Equation of State I. 0° to 40° C. (Figure 1 and Equation 4 give the pressure range).

$$PV = B_1 + B_2P + B_3P^2 + B_4P^3 + B_5P^4 + B_6P^5$$

$$B_1 = 0.082057T$$

$$B_2 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = 6.4598581 \times 10^{-2}$
$b_{-1} = -3.394785 \times 10^{1}$
$b_{-2} = -9.6373577 \times 10^{3}$
$b_{-3} = 2.3793882 \times 10^{6}$
$b_{-4} = -2.9294047 \times 10^{8}$
$b_{-5} = -4.8297663 \times 10^{10}$

$$B_3 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = 8.4227950 \times 10^{-4}$
$b_{-1} = -3.9977877 \times 10^{-1}$
$b_{-2} = -6.4659619 \times 10^{1}$
$b_{-3} = 3.3303766 \times 10^{4}$
$b_{-4} = 9.8116200 \times 10^{4}$
$b_{-5} = -7.8247914 \times 10^{8}$

Table I. Compressibility Factors for CO_2, $Z = PV/RT$

Temp., °C.	Atmosphere									
	0.5	1.0	1.5	2.0	5.0	10	20	30	40	50
0	0.9965	0.9930	0.9895	0.9860	0.9646	0.9280	0.8474	0.7483		
10	0.9969	0.9938	0.9907	0.9876	0.9689	0.9367	0.8671	0.7850		
20	0.9973	0.9945	0.9918	0.9891	0.9725	0.9441	0.8835	0.8149	0.7329	
30	0.9976	0.9951	0.9927	0.9903	0.9755	0.9503	0.8974	0.8393	0.7736	
40	0.9978	0.9957	0.9935	0.9913	0.9781	0.9557	0.9088	0.8585	0.8033	0.7414
50	0.9981	0.9961	0.9942	0.9922	0.9804	0.9603	0.9187	0.8747	0.8277	0.7767
60	0.9983	0.9965	0.9948	0.9930	0.9824	0.9643	0.9271	0.8883	0.8475	0.8045
70	0.9984	0.9968	0.9953	0.9937	0.9841	0.9679	0.9345	0.8999	0.8641	0.8271
80	0.9986	0.9972	0.9957	0.9943	0.9856	0.9710	0.9409	0.9100	0.8783	0.8459
90	0.9987	0.9974	0.9961	0.9948	0.9870	0.9737	0.9466	0.9188	0.8906	0.8620
100	0.9988	0.9977	0.9965	0.9953	0.9882	0.9762	0.9516	0.9266	0.9014	0.8760
10	0.9989	0.9979	0.9968	0.9957	0.9893	0.9784	0.9562	0.9336	0.9110	0.8883
20	0.9990	0.9981	0.9971	0.9961	0.9902	0.9803	0.9602	0.9398	0.9194	0.8991
30	0.9991	0.9982	0.9974	0.9965	0.9911	0.9821	0.9639	0.9454	0.9270	0.9087
40	0.9992	0.9984	0.9976	0.9968	0.9919	0.9837	0.9671	0.9504	0.9338	0.9173
50	0.9993	0.9985	0.9978	0.9971	0.9926	0.9852	0.9701	0.9550	0.9400	0.9251
60	0.9993	0.9987	0.9980	0.9974	0.9934	0.9867	0.9732	0.9597	0.9462	0.9329
70	0.9994	0.9988	0.9982	0.9976	0.9940	0.9880	0.9758	0.9636	0.9515	0.9395
80	0.9995	0.9989	0.9984	0.9978	0.9946	0.9891	0.9782	0.9672	0.9562	0.9454
90	0.9995	0.9990	0.9985	0.9981	0.9951	0.9902	0.9803	0.9704	0.9605	0.9507
200	0.9996	0.9991	0.9987	0.9982	0.9956	0.9912	0.9822	0.9733	0.9644	0.9556
10	0.9996	0.9992	0.9988	0.9984	0.9960	0.9920	0.9840	0.9759	0.9679	0.9599
20	0.9996	0.9993	0.9989	0.9986	0.9964	0.9928	0.9856	0.9783	0.9711	0.9639
30	0.9997	0.9994	0.9990	0.9987	0.9968	0.9935	0.9870	0.9805	0.9739	0.9675
40	0.9997	0.9994	0.9991	0.9988	0.9971	0.9942	0.9883	0.9824	0.9766	0.9708
50	0.9997	0.9995	0.9992	0.9990	0.9974	0.9948	0.9895	0.9842	0.9790	0.9738
60	0.9998	0.9995	0.9993	0.9991	0.9977	0.9953	0.9906	0.9859	0.9812	0.9765
70	0.9998	0.9996	0.9994	0.9992	0.9979	0.9958	0.9916	0.9874	0.9832	0.9790
80	0.9998	0.9996	0.9994	0.9993	0.9981	0.9963	0.9925	0.9888	0.9850	0.9813
90	0.9998	0.9997	0.9995	0.9993	0.9984	0.9967	0.9934	0.9901	0.9867	0.9834
300	0.9999	0.9997	0.9996	0.9994	0.9986	0.9971	0.9942	0.9912	0.9883	0.9854
10	0.9999	0.9997	0.9996	0.9995	0.9987	0.9975	0.9949	0.9923	0.9897	0.9872
20	0.9999	0.9998	0.9997	0.9996	0.9989	0.9978	0.9956	0.9933	0.9910	0.9888
30	0.9999	0.9998	0.9997	0.9996	0.9990	0.9981	0.9962	0.9942	0.9923	0.9904
40	0.9999	0.9998	0.9998	0.9997	0.9992	0.9984	0.9967	0.9951	0.9934	0.9918
50	0.9999	0.9999	0.9998	0.9997	0.9993	0.9986	0.9973	0.9959	0.9945	0.9931
60	0.9999	0.9999	0.9998	0.9998	0.9994	0.9989	0.9977	0.9966	0.9955	0.9943
70	1.0000	0.9999	0.9999	0.9998	0.9996	0.9991	0.9982	0.9973	0.9964	0.9955
80	1.0000	0.9999	0.9999	0.9999	0.9997	0.9993	0.9986	0.9979	0.9972	0.9965
90	1.0000	1.0000	0.9999	0.9999	0.9998	0.9995	0.9990	0.9985	0.9980	0.9975
400	1.0000	1.0000	1.0000	0.9999	0.9998	0.9997	0.9994	0.9991	0.9987	0.9984
10	1.0000	1.0000	1.0000	1.0000	0.9999	0.9999	0.9997	0.9996	0.9994	0.9993
20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0001	1.0001	1.0001
30	1.0000	1.0000	1.0000	1.0000	1.0000	1.0002	1.0003	1.0005	1.0007	1.0008
40	1.0000	1.0000	1.0000	1.0000	1.0001	1.0003	1.0006	1.0009	1.0012	1.0015
50	1.0000	1.0000	1.0001	1.0001	1.0002	1.0004	1.0009	1.0013	1.0017	1.0022
60	1.0000	1.0001	1.0001	1.0001	1.0003	1.0006	1.0011	1.0017	1.0022	1.0028
70	1.0000	1.0001	1.0001	1.0001	1.0003	1.0007	1.0013	1.0020	1.0027	1.0034
80	1.0000	1.0001	1.0001	1.0002	1.0004	1.0008	1.0016	1.0023	1.0031	1.0039
90	1.0000	1.0001	1.0001	1.0002	1.0004	1.0009	1.0018	1.0026	1.0035	1.0044
500	1.0000	1.0001	1.0001	1.0002	1.0005	1.0010	1.0019	1.0029	1.0039	1.0049
10	1.0001	1.0001	1.0002	1.0002	1.0005	1.0011	1.0021	1.0032	1.0042	1.0053
20	1.0001	1.0001	1.0002	1.0002	1.0006	1.0011	1.0023	1.0034	1.0046	1.0057
30	1.0001	1.0001	1.0002	1.0002	1.0006	1.0012	1.0024	1.0037	1.0049	1.0061
40	1.0001	1.0001	1.0002	1.0003	1.0006	1.0013	1.0026	1.0039	1.0052	1.0065
50	1.0001	1.0001	1.0002	1.0003	1.0007	1.0014	1.0027	1.0041	1.0054	1.0068
60	1.0001	1.0001	1.0002	1.0003	1.0007	1.0014	1.0029	1.0043	1.0057	1.0071
70	1.0001	1.0001	1.0002	1.0003	1.0007	1.0015	1.0030	1.0045	1.0059	1.0074
80	1.0001	1.0002	1.0002	1.0003	1.0008	1.0015	1.0031	1.0046	1.0062	1.0077
90	1.0001	1.0002	1.0002	1.0003	1.0008	1.0016	1.0032	1.0048	1.0064	1.0080
600	1.0001	1.0002	1.0002	1.0003	1.0008	1.0016	1.0033	1.0049	1.0066	1.0083

Table I. Compressibility Factors for CO_2, $Z = PV/RT$

Temp., ° C.	Atmosphere									
	60	70	80	90	100	110	120	130	140	150
0										
10										
20										
30					(Out of Range of Equations)					
40										
50	0.7205									
60	0.7586	0.7090								
70	0.7886	0.7484	0.7063							
80	0.8129	0.7794	0.7453							
90	0.8332	0.8044	0.7756	0.7471						
100	0.8507	0.8255	0.8006	0.7761						
10	0.8658	0.8436	0.8217	0.8002						
20	0.8790	0.8592	0.8398	0.8208						
30	0.8907	0.8731	0.8558	0.8390	0.8227					
40	0.9011	0.8853	0.8699	0.8551	0.8408	0.8272				
50	0.9105	0.8963	0.8825	0.8692	0.8563	0.8439	0.8321			
60	0.9119	0.9071	0.8948	0.8829	0.8715	0.8606	0.8503	0.8406	0.8316	0.8233
70	0.9277	0.9162	0.9050	0.8942	0.8839	0.8740	0.8646	0.8558	0.8476	0.8400
80	0.9348	0.9244	0.9142	0.9045	0.8951	0.8861	0.8777	0.8697	0.8622	0.8553
90	0.9411	0.9317	0.9226	0.9137	0.9053	0.8972	0.8895	0.8823	0.8756	0.8693
200	0.9469	0.9384	0.9301	0.9221	0.9145	0.9072	0.9003	0.8938	0.8878	0.8822
10	0.9521	0.9444	0.9370	0.9298	0.9229	0.9163	0.9101	0.9043	0.8989	0.8940
20	0.9568	0.9499	0.9432	0.9367	0.9305	0.9246	0.9191	0.9139	0.9091	0.9047
30	0.9611	0.9549	0.9489	0.9430	0.9375	0.9322	0.9273	0.9226	0.9184	0.9146
40	0.9650	0.9595	0.9540	0.9488	0.9438	0.9391	0.9347	0.9306	0.9269	0.9236
50	0.9686	0.9636	0.9588	0.9541	0.9496	0.9455	0.9416	0.9380	0.9347	0.9318
60	0.9719	0.9674	0.9631	0.9589	0.9550	0.9513	0.9478	0.9447	0.9418	0.9393
70	0.9749	0.9709	0.9670	0.9633	0.9598	0.9566	0.9535	0.9508	0.9484	0.9462
80	0.9777	0.9741	0.9707	0.9674	0.9643	0.9614	0.9588	0.9564	0.9544	0.9526
90	0.9802	0.9771	0.9740	0.9711	0.9684	0.9659	0.9637	0.9616	0.9599	0.9584
300	0.9825	0.9798	0.9771	0.9746	0.9722	0.9701	0.9681	0.9664	0.9649	0.9637
10	0.9847	0.9823	0.9799	0.9778	0.9757	0.9739	0.9722	0.9708	0.9696	0.9686
20	0.9867	0.9846	0.9826	0.9807	0.9789	0.9774	0.9760	0.9748	0.9739	0.9732
30	0.9885	0.9867	0.9850	0.9834	0.9819	0.9806	0.9795	0.9785	0.9778	0.9773
40	0.9902	0.9887	0.9872	0.9859	0.9847	0.9836	0.9827	0.9820	0.9815	0.9812
50	0.9918	0.9905	0.9893	0.9882	0.9872	0.9864	0.9857	0.9852	0.9849	0.9847
60	0.9933	0.9922	0.9913	0.9904	0.9896	0.9890	0.9885	0.9881	0.9880	0.9880
70	0.9946	0.9938	0.9930	0.9924	0.9918	0.9914	0.9910	0.9909	0.9909	0.9910
80	0.9959	0.9953	0.9947	0.9942	0.9938	0.9936	0.9934	0.9934	0.9936	0.9939
90	0.9971	0.9966	0.9963	0.9960	0.9957	0.9956	0.9956	0.9958	0.9960	0.9965
400	0.9982	0.9979	0.9977	0.9976	0.9975	0.9975	0.9977	0.9980	0.9983	0.9989
10	0.9992	0.9991	0.9991	0.9991	0.9992	0.9993	0.9996	1.0000	1.0005	1.0011
20	1.0001	1.0002	1.0003	1.0005	1.0007	1.0010	1.0014	1.0019	1.0025	1.0032
30	1.0010	1.0012	1.0015	1.0018	1.0021	1.0025	1.0031	1.0037	1.0044	1.0052
40	1.0019	1.0022	1.0026	1.0030	1.0035	1.0040	1.0046	1.0053	1.0061	1.0070
50	1.0026	1.0031	1.0036	1.0041	1.0047	1.0054	1.0061	1.0068	1.0077	1.0087
60	1.0034	1.0039	1.0046	1.0052	1.0059	1.0066	1.0074	1.0083	1.0092	1.0103
70	1.0040	1.0047	1.0055	1.0062	1.0070	1.0078	1.0087	1.0096	1.0106	1.0117
80	1.0047	1.0055	1.0063	1.0071	1.0080	1.0089	1.0099	1.0109	1.0120	1.0131
90	1.0053	1.0062	1.0071	1.0080	1.0090	1.0099	1.0110	1.0121	1.0132	1.0144
500	1.0058	1.0068	1.0078	1.0088	1.0099	1.0109	1.0120	1.0132	1.0144	1.0156
10	1.0064	1.0074	1.0085	1.0095	1.0107	1.0118	1.0130	1.0142	1.0154	1.0167
20	1.0069	1.0080	1.0092	1.0103	1.0115	1.0127	1.0139	1.0152	1.0165	1.0178
30	1.0073	1.0085	1.0098	1.0110	1.0122	1.0135	1.0148	1.0161	1.0174	1.0188
40	1.0078	1.0090	1.0103	1.0116	1.0129	1.0142	1.0156	1.0169	1.0183	1.0197
50	1.0082	1.0095	1.0109	1.0122	1.0136	1.0150	1.0163	1.0177	1.0192	1.0206
60	1.0085	1.0100	1.0114	1.0128	1.0142	1.0156	1.0171	1.0185	1.0200	1.0214
70	1.0089	1.0104	1.0118	1.0133	1.0148	1.0162	1.0177	1.0192	1.0207	1.0222
80	1.0092	1.0108	1.0123	1.0138	1.0153	1.0168	1.0184	1.0199	1.0214	1.0229
90	1.0096	1.0111	1.0127	1.0143	1.0158	1.0174	1.0189	1.0205	1.0221	1.0236
600	1.0099	1.0115	1.0131	1.0147	1.0163	1.0179	1.0195	1.0211	1.0227	1.0243

$$B_4 = b_0 + b_1T + b_2T^2$$

$b_0 = -1.657976 \times 10^{-4}$
$b_1 = 8.214250 \times 10^{-7}$
$b_2 = -9.375000 \times 10^{-10}$

$$B_5 = b_0 + b_1T + b_2T^2 + b_3T^3$$

$b_0 = -5.240453 \times 10^{-5}$
$b_1 = 4.674400 \times 10^{-7}$
$b_2 = -1.387687 \times 10^{-9}$
$b_3 = 1.3700 \times 10^{-12}$

$$B_6 = b_0 + b_1T + b_2T^2$$

$b_0 = -1.201731 \times 10^{-7}$
$b_1 = 7.68906 \times 10^{-10}$
$b_2 = -1.23125 \times 10^{-12}$

Equation of State II. 40° to 150° C. (Figure 1 and Equation 5 give the pressure range).

$$PV = B_1 + B_2P + B_3P^2 + B_4P^3 + B_5P^4 + B_6P^5$$

The virial coefficients B_1, B_2, and B_3 have the same form and values as those for equation of state I above.

$$B_4 = b_0 + b_1T + b_2T^2 + b_3T^3 + b_4T^4 + b_5T^5$$

$b_0 = -1.4111026 \times 10^{-2}$
$b_1 = 1.8709231 \times 10^{-4}$
$b_2 = -9.9258512 \times 10^{-7}$
$b_3 = 2.6331440 \times 10^{-9}$
$b_4 = -3.4913895 \times 10^{-12}$
$b_5 = 1.8503660 \times 10^{-15}$

$$B_5 = b_0 + b_1T + b_2T^2 + b_3T^3 + b_4T^4 + b_5T^5$$

$b_0 = -2.2824555 \times 10^{-7}$
$b_1 = -5.2077904 \times 10^{-8}$
$b_2 = 5.5480728 \times 10^{-10}$
$b_3 = -2.1772413 \times 10^{-12}$
$b_4 = 3.7794516 \times 10^{-15}$
$b_5 = -2.4538740 \times 10^{-18}$

$$B_6 = b_0 + b_1T + b_2T^2 + b_3T^3 + b_4T^4 + b_5T^5$$

$b_0 = 7.8063824 \times 10^{-7}$
$b_1 = -1.1006038 \times 10^{-8}$
$b_2 = 6.1509777 \times 10^{-11}$
$b_3 = -1.7049307 \times 10^{-13}$
$b_4 = 2.3457316 \times 10^{-16}$
$b_5 = -1.2825109 \times 10^{-19}$

Equation of State III. 150° to 600° C., 0 to 150 atm.

$$PV = B_1 + B_2P + B_3P^2 + B_4P^3 + B_5P^4 + B_6P^5 + B_7P^6$$

$$B_1 = 0.082057T$$

$$B_2 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = 7.3641555 \times 10^{-2}$
$b_{-2} = 2.2443652 \times 10^{4}$
$b_{-3} = 7.5607800 \times 10^{6}$
$b_{-1} = -7.8372475 \times 10^{1}$
$b_{-4} = -9.4684660 \times 10^{9}$
$b_{-5} = 1.7821618 \times 10^{12}$

$$B_3 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = -1.1087965 \times 10^{-3}$
$b_{-1} = 2.2167611 \times 10^{0}$
$b_{-2} = -1.1969351 \times 10^{3}$
$b_{-3} = -1.9133310 \times 10^{5}$
$b_{-4} = 3.2743621 \times 10^{8}$
$b_{-5} = -7.0705952 \times 10^{10}$

$$B_4 = b_0 + \frac{B_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = 1.6110653 \times 10^{-5}$
$b_{-1} = -3.2105095 \times 10^{-2}$
$b_{-2} = 1.7303868 \times 10^{1}$
$b_{-3} = 2.7904000 \times 10^{3}$
$b_{-4} = -4.7986870 \times 10^{6}$
$b_{-5} = 1.0480875 \times 10^{9}$

$$B_5 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = -9.2186047 \times 10^{-8}$
$b_{-1} = 1.7655017 \times 10^{-4}$
$b_{-2} = -8.9437690 \times 10^{-2}$
$b_{-3} = -1.9257100 \times 10^{1}$
$b_{-4} = 2.7602920 \times 10^{4}$
$b_{-5} = -5.9333483 \times 10^{6}$

$$B_6 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = 2.0716949 \times 10^{-10}$
$b_{-1} = -3.8872617 \times 10^{-7}$
$b_{-2} = 1.9155485 \times 10^{-4}$
$b_{-3} = 4.6683500 \times 10^{-2}$
$b_{-4} = -6.3014390 \times 10^{1}$
$b_{-5} = 1.3589287 \times 10^{4}$

$$B_7 = b_0 + \frac{b_{-1}}{T} + \frac{b_{-2}}{T^2} + \frac{b_{-3}}{T^3} + \frac{b_{-4}}{T^4} + \frac{b_{-5}}{T^5}$$

$b_0 = -9.0747550 \times 10^{-15}$
$b_{-1} = -4.8267620 \times 10^{-12}$
$b_{-2} = 1.6035883 \times 10^{-8}$
$b_{-3} = -6.6461430 \times 10^{-6}$
$b_{-4} = 2.0298222 \times 10^{-3}$
$b_{-5} = -6.6962162 \times 10^{-1}$

Since the experimental data of Michels and Michels (*14*) are restricted to the temperature range 0° to 150° C., the coefficients B_i and b_j in Equations of state I and II were evaluated solely from the data of Kennedy (*9*) in the range 100° to 600° C. The continuity of Equations II and III in the overlapping temperature range of 100° to 150° C. was within the prescribed accuracy of 0.5%. Equation of state I has 22 empirical constants, Equation II has 30, whereas Equation III has 36 constants. Finally, the three equations have been found to fit the reported *P-V-T* data of Michels and Michels (*14*), MacCormack and Schneider (*11*) and Kennedy (*9*) with an average deviation of 0.09% and a maximum of 0.5%. A program was also written for the IBM650 digital computer which was used to calculate the compressibilities, *PV/RT*, from Equations I, II, and III. The results are given in Table I. Comparison of these results with the *PV* data of Price (*7*), who smoothed and tabulated the Kennedy data, and also with the *PV/RT* values of Houghton *et al.* (*7*), who developed a low pressure (1 to 36 atm.) equation of state from the Michels and Michels data, shows, agreement within the errors quoted above for the present Equations of state I, II, and III. Similarly, a comparison of the compressibilities of Table I with the tabulations of *V* by Newitt, Pai, Kuloor, and Huggill (Din (*5*)) shows an average deviation of 0.07% and a maximum of 0.55%, while the tabulation of *PV/RT* by Hilsenrath (*6*) yields an average deviation of 0.12%, the maximum being 0.52%.

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