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GENERALIZED TABLES OF CORRECTIONS TO THERMODYNAMIC PROPERTIES FOR NONPOLAR GASES

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SUMMARY

Tables are presented based on the Lennard-Jones 6-12 potential for nonpolar molecules to be used in the representation of second and third virial coefficients and equation-of-state corrections for enthalpy, entropy, specific heats at constant volume and at constant pressure, the ratio of specific heats, the isentropic expansion coefficient, and the velocity of sound. The treatment for effects involving three molecules jointly uses an empirical adjustment of the Lennard-Jones force parameters within a cluster of three independently of the value for an isolated pair. A graphical correlation of ratios of these parameters with the critical constants is also shown which permits better estimates for compact nonpolar molecules with known critical constants but with limited data of state.

INTRODUCTION

The thermodynamic properties of real gases at pressures near atmospheric differ from those of the corresponding ideal gases. The difference is not, in general, large, but it is appreciable when careful experimental work has been performed and should be taken into account when observed gas properties are to be compared with those theoretically calculated from spectroscopic data. For example, experimental determinations of the specific heat, or of the velocity of sound, are often used to derive values of C_p^o, the ideal-gas specific heat. The real-gas corrections $C_p - C_p^o$ are, in general, calculated from some equation of state, one derived either from actual measurements of the pressure dependence of the properties in question or from compressibility measurements; alternatively, especially in the case of many substances which liquefy readily and whose vapors are hence not stable over a wide pressure range, so that such data are lacking, a "reduced" or general equation of state is used, whose specific constants are derived from the critical data of the substance or from the boiling point. The Berthelot equation of state

$$P = \frac{RT}{V - b} - \frac{a}{TV^2} \tag{1}$$

is very often used for this purpose. However, this equation is lacking in general theoretical significance (ref. 1).

Statistical mechanics indicates that a correct theoretical form for the equation of state of any nonreacting gas at moderate pressures is

$$\frac{PV}{RT} = 1 + \left[B(T)/V\right] + \left[C(T)/V^2\right] \tag{2}$$

where P is the pressure; V, the molar volume; R, the universal gas constant; T, the absolute temperature; and B and C are functions of the temperature known as the second and third virial coefficients, respectively. The coefficient B depends on only the forces between pairs of molecules and may in principle be calculated in terms of any assumed potential. The situation is essentially the same for C, but it depends on the energies of triples of molecules as well as pairs, so that the problem is considerably more complicated. A potential function that has been widely used, and that has been able to give good agreement with the experimental data for such different force-dependent properties as the second virial coefficient and the viscosity and other transport properties (ref. 2), is that due to Lennard-Jones. The Lennard-Jones expression for the potential energy of two molecules at a separation r is

$$U(r) = 4\epsilon\left[\left(\frac{r_o}{r}\right)^{12} - \left(\frac{r_o}{r}\right)^{6}\right] \tag{3}$$

where ϵ and r_o are two disposable parameters equal, respectively, to the maximum binding energy between the molecules and the distance at which the attractive and repulsive energies are equal. A gas whose molecules obey this law of force is referred to as a Lennard-Jones 6-12 gas. To a good approximation such gases include practically all common gases and vapors except those with large polar groups, such as water or alcohols, and those whose shape is far from spherical, such as carbon dioxide.

It follows from the original work of Lennard-Jones (ref. 3) that for this type of potential it is possible to calculate the second virial coefficient $B(T)$ and its temperature derivatives. These may be expressed in terms of the two parameters ϵ and r_0. Calculations of B and its derivatives have been made by several groups of authors. Values of B were given by Stockmayer and Beattie (ref. 4), fairly extensive tables from which one may compute B and T dB/dT have been published by Curtiss and Hirschfelder (ref. 5), and a revised calculation giving B, T dB/dT, T^2d^2B/dT^2, and T^3d^3B/dT^3 has been prepared by Hirschfelder, Curtiss, Bird, and Spotz (ref. 6). An extension of the calculations to lower temperatures has been made by Epstein and Roe (ref. 7) and has furnished values at the lowest temperature entries in the present tables.

Several computations have similarly been made concerning the third virial coefficients, assuming a Lennard-Jones 6-12 potential, including those of De Boer and Michels (ref. 8), Montroll and Mayer (ref. 9), Kihara (ref. 10), and Bird, Spotz, and Hirschfelder (ref. 11) as well as some unpublished calculations by one of the present authors in 1943. In contrast with the case of the second virial coefficient, the results of the third virial calculation do not fit third virial coefficients as determined from experiment, so that the results are without immediate direct application. However, the recognition that the effective force law in a group of three molecules is not necessarily identical with the sum for three independent pairs permits an appropriate fitting of the experimental data. By considering the formation of a cluster of three molecules as a chemical reaction with an equilibrium constant for formation, the selection of appropriate effective-force-law parameters can in principle be made readily, as has been discussed elsewhere (ref. 12). The results for the second virial coefficient may be expressed simply by $B = b_0 B^{(0)}(\tau)$ in the notation of reference 11, where $b_0 = \frac{2\pi}{3} N r_0^3$, $\tau = kT/\epsilon$, and $B^{(0)}(\tau)$ is a tabulated function. For the third virial coefficient more complicated relations result. Thus,

$$C = b_3^2\left\{C^{(0)}\left(\tau_3\right) - 4\left[B^{(0)}\left(\tau_3\right)\right]^2\right\} + 4b_2^2\left[B^{(0)}\left(\tau_2\right)\right]^2 \qquad (4)$$

with $\tau_3 = kT/\epsilon_3$ and $\tau_2 = kT/\epsilon_2$, b_3 and ϵ_3 being the parameters b_0 and ϵ, respectively, as determined for the cluster of three, and b_2 and ϵ_2, the regular values as determined for the second virial coefficient; $C^{(0)}(\tau)$, when multiplied by b_0^2, gives the third virial coefficient for a gas in which the mutual energy in any group of three molecules is the sum of Lennard-Jones pair energies with the same parameters as those which apply for isolated pairs.

Tables permitting the close representation of experimental values are of great utility in regard to the observed compressibility and the

Joule-Thomson coefficient (ref. 5) at various temperatures and their relation to the actual laws of force. Such tables permit the calculation of these properties at other temperatures when the parameters of the law of force have been established. The ease of such correlations and calculations is increased if similar tables are available for other thermodynamic properties. It is the purpose of this report to present tables from which one may readily calculate other effects of gas imperfection for nonpolar gases to obtain the effect for the density, enthalpy, entropy, specific heat at constant pressure and at constant volume, specific-heat ratio, isentropic expansion coefficient, and velocity of sound. Alternatively, tables are presented for calculations in which either the density or the pressure may be the variable.

This report is one of a series of papers on the thermodynamic properties of technically important gases compiled and calculated at the National Bureau of Standards under the sponsorship and with the financial assistance of the National Advisory Committee for Aeronautics.

SYMBOLS

a	sound velocity, m sec^{-1} or ft sec^{-1}
a,b	constants in Berthelot equation of state
a^o	sound velocity for ideal gas, m sec^{-1} or ft sec^{-1}
B	second virial coefficient in $1/V$ series, a function of temperature, cm^3 $mole^{-1}$
$B^{(0)}(\tau)$	second virial coefficient function, B/b_o
b_o	characteristic parameter of Lennard-Jones interaction potential, $\frac{2\pi}{3} Nr_o^3$, cm^3 $mole^{-1}$
b_2	b_o for pairs alone as distinct from pairs in larger clusters, cm^3 $mole^{-1}$
b_3	b_o for pairs within a cluster of three, cm^3 $mole^{-1}$
C	third virial coefficient in $1/V$ series, a function of temperature, $(cm^3\ mole^{-1})^2$
$C^{(0)}(\tau)$	third virial coefficient function, C/b_o^2 in simple theory

C_p	heat capacity at constant pressure, various units
C_p^o	heat capacity at constant pressure for ideal gas, various units
C_v	heat capacity at constant volume, various units
C_v^o	heat capacity at constant volume for ideal gas, various units
$\left.\begin{matrix} c_1, c_2, c_{12}, \\ c_1', c_2', c_{12}' \end{matrix}\right\}$	coefficients in correction for specific heat at constant pressure
D	fourth virial coefficient in 1/V series, a function of temperature, $(\text{cm}^3\ \text{mole}^{-1})^3$
E	internal energy, various units; also, fifth virial coefficient in 1/V series, a function of temperature, $(\text{cm}^3\ \text{mole}^{-1})^4$
E^o	internal energy for ideal gas, various units
H	enthalpy per mole, various units
H^o	enthalpy per mole for ideal gas, various units
$\left.\begin{matrix} h_1, h_2, h_{12}, \\ h_1', h_2', h_{12}' \end{matrix}\right\}$	coefficients in enthalpy correction
k	Boltzmann constant for proportionality of energy to temperature, 1.38048×10^{-16} erg $^oK^{-1}$
M	molecular weight (chemical scale), g mole^{-1}
N	Avogadro's number
P	pressure, atm or dynes cm^{-2}
P_c	critical pressure, atm or dynes cm^{-2}
P_0	atmospheric pressure, 1 atm or 1,013,250 dynes cm^{-2}
p_2	pressure parameter for pair of molecules, $R\epsilon_2/b_2k$

p_3	pressure parameter for cluster of three molecules, $R\epsilon_3/b_3k$
R	universal gas constant, various units
r	distance between two molecules
r_o	classical distance of closest intermolecular approach at zero energy according to Lennard-Jones potential, A
S	entropy per mole, various units
S^o	entropy per mole for ideal gas, various units
$s_1, s_2, s_{12}, s_1', s_2', s_{12}'$	coefficients in entropy correction
T	absolute temperature, °K or °R
T_c	critical temperature, °K or °R
U	potential energy of interaction of two molecules
V	volume per mole, $cm^3\ mole^{-1}$
V_c	critical volume, $cm^3\ mole^{-1}$
$w_1, w_2, w_{12}, w_1', w_2', w_{12}'$	coefficients in correction for specific heat at constant volume
Z	compressibility factor, PV/RT
$z_1, z_2, z_{12}, z_1', z_2', z_{12}'$	coefficients in $Z = PV/RT$
α	isentropic expansion coefficient, $-\frac{V}{P}\left(\frac{dP}{dV}\right)_S = -\gamma \frac{V}{P}\left(\frac{dP}{dV}\right)_T$
α^o	isentropic expansion coefficient for ideal gas
γ	ratio of specific heats, C_p/C_v
γ^o	ratio of specific heats for ideal gas, C_p^o/C_v^o

ϵ	maximum energy of binding between molecules with a Lennard-Jones potential, ergs
ϵ/k	characteristic parameter of Lennard-Jones interaction potential, $^{\circ}K$
ϵ_2/k	ϵ/k for pairs alone, $^{\circ}K$
ϵ_3/k	ϵ/k for pairs within a cluster of three, $^{\circ}K$
ρ	density, mole cm^{-3}, Amagat units, and so forth
τ	reduced temperature, kT/ϵ
τ_c	τ for critical condition
τ_2	τ for pairs alone, kT/ϵ_2
τ_3	τ for pairs within a cluster of three, kT/ϵ_3

TABLES

The relations on which the tabulations are based may be derived by standard thermodynamic methods on the basis of the virial equation of state (2) with C given by equation (4). In these relations, the nomenclature of Bird, Spotz, and Hirschfelder is used (ref. 11), so that $B^{(1)}(\tau) = \tau \, dB^{(0)}(\tau)/d\tau$, $B^{(2)}(\tau) = \tau^2 \, d^2B^{(0)}(\tau)/d\tau^2$, $C^{(1)}(\tau) = \tau \, dC^{(0)}(\tau)/d\tau$, and $C^{(2)}(\tau) = \tau^2 \, d^2C^{(0)}(\tau)/d\tau^2$. The tabulations and related formulas are applicable to nonpolar gases having Lennard-Jones 6-12 pair energies and distinct parameters for clusters of three molecules. With energy and volume parameters of ϵ_2 and b_2 for a pair and ϵ_3 and b_3 for a cluster of three, the pressure parameter for the pair is $p_2 = R\epsilon_2/b_2k$ and, for a cluster of three, the pressure parameter for the pair is $p_3 = R\epsilon_3/b_3k$. With the pressure parameters, the pressure dependence of the thermodynamic properties in dimensionless form can be expressed in terms of the dimensionless ratios P/p_2, $(P/p_2)^2$, and $(P/p_3)^2$, the dimensionless coefficients for which are given in tables 1 to 5. Alternatively, the dependence on volume can be expressed in terms of the dimensionless ratios b_2/V, $(b_2/V)^2$, and $(b_3/V)^2$ with dimensionless coefficients which are also given in tables 1 to 5. Detailed formulas are to be found in the appendix.

Each of tables 1 to 5 contains two sets of three columns of coefficients following the column for the temperature variable τ, one set being for density dependence and the other, for pressure dependence. In each of the two sets the first column of the three is for the linear dependence, while the second and third columns are for the quadratic dependence. Their appropriate multipliers are indicated in the tables. The second column gives the entire quadratic contribution in case the Lennard-Jones parameters for the cluster of three are identical with those for a single pair of molecules. If the parameters for the cluster of three are different, then the entire quadratic contribution is composed of three parts of which one is obtained from the second column at τ_3 and the other two are obtained from the third column at τ_3 and at τ_2, τ_2 and τ_3 being given, respectively, by kT/ϵ_2 and kT/ϵ_3. The tables cover the temperature range given by $0.7 < \tau < 400$ for all quantities tabulated with the additional extension down to 0.15 in the case of the linear terms. The entries are spaced sufficiently closely so that three-point interpolation will be adequate in most cases (ref. 13).[1] Since boiling points are typically near $\tau = 0.8$ with critical points near $\tau = 1.3$, the range of the tables covers practically all temperatures of experimental interest.

Tables 6, 7, and 8 give results for γ, α, and a involving only the linear dependence on density and pressure. Values of these quantities including the quadratic correction effects can be obtained by means of the defining formulas. Thus γ is readily obtained from the values of C_p and C_v. As α is given by $\gamma\left[Z - V(\partial Z/\partial V)_T\right]/Z$ or $\gamma Z/\left[Z - P(\partial Z/\partial P)_T\right]$, it can be computed quite directly if Z is known in terms of coefficients for powers of the density or of the pressure. Similarly, a^2 is given by $RT\alpha Z/M$. The evaluation of the quadratic terms for γ, α, and a has not been performed for these tables because of the complexity of the formulas and the adequacy of the direct calculation. Inasmuch as the ideal-gas specific-heat ratio γ^o is also a parameter, entries are given in the tables for various values of this ratio ranging from 1.40 to 1.00 in steps of 0.05 and for the single value $\gamma^o = 5/3$. The latter is the value for an ordinary monatomic gas considered as ideal. Similarly, $\gamma^o = 1.40$ is the theoretical value for an ideal diatomic gas at low temperatures where translational and rotational degrees of freedom are fully excited but where there is no vibration $\left(C_p{}^o/R = 3.5\right)$, whereas $\gamma^o = 1.10$ corresponds to relatively complex polyatomic gases at higher temperatures where many vibrational degrees of freedom are contributing $\left(C_p{}^o/R = 11\right)$.

The isentropic expansion coefficient $\alpha = -\frac{V}{P}\left(\frac{dP}{dV}\right)_S = -\gamma\frac{V}{P}\left(\frac{dP}{dV}\right)_T$ (see the appendix) is perhaps an unfamiliar quantity requiring further

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[1] $f(a + xw) = f(a) + x\,\Delta f(a) - \frac{x(1 - x)}{2}\,\Delta^2 f(a)$

explanation. For an ideal gas, it will be noted, it is identical with γ, the true specific-heat ratio. In many formulas of gas dynamics involving expansions through nozzles, the ideal-gas laws are assumed and, hence, γ and α may be written interchangeably. When deviations from ideal-gas behavior are to be considered, however, it will sometimes be found that the usual idal-gas formulas are valid if α, rather than γ, is used. For example, the familiar equation for the velocity of sound is $a^2 = PV\alpha M^{-1}$. Similarly, the resonance method to determine γ gives α the more directly, so that γ is obtained after correction for effects calculable from the equation of state. On the other hand, the method for determining γ by the amount of cooling in an adiabatic expansion gives directly a different quantity β, according to $1 - \beta^{-1} = \frac{P}{T}\left(\frac{dT}{dP}\right)_S = \frac{P}{C_p}\left(\frac{dV}{dT}\right)_P$ which in the limit of low pressure becomes $1 - \gamma^{-1}$. If the change in state during an expansion covers a wide range of pressure or temperature, so that α or γ is not constant, further refinements must be considered (ref. 14).

For the density-dependent parts of the tables, the multiplying factor for density in moles per unit volume for a given entry in the linear correction is a quantity frequently known as $b_o = \frac{2}{3}\pi N r_o^3$ and here indicated as b_2. The subscript o here replaced by 2 to signify a pair of molecules is also replaced by 3 for cases in which it refers to the effective parameter for a cluster of three molecules. If r_o is in the usual units of A $\left(10^{-8}\text{ centimeter}\right)$, values of the multiplying factor b_o for various values of r_o and various units of density are as presented in table 9. For the pressure-dependent tables, the multiplying factor for pressure for a given entry in the linear correction is the quantity $b_2/R\left(\epsilon_2/k\right)$. If b_2 is in cubic centimeters per mole, as in table 9, and ϵ_2/k is in $^{\circ}$K, the values of the constant R to transform from the density-dependent to the pressure-dependent factor for various units of pressure are as given in table 10.

USE OF TABLES

The utility of the tables is twofold. First, if values of the parameters ϵ/k and b_o are known for pairs $\left(\text{as } \epsilon_2/k \text{ and } b_2\right)$ and for triples $\left(\text{as } \epsilon_3/k \text{ and } b_3\right)$, when different, one may calculate the density dependence or pressure dependence of the thermodynamic functions, at any temperature covered, at low and moderate densities or pressures, by the following procedure. Calculate $\tau_2 = kT/\epsilon_2$ and $\tau_3 = kT/\epsilon_3$

and, according to whether density or pressure is to be used as variable, calculate b_2 and b_3 or $b_2/R(\epsilon_2/k)$ and $b_3/R(\epsilon_3/k)$ (or the reciprocals of the latter, $R\epsilon_2/b_2k = p_2$ and $R\epsilon_3/b_3k = p_3$) in the appropriate units. Next, interpolate in the density or pressure part of table 1, 2, 3, 4, or 5 that treats the desired property to find values in the first column and third column at the value of τ_2 and values in the second column and the third column at the value of τ_3. The linear contribution is obtained by multiplying the value from the first density column by b_2/V or by multiplying the value from the first pressure column by $\left[b_2/R(\epsilon_2/k)\right]P$ or P/p_2. For the quadratic dependence, the values at τ_3 are to be multiplied by $b_3{}^2/b_2{}^2$ for the density-dependent functions or by $b_3{}^2\epsilon_2{}^2/b_2{}^2\epsilon_3{}^2 = p_2{}^2/p_3{}^2$ in the case of tables for obtaining the pressure dependence. After obtaining the sum of products based on values from the second column at τ_3 and the third column at τ_2, the product based on the value in the third column at τ_3 is to be subtracted. The combined quantity is to be multiplied by $(b_2/V)^2$ when using density as a variable or by $(P/p_2)^2$ when using pressure as a variable. The adding and subtracting of the two values found in the third column with their proper multipliers is indicated by $(-1)^i(b_i/V)^2$ for the set in which density is the variable and by $(-1)^i(P/p_i)^2$ as multiplier for the set in which pressure is the variable. If the parameters for the cluster of three are identical with those for a pair, then the two contributions from the third column are of equal magnitude and opposite in sign, giving no net contribution. When the three contributions to the quadratic dependence have been evaluated and combined with the linear contribution, the result may be added to the ideal-gas value to obtain the real-gas value. This procedure is applicable either if one is to calculate the real-gas value, the ideal-gas value being known from previous calculations, or if one is to correct an observed real-gas result to the corresponding ideal-gas value. In the latter case, since the ideal-gas ratio of specific heats γ^0 enters the tables for γ, α, and a, it is necessary to find the corrections for these properties by successive approximations.

As an example of this direct use of the tables, one might consider the calculation of the density of gaseous methane at a pressure of 15 atmospheres and a temperature of 473.16° K. Turning to table 11, it is found that the appropriate parameters are estimated to be $\epsilon_2/k = 148.2^\circ$ K, $\epsilon_3/k = 145.2^\circ$ K, $p_2 = 173.3$ atmospheres, and $p_3 = 165.5$ atmospheres. These give $\tau_2 = 3.1927$ and $\tau_3 = 3.2587$, with $P/p_2 = 0.08655$ and $P/p_3 = 0.09063$, giving $(P/p_2)^2 = 0.00749$ and $(P/p_3)^2 = 0.00821$. Referring to the pressure part of table 1 for $\tau = \tau_2$

and $\tau = \tau_3$, the values obtained for the coefficients are:

At $\tau_2 = 3.1927$, $z_1' = -0.01811$

At $\tau_2 = 3.1927$, $z_{12}' = 0.00099$

At $\tau_3 = 3.2587$, $z_2' = 0.03215$

At $\tau_3 = 3.2587$, $z_{12}' = 0.00044$

The value of Z or PV/RT, the compressibility factor, is then given by

$$\frac{PV}{RT} = 1 + (-0.01811) \times 0.08655 + 0.03215 \times 0.00821 + 0.00099 \times$$

$$0.00749 - 0.00044 \times 0.00821$$

$$= 1 - 0.001567 + (0.000264 + 0.000007 - 0.000004)$$

$$= 0.9987$$

Then the value of V^{-1} is obtained from $\frac{RT}{PV}\frac{P}{RT}$ using the value of R of 82.0567 cm^3 atm/mole $^{\circ}K$:

$$V^{-1} = \frac{15 \text{ atm}}{0.9987 \times 82.0567 \text{ cm}^3 \text{ atm mole}^{-1} \, ^{\circ}\text{K}^{-1} \times 473.16 \, ^{\circ}\text{K}}$$

$$= 386.85 \times 10^{-6} \text{ mole/cm}^3$$

Multiplying by the molecular weight 16.042, a density of 0.006206 gram per cubic centimeter or 6.206 grams per liter is obtained.

Alternately, one may use the tables to derive values of ϵ/k and b_0 from experimental data, if the latter cover a wide range of temperature for one property, or several properties, and if the ideal-gas properties are known. One such procedure has been used in reference 12, taking into account effects on various properties including coefficients other than the virial coefficients.

A simple extension permits the use of a third parameter to obtain a closer representation for pairs and clusters of three molecules. Recognizing that the extent of phase space from which clusters are excluded is in some degree independent of the binding energy and the extent of phase space in which the binding energy is effective, additive constants may be included for K_2RT and $K_3(RT)^2$, that is, for B and $2B^2 - \frac{1}{2}C$. Thus, the extension is to use $B = b_2\left[\beta_2 + B^{(0)}(\tau_2)\right]$ and $C - 4B^2 = b_3^2\left\{\beta_3 + C^{(0)}(\tau_3) - \left[4B^{(0)}\right]^2(\tau_3)\right\}$, where β_2 and β_3 are constants. The changes required in all the thermodynamic formulas are simply to replace $B^{(0)}(\tau_2)$ by $\beta_2 + B^{(0)}(\tau_2)$ and to replace $C^{(0)}(\tau_3)$ by $\beta_3 + C^{(0)}(\tau_3)$. By referring to the fundamental equations in the appendix, the necessary algebra can be performed to take account of these constants so that results may be obtained from the present tables by extended combination of their values as indicated by the resulting formulas. For example, in the case of the enthalpy function $(H - H^0)/RT$, the coefficient of b_2/V in table 2 is changed from the $B^{(0)}(\tau_2) - B^{(1)}(\tau_2)$ tabulated to $\beta_2 + B^{(0)}(\tau_2) - B^{(1)}(\tau_2)$. For the coefficient of $(b_2/V)^2$, the value from the middle column, $C^{(0)}(\tau_3) - \frac{1}{2}C^{(1)}(\tau_3)$, is changed to $\beta_3 + C^{(0)}(\tau_3) - \frac{1}{2}C^{(1)}(\tau_3)$ prior to multiplication by b_3^2/b_2^2. The value in the third column at τ_2, $4\left\{\left[B^{(0)}(\tau_2)\right]^2 - B^{(0)}(\tau_2)B^{(1)}(\tau_2)\right\}$, is changed to $4\beta_2^2 + 4\beta_2 B^{(0)}(\tau_2) + 4\beta_2\left[B^{(0)}(\tau_2)B^{(1)}(\tau_2)\right] + 4\left\{\left[B^{(0)}(\tau_2)\right]^2 - B^{(0)}(\tau_2)B^{(1)}(\tau_2)\right\}$. The second of these three added quantities is $4\beta_2$ times the first tabulated coefficient for Z; the third is $4\beta_2$ times the first tabulated coefficient for the present $(H - H^0)/RT$.

VALUES OF PARAMETERS; REDUCED EQUATION OF STATE

Values of the parameters ϵ/k and r_0 have been deduced for most of the common gases from various sets of data by various authors. A tabulation and comparison of the values obtained from the viscosity and the second virial coefficient are presented in reference 2 and additional values from the second virial coefficient are given in reference 11. These values are quoted in table 12.

Other data in table 12 include values of $\tau_c = kT_c/\epsilon_2$ and V_c/b_2. Here kT_c/ϵ_2 is the ratio of the critical temperature to the average value of ϵ/k from the viscosity and second virial data. Similarly, V_c/b_2 is the ratio of the critical volume to the value of b calculated from the average value of r_0 from the two types of data. It will be noted, as Hirschfelder, Bird, and Spotz point out (ref. 2), that the agreement of the parameters from the two types of data is only fair, being best for the more spherical gases that are more likely to obey the Lennard-Jone 6-12 potential and worst for carbon dioxide and nitrous oxide. However, the average parameters reproduce all transport and low-pressure thermodynamic data fairly well. To obtain parameters for other molecules, specifically to predict PVT and thermodynamic properties more reliably, it is reasonable also to examine such data without using the viscosity parameters.

It might seem that such reduced parameters as kT_c/ϵ_2 and V_c/b_2 would be roughly constant for all gases on the basis of the law of corresponding states according to the assumption that the potential function between molecules in higher order collisions is, in effect, about the same as that in binary collisions. However, it has been demonstrated in connection with the third virial coefficient that the pair potential function in a group of three molecules is appreciably different from that for an isolated pair (ref. 12). As the difference may continue in the progression to larger clusters, it is appropriate to examine evidence for the systematic effect of parameter change. One such effect would appear in the value of P_cV_c/RT_c, which is known to vary appreciably among different substances.

Figure 1 shows corresponding values of P_cV_c/RT_c and kT_c/ϵ_2 based on PVT data for various substances from a variety of sources. While acceptance of 1.3 as an average value of kT_c/ϵ_2 may give ϵ_2/k approximately from the experimental T_c, agreeing with the theoretical estimates of 1.26 by De Boer and Michels (ref. 15) and 1.333 by Lennard-Jones and Devonshire (ref. 16), it seems likely that a better value in the absence of a direct experimental value for ϵ_2/k might be obtained by reading from the graph if the value of P_cV_c/RT_c is known.

Similarly, an average value of V_c/b_2 near 1.4 is close to the theoretical estimates of 1.50 by De Boer and Michels and 1.35 by Lennard-Jones and Devonshire. In the absence of a direct experimental value for b_2, a value might be estimated from such an average value or perhaps more closely from V_c and figure 2, which shows corresponding values of P_cV_c/RT_c and V_c/b_2 based on PVT data only. Hirschfelder, McClure, and Weeks (ref. 17) cite average values of 1.299 for kT_c/ϵ_2 and 1.47 for V_c/b_2.

The ratios between parameters for clusters of three and of two molecules are also found to be related to the values of the critical constants. Values for the ratios ϵ_3/ϵ_2 and b_3/b_2 as obtained in fitting PVT data may differ somewhat randomly, being influenced by the range of reduced temperature for which the fit is obtained. This may be attributed to failure to represent well the actual complicated potential function for the clusters. Parameters suitable over a range of temperature including both the critical temperature and somewhat higher temperatures may thus be expected to be more comparable than parameters based on segments of a higher temperature range not corresponding on a reduced-temperature basis. A procedure intended to improve the estimates through a knowledge of the critical conditions will now be described.

If the classical condition for the critical point $(\partial P/\partial V)_T = 0$ and $(\partial^2 P/\partial V^2)_T = 0$ is used with the equation of state in the virial form $PV/RT = 1 + B/V + C/V^2 + D/V^3 + E/V^4 + \ldots$, it is found that the critical density may be estimated with a series beginning as

$$\frac{1}{V_c} = -\frac{B}{3C} - \frac{2DB^2}{9C^3} + \frac{10EB^3}{81C^4} - \frac{8D^2B^3}{81C^5} + \ldots$$

and giving

$$\frac{P_cV_c}{RT_c} = \frac{1}{9}\frac{B^2}{C} + \frac{1}{27}\frac{DB^3}{C^3} - \frac{2}{243}\frac{EB^4}{C^4} + \frac{2D^2B^4}{81C^5} + \ldots$$

as a beginning approximation. This expression is not to be regarded as fully definitive, as its form is changed somewhat if the next higher derivatives are also taken as zero.

However, an examination of the relationship between B^2/C and PV/RT at the critical point can be made empirically by using the results of Meyers (ref. 18) for the representation of critical isotherms. As critical constants have been determined for many substances, P_cV_c/RT_c may give a fair estimate for B^2/C at the critical point, giving an indicated value for C if B can be estimated reliably. This can help to give a better overall function for C than might come from correlation of higher temperature data alone. The values of B^2/C so obtained are of the order of magnitude of $9P_cV_c/RT_c$ but are uniformly somewhat greater. In figure 3 values are shown as obtained by Meyers and as indicated by the values of b_3^2/b_2^2 and ϵ_3/ϵ_2 recently obtained. On the basis of approximate agreement some of the parameters obtained earlier appear fairly reliable. The considerable departure in other cases has been rectified through the fitting of C at the critical point as indicated on the basis of Meyers' critical isotherms. For some substances the fit is still only approximate over extended ranges of temperature, possibly because of departure from the spherical symmetry implied by the Lennard-Jones potential.

Using the "improved" constants, one simple correlation is shown in figure 4 in which $(\epsilon_3/\epsilon_2)(b_3/b_2)^{1/2}$ is plotted as a function of $(kT_c/\epsilon_2)(b_2/V_c)$. The scattering of points with the use of the preliminary or unimproved constants is appreciable. The use of the critical condition is seen to reduce the scattering considerably. Two sets of improved constants for approximate representation for carbon monoxide resulted from combining the critical constant with (1) older virial data as used in the NBS-NACA tables and (2) newer data of Michels.

In figure 5 $(\epsilon_3/\epsilon_2)(b_2/b_3)^{1/2}$ is shown, using the improved constants of figure 4, plotted as a function of V_c/b_2. The lower point for carbon monoxide (CO) was obtained using the older virial data; the upper point, using newer data of Michels. It appears that the points form a band of considerable and seemingly varying width. However, there is a possibility that further improvement in critical constants and parameters for clusters of two and three molecules will lead to better but more complex correlations of these data.

It would accordingly seem that, if other experimental data are missing, it still may be possible to calculate approximate corrections to the thermodynamic functions for nonpolar, approximately spherical gases from the tables and graphs presented here using the known values for the critical constants.

In table 11 some of the numerical values for parameters obtained for pairs and clusters of three are listed. Values are given both as obtained by direct PVT correlation and also as adjusted for the critical condition. In addition to these values of ϵ/k and $b_0 = \frac{2}{3}\pi N r_0^3$, corresponding values are given for the ratios ϵ_3/ϵ_2 and b_3^2/b_2^2 and for $p_2 = R\epsilon_2/kb_2$, $p_3 = R\epsilon_3/kb_3$, and p_2^2/p_3^2.

While the constants as adjusted to fit the critical condition are probably preferable near the critical temperature, it can be expected that constants fitted to good higher temperature data will be preferable for the higher temperature regions. This is due to the limitations of the Lennard-Jones functions in representing all details exactly.

DISCUSSION

It must be reemphasized that the tables are valid only to the extent that the gas imperfection is representable in terms of pair energies equivalent to binary encounters of spherical nonpolar molecules and pair energies in triple encounters, the potential energies for pairs in an encounter being of the form of equation (3). How adequate these assumptions are will, of course, depend upon the precision of the result desired. Deviations of properties of actual gases from those calculated will be of two kinds: Those due to interactions involving a greater number of molecules and those due to inadequacy of the 6-12 potential. At rather low pressures, the third virial coefficient is relatively unimportant in regard to deviations from ideal behavior, in the sense of contributing less than 5 percent of the deviation at densities below 5 Amagats. At high pressures such deviations should not be neglected, and it may be necessary to consider virials higher than the third in such cases.

There has been some interest in the limitations of the 6-12 potential for the exact representation of actual deviations from ideality. It is certain that the 6-12 potential does not give a completely accurate representation of the pair potential for any molecule, since theory indicates additional attractive terms proportional to the eighth power of the distance and exponential, rather than twelfth-power, repulsive forces even for the monatomic molecules, which give spherical symmetry. However, these refinements lead only to minor changes in the resulting form of $B(T)$, such as may be adjusted for by a change in the parameters ϵ and r_0. It is probable that no simple function with two disposable parameters can do better, in general. For molecules with large departure from spherical symmetry, the 6-12 potential may be expected to give only a rough representation of derived properties over an extended range of temperature. The comparative studies of various potential functions have, in general, hitherto been based on experimental values of the second virial coefficient derived from density measurements; since, however, the thermodynamic properties involving higher temperature derivatives of the virial coefficients, such as C_p and sound velocity, are more sensitive to the particular form of the equation of state, it can be expected that their measurement as a function of pressure and temperature will also lead to conclusions concerning the suitability of the Lennard-Jones potential function as a basis for the calculation of all of the thermodynamic properties.

National Bureau of Standards,
Washington, D. C., May 5, 1954.

APPENDIX

DETAILED FORMULAS FOR THERMODYNAMIC PROPERTIES

The relations which follow may be derived by standard thermodynamic methods using the indicated equation of state. The nomenclature of Bird, Spotz, and Hirschfelder is used; namely,

$$B^{(1)}(\tau) = \tau \, dB^{(0)}(\tau)/d\tau$$

$$B^{(2)}(\tau) = \tau^2 \, d^2B^{(0)}/d\tau^2$$

$$C^{(1)}(\tau) = \tau \, dC^{(0)}(\tau)/d\tau$$

$$C^{(2)}(\tau) = \tau^2 \, d^2C^{(0)}(\tau)/d\tau^2$$

The superscript o applied to the quantities E, H, S, C_v, C_p, and so forth indicates that the property is for the ideal gas.

The relations for Z, E, H, S, C_v, and C_p, as arranged for tabulating for a nonpolar gas having pair energies given by a Lennard-Jones 6-12 potential with distinct parameters for clusters of three molecules, are:

The compressibility factor $Z = PV/RT$:

$$Z = 1 + B^{(0)}(\tau_2)(b_2/V) + \Big\{C^{(0)}(\tau_3)(b_3^2/b_2^2) - 4\big[B^{(0)}(\tau_3)\big]^2(b_3^2/b_2^2) +$$

$$4\big[B^{(0)}(\tau_2)\big]^2\Big\}(b_2/V)^2$$

$$= 1 + \tau_2^{-1}B^{(0)}(\tau_2)(b_2kP/R\epsilon_2) + \Big(\tau_3^{-2}\Big\{C^{(0)}(\tau_3) -$$

$$\big[B^{(0)}(\tau_3)\big]^2\Big\}(b_3^2\epsilon_2^2/b_2^2\epsilon_3^2) - 3\big[\tau_3^{-1}B^{(0)}(\tau_3)\big]^2(b_3^2\epsilon_2^2/b_2^2\epsilon_3^2) +$$

$$3\big[\tau_2^{-1}B^{(0)}(\tau_2)\big]^2\Big)(b_2kP/R\epsilon_2)^2$$

The internal energy E:

$$(E - E^0)/RT = -B^{(1)}(\tau_2)(b_2/V) - \Big[0.5C^{(1)}(\tau_3)(b_3^2/b_2^2) -$$

$$4B^{(0)}(\tau_3)B^{(1)}(\tau_3)(b_3^2/b_2^2) + 4B^{(0)}(\tau_2)B^{(1)}(\tau_2)\Big](b_2/V)^2$$

$$= -\tau_2^{-1}B^{(1)}(\tau_2)(b_2kP/R\epsilon_2) - \Big\{\tau_3^{-2}\Big[0.5C^{(1)}(\tau_3) -$$

$$B^{(0)}(\tau_3)B^{(1)}(\tau_3)\Big](b_3^2\epsilon_2^2/b_2^2\epsilon_3^2) -$$

$$3\tau_3^{-2}B^{(0)}(\tau_3)B^{(1)}(\tau_3)(b_3^2\epsilon_2^2/b_2^2\epsilon_3^2) +$$

$$3\tau_2^{-2}B^{(0)}(\tau_2)B^{(1)}(\tau_2)\Big\}(b_2kP/R\epsilon_2)^2$$

The enthalpy H:

$$
\begin{aligned}
(H - H^{o})/RT = {} & \left[B^{(0)}(\tau_2) - B^{(1)}(\tau_2)\right](b_2/V) + \Bigg(\left[C^{(0)}(\tau_3) - \right. \\
& \left. 0.5C^{(1)}(\tau_3)\right](b_3{}^2/b_2{}^2) - 4\Big\{\left[B^{(0)}(\tau_3)\right]^2 - \\
& B^{(0)}(\tau_3)B^{(1)}(\tau_3)\Big\}(b_3{}^2/b_2{}^2) + 4\Big\{\left[B^{(0)}(\tau_2)\right]^2 - \\
& B^{(0)}(\tau_2)B^{(1)}(\tau_2)\Big\}\Bigg)(b_2/V)^2 \\
= {} & \tau_2{}^{-1}\left[B^{(0)}(\tau_2) - B^{(1)}(\tau_2)\right](b_2kP/R\epsilon_2) + \Bigg(\tau_3{}^{-2}\Big\{C^{(0)}(\tau_3) - \\
& 0.5C^{(1)}(\tau_3) - \left[B^{(0)}(\tau_3)\right]^2 + \\
& B^{(0)}(\tau_3)B^{(1)}(\tau_3)\Big\}(b_3{}^2\epsilon_2{}^2/b_2{}^2\epsilon_3{}^2) - \\
& 3\tau_3{}^{-2}B^{(0)}(\tau_3)\left[B^{(0)}(\tau_3) - B^{(1)}(\tau_3)\right](b_3{}^2\epsilon_2{}^2/b_2{}^2\epsilon_3{}^2) + \\
& 3\tau_2{}^{-2}B^{(0)}(\tau_2)\left[B^{(0)}(\tau_2) - B^{(1)}(\tau_2)\right]\Bigg)(b_2kP/R\epsilon_2)^2
\end{aligned}
$$

The entropy S with $P_0 = 1$ atmosphere and S^o at 1 atmosphere:

$$
\begin{aligned}
(S - S^o)/R = {} & \log_e \left(P_0V/RT\right) - \left[B^{(0)}(\tau_2) + B^{(1)}(\tau_2)\right]\left(b_2/V\right) - \\
& \Bigg(0.5\left[C^{(0)}(\tau_3) + C^{(1)}(\tau_3)\right]\left(b_3{}^2/b_2{}^2\right) - 2\Big\{\left[B^{(0)}(\tau_3)\right]^2 + \\
& 2B^{(0)}(\tau_3)B^{(1)}(\tau_3)\Big\}\left(b_3{}^2/b_2{}^2\right) + 2\Big\{\left[B^{(0)}(\tau_2)\right]^2 + \\
& 2B^{(0)}(\tau_2)B^{(1)}(\tau_2)\Big\}\Bigg)\left(b_2/V\right)^2 \\
= {} & \log_e \left(P_0/P\right) - \tau_2{}^{-1}B^{(1)}(\tau_2)\left(b_2kP/R\epsilon_2\right) + 0.5\Bigg(\tau_3{}^{-2}\Big\{C^{(0)}(\tau_3) - \\
& C^{(1)}(\tau_3) + 2B^{(0)}(\tau_3)B^{(1)}(\tau_3) - \left[B^{(0)}(\tau_3)\right]^2\Big\}\left(b_3{}^2\epsilon_2{}^2/b_2{}^2\epsilon_3{}^2\right) - \\
& 3\tau_3{}^{-2}\Big\{\left[B^{(0)}(\tau_3)\right]^2 - 2B^{(0)}(\tau_3)B^{(1)}(\tau_3)\Big\}\left(b_3{}^2\epsilon_2{}^2/b_2{}^2\epsilon_3{}^2\right) + \\
& 3\tau_2{}^{-2}\Big\{\left[B^{(0)}(\tau_2)\right]^2 - 2B^{(0)}(\tau_2)B^{(1)}(\tau_2)\Big\}\Bigg)\left(b_2kP/R\epsilon_2\right)^2
\end{aligned}
$$

The specific heat at constant volume C_V:

$$
\begin{aligned}
\left(C_v - C_v^{o}\right)/R = {} & -\left[2B^{(1)}(\tau_2) + B^{(2)}(\tau_2)\right](b_2/V) - \Big(\Big[C^{(1)}(\tau_3) + \\
& 0.5C^{(2)}(\tau_3)\Big]\left(b_3^{2}/b_2^{2}\right) - \Big\{8B^{(0)}(\tau_3)B^{(1)}(\tau_3) + 4\left[B^{(1)}(\tau_3)\right]^2 + \\
& 4B^{(0)}(\tau_3)B^{(2)}(\tau_3)\Big\}\left(b_3^{2}/b_2^{2}\right) + \Big\{8B^{(0)}(\tau_2)B^{(1)}(\tau_2) + \\
& 4\left[B^{(1)}(\tau_2)\right]^2 + 4B^{(0)}(\tau_2)B^{(2)}(\tau_2)\Big\}\Big)(b_2/V)^2 . \\
= {} & -\tau_2^{-1}\left[2B^{(1)}(\tau_2) + B^{(2)}(\tau_2)\right]\left(b_2kP/R\epsilon_2\right) + \\
& \Big(\tau_3^{-2}\Big[2B^{(0)}(\tau_3)B^{(1)}(\tau_3) + B^{(0)}(\tau_3)B^{(2)}(\tau_3) - C^{(1)}(\tau_3) - \\
& 0.5C^{(2)}(\tau_3)\Big]\left(b_3^{2}\epsilon_2^{2}/b_2^{2}\epsilon_3^{2}\right) + \tau_3^{-2}\Big\{3B^{(0)}(\tau_3)B^{(2)}(\tau_3) + \\
& 6B^{(0)}(\tau_3)B^{(1)}(\tau_3) + 4\left[B^{(1)}(\tau_3)\right]^2\Big\}\left(b_3^{2}\epsilon_2^{2}/b_2^{2}\epsilon_3^{2}\right) - \\
& \tau_2^{-2}\Big\{3B^{(0)}(\tau_2)B^{(2)}(\tau_2) + 6B^{(0)}(\tau_2)B^{(1)}(\tau_2) + \\
& 4\left[B^{(1)}(\tau_2)\right]^2\Big\}\Big)\left(b_2kP/R\epsilon_2\right)^2
\end{aligned}
$$

The specific heat at constant pressure C_p:

$$
\begin{aligned}
\left(C_p - C_p^{0}\right)/R = {} & -B^{(2)}(\tau_2)(b_2/V) + \Bigg(\bigg\{C^{(1)}(\tau_3) - C^{(0)}(\tau_3) - 0.5C^{(2)}(\tau_3) + \\
& \left[B^{(0)}(\tau_3) - B^{(1)}(\tau_3)\right]^2\bigg\}\left(b_3^{2}/b_2^{2}\right) + \bigg\{3\Big[B^{(0)}(\tau_3) - \\
& B^{(1)}(\tau_3)\Big]^2 + 4B^{(0)}(\tau_3)B^{(2)}(\tau_3)\bigg\}\left(b_3^{2}/b_2^{2}\right) - \bigg\{3\Big[B^{(0)}(\tau_2) - \\
& B^{(1)}(\tau_2)\Big]^2 + 4B^{(0)}(\tau_2)B^{(2)}(\tau_2)\bigg\}\Bigg)(b_2/V)^2 \\
= {} & -\tau_2^{-1}B^{(2)}(\tau_2)\left(b_2kP/R\epsilon_2\right) + \Bigg(\tau_3^{-2}\bigg\{C^{(1)}(\tau_3) - C^{(0)}(\tau_2) - \\
& 0.5C^{(2)}(\tau_3) + B^{(0)}(\tau_3)B^{(2)}(\tau_3) + \Big[B^{(0)}(\tau_3) - \\
& B^{(1)}(\tau_3)\Big]^2\bigg\}\left(b_3^{2}\epsilon_2^{2}/b_2^{2}\epsilon_3^{2}\right) + 3\tau_3^{-2}\bigg\{B^{(0)}(\tau_3)B^{(2)}(\tau_3) + \\
& \left[B^{(0)}(\tau_3) - B^{(1)}(\tau_3)\right]^2\bigg\}\left(b_3^{2}\epsilon_2^{2}/b_2^{2}\epsilon_3^{2}\right) - \\
& 3\tau_2^{-2}\bigg\{B^{(0)}(\tau_2)B^{(2)}(\tau_2) + \Big[B^{(0)}(\tau_2) - \\
& B^{(1)}(\tau_2)\Big]^2\bigg\}\Bigg)\left(b_2kP/R\epsilon_2\right)^2
\end{aligned}
$$

The dependence of γ, the ratio of specific heats, α, the isentropic expansion coefficient, and a, the velocity of sound, on the second virial coefficient and its derivatives may be indicated as follows:

The specific-heat ratio $\gamma = C_P/C_V$:

$$\gamma = \gamma^{o} + \left[(\gamma^{o} - 1)^{2}B^{(2)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2)\right](b_2/V)$$

$$= \gamma^{o} + \tau_2^{-1}\left[(\gamma^{o} - 1)^{2}B^{(2)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2)\right](b_2kP/R\epsilon_2)$$

The isentropic expansion coefficient $\alpha = -(V/P)(\partial P/\partial V)_S$:

$$\alpha = -(V/P)(\partial P/\partial V)_T\gamma$$

$$= \gamma^{o} + \left[\gamma^{o}B^{(0)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^{2}B^{(2)}(\tau_2)\right](b_2/V)$$

$$= \gamma^{o} + \tau_2^{-1}\left[\gamma^{o}B^{(0)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^{2}B^{(2)}(\tau_2)\right](b_2kP/R\epsilon_2)$$

The velocity of sound a with a at low pressure equal to $a^{o} = (RT\gamma^{o}/M)^{1/2} = (PV\alpha^{o}/M)^{1/2}$:

$$\frac{a - a^{o}}{a^{o}} = \left[B^{(0)}(\tau_2) + (\gamma^{o} - 1)B^{(1)}(\tau_2) + 0.5(\gamma^{o} - 1)^{2}(\gamma^{o})^{-1}B^{(2)}(\tau_2)\right](b_2/V)$$

$$= \tau_2^{-1}\left[B^{(0)}(\tau_2) + (\gamma^{o} - 1)B^{(1)}(\tau_2) + 0.5(\gamma^{o} - 1)^{2}(\gamma^{o})^{-1}B^{(2)}(\tau_2)\right](b_2kP/R\epsilon_2)$$

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TABLE 1.- COEFFICIENTS IN Z = PV/RT

$$\left[Z = 1 + z_1(\tau_2)\left(b_2/V\right) + \left[z_2(\tau_3)\left(b_3^2/b_2^2\right) + z_{12}(\tau_2) - z_{12}(\tau_3)\left(b_3^2/b_2^2\right)\right]\left(b_2/V\right)^2\right.$$

$$\left. = 1 + z_1'(\tau_2)\left(P/p_2\right) + \left[z_2'(\tau_3)\left(p_2^2/p_3^2\right) + z_{12}'(\tau_2) - z_{12}'(\tau_3)\left(p_2^2/p_3^2\right)\right]\left(P/p_2\right)^2\right]$$

τ	z_1 $(\text{at } \tau_2)$ (a)	z_2 $(\text{at } \tau_3)$ (b)	z_{12} $(\text{at } \tau_i,\ i = 2, 3)$ (c)	z_1' $(\text{at } \tau_2)$ (d)	z_2' $(\text{at } \tau_3)$ (e)	z_{12}' $(\text{at } \tau_i,\ i = 2, 3)$ (f)
0.15	-466.37		8.7×10^5	-3,109.1		2.9×10^7
.20	-110.577		48,900	-552.887		917,050
.25	-48.203		9,294	-192.811		111,528
.30	-27.881		3,109.3	-92.935		25,910.9
.35	-18.755		1,406.88	-53.585		8,614.19
.40	-13.799		761.632	-34.497		3,570.15
.45	-10.755		462.676	-23.900		1,713.61
.50	-8.7202		304.168	-17.4404		912.504
.55	-7.2741		239.649	-13.2256		594.172
.60	-6.1980		153.659	-10.3300		320.124
.65	-5.3682		115.270	-8.2588		204.621
.70	-4.7100	-3.3766	88.7378	-6.7286	-52.1655	135.8231
.75	-4.1759	-1.7920	69.7535	-5.5679	-34.1873	93.0046
.80	-3.7342	-.8495	55.7778	-4.6678	-23.1156	65.3646
.85	-3.3631	-.2766	45.2423	-3.9566	-16.0376	46.9643
.90	-3.0471	.0765	37.1396	-3.3857	-11.3684	34.3885
.95	-2.7749	.2951	30.8005	-2.9210	-8.2050	25.5960
1.00	-2.5381	.4297	25.7674	-2.5381	-6.0122	19.3256
1.05	-2.3302	.5108	21.7197	-2.2193	-4.4618	14.7753
1.10	-2.1464	.5576	18.4277	-1.9512	-3.3465	11.4221
1.15	-1.9826	.5822	15.7236	-1.7240	-2.5321	8.9170
1.20	-1.8359	.5924	13.4828	-1.5300	-1.9294	7.0223
1.25	-1.7038	.5933	11.6114	-1.3630	-1.4781	5.5735
1.30	-1.5841	.5882	10.0376	-1.2185	-1.1368	4.4545
1.35	-1.4753	.5793	8.7055	-1.0928	-.8763	3.5825
1.40	-1.3758	.5683	7.5718	-.9827	-.6758	2.8974
1.45	-1.2847	.5561	6.6020	-.8860	-.5205	2.3551
1.50	-1.2009	.5434	5.7685	-.8006	-.3994	1.9228
1.55	-1.1235	.5306	5.0492	-.7249	-.3046	1.5762
1.60	-1.0519	.5180	4.4261	-.6574	-.2299	1.2967
1.65	-.9855	.5059	3.8845	-.5972	-.1709	1.0701
1.70	-.9236	.4942	3.4123	-.5433	-.1242	.8855
1.75	-.8659	.4832	2.9994	-.4948	-.0871	.7345

[a] Multiply values by b_2/V.

[b] Multiply values by $\left(b_3/V\right)^2$.

[c] Multiply values by $(-1)^i\left(b_i/V\right)^2$.

[d] Multipy values by P/p_2.

[e] Multiply values by $\left(P/p_3\right)^2$.

[f] Multiply values by $(-1)^i\left(P/p_i\right)^2$.

TABLE 1.- COEFFICIENTS IN $Z = PV/RT$ - Continued

τ	z_1 $\left(\text{at } \tau_2\right)$ (a)	z_2 $\left(\text{at } \tau_3\right)$ (b)	z_{12} $\left(\text{at } \tau_i,\ i = 2, 3\right)$ (c)	z_1' $\left(\text{at } \tau_2\right)$ (d)	z_2' $\left(\text{at } \tau_3\right)$ (e)	z_{12}' $\left(\text{at } \tau_i,\ i = 2, 3\right)$ (f)
1.80	-0.8120	0.4728	2.6376	-0.4511	-0.0576	0.6106
1.85	-.7615	.4630	2.3198	-.4116	-.0342	.5084
1.90	-.7141	.4538	2.0400	-.3759	-.0156	.4238
1.95	-.6696	.4452	1.7934	-.3434	-.0008	.3537
2.00	-.6276	.4371	1.5757	-.3138	.0108	.2954
2.1	-.5506	.4226	1.2128	-.2622	.0271	.2063
2.2	-.4817	.4100	.9282	-.2190	.0368	.1438
2.3	-.4197	.3990	.7045	-.1825	.0421	.0999
2.4	-.3636	.3894	.5288	-.1515	.0447	.0688
2.5	-.3126	.3811	.3909	-.1250	.0453	.0469
2.6	-.2661	.3738	.2833	-.1024	.04482	.03143
2.7	-.2236	.3674	.2000	-.08281	.04354	.02057
2.8	-.1845	.3617	.1362	-.06590	.04180	.01303
2.9	-.1485	.3568	.0882	-.05121	.03980	.00787
3.0	-.1152	.3523	.0531	-.03841	.03767	.00443
3.1	-.0844	.3484	.0285	-.02723	.03552	.00222
3.2	-.0558	.3449	.0124	-.01743	.03338	.00091
3.3	-.0291	.3418	.0034	-.00883	.03131	.00023
3.4	-.0043	.3389	.0001	-.00126	.02932	.00004
3.5	.0190	.3364	.0014	.00542	.02743	.00009
3.6	.0407	.3341	.0066	.01131	.02565	.00038
3.7	.0611	.3320	.0150	.01652	.02398	.00082
3.8	.0803	.3300	.0258	.02114	.02241	.00134
3.9	.0983	.3282	.0387	.02521	.02094	.00191
4.0	.1154	.3266	.0533	.02885	.01958	.00250
4.1	.1315	.3251	.0692	.03207	.01831	.00309
4.2	.1467	.3237	.0861	.03492	.01713	.00366
4.3	.1611	.3224	.1038	.03746	.01603	.00421
4.4	.1747	.3212	.1221	.03970	.01501	.00473
4.5	.1876	.3200	.1408	.04169	.01406	.00521
4.6	.1999	.3189	.1598	.04346	.01318	.00566
4.7	.2116	.3179	.1790	.04501	.01236	.00608
4.8	.2227	.3169	.1983	.04639	.01160	.00646
4.9	.2333	.3160	.2176	.04760	.01089	.00680
5.0	.2433	.3151	.2369	.04867	.01023	.00711
5.2	.2622	.3134	.2749	.05042	.00905	.00763
5.4	.2794	.3119	.3122	.05173	.00802	.00803
5.6	.2951	.3104	.3483	.05270	.00712	.00833
5.8	.3096	.3090	.3833	.05338	.00634	.00855
6.0	.3229	.3077	.4171	.05382	.00565	.00869

[a] Multiply values by b_2/V.

[b] Multiply values by $\left(b_3/V\right)^2$.

[c] Multiply values by $(-1)^i\left(b_i/V\right)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $\left(P/p_3\right)^2$.

[f] Multiply values by $(-1)^i\left(P/p_i\right)^2$.

TABLE 1.- COEFFICIENTS IN $Z = PV/RT$ - Concluded

τ	z_1 (at τ_2) (a)	z_2 (at τ_3) (b)	z_{12} (at τ_i, $i = 2, 3$) (c)	z_1' (at τ_2) (d)	z_2' (at τ_3) (e)	z_{12}' (at τ_i, $i = 2, 3$) (f)
6.5	0.3520	0.3046	0.4955	0.05415	0.00428	0.00880
7.0	.3761	.3017	.5658	.05373	.00327	.00866
7.5	.3963	.2989	.6283	.05284	.00252	.00838
8.0	.4134	.2962	.6837	.05168	.00196	.00801
8.5	.4280	.2936	.7329	.05036	.00153	.00761
9.0	.4406	.2910	.7765	.04896	.00120	.00719
9.5	.4514	.2886	.8152	.04752	.000939	.006775
10.0	.4609	.2861	.8496	.04609	.000737	.006372
11	.4763	.2813	.9075	.04330	.000450	.005625
12	.4882	.2768	.9535	.04069	.000267	.004966
13	.4975	.2724	.9901	.03827	.000147	.004394
14	.5048	.2682	1.0194	.03606	.0000682	.003901
15	.5106	.2642	1.0428	.03404	.0000156	.003476
16	.5151	.2604	1.0615	.03220	-.0000196	.003110
17	.5187	.2567	1.0763	.03051	-.0000430	.002793
18	.5215	.2531	1.0880	.02897	-.0000583	.002519
19	.5237	.2497	1.0971	.02756	-.0000681	.002279
20	.5254	.2464	1.1041	.02627	-.0000740	.002070
22	.5275	.2402	1.1130	.02398	-.0000785	.001725
24	.5284	.2345	1.1168	.02202	-.0000776	.001454
26	.5285	.2292	1.1171	.02033	-.0000741	.001239
28	.5279	.2242	1.1148	.01885	-.0000695	.001066
30	.5269	.2195	1.1106	.01756	-.0000646	.0009255
35	.5232	.2091	1.0951	.01495	-.0000528	.0006705
40	.5186	.2001	1.0757	.01296	-.0000430	.0005042
45	.5135	.1922	1.0548	.01141	-.0000353	.0003907
50	.5084	.1853	1.0337	.01017	-.0000293	.0003101
60	.4982	.1735	.9929	.00830	-.0000208	.0002068
70	.4887	.1638	.9551	.00698	-.0000153	.0001462
80	.4798	.1556	.9208	.00600	-.0000117	.0001079
90	.4716	.1486	.8897	.00524	-.00000911	.00008238
100	.4641	.1425	.8614	.00464	-.00000728	.00006461
200	.4114	.1068	.6771	.00206	-.00000156	.00001270
300	.3801	.0894	.5780	.00127	-.00000061	.00000482
400	.3584	.0786	.5137	.00090	-.00000031	.00000241

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 2.- COEFFICIENTS IN ENTHALPY CORRECTION

$$\Bigl[(H - H^{o})/RT = 1 + h_1(\tau_2)(b_2/V) + \bigl[h_2(\tau_3)(b_3^2/b_2^2) + h_{12}(\tau_2) - h_{12}(\tau_3)(b_3^2/b_2^2)\bigr](b_2/V)^2$$

$$= 1 + h_1'(\tau_2)(P/p_2) + \bigl[h_2'(\tau_3)(p_2^2/p_3^2) + h_{12}'(\tau_2) - h_{12}'(\tau_3)(p_2^2/p_3^2)\bigr](P/p_2)^2\Bigr]$$

τ	h_1 (at τ_2) (a)	h_2 (at τ_3) (b)	h_{12} (at τ_i, $i = 2, 3$) (c)	h_1' (at τ_2) (d)	h_2' (at τ_3) (e)	h_{12}' (at τ_i, $i = 2, 3$) (f)
0.15	-3,216.4		6×10^6	-21,443		2×10^8
.20	-575.83		254,700	-2,879.2		4.8×10^6
.25	-206.59		39,830	-826.36		478,000
.30	-104.488		11,652	-348.29		97,100
.35	-64.003		4,801.4	-182.86		29,397
.40	-44.066		2,432.23	-110.165		11,401.1
.45	-32.7445		1,408.66	-72.766		5,217.26
.50	-25.6439		894.48	-51.288		2,683.44
.55	-20.8563		634.84	-37.920		1,573.98
.60	-17.4468		432.54	-29.078		901.12
.65	-14.9137		320.24	-22.944		568.47
.70	-12.9671	-17.72	244.30	-18.5244	-160.80	373.93
.75	-11.4299	-10.82	190.92	-15.2399	-104.08	254.56
.80	-10.1884	-6.65	152.18	-12.7355	-69.84	178.34
.85	-9.1665	-4.057	123.312	-10.7841	-48.284	128.006
.90	-8.3120	-2.400	101.311	-9.2356	-34.232	93.806
.95	-7.5877	-1.322	84.221	-7.9871	-24.794	69.989
1.00	-6.9663	-.609	70.725	-6.9663	-18.290	53.044
1.05	-6.4279	-.1347	59.9137	-6.1218	-13.7081	40.7576
1.10	-5.9570	.1823	51.1441	-5.4155	-10.4164	31.7009
1.15	-5.5419	.3942	43.9508	-4.8190	-8.0102	24.9248
1.20	-5.1734	.5344	37.9928	-4.3112	-6.2249	19.7879
1.25	-4.8442	.6256	33.0139	-3.8754	-4.8819	15.8467
1.30	-4.5483	.6826	28.8200	-3.4987	-3.8594	12.7899
1.35	-4.2811	.7161	25.2625	-3.1712	-3.0725	10.3961
1.40	-4.0385	.7328	22.2253	-2.8846	-2.4610	8.5046
1.45	-3.8173	.7381	19.6169	-2.6326	-1.9815	6.9977
1.50	-3.6150	.7357	17.3649	-2.4100	-1.6024	5.7883
1.55	-3.4292	.7277	15.4110	-2.2124	-1.3008	4.8109
1.60	-3.2579	.7162	13.7082	-2.0362	-1.0589	4.0160
1.65	-3.0997	.7023	12.2182	-1.8786	-.8640	3.3659
1.70	-2.9529	.6872	10.9093	-1.7370	-.7059	2.8311
1.75	-2.8164	.6712	9.7556	-1.6094	-.5772	2.3891
1.80	-2.6894	.6549	8.7354	-1.4941	-.4719	2.0221
1.85	-2.5706	.6388	7.8306	-1.3895	-.3854	1.7160
1.90	-2.4595	.6229	7.0258	-1.2945	-.3140	1.4597
1.95	-2.3553	.6074	6.3083	-1.2078	-.2550	1.2442
2.00	-2.2574	.5926	5.6671	-1.1287	-.2060	1.0626

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 2.- COEFFICIENTS IN ENTHALPY CORRECTION - Continued

τ	h_1 (at τ_2) (a)	h_2 (at τ_3) (b)	h_{12} (at τ_i, i = 2, 3) (c)	h_1' (at τ_2) (d)	h_2' (at τ_3) (e)	h_{12}' (at τ_i, i = 2, 3) (f)
2.1	-2.0782	0.5646	4.5773	-0.9896	-0.1315	0.7784
2.2	-1.9183	.5394	3.6963	-.8720	-.07948	.57278
2.3	-1.7749	.5168	2.9795	-.7717	-.04313	.42243
2.4	-1.6455	.4965	2.3930	-.6856	-.01766	.31159
2.5	-1.5381	.4786	1.9109	-.6112	.00014	.22930
2.6	-1.4213	.4626	1.5130	-.5467	.01248	.16786
2.7	-1.3236	.4484	1.1838	-.4902	.02092	.12179
2.8	-1.2340	.4358	.9107	-.4407	.02655	.08712
2.9	-1.1515	.4246	.6840	-.3971	.03016	.06100
3.0	-1.0752	.4147	.4956	-.3584	.03231	.04130
3.1	-1.0046	.4058	.3392	-.3241	.03340	.02647
3.2	-.9391	.3979	.2095	-.2935	.03374	.01535
3.3	-.8780	.3909	.1023	-.2661	.03354	.00705
3.4	-.8210	.3846	.0141	-.2415	.03297	.00091
3.5	-.7677	.3789	-.0582	-.2193	.03212	-.00356
3.6	-.7178	.3739	-.1169	-.1994	.03110	-.00677
3.7	-.6709	.3693	-.1641	-.1813	.02997	-.00899
3.8	-.6268	.3651	-.2014	-.1650	.02877	-.01046
3.9	-.5854	.3614	-.2302	-.1501	.02754	-.01135
4.0	-.5461	.3580	-.2521	-.1365	.02632	-.01182
4.1	-.5090	.3550	-.2677	-.1241	.02510	-.01194
4.2	-.4739	.3522	-.2781	-.1128	.02391	-.01182
4.3	-.4406	.3497	-.2839	-.1025	.02275	-.01152
4.4	-.4091	.3473	-.2859	-.09298	.02163	-.01107
4.5	-.3792	.3452	-.2845	-.08425	.02056	-.01054
4.6	-.3506	.3432	-.2803	-.07622	.01953	-.00994
4.7	-.3234	.3414	-.2737	-.06882	.01855	-.00929
4.8	-.2976	.3398	-.2650	-.06199	.01762	-.00863
4.9	-.2728	.3383	-.2546	-.05568	.01674	-.00795
5.0	-.2493	.3369	-.2426	-.04985	.01590	-.00728
5.2	-.2051	.3344	-.2151	-.03944	.01435	-.00597
5.4	-.1646	.3322	-.1839	-.03048	.01297	-.00473
5.6	-.1273	.3303	-.1503	-.02273	.01173	-.00359
5.8	-.0929	.3286	-.1150	-.01602	.01062	-.00256
6.0	-.0611	.3272	-.0789	-.01018	.00964	-.00164
6.5	.0090	.3241	.0126	.00138	.007597	.000224
7.0	.0678	.3216	.1020	.00969	.006043	.001562
7.5	.1179	.3194	.1869	.01572	.004847	.002492
8.0	.1609	.3173	.2662	.02012	.003918	.003119
8.5	.1982	.3154	.3395	.02333	.003191	.003524

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 2.- COEFFICIENTS IN ENTHALPY CORRECTION - Concluded

τ	h_1 (at τ_2) (a)	h_2 (at τ_3) (b)	h_{12} (at τ_i, $i = 2, 3$) (c)	h_1' (at τ_2) (d)	h_2' (at τ_3) (e)	h_{12}' (at τ_i, $i = 2, 3$) (f)
9.0	0.2309	0.3137	0.4069	0.02566	0.002617	0.003768
9.5	.2596	.3120	.4688	.02733	.002158	.003896
10.0	.2850	.3102	.5254	.02850	.001789	.003941
11	.3278	.3068	.6246	.02980	.001245	.003872
12	.3624	.3034	.7078	.03020	.000879	.003686
13	.3907	.3001	.7776	.03006	.000626	.003451
14	.4142	.2969	.8365	.02959	.000448	.003201
15	.4339	.2937	.8863	.02893	.0003205	.0029541
16	.4506	.2905	.9285	.02816	.0002282	.0027202
17	.4648	.2875	.9645	.02734	.0001603	.0025030
18	.4770	.2845	.9952	.02650	.0001101	.0023036
19	.4876	.2815	1.0214	.02566	.0000725	.0021220
20	.4967	.2786	1.0438	.02484	.0000441	.0019572
22	.5116	.2730	1.0795	.02326	.0000065	.0016728
24	.5231	.2677	1.1057	.02180	-.0000151	.0014396
26	.5320	.2627	1.1246	.02046	-.0000273	.0012477
28	.5390	.2579	1.1381	.01925	-.0000340	.0010888
30	.5444	.2533	1.1475	.01815	-.0000373	.0009562
35	.5533	.2429	1.1581	.01581	-.0000381	.0007090
40	.5579	.2337	1.1572	.01395	-.0000348	.0005424
45	.5598	.2255	1.1499	.01244	-.0000306	.0004259
50	.5600	.2181	1.1387	.01120	-.0000266	.0003416
60	.5576	.2054	1.1112	.00929	-.0000201	.0002315
70	.5532	.1948	1.0812	.00790	-.0000154	.0001655
80	.5479	.1857	1.0515	.00685	-.0000121	.0001232
90	.5423	.1779	1.0230	.00603	-.00000961	.00009472
100	.5366	.1710	.9961	.00537	-.00000780	.00007470
200	.4890	.1298	.8047	.00244	-.00000178	.00001509
300	.4567	.1093	.6943	.00152	-.00000071	.00000579
400	.4331	.0964	.6208	.00108	-.00000037	.00000291

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i (b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i (P/p_i)^2$.

TABLE 3.- COEFFICIENTS IN ENTROPY CORRECTION

$$\Big[(S - S^0)/R = \log_e \left(P_0V/RT\right) + s_1(\tau_2)\left(b_2/V\right) + \left[s_2(\tau_3)\left(b_3^2/b_2^2\right) + s_{12}(\tau_2) - s_{12}(\tau_3)\left(b_3^2/b_2^2\right)\right]\left(b_2/V\right)^2$$

$$= \log_e \left(P_0/P\right) + s_1'(\tau_2)\left(P/p_2\right) + \left[s_2'(\tau_3)\left(p_2^2/p_3^2\right) + s_{12}'(\tau_2) - s_{12}'(\tau_3)\left(p_2^2/p_3^2\right)\right]\left(P/p_2\right)^2\Big]$$

τ	s_1 (at τ_2) (a)	s_2 (at τ_3) (b)	s_{12} (at τ_i, $i = 2, 3$) (c)	s_1' (at τ_2) (d)	s_2' (at τ_3) (e)	s_{12}' (at τ_i, $i = 2, 3$) (f)
0.15	-2,283.6		4.7×10^6	-18,333		1.86×10^8
.20	-354.676		181,300	-2,326.27		4,317,000
.25	-110.184		25,890	-633.55		422,230
.30	-48.727		6,988.75	-255.36		84,150
.35	-26.493		2,690.97	-129.28		25,089.5
.40	-16.468		1,289.784	-75.668		9,616.01
.45	-11.234		714.646	-48.866		3,503.64
.50	-8.2035		438.228	-33.847		2,227.19
.55	-6.3081		275.366	-24.695		1,276.90
.60	-5.0509		202.050	-18.748		741.06
.65	-4.1773		147.333	-14.685		466.16
.70	-3.5471	-12.65	111.196	-11.7959	-134.7	306.02
.75	-3.0781	-8.13	86.292	-9.6720	-86.99	208.06
.80	-2.7199	-5.38	68.516	-8.0677	-58.28	145.66
.85	-2.4403	-3.642	55.449	-6.8275	-40.26	104.52
.90	-2.2178	-2.515	45.601	-5.8499	-28.55	76.61
.95	-2.0378	-1.765	38.020	-5.0661	-20.69	57.19
1.00	-1.8902	-1.254	32.073	-4.4283	-15.28	43.38
1.05	-1.7674	-.9009	27.3341	-3.9025	-11.477	33.370
1.10	-1.6643	-.6542	23.5026	-3.4642	-8.743	25.990
1.15	-1.5766	-.4791	20.3654	-3.0950	-6.744	20.466
1.20	-1.5015	-.3542	17.7686	-2.7812	-5.260	16.277
1.25	-1.4366	-.2643	15.5967	-2.5123	-4.143	13.060
1.30	-1.3801	-.1996	13.7637	-2.2802	-3.291	10.563
1.35	-1.3305	-.1529	12.2042	-2.0784	-2.634	8.605
1.40	-1.2868	-.1197	10.8675	-1.9019	-2.123	7.056
1.45	-1.2479	-.0961	9.7139	-1.7467	-1.721	5.820
1.50	-1.2133	-.0793	8.7122	-1.6094	-1.403	4.827
1.55	-1.1822	-.0682	7.8373	-1.4875	-1.148	4.023
1.60	-1.1541	-.0609	7.0691	-1.3788	-.9440	3.3677
1.65	-1.1287	-.0565	6.3914	-1.2813	-.7785	2.8308
1.70	-1.1056	-.0542	5.7909	-1.1937	-.6439	2.3884
1.75	-1.0846	-.0536	5.2565	-1.1146	-.5337	2.0219
1.80	-1.0653	-.0542	4.7790	-1.0430	-.4431	1.7168
1.85	-1.0476	-.0557	4.3509	-.9779	-.3683	1.4618
1.90	-1.0312	-.0578	3.9658	-.9186	-.3062	1.2477
1.95	-1.0161	-.0603	3.6182	-.8645	-.2546	1.0674
2.00	-1.0021	-.0631	3.3036	-.8149	-.2114	.9149

[a] Multiply values by b_2/V.

[b] Multiply values by $\left(b_3/V\right)^2$.

[c] Multiply values by $(-1)^i\left(b_i/V\right)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $\left(P/p_3\right)^2$.

[f] Multiply values by $(-1)^i\left(P/p_i\right)^2$.

TABLE 3.- COEFFICIENTS IN ENTROPY CORRECTION - Continued

τ	s_1 (at τ_2) (a)	s_2 (at τ_3) (b)	s_{12} (at τ_i, $i = 2, 3$) (c)	s_1' (at τ_2) (d)	s_2' (at τ_3) (e)	s_{12}' (at τ_i, $i = 2, 3$) (f)
2.1	-0.9769	-0.0693	2.7581	-0.7274	-0.1450	0.6753
2.2	-.9549	-.0756	2.3041	-.6530	-.0979	.5009
2.3	-.9355	-.0818	1.9228	-.5892	-.0642	.3725
2.4	-.9183	-.0876	1.5999	-.5341	-.0400	.2772
2.5	-.9029	-.0930	1.3245	-.4862	-.02253	.20585
2.6	-.8890	-.0980	1.0881	-.4443	-.00993	.15215
2.7	-.8764	-.1026	.8838	-.4074	-.00085	.11150
2.8	-.8650	-.1068	.7065	-.3748	.00565	.08061
2.9	-.8544	-.1105	.5517	-.3458	.01026	.05706
3.0	-.8448	-.1138	.4159	-.3200	.01347	.03909
3.1	-.8358	-.1168	.2965	-.2968	.01565	.02536
3.2	-.8275	-.1195	.1909	-.2760	.01705	.01489
3.3	-.8197	-.12175	.09725	-.2572	.01789	.00693
3.4	-.8125	-.12380	.01395	-.2402	.01831	.00091
3.5	-.8057	-.12564	-.06037	-.2248	.01841	-.00361
3.6	-.7993	-.12722	-.12687	-.2107	.01828	-.00696
3.7	-.7932	-.12867	-.18651	-.1979	.01798	-.00940
3.8	-.7875	-.12989	-.24013	-.1861	.01757	-.01113
3.9	-.7820	-.13096	-.28817	-.1753	.01707	-.01230
4.0	-.7769	-.13188	-.33203	-.1654	.01653	-.01307
4.1	-.7720	-.13260	-.37145	-.1562	.01595	-.01349
4.2	-.7673	-.1333	-.40716	-.1478	.01534	-.01365
4.3	-.7628	-.1339	-.43956	-.1399	.01473	-.01362
4.4	-.7585	-.13439	-.46897	-.1327	.01413	-.01344
4.5	-.7544	-.1348	-.49573	-.1259	.01353	-.01315
4.6	-.7504	-.13513	-.52010	-.1197	.01294	-.01277
4.7	-.7466	-.13538	-.54229	-.1138	.01237	-.01233
4.8	-.7429	-.13556	-.56254	-.1084	.01182	-.01186
4.9	-.7394	-.13568	-.58103	-.1033	.01129	-.01135
5.0	-.7359	-.13574	-.59791	-.09852	.01078	-.01083
5.2	-.7294	-.13581	-.62744	-.08986	.009828	-.009778
5.4	-.7233	-.13566	-.65214	-.08221	.008958	-.008745
5.6	-.7175	-.13536	-.67279	-.07543	.008169	-.007760
5.8	-.7121	-.13492	-.69007	-.06939	.007455	-.006838
6.0	-.7069	-.13439	-.70448	-.06400	.006810	-.005988

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 3.- COEFFICIENTS IN ENTROPY CORRECTION - Concluded

τ	s_1 (at τ_2) (a)	s_2 (at τ_3) (b)	s_{12} (at τ_i, $i = 2, 3$) (c)	s_1' (at τ_2) (d)	s_2' (at τ_3) (e)	s_{12}' (at τ_i, $i = 2, 3$) (f)
6.5	-0.6950	-0.13275	-0.73070	-0.05277	0.005458	-0.004174
7.0	-.6843	-.13088	-.74661	-.04404	.004408	-.002768
7.5	-.6747	-.12892	-.75546	-.03712	.003587	-.001696
8.0	-.6659	-.12694	-.75939	-.03156	.002940	-.000887
8.5	-.6578	-.12492	-.75984	-.02703	.002428	-.000280
9.0	-.6503	-.12287	-.75783	-.02330	.002018	.000173
9.5	-.6433	-.12084	-.75405	-.02019	.001689	.000508
10.0	-.6367	-.11892	-.74902	-.01759	.001420	.000754
11	-.6248	-.11520	-.73659	-.01350	.001020	.001059
12	-.6140	-.11172	-.72241	-.01048	.000745	.001203
13	-.6043	-.10848	-.70755	-.008214	.000552	.001254
14	-.5954	-.10546	-.69262	-.006471	.0004136	.0012504
15	-.5872	-.10264	-.67795	-.005110	.0003127	.0012162
16	-.5797	-.10000	-.66370	-.004033	.0002380	.0011653
17	-.5726	-.09753	-.64999	-.003170	.0001818	.0011064
18	-.5660	-.09522	-.63684	-.002472	.0001392	.0010443
19	-.5599	-.09306	-.62427	-.001902	.0001065	.0009823
20	-.5540	-.09103	-.61227	-.001433	.0000811	.0009221
22	-.5433	-.08732	-.58992	-.000720	.0000458	.0008105
24	-.5337	-.08403	-.56956	-.000220	.0000237	.0007125
26	-.5249	-.08108	-.55101	.000137	.0000097	.0006280
28	-.5168	-.07842	-.53402	.000395	.0000007	.0005556
30	-.5094	-.07600	-.51843	.000583	-.0000050	.0004935
35	-.4931	-.07080	-.48451	.000860	-.0000117	.0003738
40	-.4793	-.06649	-.45630	.000983	-.0000133	.0002903
45	-.4673	-.06290	-.43240	.001028	-.0000130	.0002305
50	-.4567	-.05982	-.41184	.001033	-.0000120	.0001866
60	-.4388	-.05480	-.37813	.000989	-.00000973	.00012807
70	-.4241	-.05086	-.35148	.000921	-.00000776	.00009239
80	-.4117	-.04768	-.32974	.000851	-.00000622	.00006926
90	-.4010	-.04502	-.31157	.000785	-.00000505	.00005353
100	-.3915	-.04276	-.29610	.000725	-.00000416	.00004240
200	-.3339	-.03040	-.21094	.000388	-.00000100	.00000874
300	-.3036	-.02486	-.17264	.000255	-.00000041	.00000338
400	-.2836	-.02156	-.14968	.000187	-.00000021	.00000171

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 4.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT VOLUME

$$\begin{aligned}\Big[\left(C_v - C_v^o\right)/R &= w_1(\tau_2)\left(b_2/V\right) + \left[w_2(\tau_3)\left(b_3^2/b_2^2\right) + w_{12}(\tau_2) - w_{12}(\tau_3)\left(b_3^2/b_2^2\right)\right]\left(b_2/V\right)^2 \\ &= w_1'(\tau_2)\left(P/p_2\right) + \left[w_2'(\tau_3)\left(p_2^2/p_3^2\right) + w_{12}'(\tau_2) - w_{12}'(\tau_3)\left(p_2^2/p_3^2\right)\right]\left(P/p_2\right)^2\Big]\end{aligned}$$

τ	w_1 (at τ_2) (a)	w_2 (at τ_3) (b)	w_{12} (at τ_i, $i = 2, 3$) (c)	w_1' (at τ_2) (d)	w_2' (at τ_3) (e)	w_{12}' (at τ_i, $i = 2, 3$) (f)
0.15	16,686		-6.14×10^7	111,240		-2.38×10^{10}
.20	2,029.4		-1,763,500	10,146.8		-3.85×10^8
.25	528.3		-202,200	2,113.3		-28,280,000
.30	203.66		-46,190	678.87		-4,501,000
.35	98.970		-15,614	282.771		-112,300
.40	55.832		-6,746.1	139.580		-37,350
.45	34.899		-3,436.3	77.553		-15,112
.50	23.4921		-1,965.1	46.9842		-7,040.8
.55	16.7181		-1,224.3	30.3965		-3,645.4
.60	12.4210		-814.1	20.7017		-2,047.5
.65	9.5495		-569.5	14.6915		-1,226.6
.70	7.5484	81.3	-414.9	10.7834	238.5	-774.2
.75	6.1051	52.0	-312.5	8.1401	137.7	-510.2
.80	5.0336	34.4	-241.8	6.2920	83.2	-348.5
.85	4.2186	23.5	-191.5	4.9631	52.1	-245.4
.90	3.5857	16.4	-154.6	3.9841	33.7	-177.4
.95	3.0853	11.7	-126.9	3.2477	22.4	-131.1
1.00	2.6833	8.4	-105.7	2.6833	15.2	-98.9
1.05	2.3560	6.2	-89.1	2.2438	10.6	-75.9
1.10	2.0862	4.5	-76.0	1.8965	7.46	-59.10
1.15	1.8613	3.38	-65.44	1.6185	5.35	-46.69
1.20	1.6720	2.53	-56.83	1.3933	3.89	-37.34
1.25	1.5114	1.89	-49.75	1.2091	2.86	-30.19
1.30	1.3739	1.42	-43.85	1.0568	2.13	-24.66
1.35	1.2554	1.06	-38.90	.9299	1.60	-20.33
1.40	1.1525	.784	-34.701	.8232	1.209	-16.896
1.45	1.0628	.574	-31.119	.7330	.922	-14.151
1.50	.9840	.410	-28.039	.6560	.707	-11.937
1.55	.9144	.282	-25.374	.5899	.545	-10.134
1.60	.8528	.183	-23.054	.5330	.422	-8.655
1.65	.7979	.107	-21.024	.4836	.328	-7.434
1.70	.7489	.046	-19.238	.4405	.255	-6.417
1.75	.7048	-.002	-17.660	.4027	.199	-5.567

[a] Multiply values by b_2/V.

[b] Multiply values by $\left(b_3/V\right)^2$.

[c] Multiply values by $(-1)^i\left(b_i/V\right)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $\left(P/p_3\right)^2$.

[f] Multiply values by $(-1)^i\left(P/p_i\right)^2$.

TABLE 4.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT VOLUME - Continued

τ	w_1 (at τ_2) (a)	w_2 (at τ_3) (b)	w_{12} (at τ_i, i = 2, 3) (c)	w_1' (at τ_2) (d)	w_2' (at τ_3) (e)	w_{12}' (at τ_i, i = 2, 3) (f)
1.80	0.6651	-0.039	-16.258	0.3695	0.1548	-4.8512
1.85	.6293	-.067	-15.008	.3402	.1205	-4.2452
1.90	.5968	-.089	-13.890	.3141	.0935	-3.7296
1.95	.5672	-.105	-12.886	.2909	.0723	-3.2888
2.00	.5403	-.117	-11.980	.2702	.0555	-2.9103
2.1	.4931	-.131	-10.420	.2348	.0319	-2.3011
2.2	.4532	-.138	-9.129	.2060	.0166	-1.8410
2.3	.4193	-.139	-8.050	.1823	.0070	-1.4885
2.4	.3902	-.136	-7.141	.1626	.0011	-1.2151
2.5	.3651	-.130	-6.367	.1460	-.0026	-1.0004
2.6	.3432	-.123	-5.703	.1320	-.0047	-.8301
2.7	.3241	-.116	-5.130	.1200	-.0060	-.6938
2.8	.3073	-.109	-4.632	.1098	-.0066	-.5836
2.9	.2924	-.101	-4.197	.1008	-.0068	-.4939
3.0	.2792	-.093	-3.815	.09307	-.0067	-.4203
3.1	.2674	-.085	-3.478	.08626	-.00651	-.35952
3.2	.2568	-.078	-3.178	.08025	-.00627	-.30895
3.3	.2474	-.072	-2.911	.07497	-.00592	-.26667
3.4	.2388	-.065	-2.672	.07024	-.00554	-.23110
3.5	.2310	-.059	-2.458	.06600	-.00517	-.20102
3.6	.2240	-.053	--2.265	.06222	-.00482	-.17548
3.7	.2176	-.048	-2.091	.05881	-.00451	-.15367
3.8	.2117	-.043	-1.932	.05572	-.00418	-.13499
3.9	.2064	-.039	-1.788	.05292	-.00387	-.11892
4.0	.2014	-.035	-1.657	.05036	-.00362	-.10503
4.1	.1969	-.031	-1.537	.04803	-.00339	-.09299
4.2	.1927	-.027	-1.428	.04589	-.00316	-.08253
4.3	.1889	-.023	-1.327	.04392	-.00291	-.07340
4.4	.1853	-.020	-1.234	.04211	-.00271	-.06540
4.5	.1820	-.017	-1.148	.04044	-.00250	-.05839
4.6	.1789	-.014	-1.069	.03889	-.00234	-.05222
4.7	.1760	-.011	-.996	.03745	-.00218	-.04678
4.8	.1733	-.008	-.928	.03611	-.00203	-.04196
4.9	.1708	-.005	-.865	.03486	-.00188	-.03769
5.0	.1685	-.0031	-.8066	.03370	-.00176	-.03390
5.2	.1642	.0018	-.7011	.03158	-.00152	-.02752
5.4	.1605	.0062	-.6090	.02972	-.00133	-.02242
5.6	.1571	.0101	-.5282	.02806	-.00116	-.01832
5.8	.1541	.0134	-.4571	.02657	-.00102	-.01501
6.0	.1514	.0165	-.3941	.02524	-.00090	-.01231

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 4.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT VOLUME - Concluded

τ	w_1 (at τ_2) (a)	w_2 (at τ_3) (b)	w_{12} (at τ_i, $i = 2, 3$) (c)	w_1' (at τ_2) (d)	w_2' (at τ_3) (e)	w_{12}' (at τ_i, $i = 2, 3$) (f)
6.5	0.1458	0.0226	-0.2653	0.02244	-0.000682	-0.007494
7.0	.1414	.0270	-.1674	.02020	-.000535	-.004501
7.5	.1378	.0303	-.0915	.01838	-.000434	-.002598
8.0	.1349	.0327	-.0319	.01686	-.000361	-.001369
8.5	.1325	.0346	.0156	.01558	-.000306	-.000568
9.0	.1304	.0361	.0539	.01449	-.000263	-.000044
9.5	.1286	.0374	.0850	.01354	-.000229	.000299
10.0	.1270	.0383	.1105	.01270	-.000203	.000519
11	.1245	.0390	.1490	.01132	-.000167	.000741
12	.1224	.0396	.1757	.01020	-.000140	.000805
13	.1206	.0400	.1945	.00928	-.000118	.000796
14	.1192	.0402	.2078	.00851	-.000102	.000753
15	.1179	.0403	.2173	.00786	-.000088	.000698
16	.1167	.0403	.2239	.00730	-.000078	.000640
17	.1157	.0401	.2284	.00681	-.000069	.000583
18	.1147	.0399	.2314	.00638	-.000061	.000530
19	.1139	.0396	.2333	.00599	-.000055	.000481
20	.1131	.0393	.2343	.00565	-.000050	.000437
22	.1116	.0385	.2345	.00507	-.000042	.000363
24	.1103	.0376	.2330	.00460	-.000036	.000303
26	.1091	.0367	.2306	.00420	-.000031	.000256
28	.1080	.0357	.2276	.00386	-.000027	.000218
30	.1070	.0348	.2243	.00357	-.000024	.000187
35	.1047	.0329	.2155	.00299	-.0000179	.0001312
40	.1027	.0313	.2069	.00257	-.0000138	.0000960
45	.1010	.0299	.1988	.00224	-.0000109	.0000726
50	.09937	.0286	.1914	.00199	-.0000088	.0000564
60	.09658	.0264	.1784	.00161	-.0000060	.0000362
70	.09419	.0246	.1675	.001346	-.0000044	.0000248
80	.09211	.0232	.1582	.001151	-.0000033	.0000178
90	.09026	.0220	.1503	.001003	-.0000025	.0000133
100	.08861	.0209	.1434	.000886	-.0000020	.0000102
200	.07778	.0150	.1040	.000389	-.00000042	.00000180
300	.07165	.0124	.0855	.000239	-.00000017	.00000065
400	.06745	.0107	.0743	.000169	-.00000008	.00000031

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 5.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT PRESSURE

$$\Big[(c_p - c_p^{o})/R = c_1(\tau_2)(b_2/V) + \left[c_2(\tau_3)(b_3^2/b_2^2) + c_{12}(\tau_2) - c_{12}(\tau_3)(b_3^2/b_2^2)\right](b_2/V)^2$$

$$= c_1'(\tau_2)(P/p_2) + \left[c_2'(\tau_3)(p_2^2/p_3^2) + c_{12}'(\tau_2) - c_{12}'(\tau_3)(p_2^2/p_3^2)\right](P/p_2)^2\Big]$$

τ	c_1 (at τ_2) (a)	c_2 (at τ_3) (b)	c_{12} (at τ_i, $i = 2, 3$) (c)	c_1' (at τ_2) (d)	c_2' (at τ_3) (e)	c_{12}' (at τ_i, $i = 2, 3$) (f)
0.15	22,186		-7.24×10^7	147,907		-2.76×10^9
.20	2,959.9		-2.304×10^6	14,799		-4.942×10^7
.25	845.1		-2.91×10^5	3,380.4		-4.004×10^6
.30	356.88		-72,550	1,189.6		-6.956×10^5
.35	189.47		-26,503	541.33		-187,340
.40	116.37		-12,248	290.92		-66,516
.45	78.878		-5,761.6	175.284		-28,452
.50	57.3395		-3,972.9	114.679		-13,891.5
.55	43.8824		-2,602.8	79.7863		-7,549.0
.60	34.9187		-1,778.9	58,1978		-4,340.1
.65	28.6405		-1,282.2	44.0623		-2,671.0
.70	24.0627	310.2	-957.8	34.3752	864.4	-1,723.4
.75	20.6131	220.5	-736.2	27.4841	545.0	-1,155.8
.80	17.9419	162.3	-579.4	22.4274	358.3	-800.6
.85	15.8255	122.9	-465.0	18.6182	243.8	-569.9
.90	14.1156	95.3	-379.3	15.6840	170.8	-415.2
.95	12.7108	75.4	-313.8	13.3798	122.6	-308.6
1.00	11.5398	60.7	-262.7	11.5398	90.0	-233.5
1.05	10.5513	49.5	-222.3	10.0489	67.2	-179.3
1.10	9.7074	41.0	-189.8	8.8249	51.1	-139.6
1.15	8.9798	34.27	-163.35	7.8086	39.37	-110.06
1.20	8.3470	28.93	-141.59	6.9558	30.73	-87.69
1.25	7.7922	24.64	-123.50	6.2337	24.26	-70.55
1.30	7.3023	21.14	-108.33	5.6171	19.35	-57.26
1.35	6.8669	18.26	-95.50	5.0866	15.58	-46.84
1.40	6.4778	15.867	-84.577	4.6270	12.642	-38.605
1.45	6.1280	13.862	-75.208	4.2262	10.338	-32.026
1.50	5.8122	12.165	-67.125	3.8748	8.509	-26.731
1.55	5.5258	10.722	-60.111	3.5650	7.047	-22.436
1.60	5.2648	9.486	-53.995	3.2905	5.869	-18.928
1.65	5.0263	8.423	-48.636	3.0462	4.913	-16.045
1.70	4.8074	7.499	-43.919	2.8279	4.131	-13.661
1.75	4.6059	6.696	-39.751	2.6319	3.489	-11.678

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 5.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT PRESSURE - Continued

τ	c_1 (at τ_2) (a)	c_2 (at τ_3) (b)	c_{12} (at τ_i, $i = 2, 3$) (c)	c_1' (at τ_2) (d)	c_2' (at τ_3) (e)	c_{12}' (at τ_i, $i = 2, 3$) (f)
1.80	4.4198	5.993	-36.054	2.4554	2.9573	-10.0201
1.85	4.2475	5.375	-32.763	2.2959	2.5156	-8.6278
1.90	4.0875	4.830	-29.824	2.1513	2.1466	-7.4529
1.95	3.9386	4.348	-27.191	2.0198	1.8371	-6.4573
2.00	3.7997	3.920	-24.826	1.8999	1.5761	-5.6103
2.1	3.5481	3.197	-20.771	1.6896	1.1680	-4.2670
2.2	3.3265	2.614	-17.450	1.5120	.8712	-3.2742
2.3	3.1297	2.141	-14.705	1.3608	.6531	-2.5314
2.4	2.9540	1.754	-12.419	1.2308	.4910	-1.9696
2.5	2.7961	1.434	-10.502	1.1185	.3692	-1.5405
2.6	2.6536	1.168	-8.885	1.0206	.2772	-1.2099
2.7	2.5242	.944	-7.513	.9349	.2069	-.9532
2.8	2.4062	.756	-6.344	.8594	.1530	-.7526
2.9	2.2983	.597	-5.343	.7925	.1115	-.5947
3.0	2.1992	.462	-4.482	.7331	.07944	-.46986
3.1	2.1078	.346	-3.740	.6800	.05453	-.37062
3.2	2.0234	.246	-3.097	.6323	.03509	-.29142
3.3	1.9451	.161	-2.540	.5894	.01998	-.22799
3.4	1.8723	.087	-2.054	.5507	.00825	-.17702
3.5	1.8045	.024	-1.631	.5156	-.00083	-.13598
3.6	1.7411	-.031	-1.262	.4836	-.00789	-.10286
3.7	1.6817	-.079	-.939	.4545	-.01331	-.07611
3.8	1.6260	-.121	-.656	.4279	-.01742	-.05449
3.9	1.5737	-.157	-.409	.4035	-.02049	-.03707
4.0	1.5244	-.189	-.191	.3811	-.02279	-.02292
4.1	1.4779	-.217	0	.3605	-.02446	-.01156
4.2	1.4339	-.241	.168	.3414	-.02557	-.00243
4.3	1.3923	-.261	.314	.3238	-.02623	.00488
4.4	1.3529	-.279	.443	.3075	-.02660	.01069
4.5	1.3155	-.294	.556	.2923	-.02669	.01527
4.6	1.2799	-.307	.655	.2782	-.02661	.01884
4.7	1.2461	-.318	.741	.2651	-.02635	.02159
4.8	1.2138	-.328	.815	.2529	-.02597	.02366
4.9	1.1830	-.336	.880	.2414	-.02549	.02518
5.0	1.1537	-.3433	.9366	.2307	-.02496	.02623
5.2	1.0987	-.3532	1.0260	.2113	-.023713	.027291
5.4	1.0484	-.3597	1.0902	.1941	-.022380	.027343
5.6	1.0020	-.3636	1.1341	.1789	-.021024	.026735
5.8	.9591	-.3654	1.1617	.1654	-.019688	.025708
6.0	.9194	-.3653	1.1763	.1532	-.018394	.024429

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 5.- COEFFICIENTS IN CORRECTION FOR SPECIFIC HEAT AT CONSTANT PRESSURE - Concluded

τ	c_1 (at τ_2) (a)	c_2 (at τ_3) (b)	c_{12} (at τ_i, $i = 2, 3$) (c)	c_1' (at τ_2) (d)	c_2' (at τ_3) (e)	c_{12}' (at τ_i, $i = 2, 3$) (f)
6.5	0.8319	-0.3601	1.1709	0.1280	-0.015453	0.020784
7.0	.7579	-.3499	1.1264	.1083	-.012957	.017170
7.5	.6947	-.3367	1.0595	.09262	-.010880	.013941
8.0	.6399	-.3222	.9805	.07998	-.009167	.011186
8.5	.5920	-.3071	.8957	.06965	-.007758	.008889
9.0	.5498	-.2922	.8090	.06109	-.006598	.006997
9.5	.5123	-.2776	.7229	.05393	-.005638	.005448
10.0	.4788	-.2630	.6389	.04788	-.004837	.004183
11	.4214	-.2367	.4804	.03831	-.003615	.002311
12	.3740	-.2125	.3363	.03116	-.002744	.001067
13	.3342	-.1906	.2070	.02571	-.002112	.000241
14	.3004	-.1711	.0917	.02145	-.001646	-.000306
15	.2712	-.1535	-.0110	.01808	-.001298	-.000664
16	.2458	-.1378	-.1027	.01536	-.001033	-.000896
17	.2235	-.1237	-.1845	.01315	-.0008291	-.0010395
18	.2037	-.1109	-.2576	.01132	-.0006704	-.0011231
19	.1862	-.0996	-.3232	.009798	-.0005460	-.0011653
20	.1704	-.0892	-.3821	.008520	-.0004467	-.0011790
22	.1433	-.0712	-.4830	.006514	-.0003033	-.0011540
24	.1209	-.0561	-.5655	.005036	-.0002083	-.0010926
26	.1020	-.0435	-.6336	.003922	-.0001441	-.0010170
28	.0859	-.0327	-.6901	.003067	-.0000995	-.0009381
30	.0720	-.0234	-.7374	.002400	-.0000681	-.0008615
35	.0445	-.0051	-.8254	.001271	-.0000232	-.0006928
40	.0241	.0081	-.8837	.000603	-.0000028	-.0005601
45	.0084	.0180	-.9227	.000188	.0000068	-.0004578
50	-.0039	.0256	-.9488	-.000079	.0000110	-.0003787
60	-.0221	.0361	-.9768	-.000369	.0000131	-.0002683
70	-.0348	.0428	-.9860	-.000497	.0000122	-.0001977
80	-.0441	.0473	-.9850	-.000551	.0000107	-.0001506
90	-.0510	.0502	-.9784	-.000567	.0000092	-.0001178
100	-.0564	.0523	-.9686	-.000564	.00000785	-.00009424
200	-.0773	.0554	-.8445	-.000386	.00000218	-.00002032
300	-.0814	.0521	-.7494	-.000271	.00000092	-.00000798
400	-.0821	.0487	-.6804	-.000205	.00000049	-.00000407

[a] Multiply values by b_2/V.

[b] Multiply values by $(b_3/V)^2$.

[c] Multiply values by $(-1)^i(b_i/V)^2$.

[d] Multiply values by P/p_2.

[e] Multiply values by $(P/p_3)^2$.

[f] Multiply values by $(-1)^i(P/p_i)^2$.

TABLE 6.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SPECIFIC-HEAT RATIO γ

(a) Coefficients of density-dependent corrections, $2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^{2}B^{(2)}(\tau_2)2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + \ldots B^{(2)}(\tau_2)$

τ_2	γ^{o} [a]									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-3,749.3	-469.8	-119.0	148.3	332.1	432.6	449.6	383.1	233.3	0
.20	-281.60	47.50	77.08	96.51	105.79	104.93	93.92	72.76	41.45	0
.25	-23.628	42.178	46.151	47.483	46.173	42.222	35.629	26.394	14.518	0
.30	11.626	28.700	28.676	27.635	25.575	22.496	18.400	13.285	7.152	0
.35	16.344	20.363	19.550	18.241	16.438	14.140	11.548	8.060	4.277	0
.40	15.542	15.281	14.348	13.135	11.644	9.874	7.824	5.495	2.887	0
.45	13.809	12.008	11.118	10.055	8.814	7.400	5.812	4.049	2.112	0
.50	12.1240	9.7802	8.9688	8.0399	6.9936	5.8298	4.5485	3.1498	1.6336	0
.55	10.6793	8.1908	7.4595	6.6447	5.7462	4.7641	3.6985	2.5492	1.3164	0
.60	9.4780	7.0117	6.3526	5.6314	4.8481	4.0027	3.0952	2.1256	1.0938	0
.65	8.4831	6.1085	5.5121	4.8679	4.1759	3.4362	2.6488	1.8136	.9307	0
.70	7.6546	5.3979	4.8553	4.2749	3.6568	3.0009	2.3073	1.5759	.8068	0
.75	6.9586	4.8264	4.3299	3.8030	3.2454	2.6574	2.0388	1.3898	.7101	0
.80	6.3684	4.3579	3.9013	3.4195	2.9125	2.3803	1.8230	1.2405	.6328	0
.85	5.8629	3.9677	3.5456	3.1024	2.6380	2.1526	1.6461	1.1185	.5698	0
.90	5.4262	3.6382	3.2462	2.8362	2.4085	1.9625	1.4988	1.0171	.5175	0
.95	5.0458	3.3566	2.9910	2.6100	2.2136	1.8017	1.3744	.9517	.4736	0
1.00	4.7118	3.1133	2.7711	2.4155	2.0464	1.6640	1.2681	.8588	.4361	0
1.05	4.4164	2.9012	2.5798	2.2466	1.9016	1.5448	1.1763	.7960	.4039	0
1.10	4.1537	2.7147	2.4119	2.0986	1.7749	1.4408	1.0963	.7413	.3758	0
1.15	3.9185	2.5496	2.2635	1.9681	1.6633	1.3493	1.0259	.6932	.3513	0
1.20	3.7069	2.4025	2.1514	1.8520	1.5642	1.2681	.9636	.6508	.3296	0
1.25	3.5155	2.2705	2.0131	1.7482	1.4757	1.1957	.9081	.6130	.3103	0
1.30	3.3417	2.1516	1.9067	1.6549	1.3962	1.1307	.8584	.5791	.2930	0
1.35	3.1831	2.0438	1.8103	1.5705	1.3244	1.0721	.8135	.5486	.2774	0
1.40	3.0379	1.9457	1.7226	1.4938	1.2593	1.0189	.7729	.5210	.2634	0
1.45	2.9045	1.8561	1.6427	1.4239	1.1999	.9705	.7359	.4959	.2506	0
1.50	2.7815	1.7739	1.5694	1.3599	1.1456	.9263	.7021	.4730	.2390	0
1.55	2.6678	1.6982	1.5020	1.3011	1.0957	.8857	.6711	.4520	.2283	0
1.60	2.5623	1.6284	1.4397	1.2469	1.0497	.8483	.6426	.4327	.2185	0
1.65	2.4643	1.5637	1.3822	1.1967	1.0072	.8138	.6165	.4149	.2094	0
1.70	2.3729	1.5036	1.3288	1.1502	.9678	.7818	.5919	.3984	.2011	0
1.75	2.2875	1.4477	1.2790	1.1069	.9312	.7520	.5693	.3831	.1933	0
1.80	2.2075	1.3954	1.2326	1.0665	.8971	.7243	.5482	.3688	.1861	0
1.85	2.1325	1.3466	1.1893	1.0288	.8652	.6985	.5286	.3555	.1793	0
1.90	2.0619	1.3008	1.1487	.9935	.8354	.6743	.5102	.3431	.1730	0
1.95	1.9955	1.2578	1.1105	.9604	.8074	.6516	.4929	.3315	.1672	0
2.0	1.9328	1.2173	1.0746	.9292	.7811	.6303	.4768	.3205	.1616	0
2.1	1.8176	1.1432	1.0089	.8722	.7330	.5913	.4472	.3006	.1515	0
2.2	1.7141	1.0768	.9501	.8212	.6900	.5565	.4208	.2828	.1425	0
2.3	1.6206	1.0171	.8973	.7754	.6513	.5253	.3971	.2668	.1345	0

[a] Multiply all entries by $b_{2}\rho$ to obtain correction.

TABLE 6.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SPECIFIC-HEAT RATIO γ - Continued

(a) Coefficients of density-dependent corrections, $2\gamma^0(\gamma^0 - 1)B^{(1)}(\tau_2) + (\gamma^0 - 1)^2B^{(2)}(\tau_2)$ - Concluded

τ_2	γ^0 (a)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	1.5358	0.9631	0.8496	0.7340	0.6166	0.4971	0.3758	0.2525	0.1272	0
2.5	1.4585	.9140	.8062	.6965	.5850	.4716	.3565	.2395	.1206	0
2.6	1.3877	.8692	.7667	.6623	.5562	.4484	.3389	.2276	.1147	0
2.7	1.3227	.8282	.7303	.6309	.5298	.4270	.3227	.2168	.1092	0
2.8	1.2627	.7904	.6970	.6020	.5056	.4075	.3079	.2068	.1042	0
2.9	1.2073	.7556	.6663	.5755	.4852	.3895	.2943	.1977	.0996	0
3.0	1.1559	.7233	.6378	.5509	.4626	.3728	.2817	.1892	.0953	0
3.1	1.1081	.6934	.6115	.5281	.4435	.3574	.2701	.1814	.0914	0
3.2	1.0633	.6653	.5869	.5069	.4256	.3431	.2592	.1741	.0877	0
3.3	1.0219	.6393	.5639	.4870	.4089	.3297	.2491	.1673	.0843	0
3.4	.9829	.6152	.5425	.4683	.3934	.3171	.2396	.1610	.0811	0
3.5	.9463	.5924	.5224	.4513	.3789	.3053	.2308	.1550	.0781	0
3.6	.9118	.5710	.5036	.4350	.3653	.2943	.2223	.1493	.0753	0
3.7	.8794	.5508	.4858	.4197	.3525	.2841	.2147	.1442	.0727	0
3.8	.8488	.5319	.4691	.4053	.3403	.2744	.2074	.1393	.0702	0
3.9	.8198	.5139	.4533	.3916	.3289	.2652	.2005	.1347	.0679	0
4.0	.7924	.4970	.4384	.3788	.3182	.2565	.1939	.1303	.0656	0
4.1	.7665	.4809	.4242	.3666	.3079	.2483	.1877	.1261	.0636	0
4.2	.7418	.4656	.4108	.3550	.2983	.2405	.1818	.1222	.0616	0
4.3	.7184	.4512	.3980	.3440	.2890	.2331	.1763	.1185	.0597	0
4.4	.6961	.4374	.3860	.3336	.2803	.2261	.1710	.1149	.0579	0
4.5	.6748	.4243	.3745	.3237	.2720	.2194	.1659	.1115	.0562	0
4.6	.6545	.4118	.3634	.3142	.2641	.2130	.1611	.1083	.0546	0
4.7	.6351	.3999	.3529	.3052	.2565	.2070	.1565	.1052	.0531	0
4.8	.6166	.3885	.3429	.2965	.2493	.2012	.1522	.1023	.0516	0
4.9	.5989	.3776	.3334	.2883	.2424	.1956	.1480	.0995	.0502	0
5.0	.5819	.3671	.3242	.2804	.2358	.1903	.1440	.0968	.0488	0
5.2	.5500	.3475	.3070	.2656	.2234	.1803	.1365	.0918	.0463	0
5.4	.5206	.3293	.2119	.2519	.1712	.1712	.1296	.0872	.0440	0
5.6	.4934	.3128	.2764	.2393	.2014	.1627	.1232	.0829	.0418	0
5.8	.4681	.2973	.2629	.2276	.1916	.1548	.1173	.0790	.0399	0
6.0	.4447	.2829	.2502	.2168	.1825	.1473	.1118	.0753	.0380	0
6.5	.3925	.2511	.2222	.1927	.1624	.1314	.0996	.0671	.0339	0
7.0	.3482	.2240	.1985	.1722	.1453	.1176	.0893	.0602	.0305	0
7.5	.3099	.2007	.1780	.1546	.1306	.1058	.0804	.0543	.0275	0
8.0	.2767	.1804	.1602	.1393	.1178	.0956	.0727	.0491	.0249	0
8.5	.2475	.1626	.1446	.1259	.1066	.0866	.0659	.0446	.0226	0
9.0	.2217	.1469	.1308	.1141	.0967	.0787	.0600	.0406	.0206	0
9.5	.1986	.1329	.1185	.1035	.0879	.0716	.0547	.0371	.0189	0
10.0	.1780	.1204	.1075	.0941	.0800	.0653	.0499	.0339	.0173	0

[a] Multiply all entries by $b_2\rho$ to obtain correction.

TABLE 6.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SPECIFIC-HEAT RATIO γ - Continued

(b) Coefficients of pressure-dependent corrections, $\tau^{-1}\left[2\gamma^0(\gamma^0 - 1)B^{(1)}(\tau_2) + (\gamma^0 - 1)^2B^{(2)}(\tau_2)\right]$

τ_2	γ^0 (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-24,995	-3,131.7	-793.6	988.4	2,214.2	2,883.7	2,997.1	2,554.3	1,555.2	0
.20	-1,408.0	237.52	385.40	482.55	528.96	524.63	469.58	363.78	207.26	0
.25	-94.51	168,710	184.604	189.932	184.693	168.887	142.515	105.577	58.072	0
.30	58.755	95.666	95.588	92.116	85.249	74.988	61.535	44.283	23.839	0
.35	46.696	58.180	55.856	52.118	46.966	40.401	32.421	23.028	12.221	0
.40	38.855	38.201	35.869	32.838	29.110	24.684	19.560	13.738	7.218	0
.45	30.686	26.684	24.706	22.340	19.586	16.444	12.915	8.998	4.693	0
.50	24.2479	19.5604	17.9376	16.0798	13.9872	11.6596	9.0971	6.2996	3.2673	0
.55	19.4168	14.8924	13.5628	12.0812	10.4476	8.6621	6.7245	4.6550	2.3935	0
.60	15.7967	11.6862	10.5877	9.3857	8.0802	6.6712	5.1586	3.5426	1.8231	0
.65	13.0510	9.3977	8.4801	7.4890	6.4245	5.2865	4.0751	2.7902	1.4318	0
.70	10.9352	7.7114	6.9361	6.1070	5.2240	4.2870	3.2961	2.2513	1.1526	0
.75	9.2782	6.4352	5.7733	5.0706	4.3273	3.5432	2.7185	1.8530	.9469	0
.80	7.9604	5.4474	4.8766	4.2743	3.6406	2.9734	2.2787	1.5506	.7910	0
.85	6.8976	4.6679	4.1713	3.6499	3.1036	2.5325	1.9366	1.3159	.6705	0
.90	6.0291	4.0425	3.6069	3.1514	2.6739	2.1806	1.6653	1.1301	.5750	0
.95	5.3113	3.5352	3.1484	2.7474	2.3301	1.8965	1.4467	.9807	.4985	0
1.00	4.7118	3.1155	2.7711	2.4155	2.0464	1.6640	1.2681	.8588	.4361	0
1.05	4.2061	2.7650	2.4569	2.1596	1.8110	1.4713	1.1205	.7581	.3846	0
1.10	3.7761	2.4679	2.1926	1.9078	1.6136	1.3098	.9966	.6739	.3417	0
1.15	3.4074	2.2171	1.9683	1.7114	1.4464	1.1733	.8921	.6028	.3055	0
1.20	3.0891	2.0021	1.7762	1.5453	1.3035	1.0568	.8030	.5423	.2746	0
1.25	2.8124	1.8164	1.6105	1.3986	1.1806	.9566	.7265	.4904	.2482	0
1.30	2.5705	1.6550	1.4667	1.2730	1.0740	.8698	.6605	.4455	.2254	0
1.35	2.3579	1.5139	1.3409	1.1633	.9811	.7941	.6026	.4064	.2055	0
1.40	2.1700	1.3898	1.2305	1.0670	.8995	.7278	.5520	.3721	.1881	0
1.45	2.0031	1.2800	1.1329	.9820	.8275	.6693	.5075	.3420	.1728	0
1.50	1.8544	1.1826	1.0462	.9066	.7657	.6175	.4681	.3155	.1593	0
1.55	1.7212	1.0957	.9690	.8394	.7069	.5714	.4330	.2916	.1473	0
1.60	1.6015	1.0177	.8998	.7793	.6561	.5302	.4016	.2704	.1365	0
1.65	1.4935	.9477	.8377	.7255	.6104	.4932	.3735	.2514	.1269	0
1.70	1.3958	.8845	.7816	.6766	.5693	.4599	.3482	.2343	.1183	0
1.75	1.3071	.8272	.7309	.6325	.5321	.4297	.3253	.2189	.1105	0
1.80	1.2264	.7752	.6848	.5925	.4984	.4024	.3046	.2049	.1034	0
1.85	1.1527	.7279	.6429	.5561	.4677	.3776	.2857	.1922	.0969	0
1.90	1.0852	.6846	.6045	.5229	.4397	.3549	.2685	.1806	.0911	0
1.95	1.0233	.6450	.5695	.4925	.4141	.3342	.2528	.1700	.0857	0
2.0	.9664	.6087	.5373	.4646	.3906	.3151	.2384	.1605	.0808	0
2.1	.8655	.5444	.4804	.4155	.3490	.2816	.2129	.1431	.0722	0
2.2	.7791	.4894	.4319	.3733	.3136	.2530	.1913	.1285	.0648	0
2.3	.7046	.4422	.3901	.3371	.2832	.2284	.1727	.1160	.05847	0

[b] Multiply all entries by $\frac{b_2}{R(\epsilon_2/k)}p$ to obtain correction.

TABLE 6.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SPECIFIC-HEAT RATIO γ - Concluded

(b) Coefficients of pressure-dependant corrections, $\tau^{-1}\left[2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^{2}B^{(2)}(\tau_2)\right]$ - Concluded

τ_2	γ^{o} (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	0.6399	0.4013	0.3540	0.3058	0.2569	0.2071	0.1566	0.1052	0.05301	0
2.5	.5834	.3656	.3225	.2786	.2340	.1886	.1426	.09580	.04826	0
2.6	.5337	.3343	.2949	.2547	.2139	.1725	.1303	.08754	.04410	0
2.7	.4899	.3067	.2705	.2336	.1962	.1581	.1195	.08028	.04044	0
2.8	.4510	.2823	.2489	.2150	.1806	.1455	.1100	.07387	.03721	0
2.9	.4163	.2605	.2298	.1984	.1666	.1343	.1015	.06816	.03433	0
3.0	.3853	.2411	.2126	.1836	.1542	.1243	.09390	.06307	.03177	0
3.1	.3575	.2237	.1973	.1704	.1431	.1153	.08711	.05852	.02947	0
3.2	.3324	.2080	.1834	.1584	.1330	.1072	.08100	.05441	.02740	0
3.3	.3097	.1938	.1709	.1476	.1239	.09990	.07548	.05070	.02554	0
3.4	.2891	.1809	.1596	.1378	.1157	.09326	.07047	.04735	.02385	0
3.5	.2704	.1693	.1493	.1289	.1083	.08729	.06594	.04429	.02231	0
3.6	.2533	.1586	.1399	.1208	.1015	.08181	.06181	.04152	.02092	0
3.7	.2377	.1489	.1313	.1134	.09527	.07678	.05803	.03898	.01964	0
3.8	.2234	.1400	.1234	.1067	.08957	.07221	.05458	.03666	.01847	0
3.9	.2101	.1318	.1162	.1004	.08433	.06800	.05141	.03454	.01740	0
4.0	.1981	.1242	.1096	.09470	.07954	.06413	.04848	.03258	.01641	0
4.1	.1869	.1173	.1035	.08941	.07510	.06056	.04578	.03076	.01550	0
4.2	.1766	.1109	.09781	.08452	.07101	.05726	.04329	.02909	.01466	0
4.3	.1671	.1049	.09256	.08000	.06721	.05421	.04100	.02756	.01388	0
4.4	.1582	.09941	.08775	.07582	.06370	.05139	.03886	.02611	.01316	0
4.5	.1500	.09429	.08322	.07195	.06044	.04876	.03687	.02478	.01249	0
4.6	.1423	.08952	.07900	.06830	.05741	.04630	.03502	.02354	.01187	0
4.7	.1351	.08508	.07509	.06493	.05457	.04404	.03330	.02238	.01129	0
4.8	.1285	.08093	.07144	.06177	.05194	.04191	.03171	.02131	.01073	0
4.9	.1222	.07705	.06804	.05884	.04947	.03992	.03020	.02031	.01024	0
5.0	.1164	.07342	.06484	.05608	.04716	.03806	.02880	.01936	.00977	0
5.2	.1058	.06683	.05903	.05107	.04295	.03468	.02625	.01766	.00891	0
5.4	.09641	.06102	.05391	.04665	.03925	.03170	.02399	.01614	.00815	0
5.6	.08810	.05586	.04936	.04273	.03596	.02905	.02200	.01481	.00747	0
5.8	.08071	.05126	.04532	.03924	.03304	.02669	.02022	.01361	.00687	0
6.0	.07411	.04716	.04171	.03613	.03042	.02459	.01863	.01255	.00634	0
6.5	.06039	.03863	.03419	.02964	.02498	.02021	.01533	.01033	.00522	0
7.0	.04974	.03200	.02835	.02460	.02076	.01681	.01276	.00861	.00435	0
7.5	.04132	.02675	.02373	.02062	.01741	.01411	.01072	.00724	.00367	0
8.0	.03458	.02255	.02002	.01742	.01473	.01195	.00909	.00614	.00311	0
8.5	.02912	.01913	.01701	.01482	.01254	.01019	.00776	.00525	.00266	0
9.0	.02463	.01632	.01454	.01268	.01074	.00874	.00666	.00452	.00229	0
9.5	.02091	.01399	.01248	.01090	.00925	.00754	.00575	.00390	.00199	0
10.0	.01780	.01204	.01075	.00941	.00800	.00653	.00499	.00339	.00173	0

[b] Multiply all entries by $\frac{b_0}{R(\epsilon_2/k)}P$ to obtain correction.

TABLE 7.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF ISENTROPIC EXPANSION COEFFICIENT α

(a) Coefficients of density-dependent corrections, $\gamma^{o}B^{(0)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^2B^{(2)}(\tau_2)$

τ_2	γ^{o} (a)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-4,526.6	-1,122.7	-748.6	-458.0	-250.8	-127.1	-86.8	-129.9	-256.4	-466.4
.20	-465.90	-107.30	-72.20	-47.24	-32.43	-27.77	-33.25	-48.88	-74.65	-110.58
.25	-103.966	-25.306	-18.923	-15.181	-14.080	-15.621	-19.804	-26.629	-36.093	-48.203
.30	-34.841	-10.333	-8.962	-8.610	-9.276	-10.960	-13.663	-17.384	-22.123	-27.881
.35	-14.914	-5.894	-5.770	-6.140	-7.005	-8.366	-10.221	-12.570	-15.415	-18.755
.40	-7.456	-4.038	-4.281	-4.803	-5.604	-6.685	-8.045	-9.684	-11.602	-13.799
.45	-4.116	-3.049	-3.402	-3.929	-4.630	-5.506	-6.557	-7.782	-9.181	-10.755
.50	-2.4097	-2.4281	-2.8035	-3.2963	-3.9067	-4.6345	-5.4797	-6.4424	-7.5226	-8.7202
.55	-1.4442	-1.9929	-2.3605	-2.8117	-3.3464	-3.9648	-4.6667	-5.4522	-6.3214	-7.2741
.60	-.8519	-1.6654	-2.0146	-2.4259	-2.8994	-3.4349	-4.0325	-4.6922	-5.4140	-6.1980
.65	-.4639	-1.4070	-1.7350	-2.1108	-2.5343	-3.0056	-3.5246	-4.0914	-4.7039	-5.3682
.70	-.1954	-1.1961	-1.5033	-1.8481	-2.2308	-2.6511	-3.1092	-3.6051	-4.1387	-4.7100
.75	-.0012	-1.0199	-1.3076	-1.6257	-1.9745	-2.3537	-2.7635	-3.2038	-3.6746	-4.1759
.80	.1446	-.8700	-1.1399	-1.4350	-1.7553	-2.1008	-2.4714	-2.8672	-3.2881	-3.7342
.85	.2577	-.7406	-.9946	-1.2697	-1.5659	-1.8831	-2.2215	-2.5809	-2.9615	-3.3631
.90	.3477	-.6278	-.8674	-1.1250	-1.4005	-1.6940	-2.0054	-2.3347	-2.6819	-3.0472
.95	.4209	-.5283	-.7551	-.9974	-1.2551	-1.5282	-1.8167	-2.1207	-2.4401	-2.7749
1.00	.4816	-.4400	-.6553	-.8841	-1.1262	-1.3817	-1.6507	-1.9331	-2.2289	-2.5381
1.05	.5327	-.3611	-.5660	-.7827	-1.0112	-1.2514	-1.5035	-1.7673	-2.0429	-2.3302
1.10	.5764	-.2902	-.4857	-.6917	-.9080	-1.1348	-1.3721	-1.6197	-1.8778	-2.1464
1.15	.6141	-.2261	-.4131	-.6094	-.8150	-1.0299	-1.2541	-1.4877	-1.7305	-1.9826
1.20	.6469	-.1679	-.3471	-.5347	-.7307	-.9350	-1.1477	-1.3688	-1.5982	-1.8359
1.25	.6759	-.1148	-.2870	-.4667	-.6540	-.8488	-1.0512	-1.2612	-1.4787	-1.7038
1.30	.7015	-.0662	-.2319	-.4045	-.5839	-.7702	-.9634	-1.1634	-1.3705	-1.5841
1.35	.7243	-.0216	-.1813	-.3474	-.5196	-.6982	-.8831	-1.0742	-1.2716	-1.4753
1.40	.7448	.0195	-.1347	-.2948	-.4605	-.6321	-.8094	-.9924	-1.1813	-1.3758
1.45	.7635	.0575	-.0917	-.2462	-.4060	-.5711	-.7415	-.9173	-1.0983	-1.2847
1.50	.7801	.0926	-.0518	-.2012	-.3555	-.5148	-.6789	-.8480	-1.0220	-1.2009
1.55	.7953	.1253	-.0148	-.1595	-.3087	-.4625	-.6209	-.7839	-.9514	-1.1235
1.60	.8092	.1557	.0197	-.1206	-.2652	-.4140	-.5671	-.7244	-.8860	-1.0519
1.65	.8218	.1840	.0518	-.0844	-.2246	-.3688	-.5170	-.6691	-.8253	-.9855
1.70	.8335	.2105	.0819	-.0505	-.1867	-.3266	-.4702	-.6176	-.7687	-.9236
1.75	.8442	.2353	.1100	-.0188	-.1512	-.2871	-.4265	-.5695	-.7159	-.8659
1.80	.8541	.2586	.1364	.0109	-.1180	-.2501	-.3856	-.5244	-.6666	-.8120
1.85	.8632	.2805	.1612	.0388	-.0867	-.2154	-.3472	-.4822	-.6205	-.7615
1.90	.8717	.3010	.1846	.0651	-.0573	-.1827	-.3111	-.4425	-.5768	-.7141
1.95	.8795	.3204	.2066	.0899	-.0296	-.1519	-.2771	-.4051	-.5359	-.6696
2.0	.8868	.3387	.2273	.1133	-.0034	-.1229	-.2450	-.3698	-.4974	-.6276
2.1	.8999	.3723	.2655	.1563	.0447	-.0695	-.1861	-.3051	-.4266	-.5506
2.2	.9112	.4024	.2998	.1950	.0879	-.0215	-.1332	-.2471	-.3633	-.4817
2.3	.9211	.4295	.3307	.2298	.1267	.0216	-.0856	-.1949	-.3062	-.4197

[a] Multiply all entries by $b_2\rho$ to obtain correction.

TABLE 7.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF ISENTROPIC EXPANSION COEFFICIENT α - Continued

(a) Coefficients of density-dependent corrections, $\gamma^{0}B^{(0)}(\tau_2) + 2\gamma^{0}(\gamma^{0} - 1)B^{(1)}(\tau_2) + (\gamma^{0} - 1)^{2}B^{(2)}(\tau_2)$ - Concluded

τ_2	γ^0 [a]									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	0.9298	0.4541	0.3587	0.2613	0.1621	0.0608	-0.0423	-0.1475	-0.2545	-0.3636
2.5	.9374	.4764	.3842	.2901	.1943	.0965	-.0030	-.1044	-.2076	-.3126
2.6	.9441	.4966	.4073	.3162	.2235	.1290	.0328	-.0652	-.1647	-.2661
2.7	.9500	.5152	.4284	.3401	.2503	.1587	.0656	-.0292	-.1256	-.2236
2.8	.9552	.5321	.4479	.3623	.2750	.1861	.0957	.0039	-.0896	-.1845
2.9	.9598	.5477	.4658	.3825	.2976	.2113	.1235	.0344	-.0564	-.1485
3.0	.9639	.5620	.4821	.4011	.3185	.2346	.1491	.0624	-.0257	-.1152
3.1	.9674	.5752	.4976	.4184	.3379	.2561	.1730	.0885	-.0027	-.0844
3.2	.9706	.5874	.5116	.4344	.3559	.2761	.1950	.1127	.0291	-.0558
3.3	.9733	.5987	.5245	.4492	.3726	.2946	.2155	.1352	.0537	-.0291
3.4	.9758	.6092	.5367	.4630	.3880	.3120	.2347	.1563	.0766	-.0043
3.5	.9779	.6189	.5481	.4759	.4026	.3283	.2527	.1759	.0980	.0190
3.6	.9797	.6280	.5585	.4879	.4162	.3433	.2693	.1943	.1180	.0407
3.7	.9813	.6364	.5683	.4991	.4289	.3575	.2849	.2115	.1369	.0611
3.8	.9827	.6443	.5775	.5097	.4408	.3708	.2997	.2276	.1545	.0803
3.9	.9837	.6516	.5861	.5195	.4518	.3833	.3135	.2428	.1711	.0983
4.0	.9848	.6585	.5942	.5288	.4624	.3950	.3266	.2572	.1868	.1154
4.1	.9856	.6650	.6017	.5376	.4723	.4061	.3389	.2708	.2016	.1315
4.2	.9863	.6710	.6088	.5457	.4816	.4165	.3505	.2836	.2156	.1467
4.3	.9868	.6767	.6155	.5534	.4904	.4264	.3615	.2957	.2288	.1611
4.4	.9872	.6820	.6218	.5607	.4987	.4357	.3719	.3071	.2413	.1747
4.5	.9875	.6870	.6277	.5676	.5065	.4446	.3817	.3179	.2532	.1876
4.6	.9877	.6916	.6333	.5741	.5140	.4529	.3910	.3288	.2645	.1999
4.7	.9877	.6961	.6386	.5805	.5210	.4608	.3998	.3380	.2752	.2116
4.8	.9877	.7002	.6435	.5860	.5277	.4684	.4083	.3473	.2854	.2227
4.9	.9876	.7041	.6482	.5916	.5340	.4756	.4163	.3561	.2951	.2333
5.0	.9875	.7078	.6528	.5968	.5401	.4824	.4239	.3645	.3043	.2433
5.2	.9870	.7146	.6609	.6064	.5511	.4949	.4380	.3802	.3216	.2622
5.4	.9862	.7206	.6682	.6151	.5611	.5064	.4508	.3945	.3373	.2794
5.6	.9852	.7259	.6748	.6229	.5703	.5168	.4626	.4075	.3517	.2951
5.8	.9841	.7307	.6808	.6301	.5786	.5263	.4733	.4195	.3649	.3096
6.0	.9828	.7350	.6862	.6365	.5862	.5350	.4831	.4305	.3771	.3229
6.5	.9792	.7438	.6974	.6502	.6024	.5537	.5044	.4543	.4035	.3520
7.0	.9750	.7505	.7062	.6611	.6154	.5690	.5218	.4739	.4254	.3761
7.5	.9705	.7555	.7130	.6698	.6260	.5814	.5362	.4902	.4436	.3963
8.0	.9657	.7592	.7183	.6768	.6346	.5917	.5482	.5039	.4590	.4134
8.5	.9609	.7619	.7225	.6824	.6417	.6003	.5582	.5155	.4721	.4280
9.0	.9560	.7637	.7256	.6869	.6474	.6074	.5667	.5253	.4833	.4406
9.5	.9511	.7649	.7280	.6904	.6522	.6133	.5738	.5337	.4929	.4514
10.0	.9461	.7656	.7297	.6932	.6561	.6183	.5799	.5409	.5012	.4609

[a] Multiply all entries by $b_{2\rho}$ to obtain correction.

TABLE 7.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF ISENTROPIC EXPANSION COEFFICIENT α - Continued

(b) Coefficients of pressure-dependent corrections, $\tau^{-1}\left[\gamma^{o}B^{(0)}(\tau_2) + 2\gamma^{o}(\gamma^{o} - 1)B^{(1)}(\tau_2) + (\gamma^{o} - 1)^2B^{(2)}(\tau_2)\right]$

τ_2	γ^{o} (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-30,177	-7,484.5	-4,990.9	-3,053.5	-1,672.2	-847.2	-578.4	-865.8	-1,709.3	-3,109.1
.20	-2,329.48	-536.52	-361.00	-236.21	-162.15	-138.83	-166.24	-244.39	-373.27	-552.89
.25	-415.864	-101.225	-75.690	-60.722	-56.321	-62.486	-79.217	-106.515	-144.380	-192.811
.30	-116.137	-34.443	-29.874	-28.700	-30.920	-36.534	-45.543	-57.946	-73.744	-92.935
.35	-42.615	-16.840	-16.484	-17.545	-20.015	-25.902	-29.202	-35.916	-44.044	-55.565
.40	-18.640	-10.095	-10.702	-12.008	-14.011	-16.713	-20.112	-24.209	-29.004	-34.497
.45	-9.147	-6.776	-7.559	-8.730	-10.289	-12.236	-14.570	-17.292	-20.402	-23.900
.50	-4.8194	-4.8562	-5.6070	-6.5927	-7.8133	-9.2689	-10.9594	-12.8848	-15.0452	-17.4404
.55	-2.6259	-3.6235	-4.2918	-5.1121	-6.0844	-7.2087	-8.4849	-9.9132	-11.4934	-13.2256
.60	-1.4199	-2.7757	-3.3577	-4.0432	-4.8323	-5.7248	-6.7208	-7.8204	-9.0234	-10.3300
.65	-.7136	-2.1646	-2.6693	-3.2474	-3.8990	-4.6240	-5.4225	-6.2945	-7.2599	-8.2588
.70	-.2792	-1.7087	-2.1475	-2.6402	-3.1868	-3.7873	-4.4418	-5.1501	-5.9124	-6.7286
.75	-.0016	-1.3598	-1.7454	-2.1677	-2.6326	-3.1383	-3.6846	-4.2717	-4.8994	-5.5679
.80	.1808	-1.0875	-1.4249	-1.7938	-2.1941	-2.6259	-3.0892	-3.5839	-4.1101	-4.6678
.85	.3052	-.8713	-1.1701	-1.4937	-1.8422	-2.2154	-2.6135	-3.0364	-3.4841	-3.9566
.90	.3863	-.6975	-.9638	-1.2500	-1.5562	-1.8822	-2.2282	-2.5941	-2.9799	-3.3857
.95	.4431	-.5561	-.7949	-1.0499	-1.3211	-1.6086	-1.9124	-2.2323	-2.5685	-2.9210
1.00	.4816	-.4400	-.6553	-.8841	-1.1262	-1.3817	-1.6507	-1.9331	-2.2289	-2.5381
1.05	.5074	-.3439	-.5391	-.7455	-.9630	-1.1918	-1.4319	-1.6831	-1.9456	-2.2193
1.10	.5240	-.2638	-.4416	-.6288	-.8255	-1.0517	-1.2473	-1.4725	-1.7071	-1.9512
1.15	.5340	-.1966	-.3592	-.5299	-.7087	-.8956	-1.0906	-1.2936	-1.5048	-1.7241
1.20	.5391	-.1399	-.2893	-.4456	-.6089	-.7792	-.9564	-1.1406	-1.3318	-1.5300
1.25	.5407	-.0918	-.2296	-.3734	-.5232	-.6791	-.8410	-1.0090	-1.1830	-1.3631
1.30	.5396	-.0509	-.1784	-.3111	-.4491	-.5925	-.7411	-.8949	-1.0541	-1.2185
1.35	.5366	-.0161	-.1343	-.2573	-.3849	-.5172	-.6541	-.7957	-.9419	-1.0928
1.40	.5320	.0139	-.0962	-.2105	-.3289	-.4515	-.5781	-.7089	-.8438	-.9827
1.45	.5264	.0396	-.0633	-.1698	-.2800	-.3939	-.5114	-.6326	-.7575	-.8860
1.50	.5200	.0618	-.0346	-.1342	-.2370	-.3432	-.4526	-.5653	-.6813	-.8006
1.55	.5131	.0808	-.0096	-.1029	-.1992	-.2984	-.4006	-.5057	-.6138	-.7249
1.60	.5057	.0973	.0123	-.0754	-.1657	-.2588	-.3544	-.4528	-.5538	-.6574
1.65	.4981	.1115	.0314	-.0512	-.1361	-.2235	-.3133	-.4055	-.5002	-.5972
1.70	.4903	.1239	.0482	-.0297	-.1098	-.1921	-.2766	-.3633	-.4522	-.5433
1.75	.4824	.1345	.0629	-.0108	-.0864	-.1641	-.2437	-.3254	-.4091	-.4948
1.80	.4745	.1437	.0758	.0060	-.0655	-.1390	-.2142	-.2913	-.3703	-.4511
1.85	.4666	.1516	.0871	.0210	-.0469	-.1164	-.1877	-.2606	-.3353	-.4116
1.90	.4588	.1584	.0971	.0343	-.0302	-.0962	-.1637	-.2329	-.3036	-.3759
1.95	.4510	.1643	.1059	.0461	-.0152	-.0779	-.1421	-.2077	-.2748	-.3434
2.0	.4434	.1693	.1137	.0567	-.0017	-.0614	-.1225	-.1849	-.2487	-.3138
2.1	.4285	.1773	.1264	.0744	.0213	-.0331	-.0886	-.1453	-.2038	-.2622
2.2	.4142	.1829	.1363	.0886	.0399	-.0098	-.0605	-.1123	-.1651	-.2190
2.3	.4005	.1868	.1453	.09991	.05509	.00959	-.03722	-.08474	-.1331	-.1825

[b] Multiply all entries by $\frac{b_2}{H(\epsilon_2/k)}P$ to obtain correction.

TABLE 7.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF ISENTROPIC EXPANSION COEFFICIENT α - Concluded

(b) Coefficients of pressure-dependent corrections, $\tau^{-1}\left[\gamma^0 B^{(0)}(\tau_2) + 2\gamma^0(\gamma^0 - 1)B^{(1)}(\tau_2) + (\gamma^0 - 1)^2 B^{(2)}(\tau_2)\right]$ - Concluded

τ_2	γ^0 (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	0.3874	0.1892	0.1495	0.1089	0.06754	0.02533	-0.01763	-0.06146	-0.1061	-0.1515
2.5	.3750	.1905	.1537	.1160	.07772	.03860	-.00120	-.04176	-.08304	-.1250
2.6	.3631	.1910	.1567	.1216	.08596	.04962	.01262	-.02508	-.06338	-.1024
2.7	.3519	.1908	.1587	.1260	.09270	.05878	.02430	-.01081	-.04651	-.08281
2.8	.3412	.1900	.1600	.1294	.09821	.06646	.03418	.00139	-.03198	-.06590
2.9	.3310	.1889	.1606	.1319	.1026	.07286	.04259	.01186	-.01944	-.05121
3.0	.3213	.1873	.1607	.1337	.1062	.07818	.04970	.02080	-.00856	-.03841
3.1	.3121	.1856	.1603	.1350	.1090	.08261	.05581	.02835	-.00088	-.02723
3.2	.3033	.1836	.1599	.1358	.1112	.08628	.06094	.03522	.00910	-.01743
3.3	.2949	.1814	.1589	.1361	.1129	.08927	.06532	.04098	.01626	-.00883
3.4	.2870	.1792	.1579	.1362	.1141	.09177	.06903	.04596	.02252	-.00126
3.5	.2794	.1768	.1566	.1360	.1150	.09380	.07220	.05026	.02800	.00542
3.6	.2721	.1744	.1551	.1355	.1156	.09536	.07481	.05396	.03279	.01131
3.7	.2652	.1720	.1536	.1349	.1159	.09662	.07700	.05716	.03699	.01652
3.8	.2586	.1696	.1520	.1341	.1160	.09758	.07887	.05989	.04067	.02114
3.9	.2522	.1671	.1503	.1332	.1159	.09828	.08039	.06226	.04387	.02521
4.0	.2462	.1646	.1486	.1322	.1156	.09875	.08165	.06430	.04671	.02885
4.1	.2404	.1622	.1468	.1311	.1152	.09905	.08266	.06605	.04918	.03207
4.2	.2348	.1598	.1450	.1299	.1147	.09917	.08345	.06752	.05133	.03492
4.3	.2295	.1574	.1431	.1287	.1140	.09916	.08407	.06877	.05321	.03746
4.4	.2244	.1550	.1413	.1274	.1133	.09905	.08452	.06980	.05485	.03970
4.5	.2194	.1527	.1395	.1261	.1126	.09880	.08482	.07064	.05627	.04169
4.6	.2147	.1504	.1377	.1248	.1117	.09846	.08500	.07133	.05750	.04346
4.7	.2102	.1481	.1359	.1235	.1109	.09805	.08506	.07191	.05855	.04501
4.8	.2058	.1459	.1341	.1221	.1099	.09758	.08506	.07235	.05946	.04639
4.9	.2016	.1437	.1323	.1207	.1090	.09706	.08496	.07267	.06023	.04760
5.0	.1975	.1416	.1306	.1194	.1080	.09648	.08478	.07290	.06087	.04867
5.2	.1898	.1374	.1271	.1166	.1060	.09518	.08422	.07311	.06184	.05042
5.4	.1826	.1334	.1237	.1139	.1039	.09377	.08349	.07305	.06247	.05173
5.6	.1759	.1296	.1203	.1112	.1018	.09229	.08260	.07277	.06280	.05270
5.8	.1697	.1260	.1174	.1086	.09973	.09074	.08160	.07233	.06292	.05338
6.0	.1638	.1225	.1144	.1061	.09769	.08917	.08052	.07175	.06284	.05382
6.5	.1506	.1144	.1073	.1000	.09267	.08519	.07760	.06989	.06208	.05415
7.0	.1393	.1072	.1009	.09445	.08791	.08128	.07454	.06770	.06077	.05373
7.5	.1294	.1007	.09507	.08931	.08346	.07752	.07149	.06537	.05915	.05284
8.0	.1207	.09490	.08979	.08460	.07932	.07396	.06852	.06299	.05738	.05168
8.5	.1130	.08963	.08500	.08028	.07549	.07062	.06567	.06064	.05554	.05036
9.0	.1062	.08486	.08065	.07632	.07194	.06749	.06296	.05837	.05370	.04896
9.5	.1001	.08052	.07663	.07268	.06865	.06456	.06040	.05618	.05188	.04752
10.0	.09461	.07656	.07297	.06932	.06561	.06185	.05799	.05409	.05012	.04609

[b] Multiply all entries by $\frac{b_2}{R(\epsilon_2/k)}P$ to obtain correction.

TABLE 8.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SOUND VELOCITY a

(a) Coefficients of density-dependent corrections, $B^{(0)}(\tau_2) + (\gamma^0 - 1)B^{(1)}(\tau_2) + \frac{(\gamma^0 - 1)^2}{2\gamma^0}B^{(2)}(\tau_2)$

τ_2	γ^0 (a)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-1,591.2	-634.1	-310.5	-409.3	-333.5	-286.1	-270.9	-292.2	-333.3	-466.4
.20	-195.06	-93.61	-82.05	-73.46	-68.26	-66.86	-69.74	-77.51	-90.84	-110.58
.25	-55.291	-33.139	-31.110	-29.940	-29.733	-30.610	-32.712	-36.205	-41.289	-48.203
.30	-24.393	-17.631	-17.260	-17.252	-17.651	-18.507	-19.881	-21.842	-24.475	-27.881
.35	-13.852	-11.482	-11.514	-11.739	-12.180	-12.865	-13.821	-15.091	-16.718	-18.755
.40	-9.136	-8.342	-8.485	-8.747	-9.141	-9.685	-10.397	-11.301	-12.424	-13.799
.45	-6.612	-6.466	-6.637	-6.889	-7.250	-7.672	-8.228	-8.915	-9.749	-10.755
.50	-5.0830	-5.2273	-5.3984	-5.6279	-5.985	-6.291	-6.743	-7.288	-7.942	-8.720
.55	-4.0703	-4.3488	-4.5113	-4.7184	-4.9756	-5.2890	-5.6660	-6.1153	-6.6472	-7.2741
.60	-3.3546	-3.6938	-3.8451	-4.0320	-4.2587	-4.5302	-4.8522	-5.2318	-5.6771	-6.1980
.65	-2.8233	-3.1866	-3.3267	-3.4959	-3.6978	-3.9364	-4.2165	-4.5438	-4.9250	-5.3682
.70	-2.4136	-2.7822	-2.9118	-3.0658	-3.2473	-3.4597	-3.7069	-3.9937	-4.3258	-4.7100
.75	-2.0883	-2.4522	-2.5722	-2.7133	-2.8778	-3.0687	-3.2895	-3.5442	-3.8378	-4.1759
.80	-1.8237	-2.1778	-2.2893	-2.4190	-2.5692	-2.7424	-2.9416	-3.1704	-3.4329	-3.7342
.85	-1.6042	-1.9461	-2.0499	-2.1699	-2.3079	-2.4662	-2.6474	-2.8547	-3.0918	-3.3631
.90	-1.4192	-1.7478	-1.8448	-1.9563	-2.0838	-2.2294	-2.3955	-2.5848	-2.8007	-3.0471
.95	-1.2612	-1.5761	-1.6671	-1.7711	-1.8895	-2.0242	-2.1773	-2.3514	-2.5494	-2.7749
1.00	-1.1246	-1.4262	-1.5117	-1.6091	-1.7195	-1.8448	-1.9867	-2.1477	-2.3304	-2.5381
1.05	-1.0053	-1.2941	-1.3748	-1.4662	-1.5696	-1.6865	-1.8188	-1.9684	-2.1379	-2.3302
1.10	-.9003	-1.1768	-1.2531	-1.3392	-1.4364	-1.5460	-1.6697	-1.8094	-1.9674	-2.1464
1.15	-.8071	-1.0721	-1.1443	-1.2257	-1.3173	-1.4205	-1.5366	-1.6675	-1.8154	-1.9826
1.20	-.7239	-.9779	-1.0465	-1.1236	-1.2102	-1.3076	-1.4170	-1.5401	-1.6790	-1.8359
1.25	-.6491	-.8929	-.9582	-1.0314	-1.1135	-1.2056	-1.3089	-1.4252	-1.5560	-1.7038
1.30	-.5816	-.8157	-.8779	-.9476	-1.0256	-1.1130	-1.2109	-1.3209	-1.4446	-1.5841
1.35	-.5203	-.7453	-.8048	-.8712	-.9455	-1.0285	-1.1216	-1.2259	-1.3431	-1.4755
1.40	-.4645	-.6810	-.7378	-.8013	-.8721	-.9515	-1.0398	-1.1390	-1.2504	-1.3758
1.45	-.4134	-.6218	-.6763	-.7370	-.8048	-.8805	-.9648	-1.0593	-1.1654	-1.2847
1.50	-.3664	-.5674	-.6196	-.6778	-.7427	-.8149	-.8956	-.9859	-1.0871	-1.2009
1.55	-.3232	-.5170	-.5672	-.6231	-.6852	-.7545	-.8317	-.9181	-1.0148	-1.1235
1.60	-.2832	-.4704	-.5187	-.5723	-.6320	-.6985	-.7725	-.8552	-.9479	-1.0519
1.65	-.2462	-.4270	-.4735	-.5252	-.5826	-.6464	-.7175	-.7969	-.8857	-.9855
1.70	-.2118	-.3866	-.4315	-.4812	-.5365	-.5979	-.6663	-.7425	-.8279	-.9236
1.75	-.1797	-.3489	-.3922	-.4402	-.4935	-.5526	-.6184	-.6918	-.7739	-.8659
1.80	-.1498	-.3137	-.3555	-.4018	-.4532	-.5102	-.5737	-.6444	-.7234	-.8120
1.85	-.1218	-.2806	-.3211	-.3658	-.4154	-.4705	-.5317	-.5999	-.6761	-.7615
1.90	-.0956	-.2496	-.2887	-.3320	-.3800	-.4332	-.4923	-.5582	-.6317	-.7141
1.95	-.0709	-.2204	-.2583	-.3002	-.3466	-.3981	-.4553	-.5189	-.5900	-.6696
2.0	-.0478	-.1929	-.2296	-.2702	-.3152	-.3650	-.4203	-.4819	-.5507	-.6276
2.1	-.0054	-.1424	-.1770	-.2152	-.2575	-.3043	-.3562	-.4140	-.4783	-.5506
2.2	.0325	-.0971	-.1298	-.1659	-.2057	-.2498	-.2988	-.3532	-.4138	-.4817
2.3	.0665	-.0564	-.0873	-.1214	-.1591	-.2008	-.2470	-.2984	-.3556	-.4197

[a] Multiply all entries by $a^0 b_2 \rho$ to obtain correction.

TABLE 8.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SOUND VELOCITY a - Continued

(a) Coefficients of density-dependent corrections, $B^{(0)}(\tau_2) + (\gamma^o - 1)B^{(1)}(\tau_2) + \frac{(\gamma^o - 1)^2}{2\gamma^o}B^{(2)}(\tau_2)$ - Concluded

τ_2	γ^o [a]									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	0.0972	-0.0196	-0.0489	-0.0813	-0.1170	-0.1564	-0.2002	-0.2488	-0.3030	-0.3636
2.5	.1249	.0138	-.0140	-.0447	-.0786	-.1161	-.1576	-.2038	-.2552	-.3126
2.6	.1502	.0443	.0178	-.0114	-.0437	-.0793	-.1188	-.1627	-.2115	-.2661
2.7	.1732	.0722	.0469	.0191	-.0117	-.0456	-.0833	-.1251	-.1716	-.2236
2.8	.1943	.0978	.0736	.0470	.0177	-.0147	-.0506	-.0903	-.1349	-.1845
2.9	.2137	.1213	.0983	.0728	.0448	.0138	-.0203	-.0587	-.1011	-.1483
3.0	.2315	.1431	.1210	.0966	.0698	.0401	.0073	-.0292	-.0699	-.1152
3.1	.2480	.1632	.1420	.1187	.0929	.0645	.0330	-.0020	-.0409	-.0844
3.2	.2633	.1819	.1616	.1392	.1144	.0871	.0569	.0233	-.0140	-.0558
3.3	.2774	.1993	.1797	.1582	.1345	.1082	.0792	.0469	.0110	-.0291
3.4	.2906	.2154	.1966	.1759	.1531	.1279	.0999	.0689	.0343	-.0043
3.5	.3028	.2303	.2124	.1925	.1703	.1462	.1193	.0894	.0561	.0190
3.6	.3143	.2446	.2272	.2080	.1868	.1634	.1375	.1087	.0766	.0407
3.7	.3250	.2579	.2411	.2225	.2021	.1795	.1543	.1267	.0957	.0611
3.8	.3350	.2703	.2541	.2362	.2165	.1947	.1703	.1437	.1138	.0803
3.9	.3443	.2819	.2662	.2489	.2299	.2088	.1853	.1593	.1306	.0983
4.0	.3532	.2929	.2778	.2611	.2427	.2223	.1997	.1746	.1467	.1154
4.1	.3614	.3032	.2886	.2725	.2547	.2350	.2131	.1888	.1618	.1315
4.2	.3692	.3130	.2988	.2832	.2660	.2469	.2257	.2022	.1760	.1467
4.3	.3766	.3222	.3083	.2934	.2767	.2582	.2377	.2149	.1893	.1611
4.4	.3835	.3309	.3176	.3030	.2868	.2689	.2490	.2269	.2023	.1747
4.5	.3901	.3391	.3263	.3121	.2964	.2790	.2598	.2383	.2144	.1876
4.6	.3962	.3470	.3346	.3207	.3055	.2887	.2700	.2491	.2289	.1999
4.7	.4021	.3544	.3423	.3289	.3142	.2978	.2796	.2594	.2368	.2116
4.8	.4077	.3614	.3497	.3367	.3224	.3065	.2888	.2692	.2472	.2227
4.9	.4129	.3681	.3567	.3441	.3302	.3148	.2976	.2783	.2572	.2333
5.0	.4179	.3745	.3634	.3512	.3376	.3226	.3059	.2874	.2666	.2433
5.2	.4272	.3863	.3759	.3643	.3515	.3373	.3215	.3039	.2842	.2622
5.4	.4355	.3970	.3872	.3762	.3641	.3507	.3357	.3190	.3003	.2794
5.6	.4431	.4068	.3973	.3871	.3757	.3629	.3487	.3328	.3150	.2951
5.8	.4500	.4158	.4069	.3971	.3862	.3741	.3606	.3455	.3286	.3096
6.0	.4563	.4240	.4156	.4063	.3959	.3844	.3715	.3571	.3410	.3229
6.5	.4697	.4416	.4343	.4261	.4169	.4067	.3953	.3823	.3681	.3520
7.0	.4805	.4561	.4496	.4425	.4342	.4251	.4149	.4033	.3906	.3761
7.5	.4893	.4680	.4622	.4538	.4483	.4404	.4313	.4210	.4094	.3963
8.0	.4964	.4779	.4728	.4670	.4606	.4533	.4450	.4358	.4253	.4134
8.5	.5023	.4861	.4816	.4765	.4707	.4641	.4567	.4483	.4388	.4280
9.0	.5071	.4931	.4890	.4845	.4793	.4734	.4667	.4591	.4504	.4406
9.5	.5110	.4989	.4954	.4913	.4866	.4813	.4752	.4683	.4604	.4514
10.0	.5143	.5039	.5007	.4971	.4929	.4881	.4826	.4763	.4691	.4609

[a] Multiply all entries by $a^o b_2 \rho$ to obtain correction.

TABLE 8.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SOUND VELOCITY a - Continued

(b) Coefficients of pressure-dependent corrections, $\tau^{-1}\left[B^{(0)}(\tau_2) + (\gamma^0 - 1)B^{(1)}(\tau_2) + \frac{(\gamma^0 - 1)^2}{2\gamma^0}B^{(2)}(\tau_2)\right]$

τ_2	γ^0 (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
0.15	-10,608	-4,227	-3,405	-2,729	-2,223	-1,908	-1,806	-1,948	-2,369	-3,109
.20	-973.3	-468.1	-410.1	-367.3	-341.3	-334.3	-348.7	-387.9	-454.2	-552.9
.25	-221.16	-132.56	-124.44	-119.76	-118.93	-122.44	-130.83	-144.82	-165.16	-192.81
.30	-81.309	-58.769	-57.332	-57.506	-58.836	-61.690	-66.269	-72.807	-81.584	-92.935
.35	-39.376	-32.807	-32.898	-33.540	-34.799	-36.732	-39.489	-43.118	-47.766	-53.583
.40	-22.841	-20.854	-21.212	-21.867	-22.853	-24.212	-25.993	-28.253	-31.060	-34.497
.45	-14.694	-14.370	-14.750	-15.508	-16.066	-17.048	-18.283	-19.810	-21.665	-23.900
.50	-10.1660	-10.4545	-10.7969	-11.2559	-11.8453	-12.5823	-13.4852	-14.5769	-15.8846	-17.4404
.55	-7.4006	-7.9069	-8.2024	-8.5790	-9.0466	-9.6164	-10.3019	-11.1188	-12.0839	-13.2256
.60	-5.5909	-6.1563	-6.4086	-6.7201	-7.0979	-7.5503	-8.0871	-8.7197	-9.4618	-10.3300
.65	-4.3435	-4.9024	-5.1180	-5.3784	-5.6890	-6.0560	-6.4870	-6.9905	-7.5769	-8.2588
.70	-3.4481	-3.9746	-4.1597	-4.3798	-4.6390	-4.9424	-5.2953	-5.7033	-6.1798	-6.7286
.75	-2.7844	-3.2696	-3.4297	-3.6177	-3.8370	-4.0916	-4.3860	-4.7256	-5.1170	-5.5679
.80	-2.2796	-2.7223	-2.8616	-3.0238	-3.2116	-3.4280	-3.6770	-3.9630	-4.2911	-4.6678
.85	-1.8873	-2.2895	-2.4117	-2.5528	-2.7152	-2.9014	-3.1146	-3.3585	-3.6374	-3.9566
.90	-1.5769	-1.9419	-2.0498	-2.1736	-2.3153	-2.4771	-2.6616	-2.8720	-3.1119	-3.3857
.95	-1.3276	-1.6591	-1.7349	-1.8643	-1.9889	-2.1307	-2.2919	-2.4732	-2.6836	-2.9210
1.00	-1.1246	-1.4262	-1.5118	-1.6091	-1.7195	-1.8448	-1.9867	-2.1477	-2.3304	-2.5381
1.05	-.9574	-1.2325	-1.3093	-1.3963	-1.4948	-1.6062	-1.7322	-1.8747	-2.0361	-2.2193
1.10	-.8184	-1.0698	-1.1392	-1.2173	-1.3058	-1.4053	-1.5179	-1.6449	-1.7885	-1.9512
1.15	-.7018	-.9322	-.9951	-1.0658	-1.1455	-1.2352	-1.3362	-1.4500	-1.5786	-1.7240
1.20	-.6032	-.8149	-.8721	-.9364	-1.0083	-1.0896	-1.1808	-1.2834	-1.3992	-1.5300
1.25	-.5193	-.7143	-.7665	-.8251	-.8908	-.9645	-1.0472	-1.1401	-1.2448	-1.3630
1.30	-.4474	-.6275	-.6735	-.7289	-.7889	-.8561	-.9315	-1.0161	-1.1112	-1.2185
1.35	-.3854	-.5521	-.5961	-.6453	-.7004	-.7619	-.8308	-.9081	-.9949	-1.1348
1.40	-.3318	-.4864	-.5270	-.5723	-.6230	-.6795	-.7427	-.8136	-.8932	-.9827
1.49	-.2851	-.4288	-.4664	-.5083	-.5550	-.6071	-.6654	-.7306	-.8037	-.8860
1.50	-.2443	-.3782	-.4131	-.4519	-.4951	-.5433	-.5971	-.6573	-.7247	-.8006
1.55	-.2085	-.3336	-.3660	-.4020	-.4421	-.4868	-.5366	-.5923	-.6547	-.7249
1.60	-.1770	-.2940	-.3242	-.3577	-.3950	-.4363	-.4828	-.5345	-.5924	-.6574
1.65	-.1492	-.2588	-.2870	-.3183	-.3531	-.3918	-.4348	-.4830	-.5368	-.5972
1.70	-.1246	-.2274	-.2538	-.2831	-.3156	-.3517	-.3919	-.4368	-.4870	-.5433
1.75	-.1027	-.1994	-.2241	-.2516	-.2820	-.3158	-.3534	-.3953	-.4422	-.4948
1.80	-.08322	-.1743	-.1975	-.2232	-.2518	-.2835	-.3187	-.3580	-.4019	-.4511
1.85	-.06384	-.1517	-.1735	-.1977	-.2246	-.2543	-.2874	-.3243	-.3655	-.4116
1.90	-.05050	-.1314	-.1520	-.1748	-.2000	-.2280	-.2591	-.2938	-.3325	-.3759
1.95	-.03658	-.1130	-.1325	-.1540	-.1778	-.2042	-.2335	-.2661	-.3026	-.3434
2.0	-.02388	-.09643	-.1148	-.1351	-.1576	-.1823	-.2102	-.2410	-.2753	-.3138
2.1	-.00255	-.06780	-.08427	-.1023	-.1226	-.1449	-.1696	-.1971	-.2278	-.2622
2.2	.01478	-.04415	-.05900	-.07540	-.09550	-.1136	-.1358	-.1603	-.1881	-.2190
2.3	.02891	-.02453	-.03798	-.05280	-.06918	-.08730	-.1074	-.1297	-.1546	-.1825

[b] Multiply all entries by $\frac{a^0 b_2}{R(\epsilon_2/k)}P$ to obtain correction.

TABLE 8.- COEFFICIENTS OF CORRECTIONS FROM IDEAL-GAS VALUES TO REAL-GAS VALUES OF SOUND VELOCITY a - Concluded

(b) Coefficients of pressure-dependent corrections, $\tau^{-1}\left[B^{(0)}(\tau_2) + (\gamma^o - 1)B^{(1)}(\tau_2) + \frac{(\gamma^o - 1)^2}{2\gamma^o}B^{(2)}(\tau_2)\right]$ - Concluded

τ_2	γ^o (b)									
	5/3	1.40	1.35	1.30	1.25	1.20	1.15	1.10	1.05	1.00
2.4	0.04048	-0.00818	-0.02039	-0.03386	-0.04873	-0.06518	-0.08341	-0.1037	-0.1265	-0.1515
2.5	.0500	.00533	-.00562	-.01790	-.03145	-.04644	-.06306	-.08151	-.1021	-.1250
2.6	.05776	.01704	.00684	-.00440	-.01680	-.03051	-.04570	-.06257	-.08136	-.1024
2.7	.06416	.02674	.01737	.00706	-.00433	-.01691	-.03084	-.04632	-.06355	-.08281
2.8	.06940	.03493	.02650	.01680	.00632	-.00526	-.01808	-.03232	-.04818	-.06590
2.9	.07369	.04184	.03388	.02511	.01544	.00475	-.00708	-.02022	-.03486	-.05121
3.0	.07718	.04770	.04035	.03221	.02326	.01337	.00242	-.00974	-.02328	-.03841
3.1	.08001	.05265	.04582	.03829	.02998	.02081	.01065	-.00064	-.01320	-.02723
3.2	.08228	.05684	.05049	.04349	.03576	.02723	.01778	.00730	-.00438	-.01743
3.3	.08407	.06038	.05446	.04794	.04074	.03279	.02399	.01421	.00335	-.00883
3.4	.08547	.06336	.05783	.05175	.04505	.03761	.02939	.02026	.01010	-.00126
3.5	.08653	.06587	.06070	.05500	.04872	.04178	.03409	.02555	.01604	.00542
3.6	.08730	.06796	.06312	.05778	.05190	.04539	.03819	.03018	.02127	.01131
3.7	.08783	.06969	.06515	.06015	.05463	.04852	.04176	.03424	.02588	.01652
3.8	.08815	.07113	.06686	.06216	.05697	.05125	.04487	.03780	.02993	.02114
3.9	.08827	.07227	.06826	.06385	.05894	.05354	.04755	.04090	.03349	.02521
4.0	.08829	.07322	.06944	.06527	.06067	.05558	.04993	.04366	.03667	.02883
4.1	.08815	.07396	.07039	.06646	.06211	.05731	.05198	.04605	.03945	.03207
4.2	.08791	.07452	.07115	.06744	.06333	.05879	.05373	.04815	.04191	.03492
4.3	.08758	.07493	.07174	.06823	.06435	.06005	.05528	.04998	.04407	.03746
4.4	.08716	.07520	.07219	.06886	.06519	.06111	.05660	.05157	.04597	.03970
4.5	.08668	.07537	.07251	.06936	.06587	.06201	.05772	.05296	.04764	.04169
4.6	.08614	.07543	.07274	.06973	.06642	.06275	.05868	.05416	.04977	.04346
4.7	.08556	.07540	.07283	.06999	.06685	.06336	.05950	.05519	.05059	.04501
4.8	.08493	.07529	.07285	.07015	.06716	.06385	.06017	.05608	.05151	.04639
4.9	.08427	.07512	.07280	.07023	.06739	.06424	.06073	.05683	.05248	.04760
5.0	.08358	.07489	.07268	.07024	.06753	.06453	.06119	.05747	.05352	.04867
5.2	.08215	.07428	.07228	.07006	.06760	.06487	.06183	.05844	.05466	.05042
5.4	.08065	.07352	.07170	.06968	.06743	.06494	.06216	.05907	.05561	.05173
5.6	.07913	.07264	.07098	.06913	.06708	.06480	.06226	.05943	.05626	.05270
5.8	.07759	.07168	.07016	.06847	.06659	.06450	.06217	.05956	.05665	.05338
6.0	.07605	.07066	.06926	.06771	.06599	.06406	.06192	.05952	.05684	.05382
6.5	.07227	.06795	.06681	.06555	.06414	.06257	.06081	.05885	.05664	.05415
7.0	.06865	.06515	.06425	.06319	.06203	.06073	.05927	.05764	.05580	.05373
7.5	.06524	.06240	.06163	.06077	.05981	.05872	.05750	.05613	.05459	.05264
8.0	.06206	.05973	.05910	.05838	.05757	.05666	.05563	.05447	.05316	.05168
8.5	.05909	.05719	.05666	.05606	.05538	.05460	.05373	.05274	.05163	.05036
9.0	.05634	.05478	.05434	.05383	.05325	.05260	.05185	.05101	.05005	.04896
9.5	.05379	.05252	.05214	.05171	.05122	.05066	.05002	.04930	.04847	.04752
10.0	.05143	.05039	.05007	.04971	.04929	.04881	.04826	.04763	.04691	.04609

[b] Multiply all entries by $\frac{a^o b_2}{R(\epsilon_2/k)}P$ to obtain correction.

TABLE 9.- VALUES OF b_o IN VARIOUS UNITS AS A FUNCTION OF r_o

r_o, A	b_o			
	cm^3/g-mole	cu ft/lb-mole	cu in./lb-mole	$Amagat^{-1}$ (a)
2.4	17.444	0.27942	482.84	0.77823×10^{-3}
2.5	19.717	.31583	545.75	.87963
2.6	22.179	.35527	613.91	.98947
2.7	24.838	.39786	687.50	1.10810
2.8	27.701	.44372	766.75	1.23582
2.9	30.776	.49298	851.87	1.37301
3.0	34.071	.54576	943.07	1.52001
3.1	37.593	.60218	1,040.57	1.67714
3.2	41.350	.66236	1,144.56	1.84475
3.3	45.348	.72640	1,255.22	2.02311
3.4	49.597	.79446	1,372.83	2.21267
3.5	54.104	.86666	1,497.59	2.41374
3.6	58.875	.94308	1,629.64	2.62659
3.7	63.918	1.02386	1,769.23	2.85157
3.8	69.242	1.10915	1,916.61	3.08909
3.9	74.854	1.19904	2,071.94	3.33946
4.0	80.761	1.29366	2,235.44	3.60299
4.1	86.971	1.39314	2,407.35	3.88004
4.2	93.491	1.49758	2,587.82	4.17091
4.3	100.329	1.60711	2,777.09	4.47598
4.4	107.493	1.72186	2,975.37	4.79558
4.5	114.990	1.84196	3,182.91	5.13005
4.6	122.827	1.96749	3,399.82	5.47968
4.7	131.013	2.09862	3,626.41	5.84488
4.8	139.555	2.23545	3,862.86	6.22597
4.9	148.460	2.37809	4,109.34	6.62324
5.0	157.736	2.52668	4,366.10	7.03708

[a] 1 Amagat = Density of gas at 1 atm and 273.16° K. It is here assumed that PV/RT = 1.000 under these conditions; multiply tabulated values by true values if known.

TABLE 10.- VALUES OF GAS CONSTANT R IN VARIOUS UNITS

P	V	T	R
atm	cm^3/mole	°K	82.0567 atm cm^3/mole °K
kg/cm^2	cm^3/mole	°K	84.7832 (kg/cm^2) cm^3/mole °K
bars[a]	cm^3/mole	°K	83.1440 bars cm^3/mole °K
mm Hg	cm^3/mole	°K	62363.1 (mm Hg) cm^3/mole °K
atm	l/mole	°K	0.0820544 atm l/mole °K
kg/cm^2	l/mole	°K	0.0847809 (kg/cm^2) l/mole °K
mm Hg	l/mole	°K	62.3613 (mm Hg) l/mole °K
atm	cu ft/(lb) mole	°R	0.730231 atm cu ft/mole °R
mm Hg	cu ft/(lb) mole	°R	554.976 mm Hg cu ft/mole °R

[a] 10^6 dynes/cm^2.

TABLE 11.- LENNARD-JONES CONSTANTS FOR APPROXIMATE FITTING OF VIRIAL DATA FOR CLUSTERS OF TWO AND THREE MOLECULES

Gas	ϵ_2/k, $^{\circ}K$	b_2, $cm^3/mole$	ϵ_3/k, $^{\circ}K$	b_3, $cm^3/mole$	ϵ_3/ϵ_2	b_3^2/b_2^2	$p_2 = \frac{R\epsilon_2}{kb_2}$, atm	$p_3 = \frac{R\epsilon_3}{kb_3}$, atm	p_2^2/p_3^2	Notes (a)
Argon A	119.75 119.75	49.804 49.804	118.6 119.75	50.89 51.49	0.9904 .9745	1.0442 1.0688	197.30 197.30	191.2 190.8	1.0645 1.0695	(1) (2)
Krypton Kr	169 169	61 61	164 164	63.5 63.46	.9704 .9704	1.0836 1.0823	227.3 227.3	211.9 212.1	1.151 1.148	(1) (2)
Xenon Xe	224.5 224.5	84.65 84.65	227 227.5	81.46 81.25	1.0111 1.0134	.9260 .9213	217.6 217.6	228.7 229.8	.9058 .8966	(1) (2)
Nitrogen N_2	95.05 95.42 92.5	63.78 63. 70.5	100.2 97.7 94.8	56.3 61.7 66.5	1.0538 1.0239 1.0249	.7787 .9592 .8897	122.3 124.3 107.7	146 130 117	.7012 .9149 .8473	(1) (1), (3) (2)
Oxygen O_2	116 113.2	54.7 58.9	124.7 115	48.2 56.5	1.0750 1.0159	.7758 .9202	174.0 157.7	212 167	.6713 .8917	(3) (2)
Carbon monoxide CO	100.78 100.78 99.8	69.22 69.22 66.7	97.9 99.9 101.2	68.7 69.63 64.17	.9715 .9913 1.0140	.9850 1.0119 .9256	119.5 119.5 122.8	116.9 117.7 129.4	1.0436 1.0308 .9006	(1) (2) (2)
Carbon dioxide CO_2	189 189	113.9 113.9	195.9 199.5	106.8 102.6	1.0365 1.0556	.8785 .8109	136.2 136.2	150.5 159.6	.8177 .7283	(1)
Methane CH_4	148.2	70.16	145.2	72.0	.9798	1.0523	173.3	165.5	1.0961	(1), (2)
Tetrachloromethane CF_4	152.5	131.0	160.7	115.6	1.0538	.7787	95.5	114.1	.7012	(1)
Ethene C_2H_4	199.2 199.2	115.5 115.5	204 203.2	109.5 110.4	1.0241 1.0201	.8980 .9134	141.5 141.5	152.9 151.0	.8562 .8781	(1)
Ethane C_2H_6	217.5	123.8	221.3	118.9	1.0175	.9213	144.2	152.7	.8918	(2), (4)

[a](1) Reference 12.
(2) Modified for critical conditions and extant lower temperature data.
(3) Used in NBS-NACA tables.
(4) Reference 19.

TABLE 12.- FORCE CONSTANTS FROM VISCOSITY DATA
AND SECOND VIRIAL COEFFICIENTS[a]

Gas	ϵ/k, °K		τ_c	r_o, A		V_c/b_2
	Viscosity	Second virial coefficient		Viscosity	Second virial coefficient	
Neon Ne	35.7	35.7	1.244	2.80	2.74	1.56
Argon A	124.0	119.75	1.240	3.418	3.41	1.50
Nitrogen N_2	91.46	95.05	1.351	3.681	3.70	1.42
Oxygen O_2	113.2	117.5	1.341	3.433	3.58	1.37
Carbon monoxide CO	110.3	95.33	1.296	3.590	3.65	1.50
Nitric acid NO	119.	131	1.43	3.470	3.17	1.25
Methane CH_4	136.5	148.2	1.339	3.822	3.82	1.41
Carbon dioxide CO_2	190	189	1.606	3.996	4.49	.99
Nitrous oxide N_2O	220	189	1.514	3.879	4.59	1.02
	Av. seven gases		1.320 ± 0.054			1.43 ± 0.07

[a] From reference 2, with a few alterations.

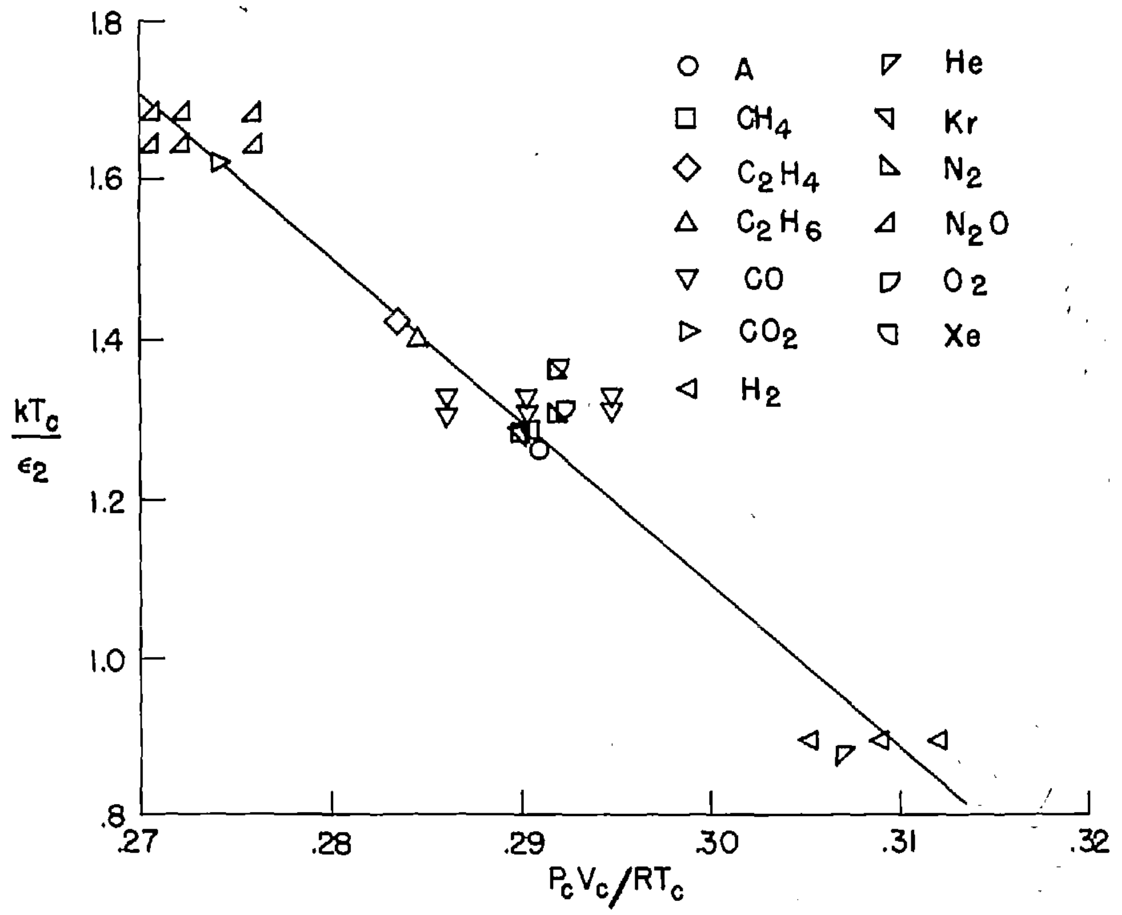

Figure 1.- Parameter kT_c/ϵ_2 versus P_cV_c/RT_c for various substances.

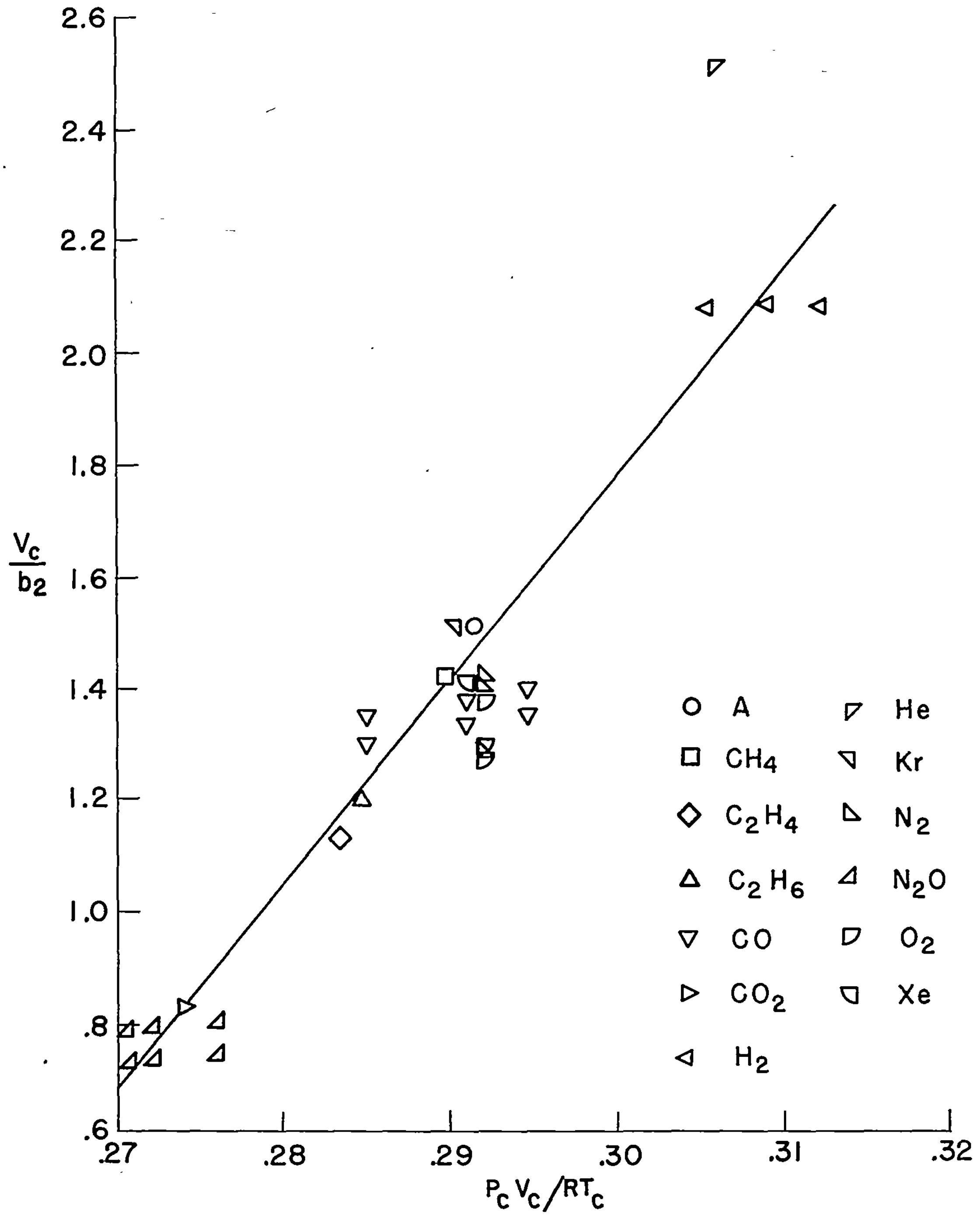

Figure 2.- Parameter V_c/b_2 versus P_cV_c/RT_c for various substances.

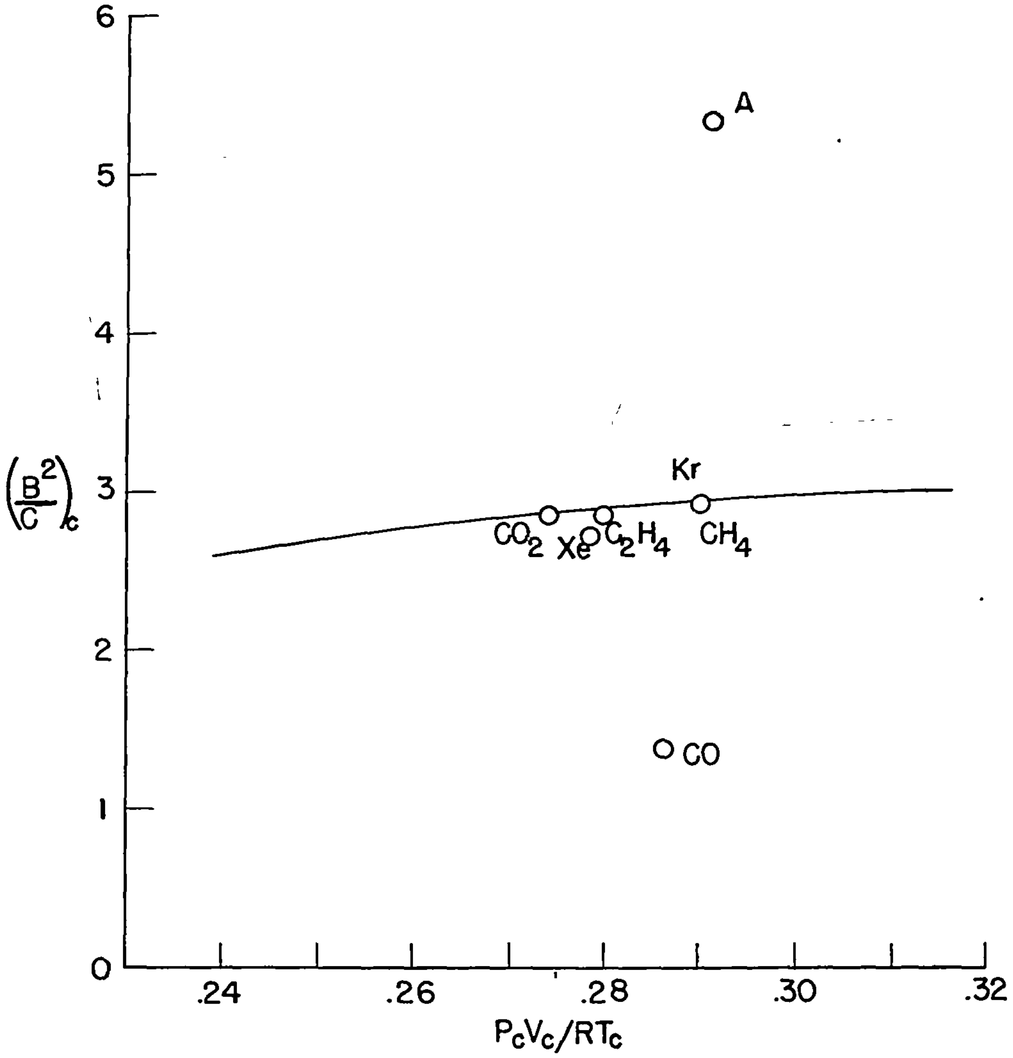

Figure 3.- Parameter B^2/C at T_c versus P_cV_c/RT_c for various substances. Circles represent values based on preliminary cluster parameters for PVT data away from critical temperature; curve is based only on critical isotherm data as represented by Meyers (ref. 18).

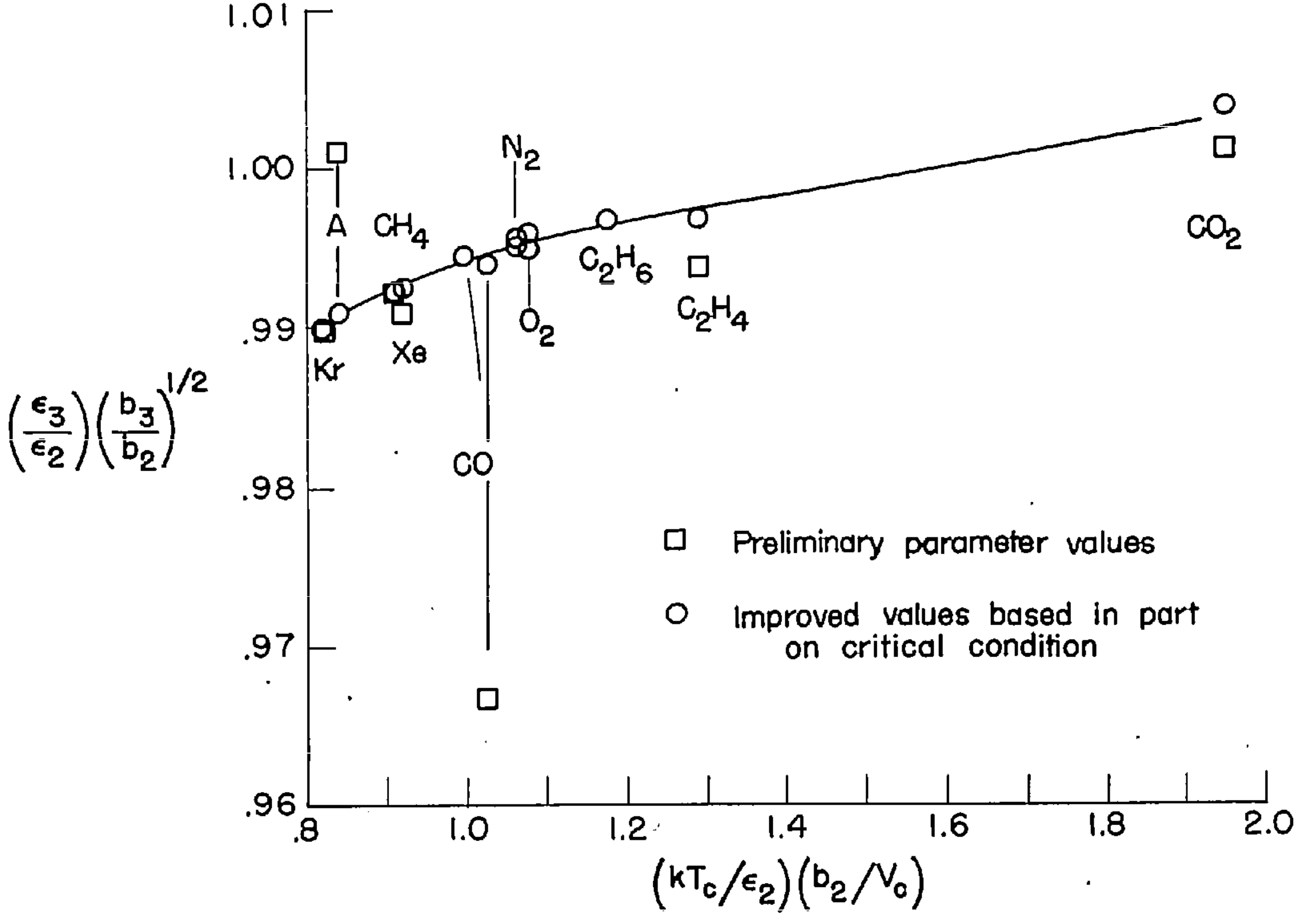

Figure 4.- Parameter $(\epsilon_3/\epsilon_2)(b_3/b_2)^{1/2}$ versus $(kT_c/\epsilon_2)(b_2/V_c)$ for various substances.

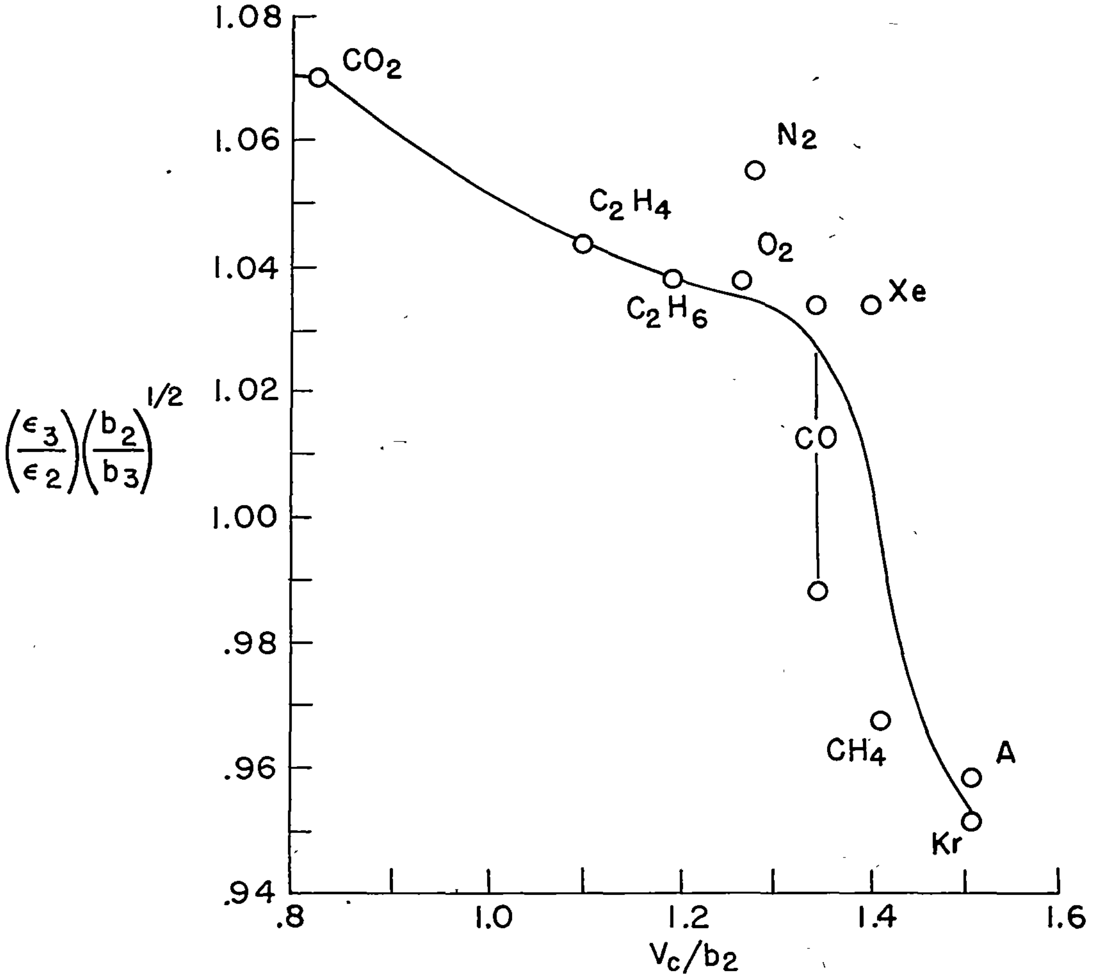

Figure 5.- Parameter $(\epsilon_3/\epsilon_2)(b_2/b_3)^{1/2}$ versus V_c/b_2 for various substances. Circles represent parameter values based in part on B^2/C requirement for classical critical condition.

NACA - Langley Field, Va.