Dear Patron:

We regret that the enclosed photocopies are the best we were able to obtain using our normal reproduction process. This is caused primarily by the age and faded conditions of some of the documents from which these copies are made.

BEST AVAILABLE COPY

NATIONAL BUREAU OF STANDARDS REPORT

2602

THERMODYNAMIC PROPERTIES OF GASEOUS NITRIC OXIDE

Harold W. Woolley
Thermodynamics Section
Division of Heat and Power

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT
0302-50-2606

June 30, 1953

NBS REPORT
2602

THERMODYNAMIC PROPERTIES OF GASEOUS NITRIC OXIDE

by

Harold W. Woolley
Thermodynamics Section
Division of Heat and Power

Sponsored in part by
National Advisory Committee for Aeronautics
Order No. W-5594.

NBS

FOREWORD

This is one of a series of reports on the thermodynamic properties of gases compiled at the National Bureau of Standards at the suggestion and with the cooperation of the National Advisory Committee for Aeronautics. Advances in methods of propulsion and the high speeds attained thereby have emphasized the importance of accurate data on thermal properties of wind-tunnel and jet-engine gases. It has been the purpose of the project on thermal properties of gases to make a critical compilation of existing published and unpublished data, and to present such data in convenient form for application. The dimensionless character of the tables and their general format should facilitate calculations in aero-dynamics, heat-transfer, and jet-engine problems. The work was conducted under the supervision of Mr. Joseph Hilsenrath by members of the Thermodynamics Section, Division of Heat and Power.

Chas W Beckett

C. W. Beckett, Chief
Thermodynamics Section

R, E, Wilson

R. E. Wilson, Acting Chief
Division of Heat and Power

TABLE OF CONTENTS

APPENDICES

SUMMARY

The tables of thermal properties of nitric oxide which have been prepared in the NBS-NACA series have been grouped together in the present report for convenient use. The properties include thermodynamic functions for the gas, both ideal and real, the transport properties for the gas and the vapor pressure of the liquid and solid. The ideal gas thermodynamic properties are given in table 16.10. Ideal gas values were furnished in advance of publication through the courtesy of H. L. Johnston, Leonard Glatt and Jack Belzer from calculations sponsered by the Office of Naval Research at the Ohio State University Cryogenic Laboratory. These include specific heat at constant pressure, enthalpy and entropy, and the free energy function. The real gas thermodynamic properties are given in tables 16.18 to 16.32 and include density, compressibility factor (PV/RT), entropy, enthalpy, specific heat at constant pressure, ratio of specific heats ($\gamma = C_p/C_v$), and velocity of sound at very low frequency.

For tables 16.18 to 16.32, the tabular entries are for pressures of .01, .1, .4, .7, 1, 4, 7, 10, 40, 70 and 100 atmospheres. The temperatures covered range from 150°K or slightly above, up to 3000°K. The extrapolation upward in temperature far above the range of P-V-T measurements is based on a semi-empirical representation of the second virial coefficient. This coefficient

is obtained by combining a contribution arising from a Lennard-Jones type intermolecular potential with a contribution due to dimer formation. The first part contributes to the virial coefficient at all temperatures, while the second part is sizable only at low temperatures.

The vapor pressure for both solid and liquid nitric oxide is given in table 16.50 with values indicated at every degree from 75°K to 180°K for ready reference.

The viscosity and thermal conductivity for nitric oxide near atmospheric pressure are given in tables 16.39 and 16.42 respectively. The viscosity is tabulated for the temperature range 100°K to 1200°K. The values were computed on the basis of a Lennard-Jones intermolecular potential, according to calculations by Hirschfelder, Bird and Spotz [13] and with their suggested parameters for nitric oxide.

The table of thermal conductivity extends from 120°K to 380°K, the range of experimental data.

No table of Prandtl number is given here, since its range would be limited by the range of the thermal conductivity table. The values of $N_{pr} = \eta C_p/k$ vary from 0.788 at 150°K to 0.728 at 350°K.

I INTRODUCTION

The computation of a set of mutually consistent tables of thermodynamic properties of nitric oxide has been accomplished through the representation of the data of state by an equation whose coefficients are functions of temperature and from which were obtained the coefficients used to calculate the derived thermodynamic properties. The data of state, when properly interpreted, and when combined with other reliable data, form a dependable basis for the estimation of many other properties.

The PVT data for nitric oxide were correlated in the limited range of pressure from zero to a maximum of 100 atmospheres and of temperature from a minimum of 150°K upward through the experimental range with an appropriate extrapolation to high temperature. The present table for nitric oxide extends down only to 150°K because of scarcity of data at elevated pressure. For most of the desired range of pressure and temperature, the compressibility factor is represented adequately by the equation

$$Z = PV/RT = 1 + B_1 P + C_1 P^2 + D_1 P^3 \qquad (1)$$

where the coefficients B_1, C_1, and D_1 are functions of the temperature and are related to the virial coefficients of the analogous equation in powers of the reciprocal of specific volume.

The pressure corrections to various thermodynamic properties were determined in accord with standard thermodynamic relationships from the

correlation of the data of state and were combined with the values of properties for the ideal gas to obtain the complete real gas properties. In this way tables 16.22 to 16.32 were obtained. Many details concerning the actual computations will be found in succeeding sections of this report and in the discussions of tables 16.20 to 16.32.

The tables are given in dimensionless form and conversion factors to some frequently used units are given at the end of each table. The pressure intervals were chosen in groups of three equal steps to facilitate non-linear Lagrangian interpolation of the tables. When linear interpolation in pressure is strictly valid for greater ranges, values for intermediate pressures have in some cases been omitted. Plots are given showing the degree of agreement between the correlation and derived quantities on the one hand and the various experimental data on the other. The graphs show the scarcity and degree of inconsistency for the various experimental determinations for nitric oxide.

The various tables of the complete NBS-NACA series have in the main been issued separately in loose leaf form to permit earlier access to the data by the users. In the present case of nitric oxide a considerable portion of the present tables is of the same form but is issued for the first time in this complete collection of the distinct tables. Thus the various tables are kept close to their conversion factors, text material, deviation plots and discussions of reliabilities. This should help make the tables more convenient for use and may maintain an awareness of the uncertainties of the tables. These advantages

of binding the loose-leaf tables at the end of the report should outweigh the disadvantages of separate pagination and multiple list of references.

II Symbols

Symbol	Definition	Units
Å	Abbreviation for Angstrom, unit of length	10^{-8} cm
a	Sound velocity at low frequency	$m \cdot sec^{-1}$, $ft\ sec^{-1}$
a_o	Sound velocity at standard conditions	323.64 m sec^{-1} 1061.8 ft sec^{-1}
B	Second virial coefficient in the 1/V series - a function of temperature	$cm^3\ mole^{-1}$
$B^{(o)}(\tau)$	Second virial coefficient function=B/b_o	1
B_1	Coefficient of P in the pressure series for PV/RT	atm^{-1}
B' and B''	TdB/dT and T^2d^2B/dT^2	$cm^3\ mole^{-1}$
b_o	Characteristic parameter of the Lennard-Jones interaction potential	61.5 $cm^3\ mole^{-1}$
C	Third virial coefficient in the 1/V series, a function of temperature	$(cm^3\ mole^{-1})^2$
C_1	Coefficient of P^2 in the pressure series for PV/RT	atm^{-2}
C_p	Heat capacity at constant pressure	various
C_p^o	Heat capacity at constant pressure for the ideal gas	various
C_v	Heat capacity at constant volume	various

Symbol	Definition	Units
C_v^o	Heat capacity at constant volume for the ideal gas	various
D	Fourth virial coefficient in the 1/V series, a function of temperature	$(cm^3\ mole^{-1})^3$
D_1	Coefficient of P^3 in the pressure series for PV/RT	atm^{-3}
E	Internal energy for one mole of gas [E is also used for the fifth virial coefficient]	various
E_0^o	Internal energy for one mole of gas in ideal gas state at 0^oK. Same as H_0^o, the enthalpy for the same conditions	various
ΔE_0^o	The heat of formation for one mole of a substance in the standard state from its constituents in their standard states at 0^oK	various
F	Free energy per mole	various
F^o	Free energy per mole in standard state [Ideal gas at one atmosphere for gaseous substances]	various
H	Enthalpy per mole	various
H^o	Enthalpy per mole in standard state [Ideal gas at one atmosphere for gaseous substances]	various
H_0^o	Enthalpy per mole in standard state at 0^oK. Same as E_0^o	various

Symbol	Definition	Units
K	Equilibrium constant for a chemical reaction	$(atm)^n$
K	Symbol for degrees Kelvin	
k	Boltzmann constant for proportionality of energy to temperature	1.3803×10^{-16} erg deg
k	Thermal conductivity	cal $cm^{-1} sec^{-1} {}^oC^{-1}$
k_o	Thermal conductivity at 273.16 ^oK and one atmosphere pressure	$5.674.10^{-5}$ cal $cm^{-1} sec^{-1} {}^oC^{-1}$
M	Molecular weight	30.008 gm $mole^{-1}$
N	Avogadro's number	6.025×10^{23} $mole^{-1}$
N	Symbol for nitrogen (one atom of, or atomic)	
O	Symbol for oxygen (one atom of, or atomic)	
P	Pressure	atm, dyne cm^{-2}
P_o	Atmospheric pressure	1 atm; 1013250 dyne cm^{-2}
p	Subscript indicating constant pressure	
R	Gas constant per mole	82.0567 $cm^3 atm {}^oK^{-1} mole^{-1}$ 1.98718 cal $deg^{-1} mole^{-1}$ 8.31439 abs joule $deg^{-1} mole^{-1}$

Symbol	Definition	Units
r_o	Classical distance of closest intermolecular approach at zero energy according to Lennard-Jones potential	3.65 A from B 3.47 A from η
S	Entropy for one mole	various
S^o	Entropy for one mole in standard state [Ideal gas at one atmosphere for gases]	various
T	Absolute temperature	degrees K degrees R
T_o	Temperature at standard conditions	273.16 ^oK
V	Volume per mole	cm^3 $mole^{-1}$
V_r	Function in theory of viscosity	1
v	Subscript indicating constant volume	
W	Function in theory of viscosity	1
	Mole fraction	1
Z	Compressibility factor, PV/RT	1
Z_o	Compressibility factor at 273.16 ^oK and one atmosphere	Z_o = .99885
α	Isentropic expansion coefficient, $-\frac{V}{P}\left(\frac{dP}{dV}\right)_S = -\frac{V}{P}\left(\frac{dP}{dV}\right)_T \gamma$	1

Symbol	Definition	Units
β_c	Part of B_1 due to dimer formation, with weak chemical bond	atm^{-1}
β_{LJ}	Part of B_1 due largely to ordinary Lennard-Jones potential	atm^{-1}
γ	Ratio of specific heats, C_p/C_v	1
ε	Maximum energy of binding between molecules due to Lennard-Jones potential	ergs
ε/k	Characteristic parameter of the Lennard-Jones interaction potential	118 °K for B 119 °K for η
η	Viscosity	poises, gm sec^{-1} cm^{-1}
η_0	Viscosity at 273.16 °K and one atmosphere	1792.0 x 10^{-7} poise
ν	Kinematic viscosity, η/ρ	$cm^2 sec^{-1}$
ν_0	Kinematic viscosity at 273.16 °K and one atmosphere	.13370 $cm^2 sec^{-1}$
ρ	Density	mole cm^{-3}, gm cm^{-3}, also Amagat units, etc.
ρ_0	Density at 273.16 °K and one atmosphere	1.34031 x 10^{-3} gm cm^{-3} 4.46651 x 10^{-5} mole cm^{-3}
τ	A reduced temperature, kT/ε	1

III. THE EXPERIMENTAL DATA OF STATE

The experimental PVT data for gaseous NO used in the present correlation include measurements near the ice point and atmospheric pressure by Berthelot [4], Leduc and Sacerdote [20], Jaquerod and Scheuer [14], Batuecas [2], and by Eucken and d'Or [8], measurements near atmospheric pressure over the temperature range 125°K to 173°K by Eucken and d'Or, over the temperature range 122°K to 308°K by Johnston and Weimer [18], and less precise measurements at higher pressures from 37 atm to 156 atm between 195°K and about 282°K by Briner, Biedermann and Rothen [5]. Data of Golding and Sage [9] in the region of pressures from 11 to 205 atm and temperatures from 278°K to 378°K, approximately, have appeared since the present correlation was made.

An examination of the low pressure data leads to the conclusion that an appreciable amount of chemically bonded dimer is formed, rather weakly bound. This effect contributes to the values of the second virial coefficients, as also does the more ordinary kind of intermolecular interaction, which can be represented empirically by a Lennard-Jones 6-12 force law. A preliminary examination showed that the second virial coefficient could not be represented adequately by a Lennard-Jones treatment alone, while the value of the dipole moment [26] is much too small to produce effects large enough to account for the strong temperature effect at low temperatures. It has been possible to account for the temperature behavior of the low pressure data on the basis of a second virial coefficient alone by including in it the effect of dimer

formation under conditions of chemical equilibrium using standard thermochemical data for NO [24] and computing thermodynamic functions for N_2O_2. For the properties of this dimer the three low vibrational frequencies reported by Smith, Keller and Johnston [25] have been used, together with a torsional frequency chosen ad hoc somewhat below the other frequencies. The estimated heat of dimerization (reduced to the absolute zero temperature) was chosen at about 2 k cal per mole of dimer. On this basis it was possible to fit the low pressure data in such a way that the ordinary intermolecular interaction is represented by a Lennard-Jones force law, whose parameters are suitably near to reasonable values for O_2 and N_2 and also near to the values one would obtain from the viscosity of nitric oxide.

It may be appropriate to note that the treatment used is of an empirical nature in large degree and that numerically it is thus not accurately descriptive of the origins of the various effects. It has not seemed necessary to attempt to cover details of the occupancy of phase space for the pair interactions with such accuracy as would approach complete self consistency. Thus, in using the conventional type of treatment for calculating thermodynamic functions for the dimer molecule, no effort was made to exclude configurations which might seem to pertain also to the phase space of the Lennard-Jones second virial contribution. Any discrepancy arising from such a source is probably rather small and less than present experimental uncertainties.

The coefficient B_1 of equation (1) is accordingly represented as the sum of two functions β_{LJ} and β_c where $\beta_{LJ} = b_o B^{(o)}(T)/RT$ according

to the formulas appropriate for a Lennard-Jones pair interaction with parameters $\varepsilon/k = 118^{\circ}K$ and $b_o = 61.5$ cm^3/mole, and β_c is the contribution due to weak chemical bonding to form N_2O_2. Then $\beta_c = -K$, where K is the equilibrium constant for formation of N_2O_2 from NO, $K = P_{N_2O_2}/P^2_{NO}$, in terms of the partial pressures of NO and N_2O_2. According to the standard rules of chemical thermodynamics

$$K = \exp\left[(2F^{\circ}_{NO} - F^{\circ}_{N_2O_2})/RT\right]$$

The derivatives of β_c with respect to temperature are given by

$$T d\beta_c/dT = K\left[2(H^{\circ}/RT)_{NO} - (H^{\circ}/RT)_{N_2O_2}\right]$$

and

$$T^2 d^2\beta_c/dT^2 = -K\left\{\left[2(H^{\circ}/RT)_{NO} - (H^{\circ}/RT)_{N_2O_2}\right]^2 + 2\left[2(H^{\circ}/RT)_{NO} - (H^{\circ}/RT)_{N_2O_2}\right] - \left[2(C^{\circ}_p/R)_{NO} - (C^{\circ}/R)_{N_2O_2}\right]\right\}$$

The thermodynamic functions for N_2O_2 were calculated with the observed frequencies 262 cm^{-1}, 196 cm^{-1} and 167 cm^{-1}. In the temperature range in which dimer formation is large enough to require calculation, the frequencies 1863 cm^{-1} and 1770 cm^{-1}, for N-O bond vibration in N_2O_2 are high enough to make only a negligible contribution. The unknown frequency of torsional vibration was taken as 150 cm^{-1}. A C_2 structure was assumed with 1.2 A for the length of the N-O bond and 2.0 A for the length of the N-N bond. The N-N-O angle was taken as 120°. With $\left(2(E^{\circ}_0)_{NO} - (E^{\circ}_0)_{N_2O_2}\right)/R = 1000^{\circ}$, the departure of the values for the experimental second virial coefficients from a Lennard-Jones type second virial coefficient was

well represented.* Above 300°K, β_c as given by the thermochemical procedure is also given adequately by the approximate formula

$$-\beta_c = \exp [-.1617 \times 10^5 T^{-2} + 1658 T^{-1} + .000184 T + .808 \ln T - 21.341].$$

The appearance of the data of state for low pressure and the closeness of their representation with the second virial coefficient computed according to the foregoing procedure are shown in figure 1, table 16.20.

A somewhat similar situation appeared to exist in regard to the higher pressure data of Briner, Biedermann and Rothen [5] in that clusters of three may be more tightly bound than corresponds to ordinary Lennard-Jones parameters alone, but the lack of independent data on trimer formation and the roughness of the older PVT measurements and different trend of the data of Golding and Sage makes this interpretation of the data less definite. The data of Briner et al. above 200°K were fitted approximately using empirical formulas for the third and fourth virial coefficients. The coefficients C_1 and D_1 of equation (1) were given by

$$C_1 = 41.90 T^{-5/2} - 1210.5 T^{-3} + 7528 T^{-7/2} - 69640 T^{-4} + 1017000 T^{-9/2}$$

and

$$D_1 = .44 \times 10^5 T^{-5} - 9.14 \times 10^{-7} T^{-3} e^{2850/T}.$$

The data for the lower temperature of 195°K have been fitted only approximately, in the range between 60 and 80 atmospheres, at which point higher coefficients apparently have effects too great to be approximated by adjustment of the lower order coefficients. The quality of fit for their data can be observed in figure 2, table 16.20.

*Footnote: An interpretation of new x-ray diffraction data by Dulmage, Meyers and Lipscomb[6] indicates a different shape for the crystalline dimer.

The latest set of experimental PVT data is due to Golding, Sage and Lacey [10] and appeared after the present correlation of the PVT data was completed. Figure 3, table 16.20, shows a plot of their values in the form RT(PV/RT-1)/P as a function of P. The curves show the behavior of the present correlation. It may be noticed that the new data do not agree with the older data of Briner, Biedermann and Rothen in their region of equal temperature. Also the new data show pairs of isotherms for the various temperatures but with appreciable differences from each other, indicating that still better data may be desirable in the high temperature region as well as at lower temperatures.

As further comment on the poor fit of the PVT data at elevated pressure and lower temperature, it may be mentioned that the pressure series becomes still less appropriate at lower temperatures. At the critical temperature near 179°K, the critical pressure of 65 atmospheres may be regarded as a singular point in the representation of PV/RT as a power series in pressure. For the present correlation the empirical formulas for third and fourth virials should not be trusted when extrapolated below the region of the experimental data leading to them. Adequate values at low pressures for temperatures below those tabulated, may be obtained by using the normal virial coefficients only, and omitting completely the C_1 and D_1 contributions from the calculations.

IV COMPARISON OF DERIVED QUANTITIES WITH EXPERIMENTAL DATA

The experimental data which can be compared with calculations based on the PVT data for nitric oxide include the specific heat at constant pressure and the velocity of sound at pressures of approximately one atmosphere.

Published measurements on the specific heat of gaseous nitric oxide include those of Heuse [12] in 1919 and Eucken and d'Or [8] in 1932. A value of Partington and Shilling [23] based on the velocity of sound is also available. The method used by Heuse was that of the flow calorimeter for which relatively little correction is involved to arrive at the indicated value of C_p. The method used by Eucken and d'Or was based on the change of temperature in an adiabatic expansion between known pressures, and is a modification of a method used by Lummer and Pringsheim [21]. The method requires a computation based on equation of state effects before the indication of the specific heat at constant pressure is obtained. Values of C_p/R thus indicated by experimental determination using the same second virial coefficient as did Eucken and d'Or are compared in figure 1, table 16.24 with values similarly obtained using the second virial coefficient of the present correlation; also shown are theoretical values based on the ideal gas values with and without the correction for departure from ideality.

As already indicated in an earlier section, the present correlation at elevated pressure is based on data of state extending upward

from about 200°K. For lower temperatures, the data are for low pressures and indicate values for the second virial coefficient only, leaving the higher coefficients undetermined. In figure 1, table 16.24, the highest curve at low temperatures includes the effects of the extrapolated higher coefficients. The intermediate curve is based on the effect of the term linear in the pressure in combination with the ideal gas values, while the lowest curve is for the ideal gas alone.

Among the published measurements of the velocity of sound in NO are those of Masson [22] in 1857, Partington and Shilling [23] in 1923, van Itterbeek and Thys [27] in 1938, Kneser [19] in 1939 and 1941 and Bender [3] in 1940. The earlier measurements were made with a vibrating reed in different gases [22] or by comparison via dust patterns in a Kundt's tube experiment [23]. It was found by van Itterbeek and Thys that there was agreement with classical theory in regard to sound absorption, with no noticeable effect due to magnetic field. They claimed an accuracy of only 5.2% for their measured velocity of sound. Similarly, Kneser in 1939 reported that relaxation effects are negligible and that the velocity of sound was in agreement with theory. His results published in 1941, and experimental values of others are compared in figure 1, table 16.32, with calculated values based on the present tables. The results of Bender are omitted as they are not strictly comparable. He reports two separate experimental runs differing considerably from each other and from the theoretical velocity for low frequency. As his results are for the ultrasound region, the difference may reasonably be attributed to relaxation effects.

Partington and Shilling reduced their results to equivalent specific heats, but their actual measurements yielded a ratio of wavelengths of sound in nitric oxide to that in dry air. The value shown in figure 1, table 16.32, was obtained by applying the velocity of sound in air from table 2.32 of this series to their experimentally determined ratio.

Another item of experimental data indicating the behavior of the second virial coefficient at low temperature is given indirectly in the comparison of the entropy of the saturated vapor at the boiling point and the computed entropy from spectroscopic data. Johnston and Giauque [15] used 0.09 cal/deg mole for the equation of state correction using a second virial coefficient based on a Berthelot equation of state. The present second virial coefficient, which gives a better representation of the low temperature data of state than does the Berthelot equation based on the critical constants, provides about twice as great an estimated entropy correction due to non-ideality at the boiling point. The residual entropy at absolute zero, estimated by Johnston and Giauque at 0.72±.1 cal/deg mole would be changed to about 0.60±.1 cal/deg mole. The original value of Johnston and Giauque is well accounted for as 1/2 R ℓn 2 = 0.69 cal/deg mole which though not identical is still within the indicated uncertainty.

Vapor Pressure

The vapor pressure of nitric oxide is given in Table 16.50 based on results of Adwentowski [1], Henglein and Krüger [11], and Johnston

and Giauque [15] for the solid and of Adwentowski, and Johnston and Giauque for the liquid. The results of Johnston and Giauque were weighted heavily in the representation. The errors of early values are probably due in considerable degree to impurities.

Transport Properties

Values of viscosity and thermal conductivity for nitric oxide are given in tables 16.39 and 16.42, respectively.

The Lennard-Jones parameters providing a representation of viscosity by the theory of Hirschfelder, Bird and Spotz [13] are $\varepsilon/k = 119°K$, and $r_o = 3.47$ A or $b_o = 52.75$ cm^3/mole. Figure 1, table 16.39, shows the agreement with the viscosity data of Johnston and McCloskey [17] and also the data of Wobser and Müller [28].

The thermal conductivity as presented in table 16.42 is a smoothed representation of the data of Johnston and Grilly [16]. Figure 1, table 16.42, shows the experimental points of Johnston and Grilly and of Eucken [7].

V REFERENCES

[1] K. Adwentowski, Über das Verhalten des Stickoxyds bei niederen Temperaturen, Ion., 2, 1(1910). Zeitschrift für kompr. und flüss. Gase, 13, 1 and 19(1910). Acad. des Sciences - Cracowie, Bull. Int. 742(1909).

[2] T. Batuecas, Sur la compressibité au-dessous de 1 atmosphere et l'écart à la loi d'Avogadro de plusieurs gaz, J. de Chim. Phys. 22, 101(1925).

[3] D. Bender, Ultraschallgeschwindigkeiten in Stickstoff, Stickoxyd und Kohlenoxyd zwischen 20 und 200°C, Ann. d. Phys. 38, 199(1940).

[4] D. Berthelot, Sur le calcul exact des poids moléculaires des gaz, Comptes Rendus 144, 76(1907).

[5] E. Briner, H. Biedermann and A. Rothen, Recherches sur la compression et la decomposition de l'oxyde d'azote, J. de Chim. Phys. 23, 157(1926).

[6] W. J. Dulmage, E. A. Meyers and W. N. Lipscomb, Molecular and crystal structure of nitric oxide dimer, J. Chem. Phys. 19, 1432(1951).

[7] A. Eucken, Über das Wärmeleitvermögen, die spezifische Wärme und die innere Reibung der Gase, Physik. Z, 14, 324(1913).

[8] A. Eucken and L. d'Or, Die Molwärme des gasförmigen Stickoxyd bei tiefen Temperaturen, Nachr. Ges. Wiss. Göttingen, 1932, 107(1932).

[9] B. H. Golding and B. H. Sage, Volumetric behavior of nitric oxide, Ind. Eng. Chem. 43, 160(1951).

[10] B. H. Golding, B. H. Sage and W. N. Lacey, Volumetric behavior of nitric oxide, ADI 2949, American Documentation Institute, Washington 6, D. C., 1950.

[11] F. A. Henglein and H. Krüger, Dampfdruckmessungen von Stickoxyd, Z. anorg. allg. Chemie, 130, 181(1923).

[12] W. Heuse, Die spezifische Wärme von Argon und einigen mehratomigen Gasen, Ann. Physik 59, 86(1919).

[13] J. O. Hirschfelder, R. B. Bird and E. L. Spotz, Viscosity and other physical properties of gases and gas mixtures, Trans. ASME 48, 921(1949).

[14] A. Jaquerod and O. Scheuer, Sur la compressibitile de différents gaz au-dessous de 1 atm et la determination de leurs poids moléculaires, Comptes Rendus 140, 1384(1905).

[15] H. L. Johnston and W. F. Giauque, The heat capacity of nitric oxide from 14°K to the boiling point and the heat of vaporization - vapor pressures of solid and liquid phases - the entropy from spectroscopic data, J. Am. Chem. Soc. 51, 3194(1929).

[16] H. L. Johnston and E. R. Grilly, An improved hot-wire cell for accurate measurements of thermal conductivities of gases over a wide temperature range, J. Chem. Phys. 14, 219(1946).

[17] H. L. Johnston and K. E. McCloskey, Viscosity of common gases from 90° absolute to room temperature, J. Phys. Chem., 44, 1038(1940).

[18] H. L. Johnston and H. R. Weimer, Low pressure data of state of nitric oxide and of nitrous oxide between their boiling points and room temperature, J. Am. Chem. Soc. 56, 625(1934).

[19] H. O. Kneser, Schallabsorption, spezifische Wärme und Einstelldauer des Elektronenspins in Stickoxyd, Ann. Physik 39, 261(1941).

[20] A. Leduc, Compressibilité des gaz; volumes moléculaires et poids atomiques, Annales de Chimie et de Physique, 8th Ser. 19, 441(1910).

[21] O. Lummer and E. Pringsheim, Bestimmung des Verhältnisses ($\varkappa$) der spezifischen Wärmen einiger Gase, Wied. Ann. 64, 555(1898).

[22] A. Masson, On the velocity of sound in solids, liquids, and elastic fluids, and on the correlation of the physical properties of bodies, Phil. Mag. 13, 533(1857).

[23] J. R. Partington and W. G. Shilling, The Specific Heats of Nitrous and Nitric Oxides, Phil. Mag. 45, 416(1923).

[24] F. D. Rossini, D. D. Wagman, W. H. Evans, S. Levine and I. Jaffe, Selected Values of Chemical Thermodynamic Properties, Circular of the National Bureau of Standards 500, (1952).

[25] A. L. Smith, W. E. Keller and H. L. Johnston, The infrared and Raman spectra of condensed nitric oxide, Ohio State U. Res. Found. Tech. Rept. TR 328-13 Unclassified, Sept. 27, 1950.

[26] C. P. Smyth and K. B. McAlpine, The dipole moment of nitric oxide, J. Chem. Phys. 1, 60(1933).

[27] A. van Itterbeek and L. Thys, Measurements on the velocity and the absorption of sound in gaseous nitric oxide in a magnetic field, Physica 5, 640(1938).

[28] R. Wobser and Fr. Müller, Die innere Reibung von Gasen und Dämpfen und ihre Messung im Hoppler-Viskosimeter, Kolloid Beihefte 52, 165(1941).

Table 16.10

Thermodynamic Properties for Nitric Oxide in the Ideal Gas State*

June 1953

*Values tabulated herein are based on tables very kindly supplied in advance of publication by Dr. H. L. Johnston of the Ohio State University.

Table 16.10 Thermal Functions of Nitric Oxide NO
Ideal Gas State

Temp. °K	C_p°/R	Δ	$(H^\circ-E_0^\circ)/RT$	Δ	S°/R	Δ	$-(F^\circ-E_0^\circ)/RT$	Δ
150	3.7501	-210	2.0640	1365	22.8227	2414	19.0640	2425
160	3.7291	-191	2.2005	1361	23.0641	2255	19.3065	2277
170	3.7100	-172	2.3366	1355	23.2896	2115	19.5342	2146
180	3.6928	-155	2.4721	1351	23.5011	1992	19.7488	2028
190	3.6773	-139	2.6072	1346	23.7003	1883	19.9516	1922
200	3.6634	-123	2.7418	1339	23.8886	1785	20.1438	1826
210	3.6511	-109	2.8757	1335	24.0671	1696	20.3264	1739
220	3.6402	- 96	3.0092	1331	24.2367	1616	20.5003	1660
230	3.6306	- 84	3.1423	1327	24.3983	1544	20.6663	1588
240	3.6222	- 72	3.2750	1324	24.5527	1476	20.8251	1521
250	3.6150	- 64	3.4074	1323	24.7003	1416	20.9772	1459
260	3.6086	- 55	3.5397	1320	24.8419	1361	21.1231	1402
270	3.6031	- 46	3.6717	1318	24.9780	1310	21.2633	1350
280	3.5985	- 36	3.8035	1317	25.1090	1262	21.3983	1302
290	3.5949	- 28	3.9352	1315	25.2352	1218	21.5285	1256
300	3.5921	- 21	4.0667	1315	25.3570	1178	21.6541	1213
310	3.5900	- 14	4.1982	1314	25.4748	1140	21.7754	1174
320	3.5886	- 6	4.3296	1314	25.5888	1104	21.8928	1137
330	3.5880	+ 2	4.4610	1313	25.6992	1071	22.0065	1102
340	3.5882	+ 11	4.5923	1314	25.8063	1040	22.1167	1069
350	3.5893	+ 15	4.7237	1314	25.9103	1011	22.2236	1038
360	3.5908	+ 22	4.8551	1315	26.0114	985	22.3274	1009
370	3.5930	+ 29	4.9866	1316	26.1099	958	22.4283	982
380	3.5959	+ 35	5.1182	1317	26.2057	935	22.5265	955
390	3.5994	+ 40	5.2499	1318	26.2992	912	22.6220	931
400	3.6034	+ 44	5.3817	1320	26.3904	890	22.7151	907
410	3.6078	50	5.5137	1322	26.4794	870	22.8058	885
420	3.6128	55	5.6459	1324	26.5664	851	22.8943	864
430	3.6183	60	5.7783	1326	26.6515	832	22.9807	844
440	3.6243	66	5.9109	1328	26.7347	815	23.0651	825
450	3.6309	68	6.0437	1330	26.8162	799	23.1476	806
460	36377	71	6.1767	1333	26.8961	783	23.2282	788
470	3.6448	75	6.3100	1336	26.9744	768	23.3070	772
480	3.6523	77	6.4436	1338	27.0512	754	23.3842	756
490	3.6600	81	6.5774	1342	27.1266	740	23.4598	741
500	3.6681		6.7116		27.2006		23.5339	

Table 16.10 (Continued)

Temp. °K	C_p°/R	Δ	$(H^\circ-E_0^\circ)/RT$	Δ	S°/R	Δ	$-(F^\circ-E_0^\circ)/RT$	Δ
500	3.6681	83	6.7116	1344	27.2006	727	23.5339	726
510	3.6764	85	6.8460	1347	27.2733	715	23.6065	712
520	3.6849	87	6.9807	1351	27.3448	703	23.6777	699
530	3.6936	89	7.1158	1354	27.4151	692	23.7476	686
540	3.7025	90	7.2512	1357	27.4843	680	23.8162	673
550	3.7115	91	7.3869	1360	27.5523	670	23.8835	661
560	3.7206	93	7.5229	1364	27.6193	659	23.9496	650
570	3.7299	94	7.6593	1367	27.6852	649	24.0146	638
580	3.7393	94	7.7960	1371	27.7501	640	24.0784	628
590	3.7487	95	7.9331	1374	27.8141	631	24.1412	617
600	3.7582	95	8.0705	1377	27.8772	622	24.2029	607
610	3.7677	95	8.2082	1382	27.9394	613	24.2636	598
620	3.7772	96	8.3464	1384	28.0007	606	24.3234	589
630	3.7868	96	8.4848	1388	28.0613	597	24.3823	579
640	3.7964	95	8.6236	1392	28.1210	589	24.4402	571
650	3.8059	95	8.7628	1395	28.1799	581	24.4973	562
660	3.8154	95	8.9023	1398	28.2380	575	24.5535	554
670	3.8249	94	9.0421	1402	28.2955	567	24.6089	547
680	3.8343	94	9.1823	1406	28.3522	560	24.6636	538
690	3.8437	93	9.3229	1409	28.4082	554	24.7174	532
700	3.8530	93	9.4638	1412	28.4636	548	24.7706	524
710	3.8623	92	9.6050	1415	28.5184	541	24.8230	517
720	3.8715	91	9.7465	1419	28.5725	535	24.8747	510
730	3.8806	90	9.8884	1423	28.6260	529	24.9257	504
740	3.8896	90	10.0307	1425	28.6789	522	24.9761	497
750	3.8986	88	10.1732	1429	28.7311	517	25.0258	491
760	3.9074	88	10.3161	1432	28.7828	511	25.0749	485
770	3.9162	87	10.4593	1435	28.8339	505	25.1234	479
780	3.9249	85	10.6028	1439	28.8844	501	25.1713	473
790	3.9334	85	10.7467	1441	28.9345	495	25.2186	467
800	3.9419	407	10.8908	7254	28.9840	2403	25.2653	2259
850	3.9826	381	11.6162	7325	29.2243	2287	25.4912	2138
900	4.0207	353	12.3487	7392	29.4530	2183	25.7050	2031
950	4.0560	326	13.0879	7455	29.6713	2089	25.9081	1934
1000	4.0886	302	13.8334	7512	29.8802	2002	26.1015	1847
1050	4.1188		14.5846		30.0804		26.2862	

Table 16.10 (Continued)

Temp. °K	C_p°/R	Δ	$(H^\circ-E_0^\circ)/RT_0$	Δ	S°/R	Δ	$-(F^\circ-E_0^\circ)/RT$	Δ
1050	4.1188	279	14.5846	7565	30.0804	1923	26.2862	1769
1100	4.1467	256	15.3411	7614	30.2727	1849	26.4631	1697
1150	4.1723	237	16.1025	7659	30.4576	1781	26.6328	1631
1200	4.1960	219	16.8684	7701	30.6357	1717	26.7959	1571
1250	4.2179	202	17.6385	7739	30.8074	1658	26.9530	1514
1300	4.2381	187	18.4124	7775	30.9732	1604	27.1044	1463
1350	4.2568	174	19.1899	7809	31.1336	1551	27.2507	1414
1400	4.2742	161	19.9708	7839	31.2887	1503	27.3921	1370
1450	4.2903	150	20.7547	7866	31.4390	1456	27.5291	1328
1500	4.3053	139	21.5413	7892	31.5846	1415	27.6619	1288
1550	4.3192	130	22.3305	7920	31.7261	1373	27.7907	1251
1600	4.3322	122	23.1225	7940	31.8634	1335	27.9158	1217
1650	4.3444	114	23.9165	7962	31.9969	1298	28.0375	1184
1700	4.3558	107	24.7127	7985	32.1267	1265	28.1559	1152
1750	4.3665	101	25.5112	8000	32.2532	1231	28.2711	1124
1800	4.3766	94	26.3112	8020	32.3763	1201	28.3835	1095
1850	4.3860	90	27.1132	8037	32.4964	1171	28.4930	1069
1900	4.3950	85	27.9169	8053	32.6135	1143	28.5999	1044
1950	4.4035	80	28.7222	8067	32.7278	1115	28.7043	1020
2000	4.4115	76	29.5289	8082	32.8393	1091	28.8063	997
2050	4.4191	72	30.3371	8097	32.9484	1066	28.9060	975
2100	4.4263	69	31.1468	8107	33.0550	1042	29.0035	954
2150	4.4332	66	31.9575	8121	33.1592	1020	29.0989	935
2200	4.4398	63	32.7696	8133	33.2612	998	29.1924	915
2250	4.4461	61	33.5829	8145	33.3610	978	29.2839	897
2300	4.4522	58	34.3974	8155	33.4588	958	29.3736	879
2350	4.4580	55	35.2129	8165	33.5546	939	29.4615	863
2400	4.4635	54	36.0294	8176	33.6485	921	29.5478	846
2450	4.4689	51	36.8470	8183	33.7406	903	29.6324	831
2500	4.4740	50	37.6653	8195	33.8309	887	29.7155	815
2550	4.4790	48	38.4848	8203	33.9196	870	29.7970	802
2600	4.4838	46	39.3051	8211	34.0066	855	29.8772	787
2650	4.4884	46	40.1262	8220	34.0921	840	29.9559	773
2700	4.4930	43	40.9482	8228	34.1761	824	30.0332	761
2750	4.4973	43	41.7710	8236	34.2585	811	30.1093	749
2800	4.5016		42.5946		34.3396		30.1842	

Table 16.10 (Continued)

Temp. °K	$\frac{C_P^\circ}{R}$	Δ	$\frac{H^\circ - E_0^\circ}{RT}$	Δ	$\frac{S^\circ}{R}$	Δ	$\frac{-(F^\circ - E_0^\circ)}{RT}$	Δ
2800	4.5016	41	42.5946	8244	34.3396	797	30.1842	736
2850	4.5057	41	43.4190	8252	34.4193	784	30.2578	724
2900	4.5098	39	44.2442	8258	34.4977	771	30.3302	713
2950	4.5137	38	45.0700	8265	34.5748	759	30.4015	702
3000	4.5175		45.8965		34.6507		30.4717	

Table 16.10 Nitric Oxide (Ideal Gas State)

The Properties Tabulated

The thermodynamic properties of nitric oxide in the ideal gas state are given in dimensionless form in this table. The properties listed are C_p^o/R, $(H^o-E_0^o)/RT_0$, S^o/R, and $-(F^o-E_0^o)RT$, tabulated as functions of degrees K. The values extend from 150°K to 3000°K being obtained with some interpolation from a more extensive table of ideal gas values furnished in advance of publication through the courtesy of H. L. Johnson, Leonard Glatt and Jack Belzer from calculations sponsored by the Office of Naval Research at the Ohio State University Cryogenic Laboratory. Their calculation was made with an eight constant formula for the vibrational energy to represent 16 known vibrational levels and giving convergence at the dissociation energy. The rotational energy was given by a unified theoretical formula accurately representing the doublet splitting and included slight adjustments of rotational constants versus vibrational state to give a closer fit of the observed rotational levels. The contributions by higher electronic states also were included.

In the present table the values are given on the basis of the physical constants used throughout this series. The values have also been adjusted to be without the entropy of nuclear spin.

Reliability of the Tables

The present table gives the best values available for the thermodynamic properties of nitric oxide in the ideal gas state. In view of the care taken to fit the observed spectra over the entire range and to conform to the known dissociation, it appears reasonable to regard the results as typical of the best ideal gas values. It appears likely that the uncertainties in C_p^o/R, S^o/R, and $-(F^o-E_0^o)/RT$ are in the final digits of their tabulated values, with $(H^o-E_0^o)/RT_0$ given to a percentage accuracy of the same general magnitude.

Conversion Factors

The functions in this table have been expressed in dimensionless form. In order that they may be converted readily to any system of units, conversion factors are listed for some frequently used units. For other conversion factors see Table 1.30 of this series.

CONVERSION FACTORS

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply By
C_p°/R	C_p°	cal $mole^{-1}$ $^\circ K^{-1}$ (or $^\circ C^{-1}$)	1.98719
S°/R	S°	cal g^{-1} $^\circ K^{-1}$ (or $^\circ C^{-1}$)	0.0662220
$-(F^\circ-E_0^\circ)/RT$	$-(F^\circ-E_0^\circ)/T$	joules g^{-1} $^\circ K^{-1}$ (or $^\circ C^{-1}$)	0.277074
		Btu $(lb\ mole)^{-1}$ $^\circ R^{-1}$ (or $^\circ F^{-1}$)	1.98588
		Btu lb^{-1} $^\circ R^{-1}$ (or $^\circ F^{-1}$)	0.0661785

To Convert Tabulated Value of	To	Having the Dimensions Indicated below	Multiply By
$(H^\circ-E_0^\circ)/RT_0$	$H^\circ-E_0^\circ$	cal $mole^{-1}$	542.821
		cal g^{-1}	18.0892
		joules g^{-1}	75.6854
		Btu $(lb\ mole)^{-1}$	976.437
		Btu lb^{-1}	32.5392

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, *Secretary*

NATIONAL BUREAU OF STANDARDS
E. U. Condon, *Director*

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 16.18 Density of Nitric Oxide

Preliminary Issue

September 1951

ρ/ρ_0

Compiled by Harold W. Woolley

FOREWORD

This is one of a series of tables of Thermal Properties of Gases being compiled at the National Bureau of Standards at the suggestion and with the cooperation of the National Advisory Committee for Aeronautics. Recent advances in methods of propulsion and the high speeds attained thereby have emphasized the importance of accurate data on thermal properties of wind-tunnel and jet-engine gases. It is the purpose of the project on Thermal Properties of Gases to make a critical compilation of existing published and unpublished data, and to present such data in convenient form for application. The loose-leaf form has been chosen as being most convenient, and revisions are anticipated as new data become available.

The dimensionless character of the tables and their general format should facilitate calculations in aerodynamics, heat-transfer, and jet-engine problems. Suggestions for the extension or improvement of these tables are desired as well as information regarding unpublished data. Information and other correspondence regarding these tables should be addressed to *Joseph Hilsenrath*, Heat and Power Division, National Bureau of Standards. This table is also available on IBM punched cards.

Table 16.18 Density of Nitric Oxide

T°K \ P	0.1 atm.		0.4 atm.		0.7 atm.		1.0 atm.		P/P₀ T°R
100	.2761	270							180
110	.2491	212							198
120	.2279	177	.9189	739	1.6250	1386			216
130	.2102	151	.8450	617	1.4864	1107	2.1361	1636	234
140	.1951	130	.7833	530	1.3757	941	1.9725	1365	252
150	.18207	1141	.73029	4614	1.28158	8164	1.83603	11796	270
160	.17066	1006	.68415	4059	1.19994	7164	1.71809	10325	288
170	.16060	894	.64356	3600	1.12830	6345	1.61488	9129	306
180	.15166	800	.60756	3217	1.06485	5662	1.52359	8136	324
190	.14366	719	.57539	2891	1.00823	5086	1.44219	7301	342
200	.13647	650	.54648	2614	.95737	4593	1.36916	6591	360
210	.12997	592	.52034	2374	.91144	4171	1.30325	5978	378
220	.12405	540	.49660	2165	.86973	3803	1.24347	5452	396
230	.11865	494	.47495	1985	.83170	3483	1.18895	4991	414
240	.11371	455	.45510	1825	.79687	3202	1.13904	4585	432
250	.10916	420	.43685	1685	.76485	2954	1.09319	4230	450
260	.10496	389	.42000	1559	.73531	2733	1.05089	3913	468
270	.10107	362	.40441	1447	.70798	2537	1.01176	3631	486
280	.09745	336	.38994	1347	.68261	2361	.97545	3377	504
290	.09409	314	.37647	1257	.65900	2203	.94168	3151	522
300	.09095	293	.36390	1175	.63697	2060	.91017	2947	540
310	.08802	275	.35215	1102	.61637	1930	.88070	2761	558
320	.08527	259	.34113	1035	.59707	1813	.85309	2593	576
330	.08268	243	.33078	974	.57894	1706	.82716	2439	594
340	.08025	229	.32104	918	.56188	1609	.80277	2299	612
350	.07796	217	.31186	867	.54579	1518	.77978	2178	630
360	.07578	205	.30319	820	.53061	1436	.75806	2053	648
370	.07374	194	.29499	777	.51625	1360	.73753	1944	666
380	.07180	184	.28722	737	.50265	1291	.71809	1844	684
390	.06996	175	.27985	700	.48974	1226	.69965	1752	702
400	.06821	166	.27285	666	.47748	1165	.68213	1667	720
410	.06655	159	.26619	634	.46583	1111	.66546	1586	738
420	.06496	151	.25985	605	.45472	1058	.64960	1513	756
430	.06345	144	.25380	577	.44414	1010	.63447	1443	774
440	.06201	138	.24803	551	.43404	965	.62004	1380	792
450	.06063		.24252		.42439		.60624		810

Table 16.18 Density of Nitric Oxide

P / T°K	0.1 atm.		0.4 atm.		0.7 atm.		1.0 atm.		P/Po / T°R
450	.06063	132	.24252	528	.42439	924	.60624	1319	810
460	.05931	126	.23724	505	.41515	883	.59305	1263	828
470	.05805	121	.23219	484	.40632	848	.58042	1210	846
480	.05684	116	.22735	464	.39784	812	.56832	1161	864
490	.05568	111	.22271	445	.38972	780	.55671	1114	882
500	.05457	107	.21826	428	.38192	749	.54557	1071	900
510	.05350	103	.21398	412	.37443	720	.53486	1029	918
520	.05247	99	.20986	396	.36723	693	.52457	990	936
530	.05148	95	.20590	381	.36030	668	.51467	954	954
540	.05053	92	.20209	368	.35362	643	.50513	919	972
550	.04961	89	.19841	354	.34719	620	.49594	886	990
560	.04872	85	.19487	342	.34099	599	.48708	854	1008
570	.04787	83	.19145	330	.33500	577	.47854	826	1026
580	.04704	80	.18815	319	.32923	559	.47028	797	1044
590	.04624	77	.18496	309	.32364	539	.46231	771	1062
600	.04547	74	.18187	298	.31825	522	.45460	746	1080
610	.04473	72	.17889	288	.31303	505	.44714	721	1098
620	.04401	70	.17601	280	.30798	489	.43993	698	1116
630	.04331	68	.17321	270	.30309	473	.43295	677	1134
640	.04263	66	.17051	263	.29836	459	.42618	656	1152
650	.04197	63	.16788	254	.29377	445	.41962	635	1170
660	.04134	62	.16534	247	.28932	433	.41327	618	1188
670	.04072	60	.16287	240	.28499	419	.40709	598	1206
680	.04012	58	.16047	232	.28080	407	.40111	582	1224
690	.03954	56	.15815	226	.27673	395	.39529	564	1242
700	.03898	55	.15589	220	.27278	384	.38965	549	1260
710	.03843	54	.15369	213	.26894	374	.38416	534	1278
720	.03789	52	.15156	208	.26520	363	.37882	519	1296
730	.03737	50	.14948	202	.26157	353	.37363	505	1314
740	.03687	49	.14746	196	.25804	345	.36858	491	1332
750	.03638	48	.14550	192	.25459	335	.36367	478	1350
760	.03590	47	.14358	186	.25124	326	.35889	467	1368
770	.03543	45	.14172	182	.24798	318	.35422	454	1386
780	.03498	44	.13990	177	.24480	310	.34968	442	1404
790	.03454	44	.13813	173	.24170	302	.34526	432	1422
800	.03410		.13640		.23868		.34094		1440

Table 16.16 Density of Nitric Oxide

P / T°K	0.1 atm.		0.4 atm.		0.7 atm.		1.0 atm		P/P₀ / T°R
800	.03410	200	.13640	802	.23868	1404	.34094	2005	1440
850	.03210	178	.12838	713	.22464	1248	.32089	1783	1530
900	.03032	160	.12125	638	.21216	1116	.30306	1595	1620
950	.02878	144	.11487	575	.20100	1005	.28711	1435	1710
1000	.02728	130	.10912	519	.19095	909	.27276	1299	1800
1050	.02598	118	.10393	473	.18186	827	.25977	1180	1890
1100	.02480	108	.09920	431	.17359	754	.24797	1078	1980
1150	.02372	98	.09489	395	.16605	692	.23719	988	2070
1200	.02274	91	.09094	364	.15913	637	.22731	909	2160
1250	.02183	84	.08730	336	.15276	587	.21822	840	2250
1300	.02099	78	.08394	311	.14689	544	.20982	776	2340
1350	.02021	72	.08083	288	.14145	505	.20206	722	2430
1400	.01949	67	.07795	269	.13640	471	.19484	672	2520
1450	.01882	63	.07526	251	.13169	438	.18812	627	2610
1500	.01819	59	.07275	235	.12731	411	.18185	586	2700
1550	.01760	55	.07040	219	.12320	385	.17599	550	2790
1600	.01705	51	.06821	207	.11935	362	.17049	517	2880
1650	.01654	49	.06614	195	.11573	340	.16532	486	2970
1700	.01605	46	.06419	183	.11233	321	.16046	458	3060
1750	.01559	43	.06236	173	.10912	303	.15588	433	3150
1800	.01516	41	.06063	164	.10609	287	.15155	410	3240
1850	.01475	39	.05899	155	.10322	271	.14745	388	3330
1900	.01436	37	.05744	148	.10051	258	.14357	368	3420
1950	.01399	35	.05596	140	.09793	245	.13989	349	3510
2000	.01364	33	.05456	133	.09548	233	.13640	333	3600
2050	.01331	32	.05323	126	.09315	221	.13307	317	3690
2100	.01299	30	.05197	121	.09094	212	.12990	302	3780
2150	.01269	29	.05076	116	.08882	202	.12688	288	3870
2200	.01240	27	.04960	110	.08680	192	.12400	276	3960
2250	.01213	27	.04850	105	.08488	185	.12124	263	4050
2300	.01186		.04745		.00303		.11861		4140

Table 16.18 Density of Nitric Oxide

T°K \ P	0.1 atm.		0.4 atm.		0.7 atm.		1.0 atm.		P/P₀ T°R
2300	.01186	25	.04745	101	.08303	177	.11861	253	4140
2350	.01161	24	.04644	97	.08126	169	.11608	241	4230
2400	.01137	23	.04547	93	.07957	162	.11367	232	4320
2450	.01114	23	.04454	89	.07795	156	.11135	223	4410
2500	.01091	21	.04365	85	.07639	150	.10912	214	4500
2550	.01070	21	.04280	83	.07489	144	.10698	206	4590
2600	.01049	19	.04197	79	.07345	138	.10492	197	4680
2650	.01030	19	.04118	76	.07207	134	.10295	191	4770
2700	.01011	19	.04042	74	.07073	129	.10104	184	4860
2750	.00992	18	.03968	70	.06944	124	.09920	177	4950
2800	.00974	17	.03898	69	.06820	119	.09743	171	5040
2850	.00957	16	.03829	66	.06701	116	.09578	165	5130
2900	.00941	16	.03763	64	.06585	111	.09407	159	5220
2950	.00925	16	.03699	61	.06474	108	.09248	154	5310
3000	.00909		.03638		.06366		.09094		5400

Table 16.18 Density of Nitric Oxide

P / T°K	1.0 atm.	4.0 atm.	7.0 atm.	10 atm.	P/P₀ / T°R
					234
130	2.1361 - 1636				252
140	1.9725 - 1365	8.235 - 656			
					270
150	1.8360 - 1179	7.579 - 543	13.86 - 121	18.67 - 151	288
160	1.7181 - 1033	7.036 - 454	12.65 - 90	17.16 - 116	306
170	1.6148 - 913	6.582 - 392	11.75 - 74	16.00 - 98	324
180	1.5235 - 813	6.190 - 345	11.01 - 64	15.02 - 86	342
190	1.4422 - 730	5.845 - 308	10.37 - 57		
					360
200	1.3692 - 659	5.537 - 275	9.800 - 502	14.16 - 75	378
210	1.3033 - 598	5.262 - 248	9.298 - 451	13.41 - 67	396
220	1.2435 - 546	5.014 - 226	8.847 - 408	12.74 - 60	414
230	1.1889 - 499	4.788 - 205	8.439 - 370	12.14 - 54	432
240	1.1390 - 458	4.583 - 188	8.069 - 338	11.60 - 50	
					450
250	1.0932 - 423	4.395 - 173	7.731 - 310	11.10 - 45	468
260	1.0509 - 391	4.222 - 160	7.421 - 286	10.65 - 42	486
270	1.0118 - 363	4.062 - 148	7.135 - 263	10.23 - 38	504
280	.9755 - 338	3.914 - 137	6.872 - 244	9.850 - 355	522
290	.9417 - 315	3.777 - 128	6.628 - 228	9.495 - 330	
					540
300	.9102 - 295	3.649 - 120	6.400 - 211	9.165 - 306	558
310	.8807 - 276	3.529 - 111	6.189 - 198	8.859 - 285	576
320	.8531 - 259	3.418 - 105	5.991 - 185	8.574 - 269	594
330	.8272 - 244	3.313 - 99	5.806 - 175	8.305 - 250	612
340	.8028 - 230	3.214 - 92	5.631 - 163	8.055 - 237	
					630
350	.7798 - 217	3.122 - 88	5.468 - 155	7.818 - 221	648
360	.7581 - 206	3.034 - 83	5.313 - 145	7.597 - 210	666
370	.7375 - 194	2.951 - 78	5.168 - 138	7.387 - 190	684
380	.7181 - 185	2.873 - 74	5.030 - 130	7.188 - 187	702
390	.6996 - 175	2.799 - 70	4.900 - 125	7.001 - 178	
					720
400	.6821 - 166	2.729 - 68	4.775 - 118	6.823 - 169	738
410	.6655 - 159	2.661 - 63	4.657 - 113	6.654 - 161	756
420	.6496 - 151	2.598 - 61	4.545 - 106	6.493 - 153	774
430	.6345 - 145	2.537 - 58	4.439 - 102	6.340 - 146	792
440	.6200 - 138	2.479 - 55	4.337 - 97	6.194 - 139	
					810
450	.6062	2.424	4.240	6.055	

Table 16.18 Density of Nitric Oxide

T°K \ P	1.0 atm.		4.0 atm.		7.0 atm.		10 atm.		P/T°R
450	.6062	132	2.4241	530	4.2404	930	6.0554	1334	810
460	.5930	126	2.3711	506	4.1474	886	5.9220	1272	828
470	.5804	121	2.3205	486	4.0588	854	5.7948	1213	846
480	.5683	116	2.2719	464	3.9734	814	5.6735	1169	864
490	.5567	111	2.2255	447	3.8920	783	5.5566	1122	882
500	.5456	107	2.1808	430	3.8137	751	5.4444	1073	900
510	.5349	103	2.1378	411	3.7386	723	5.3371	1032	918
520	.5246	99	2.0967	398	3.6663	695	5.2339	992	936
530	.5147	96	2.0569	380	3.5968	666	5.1347	956	954
540	.5051	92	2.0189	367	3.5302	646	5.0391	921	972
550	.4959	88	1.9822	356	3.4656	618	4.9470	888	990
560	.4871	86	1.9466	342	3.4038	601	4.8582	858	1008
570	.4785	82	1.9124	330	3.3437	576	4.7724	822	1026
580	.4703	80	1.8794	318	3.2861	561	4.6902	800	1044
590	.4623	77	1.8476	310	3.2300	538	4.6102	768	1062
600	.4546	75	1.8166	298	3.1762	521	4.5334	748	1080
610	.4471	72	1.7868	288	3.1241	507	4.4586	719	1098
620	.4399	70	1.7580	279	3.0734	487	4.3867	701	1116
630	.4329	67	1.7301	270	3.0247	473	4.3166	674	1134
640	.4262	66	1.7031	262	2.9774	458	4.2492	654	1152
650	.4196	63	1.6769	254	2.9316	447	4.1838	634	1170
660	.4133	62	1.6515	248	2.8869	431	4.1204	619	1188
670	.4071	60	1.6267	240	2.8438	418	4.0585	597	1206
680	.4011	58	1.6027	232	2.8020	406	3.9988	579	1224
690	.3953	57	1.5795	226	2.7614	395	3.9409	563	1242
700	.3896	54	1.5569	219	2.7219	383	3.8846	547	1260
710	.3842	54	1.5350	213	2.6836	373	3.8299	532	1278
720	.3788	52	1.5137	207	2.6463	362	3.7767	518	1296
730	.3736	50	1.4930	202	2.6101	353	3.7249	503	1314
740	.3686	49	1.4728	197	2.5748	343	3.6746	490	1332
750	.3637	48	1.4531	191	2.5405	335	3.6256	477	1350
760	.3589	47	1.4340	186	2.5070	325	3.5779	465	1368
770	.3542	45	1.4154	181	2.4745	317	3.5314	452	1386
780	.3497	44	1.3973	177	2.4428	310	3.4862	442	1404
790	.3453	44	1.3796	173	2.4118	301	3.4420	430	1422
800	.3409		1.3623		2.3817		3.3990		1440

Table 16.18 Density of Nitric Oxide

P / T°K	1.0 atm.			4.0 atm.			7.0 atm.			10 atm.			P / T°R
800	.3409	–	200	1.3623	–	801	2.3817	–	1401	3.3990	–	1999	1440
850	.3209	–	178	1.2822	–	711	2.2416	–	1245	3.1991	–	1775	1530
900	.3031	–	160	1.2111	–	638	2.1171	–	1113	3.0216	–	1590	1620
950	.2871	–	143	1.1473	–	573	2.0058	–	1003	2.8626	–	1428	1710
1000	.2728	–	130	1.0900	–	519	1.9055	–	905	2.7198	–	1293	1800
1050	.2598	–	118	1.0381	–	471	1.8150	–	823	2.5905	–	1178	1890
1100	.2480	–	108	.9910	–	431	1.7327	–	754	2.4727	–	1072	1980
1150	.2372	–	99	.9479	–	395	1.6573	–	689	2.3655	–	984	2070
1200	.2273	–	91	.9084	–	363	1.5884	–	635	2.2671	–	904	2160
1250	.2182	–	84	.8721	–	335	1.5249	–	585	2.1767	–	835	2250
1300	.2098	–	77	.8386	–	311	1.4664	–	543	2.0932	–	776	2340
1350	.2021	–	73	.8075	–	287	1.4121	–	503	2.0156	–	718	2430
1400	.1948	–	67	.7788	–	269	1.3618	–	470	1.9438	–	668	2520
1450	.1881	–	62	.7519	–	250	1.3148	–	437	1.8770	–	626	2610
1500	.1819	–	59	.7269	–	235	1.2711	–	410	1.8144	–	583	2700
1550	.1760	–	55	.7034	–	219	1.2301	–	383	1.7561	–	547	2790
1600	.1705	–	52	.6815	–	207	1.1918	–	361	1.7014	–	516	2880
1650	.1653	–	48	.6608	–	194	1.1557	–	340	1.6498	–	483	2970
1700	.1605	–	46	.6414	–	183	1.1217	–	320	1.6015	–	458	3060
1750	.1559	–	44	.6231	–	173	1.0897	–	302	1.5557	–	431	3150
1800	.1515	–	40	.6058	–	163	1.0595	–	287	1.5126	–	408	3240
1850	.1475	–	39	.5895	–	155	1.0308	–	270	1.4718	–	386	3330
1900	.1436	–	37	.5740	–	148	1.0038	–	257	1.4332	–	368	3420
1950	.1399	–	35	.5592	–	139	.9781	–	245	1.3964	–	348	3510
2000	.1364	–	33	.5453	–	133	.9536	–	231	1.3616	–	332	3600
2050	.1331	–	32	.5320	–	127	.9305	–	222	1.3284	–	315	3690
2100	.1299	–	30	.5193	–	120	.9083	–	211	1.2969	–	301	3780
2150	.1269	–	29	.5073	–	116	.8872	–	201	1.2668	–	288	3870
2200	.1240	–	28	.4957	–	110	.8671	–	193	1.2380	–	274	3960
2250	.1212	–	26	.4847	–	105	.8478	–	184	1.2106	–	263	4050
2300	.1186			.4742			.8294			1.1843			4140

Table 16.18 Density of Nitric Oxide

P / T°K	1.0 atm.		4.0 atm.		7.0 atm.		10 atm.		P / T°R
2300	.1186	25	.4742	101	.8294	176	1.1843	252	4140
2350	.1161	24	.4641	97	.8118	169	1.1591	241	4230
2400	.1137	24	.4544	93	.7949	162	1.1350	231	4320
2450	.1113	22	.4452	89	.7787	156	1.1119	223	4410
2500	.1091	21	.4363	86	.7631	149	1.0896	219	4500
2550	.1070	21	.4277	82	.7482	144	1.0684	206	4590
2600	.1049	20	.4195	79	.7338	138	1.0478	197	4680
2650	.1029	19	.4116	76	.7200	133	1.0281	191	4770
2700	.1010	18	.4040	74	.7067	129	1.0090	183	4860
2750	.0992	18	.3966	71	.6938	124	.9908	177	4950
2800	.0974	17	.3895	68	.6814	119	.9731	171	5040
2850	.0957	16	.3827	65	.6695	116	.9560	165	5130
2900	.0941	16	.3762	64	.6579	111	.9395	158	5220
2950	.0925	16	.3698	62	.6468	107	.9237	154	5310
3000	.0909		.3636		.6361		.9083		5400

Table 16.18 Density of Nitric Oxide

P/P₀

T°K \ P	10 atm.		40 atm.		70 atm.		100 atm.		P / T°R
									288
									306
160	18.67	151							324
170	17.16	116							342
180	16.00	98	83.9	120	177.	39			
190	15.02	86	71.9	69					
									360
200	14.16	75	65.0	50	138.	17	268.	64	378
210	13.41	67	60.0	40	121.	12	204.	28	396
220	12.74	60	56.03	34.3	109.4	8.7	176.	19	414
230	12.14	54	52.60	29.4	100.7	7.0	157.	13	432
240	11.60	50	49.66	25.9	93.71	5.87	144.	10	
									450
250	11.10	45	47.07	23.9	87.84	5.05	134.	9.10	468
260	10.65	42	44.78	20.6	82.79	4.42	124.	7.6	486
270	10.23	38	42.72	18.5	78.37	3.96	117.	6.6	504
280	9.850	35.5	40.87	16.8	74.47	3.49	110.	5.8	522
290	9.495	33.0	39.19	15.9	70.98	3.13	104.	5.51	
									540
300	9.165	30.6	37.65	14.1	67.84	2.83	99.80	4.60	558
310	8.859	28.5	36.23	13.0	65.01	2.57	95.20	4.23	576
320	8.577	26.9	34.94	12.0	62.44	2.36	91.07	3.74	594
330	8.305	25.0	33.74	11.4	60.08	2.16	87.33	3.41	612
340	8.055	23.7	32.65	10.3	57.92	1.99	83.92	3.12	
									630
350	7.818	22.1	31.60	9.7	55.93	1.84	80.80	2.86	648
360	7.597	21.0	30.63	9.0	54.09	1.72	77.94	2.63	666
370	7.398	19.9	29.73	8.5	52.37	1.59	75.31	2.44	684
380	7.188	18.7	28.88	8.0	50.78	1.49	72.87	2.27	702
390	7.001	17.8	28.08	7.5	49.29	1.40	70.60	2.11	
									720
400	6.823	16.9	27.33	7.2	47.89	1.31	68.49	1.97	738
410	6.654	16.1	26.61	6.7	46.58	1.23	66.52	1.86	756
420	6.493	15.3	25.94	6.4	45.35	1.17	64.67	1.75	774
430	6.340	14.6	25.30	6.0	44.18	1.110	62.94	1.68	792
440	6.194	13.9	24.70	5.7	43.08	1.04	61.32	1.54	
									810
450	6.055		24.13		42.04		59.78		

Table 16.18 Density of Nitric Oxide

T°K \ P	10 atm.			40 atm.			70 atm.			100 atm.			P/T°R
800	3.3990	–	1999	13.450	–	790	23.271	–	1362	32.848	–	1915	1440
850	3.1991	–	1775	12.660	–	700	21.909	–	1207	30.933	–	1698	1530
900	3.0216	–	1590	11.960	–	626	20.702	–	1080	29.235	–	1515	1620
950	2.8626	–	1428	11.334	–	563	19.622	–	970	27.730	–	1361	1710
1000	2.7198	–	1293	10.771	–	510	18.652	–	876	26.359	–	1233	1800
1050	2.5905	–	1178	10.261	–	463	17.776	–	798	25.126	–	1121	1890
1100	2.4727	–	1072	9.798	–	423	16.978	–	729	24.005	–	1022	1980
1150	2.3655	–	984	9.375	–	388	16.249	–	668	22.983	–	938	2070
1200	2.2671	–	904	8.987	–	356	15.581	–	614	22.045	–	863	2160
1250	2.1767	–	835	8.631	–	330	14.967	–	568	21.182	–	799	2250
1300	2.0932	–	776	8.301	–	305	14.399	–	525	20.383	–	738	2340
1350	2.0156	–	718	7.996	–	283	13.874	–	489	19.645	–	687	2430
1400	1.9438	–	668	7.713	–	264	13.385	–	455	18.958	–	639	2520
1450	1.8770	–	626	7.449	–	247	12.930	–	425	18.319	–	597	2610
1500	1.8144	–	583	7.202	–	230	12.505	–	397	17.722	–	560	2700
1550	1.7561	–	547	6.972	–	216	12.108	–	373	17.162	–	525	2790
1600	1.7014	–	516	6.756	–	203	11.735	–	351	16.637	–	493	2880
1650	1.6498	–	483	6.553	–	192	11.384	–	329	16.144	–	466	2970
1700	1.6015	–	458	6.361	–	180	11.055	–	312	15.678	–	439	3060
1750	1.5557	–	431	6.181	–	170	10.743	–	294	15.239	–	414	3150
1800	1.5126	–	408	6.011	–	161	10.449	–	279	14.825	–	394	3240
1850	1.4718	–	386	5.850	–	153	10.170	–	264	14.431	–	373	3330
1900	1.4332	–	368	5.697	–	145	9.906	–	251	14.058	–	354	3420
1950	1.3964	–	348	5.552	–	138	9.655	–	238	13.704	–	336	3510
2000	1.3616	–	332	5.414	–	131	9.417	–	227	13.368	–	319	3600
2050	1.3284	–	315	5.283	–	125	9.190	–	216	13.049	–	305	3690
2100	1.2969	–	301	5.158	–	119	8.974	–	206	12.744	–	290	3780
2150	1.2668	–	288	5.039	–	114	8.768	–	197	12.454	–	278	3870
2200	1.2380	–	274	4.925	–	109	8.571	–	188	12.176	–	266	3960
2250	1.2106	–	263	4.816	–	104	8.383	–	180	11.910	–	256	4050
2300	1.1843			4.712			8.203			11.654			4140

Table 16.18 Density of Nitric Oxide

T°K \ P	10 atm.			40 atm.			70 atm.			100 atm.			P/Pa T°R
2300	1.1843	–	252	4.712	–	99	8.203	–	173	11.654	–	243	4140
2350	1.1591	–	241	4.613	–	96	8.030	–	165	11.411	–	234	4230
2400	1.1350	–	231	4.517	–	91	7.865	–	159	11.177	–	224	4320
2450	1.1119	–	223	4.426	–	88	7.706	–	152	10.953	–	215	4410
2500	1.0896	–	212	4.338	–	85	7.554	–	147	10.738	–	208	4500
2550	1.0684	–	206	4.253	–	81	7.407	–	140	10.530	–	199	4590
2600	1.0478	–	197	4.172	–	79	7.267	–	136	10.331	–	192	4680
2650	1.0281	–	191	4.093	–	75	7.131	–	131	10.139	–	185	4770
2700	1.0090	–	182	4.018	–	72	7.000	–	126	9.954	–	178	4860
2750	.9908	–	177	3.946	–	70	6.874	–	122	9.776	–	172	4950
2800	.9731	–	171	3.876	–	68	6.752	–	117	9.604	–	166	5040
2850	.9560	–	165	3.808	–	65	6.635	–	113	9.438	–	161	5130
2900	.9395	–	158	3.743	–	63	6.522	–	109	9.277	–	155	5220
2950	.9237	–	154	3.680	–	62	6.413	–	107	9.122	–	149	5310
3000	.9083			3.618			6.306			8.973			5400

Table 16.18 Density of Nitric Oxide

The Property Tabulated

The density relative to standard conditions, ρ/ρ_0, of nitric oxide is tabulated as a function of temperature in degrees Kelvin and degrees Rankine, and as a function of pressure in standard atmospheres. Standard conditions are 1 atmosphere of pressure and 0°C (273.16°K). The values of density given are for a gas with no dissociation in the region of temperature and pressure covered.

The values in this table were obtained from the formula $\rho/\rho_0 = PV_0/RTZ$. The values of Z were taken from Table 16.20 of this series.

Reliability of the Table

In the temperature region from 200°K to 300°K, where data other than at low pressure are available, the tabulated values may be accurate to about .05% up to 1 atmosphere, 0.1% at 10 atmospheres, and 0.6% at 100 atmospheres as indicated from Table 16.20. At higher temperatures, the values are probably less reliable, as they are obtained by extrapolation.

Interpolation

The validity of linear interpolation varies throughout the table. Where the arguments are spaced uniformly in either temperature or pressure, the error produced by such interpolation does not exceed one-eighth of the second difference. The first temperature differences Δ_T are given to facilitate linear interpolation. When the error produced by linear interpolation approaches the accuracy of the table, three or four point Lagrangian interpolation is recommended. If tables of Lagrangian Interpolation Coefficients [8] are not at hand, adequate values may be obtained by the relationship:

$$\rho/\rho_0 = \frac{272.846\ P}{TZ}$$

where the compressibility Z is obtained by linear interpolation in Table 16.20 of this series, P is the pressure in atmospheres and T is the Kelvin temperature.

Conversion Factors

The function in this table has been expressed in dimensionless form. In order that it may be converted readily to any system of units, the standard density ρ_0 is listed for the frequently used units. For conversion factors not listed here see Table 1.30 of this series.

To convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
ρ/ρ_0	ρ	g cm^{-3}	1.34031 x 10^{-3}
		g $liter^{-1}$	1.34035
		lb in^{-3}	4.84221 x 10^{-2}
		lb ft^{-3}	8.367 x 10^{-2}
		moles cm^{-3}	4.46651 x 10^{-2}

REFERENCES

[1] A. Jaquerod and O. Scheuer, Sur la compressibilité de différents gaz au-dessous de 1 atm et la determination de leurs poids moléculaires, Comptes Rendus 140, 1384 (1905).

[2] D. Berthelot, Sur le calcul exact des poids moléculaires des gaz, Comptes Rendus 144, 76 (1907).

[3] A. Leduc, Compressibilité des gaz; volumes moléculaires et poids atomiques, Annales de Chimie et de Physique, 8th Ser. 19, 441 (1910).

[4] T. Batuecas, Sur la compressibilité à 0° et au-dessous de 1 atmosphère et l'écart à la loi d'Avogadro de plusieurs gaz, J. de Chim. Phys. 22, 101 (1925).

[5] A. Eucken and L. d'Or, Die Molwärme des gas förmigen Stickoxyd bei tiefen Temperaturen, Nachr. Ges. Wiss. Göttingen, 1932, 107 (1932).

[6] H. L. Johnston and H. R. Weimer, Low pressure data of state of nitric oxide and of nitrous oxide between their boiling points and room temperature, J. Amer. Chem. Soc. 56, 625 (1934).

[7] E. Briner, H. Biedermann and A. Rothen, Recherches sur la compression et la décomposition de l'oxyde d'azote, J. de Chim. Phys. 23, 157 (1926).

[8] "Tables of Lagrangian Interpolation Coefficients", Columbia University Press, New York, N. Y. (1944).

U.S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

TABLE 16.20 Compressibility Factor for Nitric Oxide

Compiled by

Harold W. Woolley

Reissue
June 1953

TABLE 16.20 Compressibility Factor for Nitric Oxide $Z = PV/RT$

T °K	.1 atm	Δ_p	.4 atm	Δ_p	.7 atm	Δ_p	.1 atm	T °R
100	.98794							180
110	.99562							198
120	.99759	-791	.98968	-1025	.97943			216
130	.99839	-492	.99347	-506	.98841	-588	.98253	234
140	.99881	-357	.99524	-358	.99166	-363	.98803	252
150	.99907	-277	.99630	-278	.99352	-281	.99071	270
160	.99925	-222	.99703	-223	.99480	-224	.99256	288
170	.99939	-183	.99756	-183	.99573	-183	.99390	306
180	.99949	-152	.99797	-152	.99645	-152	.99493	324
190	.99957	-127	.99830	-128	.99702	-128	.99574	342
200	.99964	-108	.99856	-108	.99748	-108	.99640	360
210	.99969	-91	.99878	-92	.99786	-92	.99694	378
220	.99974	-79	.99895	-79	.99816	-79	.99737	396
230	.99978	-69	.99909	-65	.99844	-68	.99776	414
240	.99981	-59	.99922	-56	.99866	-58	.99808	432
250	.99984	-50	.99934	-49	.99885	-50	.99835	450
260	.99986	-43	.99943	-42	.99901	-42	.99859	468
270	.99988	-36	.99952	-37	.99915	-36	.99879	486
280	.99990	-31	.99959	-31	.99928	-31	.99897	504
290	.99991	-26	.99965	-27	.99938	-26	.99912	522
300	.99993	-23	.99970	-22	.99948	-23	.99925	540
310	.99994	-19	.99975	-19	.99956	-19	.99937	558
320	.99995	-16	.99979	-16	.99963	-15	.99948	576
330	.99996	-13	.99983	-13	.99970	-13	.99957	594
340	.99996	-10	.99986	-11	.99975	-10	.99965	612
350	.99997	-8	.99989	-8	.99981	-9	.99972	630
360	.99998	-7	.99991	-6	.99985	-6	.99979	648
370	.99998	-4	.99994	-5	.99989	-5	.99984	666
380	.99999	-3	.99996	-3	.99993	-3	.99990	684
390	.99999	-1	.99998	-1	.99997	-3	.99994	702
400	1.00000	-1	.99999	0	.99999	-1	.99998	720
410	1.00000	+1	1.00001	0	1.00001	+1	1.00002	738
420	1.00000	2	1.00002	+2	1.00004	1	1.00005	756
430	1.00001	2	1.00003	3	1.00006	2	1.00008	774
440	1.00001	3	1.00004	4	1.00008	3	1.00011	792
450	1.00001	4	1.00005	4	1.00009	4	1.00013	810

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	.1 atm	Δ_p	.4 atm	Δ_p	.7 atm	Δ_p	.1 atm	T °R
450	1.00001	4	1.00005	4	1.00009	4	1.00013	810
460	1.00002	4	1.00006	5	1.00011	5	1.00016	828
470	1.00002	5	1.00007	5	1.00012	6	1.00018	846
480	1.00002	6	1.00008	6	1.00014	5	1.00019	864
490	1.00002	6	1.00008	7	1.00015	6	1.00021	882
500	1.00002	7	1.00009	7	1.00016	6	1.00022	900
510	1.00002	8	1.00010	7	1.00017	7	1.00024	918
520	1.00002	8	1.00010	8	1.00018	7	1.00025	936
530	1.00003	8	1.00011	7	1.00018	8	1.00026	954
540	1.00003	8	1.00011	8	1.00019	8	1.00027	972
550	1.00003	8	1.00011	9	1.00020	8	1.00028	990
560	1.00003	9	1.00012	8	1.00020	9	1.00029	1008
570	1.00003	9	1.00012	9	1.00021	8	1.00029	1026
580	1.00003	9	1.00012	9	1.00021	9	1.00030	1044
590	1.00003	9	1.00012	10	1.00022	8	1.00030	1062
600	1.00003	10	1.00013	9	1.00022	9	1.00031	1080
610	1.00003	10	1.00013	9	1.00022	10	1.00032	1098
620	1.00003	10	1.00013	10	1.00023	9	1.00032	1116
630	1.00003	10	1.00013	10	1.00023	10	1.00033	1134
640	1.00003	10	1.00013	10	1.00023	10	1.00033	1152
650	1.00003	10	1.00013	10	1.00023	10	1.00033	1170
660	1.00003	10	1.00013	10	1.00023	10	1.00033	1188
670	1.00003	10	1.00013	11	1.00024	10	1.00034	1206
680	1.00003	11	1.00014	10	1.00024	10	1.00034	1224
690	1.00003	11	1.00014	10	1.00024	10	1.00034	1242
700	1.00003	11	1.00014	10	1.00024	10	1.00034	1260
710	1.00003	11	1.00014	10	1.00024	10	1.00034	1278
720	1.00003	11	1.00014	10	1.00024	10	1.00034	1296
730	1.00003	11	1.00014	10	1.00024	10	1.00034	1314
740	1.00003	11	1.00014	10	1.00024	10	1.00034	1332
750	1.00003	11	1.00014	10	1.00024	10	1.00034	1350
760	1.00003	11	1.00014	10	1.00024	10	1.00034	1368
770	1.00003	11	1.00014	10	1.00024	10	1.00034	1386
780	1.00003	11	1.00014	10	1.00024	10	1.00034	1404
790	1.00003	11	1.00014	10	1.00024	10	1.00034	1422
800	1.00003	11	1.00014	10	1.00024	10	1.00034	1440

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.)

$Z = PV/RT$

T °K	.1 atm	Δ_p	.4 atm	Δ_p	.7 atm	Δ_p	1 atm	T °R
800	1.00003	11	1.00014	10	1.00024	10	1.00034	1440
850	1.00003	11	1.00014	10	1.00024	10	1.00034	1530
900	1.00003	10	1.00013	10	1.00023	10	1.00033	1620
950	1.00003	10	1.00013	10	1.00023	10	1.00033	1710
1000	1.00003	10	1.00013	9	1.00022	10	1.00032	1800
1050	1.00003	10	1.00013	9	1.00022	9	1.00031	1890
1100	1.00003	9	1.00012	9	1.00021	9	1.00030	1980
1150	1.00003	9	1.00012	9	1.00021	8	1.00029	2070
1200	1.00003	9	1.00012	8	1.00020	9	1.00029	2160
1250	1.00003	8	1.00011	9	1.00020	8	1.00028	2250
1300	1.00003	8	1.00011	8	1.00019	8	1.00027	2340
1350	1.00003	8	1.00011	8	1.00019	7	1.00026	2430
1400	1.00003	7	1.00010	8	1.00018	8	1.00026	2520
1450	1.00003	7	1.00010	8	1.00018	7	1.00025	2610
1500	1.00002	8	1.00010	7	1.00017	8	1.00025	2700
1550	1.00002	8	1.00010	7	1.00017	7	1.00024	2790
1600	1.00002	7	1.00009	7	1.00016	7	1.00023	2880
1650	1.00002	7	1.00009	7	1.00016	7	1.00023	2970
1700	1.00002	7	1.00009	7	1.00016	6	1.00022	3060
1750	1.00002	7	1.00009	6	1.00015	7	1.00022	3150
1800	1.00002	7	1.00009	6	1.00015	6	1.00021	3240
1850	1.00002	6	1.00008	7	1.00015	6	1.00021	3330
1900	1.00002	6	1.00008	6	1.00014	6	1.00020	3420
1950	1.00002	6	1.00008	6	1.00014	6	1.00020	3510
2000	1.00002	6	1.00008	6	1.00014	5	1.00019	3600
2050	1.00002	6	1.00008	5	1.00013	6	1.00019	3690
2100	1.00002	5	1.00007	6	1.00013	5	1.00018	3780
2150	1.00002	5	1.00007	6	1.00013	5	1.00018	3870
2200	1.00002	5	1.00007	5	1.00012	6	1.00018	3960
2250	1.00002	5	1.00007	5	1.00012	5	1.00017	4050
2300	1.00002	5	1.00007	5	1.00012	5	1.00017	4140

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.)

$Z = PV/RT$

T °K	.1 atm	Δ_p	.4 atm	Δ_p	.7 atm	Δ_p	.1 atm	T °R
2300	1.00002	5	1.00007	5	1.00012	5	1.00017	4140
2350	1.00002	5	1.00007	5	1.00012	5	1.00017	4230
2400	1.00002	5	1.00007	4	1.00011	5	1.00016	4320
2450	1.00002	4	1.00006	5	1.00011	5	1.00016	4410
2500	1.00002	4	1.00006	5	1.00011	5	1.00016	4500
2550	1.00002	4	1.00006	5	1.00011	4	1.00015	4590
2600	1.00002	4	1.00006	5	1.00011	4	1.00015	4680
2650	1.00001	5	1.00006	4	1.00010	5	1.00015	4770
2700	1.00001	5	1.00006	4	1.00010	5	1.00015	4860
2750	1.00001	5	1.00006	4	1.00010	4	1.00014	4950
2800	1.00001	5	1.00006	4	1.00010	4	1.00014	5040
2850	1.00001	5	1.00006	4	1.00010	4	1.00014	5130
2900	1.00001	4	1.00005	5	1.00010	4	1.00014	5220
2950	1.00001	4	1.00005	4	1.00009	4	1.00013	5310
3000	1.00001	4	1.00005	4	1.00009	4	1.00013	5400

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	1 atm	Δ_p	4 atm	Δ_p	7 atm	Δ_p	10 atm	T °R
130	.9825							234
140	.9880	-414	.9466					252
150	.9907	-307	.9600	-410	.9190			270
160	.9926	-231	.9695	-257	.9438	-302	.9136	288
170	.9939	-186	.9753	-194	.9559	-207	.9352	306
180	.9949	-153	.9796	-158	.9638	-163	.9475	324
190	.9957	-129	.9828	-131	.9697	-134	.9563	342
200	.9964	-109	.9855	-111	.9744	-113	.9631	360
210	.9969	-93	.9876	-94	.9782	-96	.9686	378
220	.9974	-80	.9894	-81	.9813	-83	.9730	396
230	.9978	-68	.9910	-70	.9840	-70	.9770	414
240	.9981	-59	.9922	-59	.9863	-61	.9802	432
250	.9984	-51	.9933	-51	.9882	-52	.9830	450
260	.9986	-43	.9943	-44	.9899	-45	.9854	468
270	.9988	-37	.9951	-37	.9914	-39	.9875	486
280	.9990	-32	.9958	-32	.9926	-33	.9893	504
290	.9991	-27	.9964	-27	.9937	-28	.9909	522
300	.9993	-23	.9970	-23	.9947	-24	.9923	540
310	.9994	-19	.9975	-20	.9955	-20	.9935	558
320	.9995	-16	.9979	-17	.9962	-17	.9945	576
330	.9996	-14	.9982	-13	.9969	-14	.9955	594
340	.9997	-11	.9986	-11	.9975	-12	.9963	612
350	.9997	-8	.9989	-9	.9980	-9	.9971	630
360	.9998	-7	.9991	-6	.9985	-8	.9977	648
370	.9998	-4	.9994	-5	.9989	-6	.9983	666
380	.9999	-3	.9996	-4	.9992	-3	.9989	684
390	.9999	-2	.9997	-2	.9995	-2	.9993	702
400	1.0000	-1	.9999	0	.9999	-1	.9998	720
410	1.0000	+1	1.0001	+1	1.0002	-1	1.0001	738
420	1.0001	1	1.0002	2	1.0004	+1	1.0005	756
430	1.0001	2	1.0003	3	1.0006	2	1.0008	774
440	1.0001	3	1.0004	4	1.0008	3	1.0011	792
450	1.0001	4	1.0005	4	1.0009	4	1.0013	810

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) Z = PV/RT

T °K	1 atm	Δ_p	4 atm	Δ_p	7 atm	Δ_p	10 atm	T °R
450	1.0001	4	1.0005	4	1.0009	4	1.0013	810
460	1.0002	4	1.0006	5	1.0011	5	1.0016	828
470	1.0002	5	1.0007	5	1.0012	6	1.0018	846
480	1.0002	6	1.0008	6	1.0014	5	1.0019	964
490	1.0002	6	1.0008	7	1.0015	6	1.0021	882
500	1.0002	7	1.0009	7	1.0016	7	1.0023	900
510	1.0002	8	1.0010	7	1.0017	7	1.0024	918
520	1.0003	7	1.0010	8	1.0018	7	1.0025	936
530	1.0003	8	1.0011	8	1.0019	7	1.0026	954
540	1.0003	8	1.0011	8	1.0019	8	1.0027	972
550	1.0003	8	1.0011	9	1.0020	8	1.0028	990
560	1.0003	9	1.0012	8	1.0020	9	1.0029	1008
570	1.0003	9	1.0012	9	1.0021	9	1.0030	1026
580	1.0003	9	1.0012	9	1.0021	9	1.0030	1044
590	1.0003	9	1.0012	10	1.0022	9	1.0031	1062
600	1.0003	10	1.0013	9	1.0022	9	1.0031	1080
610	1.0003	10	1.0013	9	1.0022	10	1.0032	1098
620	1.0003	10	1.0013	10	1.0023	9	1.0032	1116
630	1.0003	10	1.0013	10	1.0023	10	1.0033	1134
640	1.0003	10	1.0013	10	1.0023	10	1.0033	1152
650	1.0003	10	1.0013	10	1.0023	10	1.0033	1170
660	1.0003	10	1.0013	11	1.0024	9	1.0033	1188
670	1.0003	11	1.0014	10	1.0024	10	1.0034	1206
680	1.0003	11	1.0014	10	1.0024	10	1.0034	1224
690	1.0003	11	1.0014	10	1.0024	10	1.0034	1242
700	1.0003	11	1.0014	10	1.0024	10	1.0034	1260
710	1.0003	11	1.0014	10	1.0024	10	1.0034	1278
720	1.0003	11	1.0014	10	1.0024	10	1.0034	1296
730	1.0003	11	1.0014	10	1.0024	10	1.0034	1314
740	1.0003	11	1.0014	10	1.0024	10	1.0034	1332
750	1.0003	11	1.0014	10	1.0024	10	1.0034	1350
760	1.0003	11	1.0014	10	1.0024	10	1.0034	1368
770	1.0003	11	1.0014	10	1.0024	10	1.0034	1386
780	1.0003	11	1.0014	10	1.0024	10	1.0034	1404
790	1.0003	11	1.0014	10	1.0024	10	1.0034	1422
800	1.0003	11	1.0014	10	1.0024	10	1.0034	1440

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) Z = PV/RT

T °K	1 atm	Δ_p	4 atm	Δ_p	7 atm	Δ_p	10 atm	T °R
800	1.0003	11	1.0014	10	1.0024	10	1.0034	1440
850	1.0003	11	1.0014	10	1.0024	10	1.0034	1530
900	1.0003	10	1.0013	11	1.0024	9	1.0033	1620
950	1.0003	10	1.0013	10	1.0023	10	1.0033	1710
1000	1.0003	10	1.0013	10	1.0023	9	1.0032	1800
1050	1.0003	10	1.0013	9	1.0022	9	1.0031	1890
1100	1.0003	9	1.0012	9	1.0021	10	1.0031	1980
1150	1.0003	9	1.0012	9	1.0021	9	1.0030	2070
1200	1.0003	9	1.0012	8	1.0020	9	1.0029	2160
1250	1.0003	8	1.0011	9	1.0020	8	1.0028	2250
1300	1.0003	8	1.0011	8	1.0019	8	1.0027	2340
1350	1.0003	8	1.0011	8	1.0019	8	1.0027	2430
1400	1.0003	7	1.0010	8	1.0018	8	1.0026	2520
1450	1.0003	7	1.0010	8	1.0018	7	1.0025	2610
1500	1.0003	7	1.0010	7	1.0017	8	1.0025	2700
1550	1.0002	8	1.0010	7	1.0017	7	1.0024	2790
1600	1.0002	7	1.0009	7	1.0016	7	1.0023	2880
1650	1.0002	7	1.0009	7	1.0016	7	1.0023	2970
1700	1.0002	7	1.0009	7	1.0016	6	1.0022	3060
1750	1.0002	7	1.0009	6	1.0015	7	1.0022	3150
1800	1.0002	7	1.0009	6	1.0015	6	1.0021	3240
1850	1.0002	6	1.0008	7	1.0015	6	1.0021	3330
1900	1.0002	6	1.0008	6	1.0014	6	1.0020	3420
1950	1.0002	6	1.0008	6	1.0014	6	1.0020	3510
2000	1.0002	6	1.0008	6	1.0014	5	1.0019	3600
2050	1.0002	6	1.0008	5	1.0013	6	1.0019	3690
2100	1.0002	5	1.0007	6	1.0013	5	1.0018	3780
2150	1.0002	5	1.0007	6	1.0013	5	1.0018	3870
2200	1.0002	5	1.0007	5	1.0012	6	1.0018	3960
2250	1.0002	5	1.0007	5	1.0012	5	1.0017	4050
2300	1.0002	5	1.0007	5	1.0012	5	1.0017	4140

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	1 atm	Δ_p	4 atm	Δ_p	7 atm	Δ_p	10 atm	T °R
2300	1.0002	5	1.0007	5	1.0012	5	1.0017	4140
2350	1.0002	5	1.0007	5	1.0012	5	1.0017	4230
2400	1.0002	5	1.0007	4	1.0011	5	1.0016	4320
2450	1.0002	4	1.0006	5	1.0011	5	1.0016	4410
2500	1.0002	4	1.0006	5	1.0011	4	1.0015	4500
2550	1.0002	4	1.0006	5	1.0011	4	1.0015	4590
2600	1.0002	4	1.0006	4	1.0010	5	1.0015	4680
2650	1.0002	4	1.0006	4	1.0010	5	1.0015	4770
2700	1.0002	4	1.0006	4	1.0010	4	1.0014	4860
2750	1.0001	5	1.0006	4	1.0010	4	1.0014	4950
2800	1.0001	5	1.0006	4	1.0010	4	1.0014	5040
2850	1.0001	4	1.0005	5	1.0010	4	1.0014	5130
2900	1.0001	4	1.0005	4	1.0009	4	1.0013	5220
2950	1.0001	4	1.0005	4	1.0009	4	1.0013	5310
3000	1.0001							5400

TABLE E6.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	10 atm	Δ_p	40 atm	Δ_p	70 atm	Δ_p	100 atm	T °R
								288
160	.9136							306
170	.9352							324
180	.9475	-2250	.7225					342
190	.9563	-1579	.7984	-2307	.5677			
200	.9631	-1242	.8389	-1493	.6896	-1807	.5089	360
210	.9686	-1029	.8657	-1120	.7537	-1164	.6373	378
220	.9730	-876	.8854	-917	.7937	-876	.7061	396
230	.9770	-748	.9022	-773	.8249	-715	.7534	414
240	.9802	-644	.9158	-666	.8492	-612	.7880	432
250	.9830	-556	.9274	-577	.8697	-535	.8162	450
260	.9854	-480	.9374	-501	.8873	-469	.8404	468
270	.9875	-413	.9462	-436	.9026	-412	.8614	486
280	.9893	-355	.9538	-378	.9160	-359	.8801	504
290	.9909	-305	.9604	-325	.9279	-313	.8966	522
300	.9923	-260	.9663	-279	.9384	-271	.9113	540
310	.9935	-220	.9715	-238	.9477	-232	.9245	558
320	.9945	-184	.9761	-202	.9559	-196	.9363	576
330	.9955	-154	.9801	-168	.9633	-165	.9468	594
340	.9963	-126	.9837	-138	.9699	-136	.9563	612
350	.9971	-102	.9869	-112	.9757	-109	.9648	630
360	.9977	-79	.9898	-89	.9809	-85	.9724	648
370	.9983	-60	.9923	-67	.9856	-64	.9792	666
380	.9989	-43	.9946	-48	.9898	-44	.9854	684
390	.9993	-27	.9966	-30	.9936	-27	.9909	702
400	.9998	-13	.9985	-15	.9970	-11	.9959	720
410	1.0001	+1	1.0002	-2	1.0000	+3	1.0003	738
420	1.0005	12	1.0017	+10	1.0027	17	1.0044	756
430	1.0008	22	1.0030	22	1.0052	28	1.0080	774
440	1.0011	31	1.0042	32	1.0074	38	1.0112	792
450	1.0013	40	1.0053	42	1.0095	47	1.0142	810

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) Z = PV/RT

T °K	10 atm	Δ_p	40 atm	Δ_p	70 atm	Δ_p	100 atm	T °R
450	1.0013	40	1.0053	42	1.0095	47	1.0142	810
460	1.0016	47	1.0063	50	1.0113	56	1.0169	828
470	1.0018	53	1.0071	58	1.0129	64	1.0193	846
480	1.0019	60	1.0079	64	1.0143	72	1.0215	864
490	1.0021	65	1.0086	71	1.0157	77	1.0234	882
500	1.0023	69	1.0092	77	1.0169	83	1.0252	900
510	1.0024	76	1.0100	81	1.0181	89	0.0270	918
520	1.0025	80	1.0105	86	1.0191	93	1.0284	836
530	1.0026	84	1.0110	89	1.0199	98	1.0297	954
540	1.0027	87	1.0114	93	1.0207	101	1.0308	972
550	1.0028	90	1.0118	96	1.0214	104	1.0318	990
560	1.0029	92	1.0121	99	1.0220	107	1.0327	1008
570	1.0030	94	1.0124	102	1.0226	110	1.0336	1026
580	1.0030	97	1.0127	104	1.0231	112	1.0343	1044
590	1.0031	99	1.0130	105	1.0235	114	1.0349	1062
600	1.0031	101	1.0132	107	1.0239	116	1.0355	1080
610	1.0032	102	1.0134	109	1.0243	117	1.0360	1098
620	1.0032	103	1.0135	111	1.0246	119	1.0365	1116
630	1.0033	104	1.0137	111	1.0248	120	1.0368	1134
640	1.0033	105	1.0138	113	1.0251	121	1.0372	1152
650	1.0033	106	1.0139	114	1.0253	122	1.0375	1170
660	1.0033	107	1.0140	115	1.0255	123	1.0378	1188
670	1.0034	107	1.0141	115	1.0256	123	1.0379	1206
680	1.0034	108	1.0142	115	1.0257	124	1.0381	1224
690	1.0034	109	1.0143	115	1.0258	125	1.0383	1242
700	1.0034	109	1.0143	116	1.0259	125	1.0384	1260
710	1.0034	109	1.0143	117	1.0260	124	1.0384	1278
720	1.0034	110	1.0144	116	1.0260	125	1.0385	1296
730	1.0034	110	1.0144	117	1.0261	125	1.0386	1314
740	1.0034	110	1.0144	117	1.0261	125	1.0386	1332
750	1.0034	110	1.0144	117	1.0261	125	1.0386	1350
760	1.0034	110	1.0144	117	1.0261	125	1.0386	1368
770	1.0034	110	1.0144	117	1.0261	124	1.0385	1386
780	1.0034	110	1.0144	116	1.0260	123	1.0383	1422
800	1.0034	109	1.0143	116	1.0259	124	1.0383	1440

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	10 atm	Δ_p	40 atm	Δ_p	70 atm	Δ_p	100 atm	T °R
800	1.0034	109	1.0143	116	1.0259	124	1.0383	1440
850	1.0034	108	1.0142	114	1.0256	121	1.0377	1530
900	1.0033	106	1.0139	112	1.0251	119	1.0370	1620
950	1.0033	103	1.0136	110	1.0246	115	1.0361	1710
1000	1.0032	101	1.0133	107	1.0240	111	1.0351	1800
1050	1.0031	99	1.0130	103	1.0233	109	1.0342	1890
1100	1.0031	95	1.0126	101	1.0227	106	1.0333	1980
1150	1.0030	93	1.0123	98	1.0221	102	1.0323	2070
1200	1.0029	91	1.0120	95	1.0215	99	1.0314	2160
1250	1.0028	88	1.0116	93	1.0209	96	1.0305	2250
1300	1.0027	86	1.0113	90	1.0203	94	1.0297	2340
1350	1.0027	83	1.0110	87	1.0197	90	1.0287	2430
1400	1.0026	81	1.0107	85	1.0192	88	1.0280	2520
1450	1.0025	79	1.0104	83	1.0187	85	1.0272	2610
1500	1.0025	77	1.0102	79	1.0181	83	1.0264	2700
1550	1.0024	75	1.0099	78	1.0177	80	1.0257	2790
1600	1.0023	73	1.0096	76	1.0172	78	1.0250	2880
1650	1.0023	71	1.0094	74	1.0168	75	1.0243	2970
1700	1.0022	70	1.0092	71	1.0163	74	1.0237	3060
1750	1.0022	67	1.0089	70	1.0159	72	1.0231	3150
1800	1.0021	66	1.0087	68	1.0155	70	1.0225	3240
1850	1.0021	64	1.0085	66	1.0151	69	1.0220	3330
1900	1.0020	63	1.0083	65	1.0148	66	1.0214	3420
1950	1.0020	61	1.0081	63	1.0144	66	1.0210	3510
2000	1.0019	60	1.0079	62	1.0141	63	1.0204	3600
2050	1.0019	59	1.0078	60	1.0138	62	1.0200	3690
2100	1.0018	56	1.0074	60	1.0134	57	1.0191	3780
2150	1.0018	56	1.0074	58	1.0132	58	1.0190	3870
2200	1.0018	55	1.0073	56	1.0129	57	1.0186	3960
2250	1.0017	54	1.0071	55	1.0126	56	1.0182	4050
2300	1.0017	53	1.0070	53	1.0123	57	1.0180	4140

TABLE 16.20 Compressibility Factor for Nitric Oxide (Cont.) $Z = PV/RT$

T °K	10 atm	Δ_p	40 atm	Δ_p	70 atm	Δ_p	100 atm	T °R
2300	1.0017	53	1.0070	53	1.0123	57	1.0180	4140
2350	1.0017	51	1.0068	53	1.0121	54	1.0175	4230
2400	1.0016	51	1.0067	51	1.0118	53	1.0171	4320
2450	1.0016	49	1.0065	51	1.0116	52	1.0168	4410
2500	1.0016	48	1.0064	50	1.0114	50	1.0164	4500
2550	1.0015	48	1.0063	49	1.0112	49	1.0161	4590
2600	1.0015	47	1.0062	47	1.0109	49	1.0158	4680
2650	1.0015	46	1.0061	46	1.0107	48	1.0155	4770
2700	1.0015	45	1.0060	45	1.0105	47	1.0152	4860
2750	1.0014	44	1.0058	45	1.0103	46	1.0149	4950
2800	1.0014	43	1.0057	45	1.0102	44	1.0146	5040
2850	1.0014	42	1.0056	44	1.0100	44	1.0144	5130
2900	1.0014	41	1.0055	43	1.0098	44	1.0142	5220
2950	1.0013	41	1.0054	42	1.0096	43	1.0139	5310
3000	1.0013	41	1.0054	41	1.0095	41	1.0136	5400

TABLE 16.20 Compressibility Factor of Nitric Oxide

The Property Tabulated

The dimensionless compressibility factor, $Z = PV/RT$, of nitric oxide is tabulated as a function of temperature in degrees Kelvin and degrees Rankine, and of pressure in standard atmospheres. The values given are those which would exist if there were no dissociation within the range covered. The experimental data are shown in figures 1 and 2 and 3. The low pressure data [1 to 6] indicate that the second virial coefficient at low temperature departs considerably from such a behavior as would be consistent with a Lennard-Jones force law. Nitric oxide is capable of chemical bonding, giving rise to dimer formation [8]. Allowing for this in addition to the regular Lennard-Jones type of contribution, it is found that the second virial coefficient can be represented adequately as shown by the curve in figure 1, with reasonable values for the Lennard-Jones parameters (b_o = 61.5 cm^3/mole and ϵ/k = 118°K) and for vibrational frequencies for the dimer [9] with 150 cm^{-1} assumed for torsion. The fitting of the higher pressure data [7] of figure 2 involves an empirical choice of third and fourth virial coefficients. The data in figure 3 [12] appeared after this correlation was completed.

Reliability of the Table

In the region of the experimental data, the table is considered to be as reliable as the data on which it is based. The only available data for elevated pressure show considerable scattering and the resulting isotherms are somewhat different from those for most gases. Because of doubt concerning the interpretation of these data, a considerable revision upward in the estimates for the uncertainties of the values tabulated might be desired. On the basis of the scattering of the data, the values tabulated in the experimental region may be accurate to about 0.05% up to 1 atmosphere, 0.1% at 10 atmospheres, and 0.6% at 100 atmospheres. At higher temperatures, at which the values are based on extrapolations, the values must be less certain.

Interpolation

The validity of linear interpolation varies throughout this table; the error produced thereby does not exceed one-eighth of the second difference. The pressure entries are in groups spaced at uniform intervals so as to facilitate Lagrangian interpolation [11] when more accurate interpolated values are desired.

Conversion Factors

The compressibility factor is dimensionless. Values of the gas constant R are listed for the frequently used units in order to facilitate the use of this table in calculating, by means of the equation $Z = PV/RT$, the pressure P, the temperature T, or the specific volume V (or the density $\rho = 1/V$), when any two of these are known. The values given below are based on a molecular weight of 30.008.

Values of R for Nitric Oxide

For temperatures in degrees Kelvin

Density \ Pressure	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	2.73449	2.82535	2078.21	40.1861
mole/cm^3	82.0567	84.7832	62363.1	1205.91
mole/liter	.0820544	.0847809	62.3613	1.20587
lb/ft^3	.0438023	.0452577	33.2897	.643719
lb mole/ft^3	1.31442	1.35809	998.959	19.3167

For temperatures in degrees Rankine

Density \ Pressure	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	1.51916	1.569638	1154.56	22.3256
mole/cm^3	45.5870	47.1017	34646.1	669.947
mole/liter	0.0455857	0.0471004	34.6451	0.669928
lb/ft^3	.0243345	.0251431	18.4942	.357620
lb mole/ft^3	0.730231	0.754495	554.976	10.7315

REFERENCES

1 A. Jaquerod and O. Scheuer, Sur la compressibilité de différents gaz au-dessous de 1 atm. et la determination de leurs poids moléculaires, Comptes Rendus 140, 1384 (1905).

2 D. Berthelot, Sur le calcul exact des poids moléculaires des gaz, Comptes Rendus 144, 76 (1907).

3 A. Leduc, Compressibilité des gaz; volumes moléculaires et poids atomiques, Annales de Chimie et de Physique, 8th Ser. 19, 441 (1910).

4 T. Batuecas, Sur la compressibilité à 0° au-dessous de 1 atmosphere et l'ecart à la loi d'Avogadro de plusieurs gaz, J. de Chim. Phys. 22, 101 (1925).

5 A. Eucken and L. d'Or, Die Molwärme des gas förmigen Stickoxyd bei tiefen Temperaturen, Nachr. Ges. Wiss. Gottingen, 1932, 107 (1932).

6 H. L. Johnston and H. R. Weimer, Low pressure data of state of nitric oxide and of nitrous oxide between their boiling points and room temperature, J. Amer. Chem. Soc. 56, 625 (1934).

7 E. Briner, H. Biedermann and A. Rothen, Recherches sur la compression et la decomposition de l'oxyde d'azote, J. de Chim. Phys. 23, 157 (1926).

8 G. Briegleb, Uber den polaren Aufbau der Molekule und die Natur der Nebenvalenzkrafte, Zeit. physik. Chemie B 23, 127 (1933).

9 A. L. Smith, W. E. Keller and H. L. Johnston, Infrared and Raman spectra of liquid and solid NO, paper presented June 15, 1950 at the Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio.

10 H. L. Johnston, Association heat and degree of association of nitric oxide in liquid and solid phases as determined by means of spectra and magnetic susceptibility measurements, paper presented December 12, 1950 at the Spectroscopy Conference, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Maryland.

11 Tables of Lagrangian Interpolation Coefficients (Columbia University Press, New York, N. Y., 1944).

12 B. H. Golding and B. H. Sage, Volumetric Behavior of Nitric Oxide, Ind. Eng. Chem. 43, 160 (1951). B. H. Golding, B. H. Sage and W. N. Lacey, Volumetric Behavior of Nitric Oxide, ADI 2949, American Documentation Institute, Washington 6, D. C. (1950).

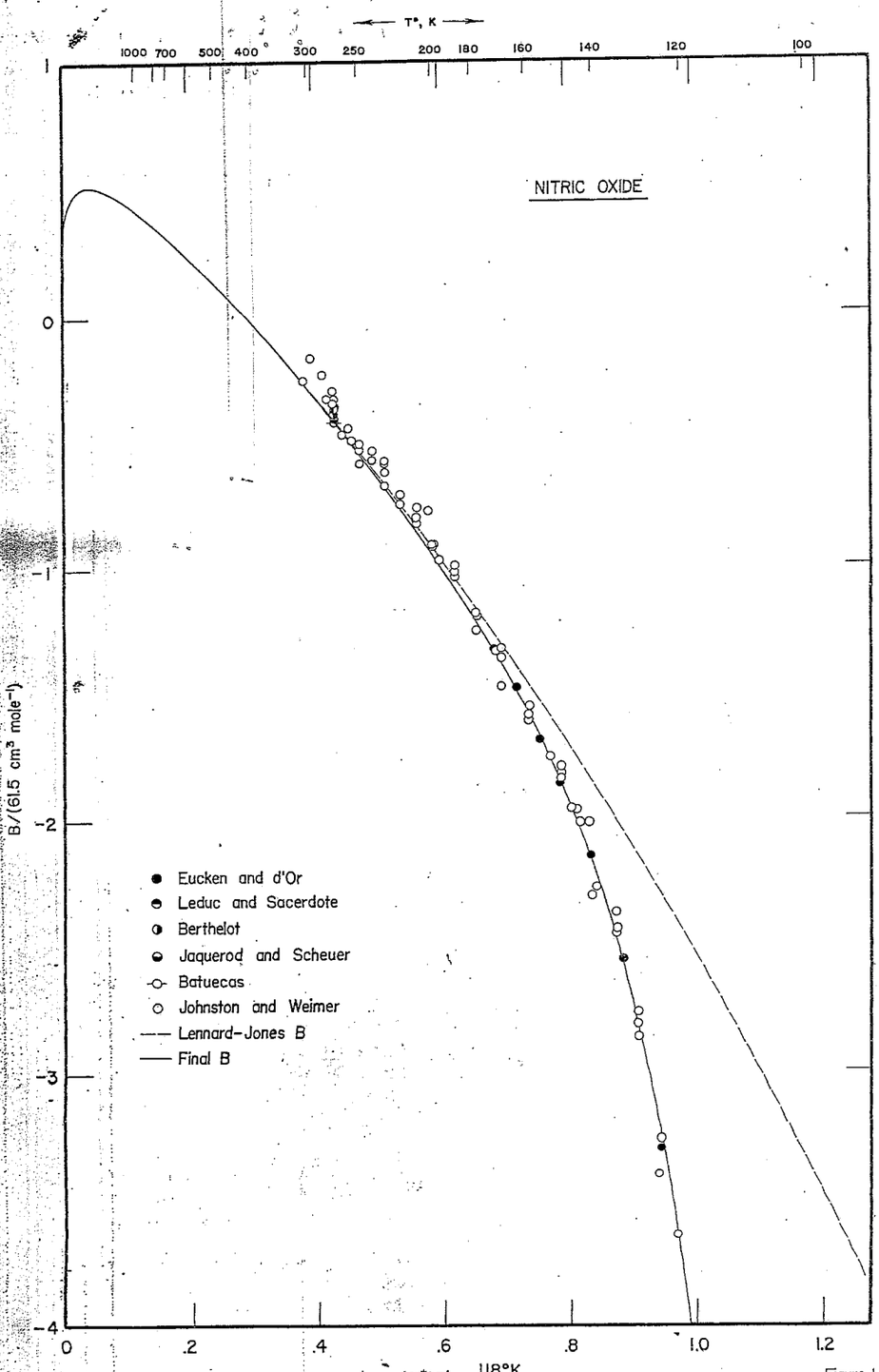

Figure 1

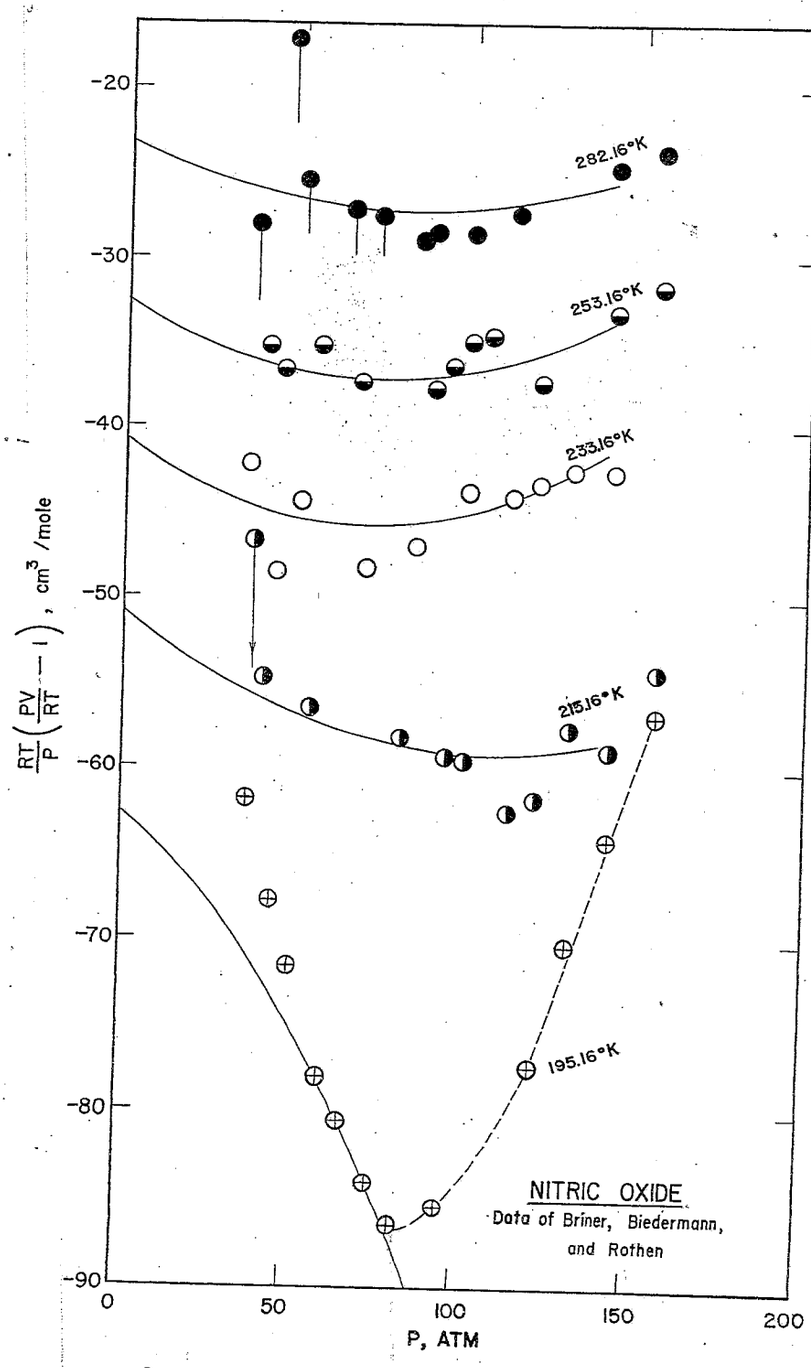

Figure 2

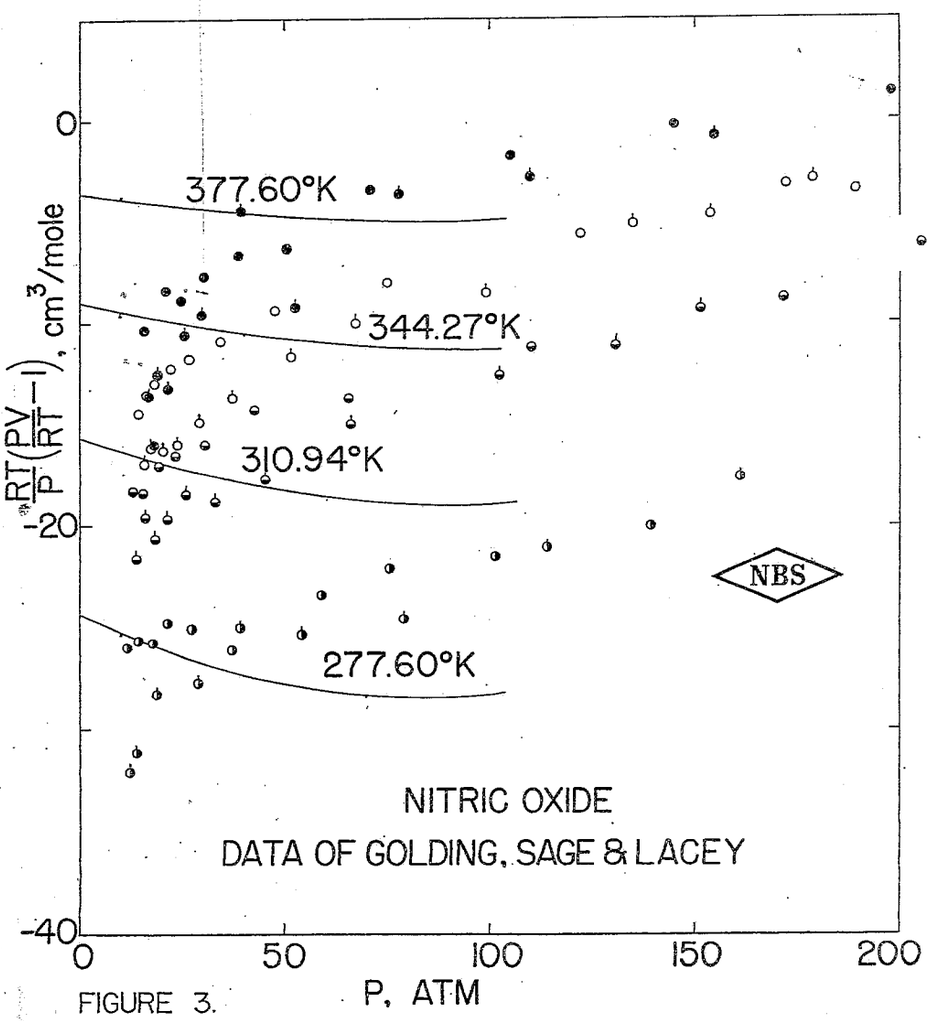

FIGURE 3.

U. S. Department of Commerce National Bureau of Standards

The NBS-NACA Tables of Thermal Properties of Gases

Table 16.22 The Enthalpy and Entropy of Nitric Oxide

$(H - E_0^0)/RT_0$, S/R

by

Harold W. Woolley

June 1953

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure .1 atm		.4 atm		.7 atm		1 atm		T °R
150	2.0622		2.0569		2.0516		2.0461		270
		1369		1382		1394		1409	
160	2.1991		2.1951		2.1910		2.1870		288
		1363		1366		1370		1373	
170	2.3354		2.3317		2.3280		2.3243		306
		1356		1361		1366		1370	
180	2.4710		2.4678		2.4646		2.4613		324
		1352		1356		1359		1363	
190	2.6062		2.6034		2.6005		2.5976		342
		1347		1349		1352		1355	
200	2.7409		2.7383		2.7357		2.7331		360
		1340		1342		1345		1347	
210	2.8749		2.8725		2.8702		2.8678		378
		1336		1338		1339		1341	
220	3.0085		3.0063		3.0041		3.0019		396
		1331		1333		1335		1337	
230	3.1416		3.1396		3.1376		3.1356		414
		1328		1329		1331		1332	
240	3.2744		3.2725		3.2707		3.2688		432
		1324		1326		1327		1328	
250	3.4068		3.4051		3.4034		3.4016		450
		1324		1325		1325		1327	
260	3.5392		3.5376		3.5359		3.5343		468
		1320		1321		1323		1324	
270	3.6712		3.6697		3.6682		3.6667		486
		1318		1319		1320		1321	
280	3.8030		3.8016		3.8002		3.7988		504
		1318		1318		1319		1320	
290	3.9348		3.9334		3.9321		3.9308		522
		1315		1317		1317		1318	
300	4.0663		4.0651		4.0638		4.0626		540
		1315		1315		1317		1317	
310	4.1978		4.1966		4.1955		4.1943		558
		1314		1315		1315		1316	
320	4.3292		4.3281		4.3270		4.3259		576
		1315		1315		1316		1317	
330	4.4607		4.4596		4.4586		4.4576		594
		1313		1314		1314		1315	
340	4.5920		4.5910		4.5900		4.5891		612
		1314		1315		1316		1316	
350	4.7234		4.7225		4.7216		4.7207		630
		1314		1315		1315		1315	
360	4.8548		4.8540		4.8531		4.8522		648
		1315		1315		1316		1317	
370	4.9863		4.9855		4.9847		4.9839		666
		1316		1317		1317		1317	
380	5.1179		5.1172		5.1164		5.1156		684
		1318		1317		1318		1319	
390	5.2497		5.2489		5.2482		5.2475		702
		1318		1319		1319		1319	
400	5.3815		5.3808		5.3801		5.3794		720
		1320		1320		1321		1321	
410	5.5135		5.5128		5.5122		5.5115		738
		1322		1323		1323		1324	
420	5.6457		5.6451		5.6445		5.6439		756
		1324		1324		1324		1325	
430	5.7781		5.7775		5.7769		5.7764		774
		1326		1327		1327		1327	
440	5.9107		5.9102		5.9096		5.9091		792
		1328		1328		1329		1329	
450	6.0435		6.0430		6.0425		6.0420		810

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure .1 atm		1 atm		T °R	T °K	1 atm		.1 atm		T °R
450	6.0435	1330	6.0420	1331	810	800	10.8908	7254	10.8909	7255	1440
460	6.1765	1333	6.1751	1334	828	850	11.6162	7325	11.6164	7327	1530
470	6.3098	1337	6.3085	1337	846	900	12.3487	7392	12.3491	7393	1620
480	6.4435	1338	6.4422	1338	864	950	13.0879	7456	13.0884	7455	1710
490	6.5773	1342	6.5760	1343	882	1000	13.8335	7512	13.8339	7513	1800
500	6.7115	1344	6.7103	1345	900	1050	14.5847	7565	14.5852	7566	1890
510	6.8459	1347	6.8448	1348	918	1100	15.3412	7614	15.3418	7614	1980
520	6.9806	1351	6.9796	1352	936	1150	16.1026	7659	16.1032	7660	2070
530	7.1157	1354	7.1148	1354	954	1200	16.8685	7701	16.8692	7702	2160
540	7.2511	1357	7.2502	1358	972	1250	17.6386	7739	17.6394	7739	2250
550	7.3868	1360	7.3860	1360	990	1300	18.4125	7775	18.4133	7775	2340
560	7.5228	1364	7.5220	1365	1008	1350	19.1900	7809	19.1908	7810	2430
570	7.6592	1367	7.6585	1368	1026	1400	19.9709	7839	19.9718	7839	2520
580	7.7959	1371	7.7953	1371	1044	1450	20.7548	7866	20.7557	7867	2610
590	7.9330	1374	7.9324	1375	1062	1500	21.5414	7892	21.5424	7892	2700
600	8.0704	1377	8.0699	1377	1080	1550	22.3306	7920	22.3316	7920	2790
610	8.2081	1382	8.2076	1383	1098	1600	23.1226	7940	23.1236	7940	2880
620	8.3463	1385	8.3459	1384	1116	1650	23.9166	7962	23.9176	7963	2970
630	8.4848	1388	8.4843	1389	1134	1700	24.7128	7985	24.7139	7985	3060
640	8.6236	1392	8.6232	1392	1152	1750	25.5113	8000	25.5124	8000	3150
650	8.7628	1395	8.7624	1395	1170	1800	26.3113	8020	26.3124	8020	3240
660	8.9023	1398	8.9019	1399	1188	1850	27.1133	8037	27.1144	8037	3330
670	9.0421	1402	9.0418	1402	1206	1900	27.9170	8053	27.9181	8054	3420
680	9.1823	1406	9.1820	1407	1224	1950	28.7223	8067	28.7235	8067	3510
690	9.3229	1409	9.3227	1409	1242	2000	29.5290	8082	29.5302	8082	3600
700	9.4638	1412	9.4636	1412	1260	2050	30.3372	8097	30.3384	8097	3690
710	9.6050	1415	9.6048	1416	1278	2100	31.1469	8107	31.1481	8107	3780
720	9.7465	1419	9.7464	1419	1296	2150	31.9576	8121	31.9588	8121	3870
730	9.8884	1423	9.8883	1423	1314	2200	32.7697	8133	32.7709	8133	3960
740	10.0307	1425	10.0306	1426	1332	2250	33.5830	8145	33.5842	8146	4050
750	10.1732	1429	10.1732	1429	1350	2300	34.3975		34.3988		4140
760	10.3161	1432	10.3161	1432	1368						
770	10.4593	1435	10.4593	1436	1386						
780	10.6028	1439	10.6029	1439	1404						
790	10.7467	1441	10.7468	1441	1422						
800	10.8908		10.8909		1440						

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure .1 atm		.1 atm		T °R
2300	34.3975	8155	34.3988	8155	4140
2350	35.2130	8165	35.2143	8165	4230
2400	36.0295	8176	36.0308	8176	4320
2450	36.8471	8183	36.8484	8183	4410
2500	37.6654	8195	37.6667	8195	4500
2550	38.4849	8203	38.4862	8203	4590
2600	39.3052	8211	39.3065	8211	4680
2650	40.1263	8220	40.1276	8220	4770
2700	40.9483	8228	40.9496	8228	4860
2750	41.7711	8236	41.7724	8236	4950
2800	42.5947	8244	42.5960	8244	5040
2850	43.4191	8252	43.4204	8252	5130
2900	44.2443	8258	44.2456	8258	5220
2950	45.0701	8265	45.0714	8266	5310
3000	45.8966		45.8980		5400

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
150	2.0461	1409	1.9813	1625	1.8752	2159	1.6963	3251	270
160	2.1870	1373	2.1438	1429	2.0911	1552	2.0214	1793	288
170	2.3243	1370	2.2867	1422	2.2463	1494	2.2007	1639	306
180	2.4613	1363	2.4289	1398	2.3957	1439	2.3646	1454	324
190	2.5976	1355	2.5687	1383	2.5396	1411	2.5100	1442	342
200	2.7331	1347	2.7070	1370	2.6807	1393	2.6542	1418	360
210	2.8678	1341	2.8440	1361	2.8200	1381	2.7960	1400	378
220	3.0019	1337	2.9801	1353	2.9581	1370	2.9360	1387	396
230	3.1356	1332	3.1154	1347	3.0951	1361	3.0747	1377	414
240	3.2688	1328	3.2501	1342	3.2312	1356	3.2124	1367	432
250	3.4016	1327	3.3843	1338	3.3668	1350	3.3491	1363	450
260	3.5343	1324	3.5181	1334	3.5018	1344	3.4854	1355	468
270	3.6667	1321	3.6515	1331	3.6362	1341	3.6209	1350	486
280	3.7988	1320	3.7846	1329	3.7703	1338	3.7559	1347	504
290	3.9308	1318	3.9175	1326	3.9041	1334	3.8906	1343	522
300	4.0626	1317	4.0501	1325	4.0375	1332	4.0249	1339	540
310	4.1943	1316	4.1826	1323	4.1707	1331	4.1588	1338	558
320	4.3259	1317	4.3149	1323	4.3038	1329	4.2926	1335	576
330	4.4576	1315	4.4472	1321	4.4367	1327	4.4261	1333	594
340	4.5891	1316	4.5793	1321	4.5694	1326	4.5594	1333	612
350	4.7207	1315	4.7114	1321	4.7020	1327	4.6927	1331	630
360	4.8522	1317	4.8435	1322	4.8347	1327	4.8258	1333	648
370	4.9839	1317	4.9757	1322	4.9674	1326	4.9591	1331	666
380	5.1156	1319	5.1079	1322	5.1000	1328	5.0922	1330	684
390	5.2475	1319	5.2401	1324	5.2328	1326	5.2252	1332	702
400	5.3794	1321	5.3725	1325	5.3654	1330	5.3584	1334	720
410	5.5115	1324	5.5050	1327	5.4984	1330	5.4918	1333	738
420	5.6439	1325	5.6377	1329	5.6314	1332	5.6251	1337	756
430	5.7764	1327	5.7706	1330	5.7646	1334	5.7588	1336	774
440	5.9091	1329	5.9036	1332	5.8980	1335	5.8924	1338	792
450	6.0420		6.0368		6.0315		6.0262		810

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
450	6.0420	1331	6.0368	1334	6.0315	1337	6.0262	1340	810
460	6.1751	1334	6.1702	1337	6.1652	1340	6.1602	1343	828
470	6.3085	1337	6.3039	1339	6.2992	1342	6.2945	1345	846
480	6.4422	1338	6.4378	1341	6.4334	1345	6.4290	1346	864
490	6.5760	1343	6.5719	1346	6.5679	1347	6.5636	1350	882
500	6.7103	1345	6.7065	1347	6.7026	1350	6.6986	1353	900
510	6.8448	1348	6.8412	1350	6.8376	1352	6.8339	1355	918
520	6.9796	1352	6.9762	1354	6.9728	1356	6.9694	1358	936
530	7.1148	1354	7.1116	1357	7.1084	1359	7.1052	1361	954
540	7.2502	1358	7.2473	1360	7.2443	1361	7.2413	1363	972
550	7.3860	1360	7.3833	1362	7.3804	1365	7.3776	1366	990
560	7.5220	1365	7.5195	1366	7.5169	1368	7.5142	1370	1008
570	7.6585	1368	7.6561	1369	7.6537	1371	7.6512	1373	1026
580	7.7953	1371	7.7930	1374	7.7908	1375	7.7885	1377	1044
590	7.9324	1375	7.9304	1376	7.9283	1377	7.9262	1379	1062
600	8.0699	1377	8.0680	1379	8.0660	1381	8.0641	1382	1080
610	8.2076	1383	8.2059	1384	8.2041	1386	8.2023	1387	1098
620	8.3459	1384	8.3443	1386	8.3427	1387	8.3410	1389	1116
630	8.4843	1389	8.4829	1389	8.4814	1391	8.4799	1393	1134
640	8.6232	1392	8.6218	1394	8.6205	1395	8.6192	1396	1152
650	8.7624	1395	8.7612	1397	8.7600	1398	8.7588	1399	1170
660	8.9019	1399	8.9009	1399	8.8998	1401	8.8987	1403	1188
670	9.0418	1402	9.0408	1404	9.0399	1405	9.0390	1406	1206
680	9.1820	1407	9.1812	1408	9.1804	1409	9.1796	1409	1224
690	9.3227	1409	9.3220	1410	9.3213	1412	9.3205	1413	1242
700	9.4636	1412	9.4630	1414	9.4625	1414	9.4618	1416	1260
710	9.6048	1416	9.6044	1416	9.6039	1417	9.6034	1418	1278
720	9.7464	1419	9.7460	1420	9.7456	1422	9.7452	1423	1296
730	9.8883	1423	9.8880	1424	9.8878	1426	9.8875	1426	1314
740	10.0306	1426	10.0304	1426	10.0304	1428	10.0301	1428	1332
750	10.1732	1429	10.1730	1431	10.1732	1431	10.1729	1433	1350
760	10.3161	1432	10.3161	1433	10.3163	1433	10.3162	1435	1368
770	10.4593	1436	10.4594	1436	10.4596	1437	10.4597	1438	1386
780	10.6029	1439	10.6030	1440	10.6033	1441	10.6035	1441	1404
790	10.7468	1441	10.7470	1442	10.7474	1442	10.7476	1444	1422
800	10.8909		10.8912		10.8916		10.8920		1440

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
800	10.8909	7255	10.8912	7260	10.8916	7263	10.8920	7267	1440
850	11.6164	7327	11.6172	7329	11.6179	7333	11.6187	7336	1530
900	12.3491	7393	12.3501	7396	12.3512	7399	12.3523	7402	1620
950	13.0884	7455	13.0897	7459	13.0911	7461	13.0925	7464	1710
1000	13.8339	7513	13.8356	7514	13.8372	7518	13.8389	7519	1800
1050	14.5852	7566	14.5870	7568	14.5890	7569	14.5908	7572	1890
1100	15.3418	7614	15.3438	7617	15.3459	7618	15.3480	7621	1980
1150	16.1032	7660	16.1055	7661	16.1077	7664	16.1101	7664	2070
1200	16.8692	7702	16.8716	7703	16.8741	7704	16.8765	7706	2160
1250	17.6394	7739	17.6419	7741	17.6445	7742	17.6471	7744	2250
1300	18.4133	7775	18.4160	7777	18.4187	7778	18.4215	7779	2340
1350	19.1908	7810	19.1937	7810	19.1965	7812	19.1994	7813	2430
1400	19.9718	7839	19.9747	7841	19.9777	7842	19.9807	7843	2520
1450	20.7557	7867	20.7588	7867	20.7619	7868	20.7650	7869	2610
1500	21.5424	7892	21.5455	7893	21.5487	7894	21.5519	7895	2700
1550	22.3316	7920	22.3348	7921	22.3381	7922	22.3414	7923	2790
1600	23.1236	7940	23.1269	7942	23.1303	7942	23.1337	7942	2880
1650	23.9176	7963	23.9211	7962	23.9245	7963	23.9279	7965	2970
1700	24.7139	7985	24.7173	7986	24.7208	7987	24.7244	7987	3060
1750	25.5124	8000	25.5159	8001	25.5195	8002	25.5231	8002	3150
1800	26.3124	8020	26.3160	8021	26.3197	8021	26.3233	8022	3240
1850	27.1144	8037	27.1181	8038	27.1218	8038	27.1255	8039	3330
1900	27.9181	8054	27.9219	8053	27.9256	8054	27.9294	8054	3420
1950	28.7235	8067	28.7272	8068	28.7310	8068	28.7348	8069	3510
2000	29.5302	8082	29.5340	8083	29.5378	8083	29.5417	8084	3600
2050	30.3384	8097	30.3423	8097	30.3461	8098	30.3501	8098	3690
2100	31.1481	8107	31.1520	8108	31.1559	8108	31.1599	8108	3780
2150	31.9588	8121	31.9628	8121	31.9667	8122	31.9707	8122	3870
2200	32.7709	8133	32.7749	8134	32.7789	8134	32.7829	8135	3960
2250	33.5842	8146	33.5883	8145	33.5923	8146	33.5964	8146	4050
2300	34.3988		34.4028		34.4069		34.4110		4140

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
2300	34.3988		34.4028		34.4069		34.4110		4140
2350	35.2143	8155	35.2184	8156	35.2225	8156	35.2266	8156	4230
2400	36.0308	8165	36.0349	8165	36.0390	8165	36.0432	8166	4320
2450	36.8484	8176	36.8525	8176	36.8567	8177	36.8609	8177	4410
2500	37.6667	8183	37.6709	8184	37.6750	8183	37.6792	8183	4500
		8195		8195		8196		8196	
2550	38.4862		38.4904		38.4946		38.4988		4590
2600	39.3065	8203	39.3107	8203	39.3149	8203	39.3192	8204	4680
2650	40.1276	8211	40.1319	8212	40.1361	8212	40.1404	8212	4770
2700	40.9496	8220	40.9539	8220	40.9582	8221	40.9625	8221	4860
2750	41.7724	8228	41.7767	8228	41.7810	8228	41.7853	8228	4950
		8236		8236		8236		8237	
2800	42.5960		42.6003		42.6046		42.6090		5040
2850	43.4204	8244	43.4248	8245	43.4291	8245	43.4334	8244	5130
2900	44.2456	8252	44.2500	8252	44.2543	8252	44.2587	8253	5220
2950	45.0714	8258	45.0758	8258	45.0801	8258	45.0845	8258	5310
3000	45.8980	8266	45.9023	8265	45.9066	8265	45.9111	8266	5400

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
150	1.6963								270
160	2.0214	3251							288
170	2.2007	1793	.952						306
180	2.3646	1639	1.805	853	.431				324
190	2.5100	1454	2.142	337	1.498	1067	.367		342
		1442		212		425		903	
200	2.6542	1418	2.354	186	1.923	310	1.270	576	360
210	2.7960	1400	2.540	166	2.233	224	1.846	334	378
220	2.9360	1387	2.706	158	2.457	188	2.180	240	396
230	3.0747	1377	2.864	154	2.645	173	2.420	200	414
240	3.2124	1367	3.018	149	2.818	163	2.620	179	432
250	3.3491	1363	3.167	149	2.981	161	2.799	172	450
260	3.4854	1355	3.316	146	3.142	156	2.971	165	468
270	3.6209	1350	3.462	145	3.298	154	3.136	163	486
280	3.7559	1347	3.607	143	3.452	152	3.299	159	504
290	3.8906	1343	3.750	143	3.604	151	3.458	158	522
300	4.0249	1339	3.893	142	3.755	149	3.616	155	540
310	4.1588	1338	4.035	140	3.904	148	3.771	155	558
320	4.2926	1335	4.175	141	4.052	147	3.926	153	576
330	4.4261	1333	4.316	139	4.199	145	4.079	152	594
340	4.5594	1333	4.455	140	4.344	146	4.231	152	612
350	4.6927	1331	4.595	137	4.490	144	4.383	149	630
360	4.8258	1333	4.732	140	4.634	144	4.532	150	648
370	4.9591	1331	4.872	137	4.778	142	4.682	148	666
380	5.0922	1330	5.009	138	4.920	143	4.830	147	684
390	5.2252	1332	5.147	138	5.063	143	4.977	147	702
400	5.3584	1334	5.285	137	5.206	141	5.124	147	720
410	5.4918	1333	5.422	137	5.347	142	5.271	146	738
420	5.6251	1337	5.559	137	5.489	141	5.417	144	756
430	5.7588	1336	5.696	138	5.630	141	5.561	145	774
440	5.8924	1338	5.834	137	5.771	141	5.706	145	792
450	6.0262		5.971		5.912		5.851		810

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
450	6.0262	1340	5.971	137	5.912	140	5.851	144	810
460	6.1602	1343	6.108	137	6.052	141	5.995	143	828
470	6.2945	1345	6.245	137	6.193	140	6.138	144	846
480	6.4290	1346	6.382	138	6.333	140	6.282	144	864
490	6.5636	1350	6.520	138	6.473	142	6.426	143	882
500	6.6986	1353	6.658	138	6.615	141	6.569	144	900
510	6.8339	1355	6.796	138	6.756	140	6.713	144	918
520	6.9694	1358	6.934	138	6.896	141	6.857	143	936
530	7.1052	1361	7.072	138	7.037	140	7.000	143	954
540	7.2413	1363	7.210	138	7.177	141	7.143	142	972
550	7.3776	1366	7.348	139	7.318	141	7.285	144	990
560	7.5142	1370	7.487	139	7.459	140	7.429	143	1008
570	7.6512	1373	7.626	139	7.599	142	7.572	143	1026
580	7.7885	1377	7.765	139	7.741	141	7.715	144	1044
590	7.9262	1379	7.904	140	7.882	142	7.859	144	1062
600	8.0641	1382	8.044	140	8.024	141	8.003	142	1080
610	8.2023	1387	8.184	140	8.165	142	8.145	144	1098
620	8.3410	1389	8.324	141	8.307	142	8.289	144	1116
630	8.4799	1393	8.465	141	8.449	143	8.433	145	1134
640	8.6192	1396	8.606	141	8.592	142	8.578	144	1152
650	8.7588	1399	8.747	141	8.734	143	8.722	144	1170
660	8.8987	1403	8.888	141	8.877	143	8.866	144	1188
670	9.0390	1406	9.029	142	9.020	143	9.010	145	1206
680	9.1796	1409	9.171	142	9.163	143	9.155	145	1224
690	9.3205	1413	9.313	143	9.306	144	9.300	145	1242
700	9.4618	1416	9.456	143	9.450	144	9.445	145	1260
710	9.6034	1418	9.599	143	9.594	144	9.590	145	1278
720	9.7452	1423	9.742	143	9.738	145	9.735	146	1296
730	9.8875	1426	9.885	144	9.883	145	9.881	146	1314
740	10.0301	1428	10.029	143	10.028	145	10.027	146	1332
750	10.1729	1433	10.172	145	10.173	145	10.173	147	1350
760	10.3162	1435	10.317	144	10.318	145	10.320	146	1368
770	10.4597	1438	10.461	145	10.463	146	10.466	147	1386
780	10.6035	1441	10.606	145	10.609	146	10.613	147	1404
790	10.7476	1444	10.751	145	10.755	146	10.760	147	1422
800	10.8920		10.896		10.901		10.907		1440

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^\circ)/RT_0$

T °K	Pressure 10 atm	40 atm	70 atm	100 atm	T °R
800	10.8920 7267	10.896 731	10.901 734	10.907 739	1440
850	11.6187 7336	11.627 737	11.635 742	11.646 744	1530
900	12.3523 7402	12.364 743	12.377 746	12.390 750	1620
950	13.0925 7464	13.107 749	13.123 752	13.140 755	1710
1000	13.8389 7519	13.856 754	13.875 756	13.895 759	1800
1050	14.5908 7572	14.610 760	14.631 762	14.654 764	1890
1100	15.3480 7621	15.370 764	15.393 766	15.418 767	1980
1150	16.1101 7664	16.134 768	16.159 770	16.185 772	2070
1200	16.8765 7706	16.902 772	16.929 773	16.957 775	2160
1250	17.6471 7744	17.674 776	17.702 778	17.732 779	2250
1300	18.4215 7779	18.450 779	18.480 780	18.511 781	2340
1350	19.1994 7813	19.229 782	19.260 784	19.292 785	2430
1400	19.9807 7843	20.011 786	20.044 786	20.077 788	2520
1450	20.7650 7869	20.797 788	20.830 789	20.865 790	2610
1500	21.5519 7895	21.585 790	21.619 791	21.655 792	2700
1550	22.3414 7923	22.375 793	22.410 794	22.447 794	2790
1600	23.1337 7942	23.168 795	23.204 796	23.241 797	2880
1650	23.9279 7965	23.963 797	24.000 798	24.038 798	2970
1700	24.7244 7987	24.760 800	24.798 800	24.836 801	3060
1750	25.5231 8002	25.560 801	25.598 801	25.637 802	3150
1800	26.3233 8022	26.361 802	26.399 803	26.439 804	3240
1850	27.1255 8039	27.163 805	27.202 805	27.243 805	3330
1900	27.9294 8054	27.968 806	28.007 807	28.048 807	3420
1950	28.7348 8069	28.774 807	28.814 808	28.855 808	3510
2000	29.5417 8084	29.581 809	29.622 809	29.663 810	3600
2050	30.3501 8098	30.390 810	30.431 810	30.473 811	3690
2100	31.1599 8108	31.200 811	31.241 812	31.284 812	3780
2150	31.9707 8122	32.011 813	32.053 813	32.096 813	3870
2200	32.7829 8135	32.824 814	32.866 814	32.909 814	3960
2250	33.5964 8146	33.638 814	33.680 815	33.723 816	4050
2300	34.4110	34.452	34.495	34.539	4140

Table 16.22/1 Enthalpy of Nitric Oxide $(H - E_0^o)/RT_0$

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
2300	34.4110	8156	34.452	816	34.495	816	34.539	816	4140
2350	35.2266	8166	35.268	817	35.311	817	35.355	818	4230
2400	36.0432	8177	36.085	818	36.128	819	36.173	818	4320
2450	36.8609	8183	36.903	819	36.947	818	36.991	819	4410
2500	37.6792	8196	37.722	820	37.765	821	37.810	820	4500
2550	38.4988	8204	38.542	820	38.586	820	38.630	821	4590
2600	39.3192	8212	39.362	822	39.406	822	39.451	822	4680
2650	40.1404	8221	40.184	822	40.228	822	40.273	823	4770
2700	40.9625	8228	41.006	823	41.050	824	41.096	823	4860
2750	41.7853	8237	41.829	824	41.874	823	41.919	824	4950
2800	42.6090	8244	42.653	824	42.697	825	42.743	825	5040
2850	43.4334	8253	43.477	826	43.522	826	43.568	826	5130
2900	44.2587	8258	44.303	826	44.348	826	44.394	826	5220
2950	45.0845	8266	45.129	826	45.174	827	45.220	827	5310
3000	45.9111		45.955		46.001		46.047		5400

Conversion Factors

To convert tabulated value of	To	Having the dimensions indicated below	Multiply by
$(H-E_0^o)/RT_0$	$H-E_0^o$	cal mole^{-1}	542.821
		cal g^{-1}	18.0892
		joules g^{-1}	75.6854
		Btu (lb mole)$^{-1}$	976.437
		Btu lb^{-1}	32.5392

S/R

Table 16.22/2 Entropy of Nitric Oxide

T °K	.1 atm	.4 atm	.7 atm	1 atm	T °R
150	25.1230 2420	23.7298 2437	23.1632 2455	22.7994 2475	270
160	25.3650 2258	23.9735 2269	23.4087 2280	23.0469 2290	288
170	25.5908 2118	24.2004 2125	23.6367 2132	23.2759 2139	306
180	25.8026 1993	24.4129 1999	23.8499 2004	23.4898 2010	324
190	26.0019 1885	24.6128 1888	24.0503 1892	23.6908 1896	342
200	26.1904 1786	24.8016 1789	24.2395 1792	23.8804 1795	360
210	26.3690 1696	24.9805 1699	24.4187 1702	24.0599 1704	378
220	26.5386 1617	25.1504 1619	24.5889 1620	24.2303 1623	396
230	26.7003 1545	25.3123 1546	24.7509 1549	24.3926 1550	414
240	26.8548 1476	25.4669 1478	24.9058 1479	24.5476 1480	432
250	27.0024 1417	25.6147 1418	25.0537 1419	24.6956 1421	450
260	27.1441 1361	25.7565 1362	25.1956 1364	24.8377 1364	468
270	27.2802 1310	25.8927 1312	25.3320 1312	24.9741 1314	486
280	27.4112 1263	26.0239 1263	25.4632 1264	25.1055 1264	504
290	27.5375 1218	26.1502 1219	25.5896 1220	25.2319 1221	522
300	27.6593 1178	26.2721 1179	25.7116 1179	25.3540 1180	540
310	27.7771 1140	26.3900 1141	25.8295 1142	25.4720 1142	558
320	27.8911 1104	26.5041 1104	25.9437 1105	25.5862 1106	576
330	28.0015 1072	26.6145 1072	26.0542 1072	25.6968 1072	594
340	28.1087 1040	26.7217 1040	26.1614 1041	25.8040 1042	612
350	28.2127 1011	26.8257 1012	26.2655 1012	25.9082 1012	630
360	28.3138 985	26.9269 986	26.3667 986	26.0094 986	648
370	28.4123 958	27.0255 958	26.4653 959	26.1080 960	666
380	28.5081 935	27.1213 935	26.5612 936	26.2040 936	684
390	28.6016 912	27.2148 913	26.6548 912	26.2976 913	702
400	28.6928 890	27.3061 890	26.7460 891	26.3889 890	720
410	28.7818 870	27.3951 870	26.8351 870	26.4779 871	738
420	28.8688 852	27.4821 852	26.9221 852	26.5650 852	756
430	28.9540 832	27.5673 832	27.0073 832	26.6502 833	774
440	29.0372 815	27.6505 815	27.0905 816	26.7335 815	792
450	29.1187			26.8150	810

Table 16.22/2 Entropy of Nitric Oxide

S/R

T °K	Pressure .1 atm		Pressure 1 atm		T °R	T °K	Pressure .1 atm		Pressure 1 atm		T °R
450	29.1187	799	26.8150	800	810	800	31.2866	2403	28.9837	2403	1440
460	29.1986	783	26.8950	783	828	850	31.5269	2287	29.2240	2288	1530
470	29.2769	768	26.9733	769	846	900	31.7556	2183	29.4528	2183	1620
480	29.3537	754	27.0502	754	864	950	31.9739	2089	29.6711	2089	1710
490	29.4291	740	27.1256	741	882	1000	32.1828	2002	29.8800	2002	1800
500	29.5031	727	27.1997	727	900	1050	32.3830	1923	30.0802	1924	1890
510	29.5758	715	27.2724	716	918	1100	32.5753	1849	30.2726	1849	1980
520	29.6473	703	27.3440	703	936	1150	32.7602	1781	30.4575	1781	2070
530	29.7176	692	27.4143	692	954	1200	32.9383	1717	30.6356	1717	2160
540	29.7868	680	27.4835	681	972	1250	33.1100	1658	30.8073	1658	2250
550	29.8548	670	27.5516	670	990	1300	33.2758	1604	30.9731	1604	2340
560	29.9218	659	27.6186	659	1008	1350	33.4362	1551	31.1335	1551	2430
570	29.9877	649	27.6845	649	1026	1400	33.5913	1503	31.2886	1503	2520
580	30.0526	640	27.7494	641	1044	1450	33.7416	1456	31.4389	1456	2610
590	30.1166	631	27.8135	631	1062	1500	33.8872	1415	31.5845	1415	2700
600	30.1797	622	27.8766	622	1080	1550	34.0287	1373	31.7260	1374	2790
610	30.2419	613	27.9388	613	1098	1600	34.1660	1335	31.8634	1335	2880
620	30.3032	606	28.0001	607	1116	1650	34.2995	1298	21.9969	1298	2970
630	30.3638	597	28.0608	597	1134	1700	34.4293	1265	32.1267	1265	3060
640	30.4235	590	28.1205	589	1152	1750	34.5558	1231	32.2532	1231	3150
650	30.4825	581	28.1794	581	1170	1800	34.6789	1201	32.3763	1201	3240
660	30.5406	575	28.2375	575	1188	1850	34.7990	1171	32.4964	1171	3330
670	30.5981	567	28.2950	568	1206	1900	34.9161	1143	32.6135	1143	3420
680	30.6548	560	28.3518	560	1224	1950	34.0304	1115	32.7278	1115	3510
690	30.7108	554	28.4078	554	1242	2000	35.1419	1091	32.8393	1091	3600
700	30.7662	548	28.4632	548	1260	2050	35.2510	1066	32.9484	1066	3690
710	30.8210	541	28.5180	541	1278	2100	35.3576	1042	33.0550	1042	3780
720	30.8751	535	28.5721	535	1296	2150	35.4618	1020	33.1592	1020	3870
730	30.9286	529	28.6256	529	1314	2200	35.5638	998	33.2612	998	3960
740	30.9815	522	28.6785	522	1332	2250	35.6636	978	33.3610	978	4050
750	31.0337	517	28.7307	518	1350	2300	35.7614		33.4588		4140
760	31.0854	511	28.7825	511	1368						
770	31.1365	505	28.8336	505	1386						
780	31.1870	501	28.8841	501	1404						
790	31.2371	495	28.9342	495	1422						

Table 16.22/2 Entropy of Nitric Oxide

T °K	Pressure .1 atm		Pressure 1 atm		S/R T °R
2300	35.7614	958	33.4588	958	4140
2350	35.8572	939	33.5546	939	4230
2400	35.9511	921	33.6485	921	4320
2450	36.0432	903	33.7406	903	4410
2500	36.1335	887	33.8309	887	4500
2550	36.2222	870	33.9196	870	4590
2600	36.3092	855	34.0066	855	4680
2650	36.3947	840	34.0921	840	4770
2700	36.4787	824	34.1761	824	4860
2750	36.5611	811	34.2585	811	4950
2800	36.6422	797	34.3396	797	5040
2850	36.7219	784	34.4193	784	5130
2900	36.8003	771	34.4977	771	5220
2950	36.8774	759	34.5748	759	5310
3000	36.9533		34.6507		5400

Table 16.22/2 Entropy of Nitric Oxide S/R

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
150	22.7994	2475	21.3238	2807	20.6031	3593	19.959	555	270
160	23.0469	2290	21.6045	2432	20.9724	2693	20.514	317	288
170	23.2759	2139	21.8477	2219	21.2417	2333	20.831	250	306
180	23.4898	2010	22.0696	2062	21.4750	2122	21.081	220	324
190	23.6908	1896	22.2758	1935	21.6872	1976	21.301	202	342
200	23.8804	1795	22.4693	1826	21.8848	1856	21.5028	1887	360
210	24.0599	1704	22.6519	1729	22.0704	1754	21.6915	1779	378
220	24.2303	1623	22.8248	1643	22.2458	1664	21.8694	1687	396
230	24.3926	1550	22.9891	1567	22.4122	1584	22.0381	1601	414
240	24.5476	1480	23.1458	1495	22.5706	1510	22.1982	1524	432
250	24.6956	1421	23.2953	1433	22.7216	1445	22.3506	1458	450
260	24.8377	1364	23.4386	1376	22.8661	1387	22.4964	1399	468
270	24.9741	1314	23.5762	1322	23.0048	1332	22.6363	1342	486
280	25.1055	1264	23.7084	1274	23.1380	1282	22.7705	1290	504
290	25.2319	1221	23.8358	1228	23.2662	1236	22.8995	1243	522
300	25.3540	1180	23.9586	1187	23.3898	1194	23.0238	1201	540
310	25.4720	1142	24.0773	1148	23.5092	1154	23.1439	1160	558
320	25.5862	1106	24.1921	1111	23.6246	1116	23.2599	1122	576
330	25.6968	1072	24.3032	1077	23.7362	1082	23.3721	1088	594
340	25.8040	1042	24.4109	1046	23.8444	1051	23.4809	1055	612
350	25.9082	1012	24.5155	1017	23.9495	1020	23.5864	1024	630
360	26.0094	986	24.6172	990	24.0515	994	23.6888	997	648
370	26.1080	960	24.7162	963	24.1509	966	23.7885	970	666
380	26.2040	936	24.8125	939	24.2475	942	23.8855	945	684
390	26.2976	913	24.9064	915	24.3417	919	23.9800	921	702
400	26.3889	890	24.9979	893	24.4336	896	24.0721	899	720
410	26.4779	871	25.0872	873	24.5232	875	24.1620	878	738
420	26.5650	852	25.1745	854	24.6107	856	24.2498	859	756
430	26.6502	833	25.2599	835	24.6963	837	24.3357	838	774
440	26.7335	815	25.3434	818	24.7800	820	24.4195	822	792
450	26.8150		25.4252		24.8620		24.5017		810

Table 16.22/2 Entropy of Nitric Oxide

S/R

T °K	1 atm		4 atm		7 atm		10 atm		T °R
450	26.8150	800	25.4252	801	24.8620	803	24.5017	805	810
460	26.8950	783	25.5053	785	24.9423	787	24.5822	788	828
470	26.9733	769	25.5838	770	25.0210	772	24.6610	774	846
480	27.0502	754	25.6608	756	25.0982	757	24.7384	758	864
490	27.1256	741	25.7364	742	25.1739	743	24.8142	745	882
500	27.1997	727	25.8106	729	25.2482	730	24.8887	731	900
510	27.2724	716	25.8835	716	25.3212	718	24.9618	719	918
520	27.3440	703	25.9551	705	25.3930	706	25.0337	707	936
530	27.4143	692	26.0256	693	25.4636	694	25.1044	696	954
540	27.4835	681	26.0949	681	25.5330	682	25.1740	683	972
550	27.5516	670	26.1630	671	25.6012	672	25.2423	673	990
560	27.6186	659	26.2301	660	25.6684	661	25.3096	662	1008
570	27.6845	649	26.2961	651	25.7345	651	25.3758	652	1026
580	27.7494	641	26.3612	641	25.7996	642	25.4410	643	1044
590	27.8135	631	26.4253	632	25.8638	633	25.5053	633	1062
600	27.8766	622	26.4885	623	25.9271	623	25.5686	624	1080
610	27.9388	613	26.5508	614	25.9894	615	25.6310	615	1098
620	28.0001	607	26.6122	607	26.0509	607	25.6925	608	1116
630	28.0608	597	26.6729	597	26.1116	598	25.7533	599	1134
640	28.1205	589	26.7326	590	26.1714	590	25.8132	591	1152
650	28.1794	581	26.7916	582	26.2304	583	25.8723	583	1170
660	28.2375	575	26.8498	575	26.2887	576	25.9306	577	1188
670	28.2950	568	26.9073	568	26.3463	568	25.9883	568	1206
680	28.3518	560	26.9641	561	26.4031	561	26.0451	562	1224
690	28.4078	554	27.0202	554	26.4592	556	26.1013	555	1242
700	28.4632	548	27.0756	548	26.5148	549	26.1568	549	1260
710	28.5180	541	27.1304	542	26.5697	542	26.2117	543	1278
720	28.5721	535	27.1846	535	26.6239	535	26.2660	536	1296
730	28.6256	529	27.2381	530	26.6774	530	26.3196	530	1314
740	28.6785	522	27.2911	523	26.7304	523	26.3726	524	1332
750	28.7307	518	27.3434	517	26.7827	518	26.4250	518	1350
760	28.7825	511	27.3951	512	26.8345	512	26.4768	512	1368
770	28.8336	505	27.4463	505	26.8857	505	26.5280	506	1386
780	28.8841	501	27.4968	502	26.9362	502	26.5786	502	1404
790	28.9342	495	27.5470	495	26.9864	496	26.6288	496	1422
800	28.9837		27.5965		27.0360		26.6784		1440

Table 16.22/2 Entropy of Nitric Oxide S/R

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
800	28.9837	2403	27.5965	2405	27.0360	2406	26.6784	2407	1440
850	29.2240	2288	27.8370	2288	27.2766	2289	26.9191	2291	1530
900	29.4528	2183	28.0658	2184	27.5055	2185	27.1482	2185	1620
950	29.6711	2089	28.2842	2090	27.7240	2091	27.3667	2092	1710
1000	29.8800	2002	28.4932	2003	27.9331	2003	27.5759	2004	1800
1050	30.0802	1924	28.6935	1924	28.1334	1924	27.7763	1925	1890
1100	30.2726	1849	28.8859	1850	28.3258	1851	27.9688	1850	1980
1150	30.4575	1781	29.0709	1781	28.5109	1782	28.1538	1782	2070
1200	30.6356	1717	29.2490	1717	28.6891	1718	28.3320	1719	2160
1250	30.8073	1658	29.4207	1659	28.8609	1658	28.5039	1659	2250
1300	30.9731	1604	29.5866	1604	29.0267	1605	28.6698	1604	2340
1350	31.1335	1551	29.7470	1551	29.1872	1551	28.8302	1552	2430
1400	31.2886	1503	29.9021	1504	29.3423	1504	28.9854	1504	2520
1450	31.4389	1456	30.0525	1456	29.4927	1456	29.1358	1457	2610
1500	21.5845	1415	20.1981	1416	29.6383	1415	29.2815	1415	2700
1550	31.7260	1374	30.3397	1373	29.7798	1374	29.4230	1374	2790
1600	31.8634	1335	30.4770	1335	29.9172	1335	29.5604	1335	2880
1650	31.9969	1298	30.6105	1298	30.0507	1298	29.6939	1298	2970
1700	32.1267	1265	30.7403	1265	30.1805	1266	29.8237	1266	3060
1750	32.2532	1231	30.8668	1231	30.3071	1231	29.9503	1231	3150
1800	32.3763	1201	30.9899	1201	30.4302	1201	30.0734	1201	3240
1850	32.4964	1171	31.1100	1171	30.5503	1171	30.1935	1172	3330
1900	32.6135	1143	31.2271	1143	30.6674	1143	30.3107	1143	3420
1950	32.7278	1115	31.3414	1115	30.7817	1115	30.4250	1115	3510
2000	32.8393	1091	31.4529	1091	30.8932	1092	30.5365	1091	3600
2050	32.9484	1066	31.5620	1066	31.0024	1066	30.6456	1067	3690
2100	33.0550	1042	31.6686	1043	31.1090	1042	30.7523	1042	3780
2150	33.1592	1020	31.7729	1020	31.2132	1020	30.8565	1020	3870
2200	33.2612	998	31.8749	998	31.3152	998	30.9585	998	3960
2250	33.3610	978	31.9747	978	31.4150	978	31.0583	978	4050
2300	33.4588		32.0725		31.5128		31.1561		4140

Table 16.22/2 Entropy of Nitric Oxide

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		S/R T °R
2300	33.4588	958	32.0725	958	31.5128	958	31.1561	958	4140
2350	33.5546	939	32.1683	939	31.6086	939	31.2519	939	4230
2400	33.6485	921	32.2622	921	31.7025	921	31.3458	921	4320
2450	33.7406	903	32.3543	903	31.7946	903	31.4379	904	4410
2500	33.8309	887	32.4446	887	31.8849	888	31.5283	887	4500
2550	33.9196	870	32.5333	870	31.9737	870	31.6170	870	4590
2600	34.0066	855	32.6203	855	32.0607	855	31.7040	855	4680
2650	34.0921	840	32.7058	840	32.1462	840	31.7895	840	4770
2700	34.1761	824	32.7898	824	32.2302	824	21.8735	824	4860
2750	34.2585	811	32.8722	811	32.3126	811	31.9559	811	4950
2800	34.3396	797	32.9533	797	32.3937	797	32.0370	797	5040
2850	34.4193	784	33.0330	784	32.4734	784	32.1167	784	5130
2900	34.4977	771	33.1114	771	32.5518	771	32.1951	771	5220
2950	34.5748	759	33.1885	759	32.6289	759	32.2722	759	5310
3000	34.6507		33.2644		32.7048		32.3481		5400

Table 16.22/2 Entropy of Nitric Oxide

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		S/R T °R
150	19.959	555							270
160	20.514	317							288
170	20.831	250							306
180	21.081	220	19.029	496					324
190	21.301	202	19.525	297	18.206	596			342
200	21.5028	1887	19.822	247	18.802	413	17.695	767	360
210	21.6915	1779	20.069	213	19.215	284	18.462	426	378
220	21.8694	1687	20.282	189	19.499	224	18.888	283	396
230	22.0381	1601	20.471	181	19.723	206	19.171	240	414
240	22.1982	1524	20.652	167	19.929	183	19.411	201	432
250	22.3506	1458	20.819	158	20.112	171	19.612	183	450
260	22.4964	1399	20.977	151	20.283	163	19.795	171	468
270	22.6363	1342	21.128	144	20.446	151	19.966	161	486
280	22.7705	1290	21.272	138	20.597	146	20.127	153	504
290	22.8995	1243	21.410	132	20.743	139	20.280	145	522
300	23.0238	1201	21.5415	1270	20.8820	1338	20.4254	1399	540
310	23.1439	1160	21.6685	1222	21.0158	1284	20.5653	1341	558
320	23.2599	1122	21.7907	1179	21.1442	1235	20.6994	1288	576
330	23.3721	1088	21.9086	1138	21.2677	1190	20.8282	1239	594
340	23.4809	1055	22.0224	1103	21.3867	1149	20.9521	1195	612
350	23.5864	1024	22.1327	1066	21.5016	1111	21.0716	1155	630
360	23.6888	997	22.2393	1035	21.6127	1076	21.1871	1115	648
370	23.7885	970	22.3428	1006	21.7203	1043	21.2986	1080	666
380	23.8855	945	22.4434	978	21.8246	1012	21.4066	1047	684
390	23.9800	921	22.5412	951	21.9258	984	21.5113	1016	702
400	24.0721	899	22.6363	927	22.0242	956	21.6129	987	720
410	24.1620	878	22.7290	904	22.1198	932	21.7116	959	738
420	24.2498	859	22.8194	882	22.2130	907	21.8075	934	756
430	24.3357	838	22.9076	861	22.3037	884	21.9009	909	774
440	24.4195	822	22.9937	842	22.3921	865	21.9918	887	792
450	24.5017		23.0779		22.4786		22.0805		810

Table 16.22/2 Entropy of Nitric Oxide

S/R

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
450	24.5017	805	23.0779	824	22.4786	844	22.0805	865	810
460	24.5822	788	23.1603	806	22.5630	825	22.1670	845	828
470	24.6610	774	23.2409	790	22.6455	808	22.2515	827	846
480	24.7384	758	23.3199	774	22.7263	791	22.3342	808	864
490	24.8142	745	23.3973	759	22.8054	774	22.4150	791	882
500	24.8887	731	23.4732	745	22.8828	760	22.4941	775	900
510	24.9618	719	23.5477	732	22.9588	747	22.5716	762	918
520	25.0337	707	23.6209	719	23.0335	732	22.6478	745	936
530	25.1044	696	23.6928	706	23.1067	717	22.7223	731	954
540	25.1740	683	23.7634	694	23.1784	705	22.7954	717	972
550	25.2423	673	23.8328	683	23.2489	694	22.8671	705	990
560	25.3096	662	23.9011	671	23.3183	681	22.9376	692	1008
570	25.3758	652	23.9682	660	23.3864	670	23.0068	680	1026
580	25.4410	643	24.0342	651	23.4534	660	23.0748	669	1044
590	25.5053	633	24.0993	642	23.5194	650	23.1417	658	1062
600	25.5686	624	24.1635	632	23.5844	639	23.2075	649	1080
610	25.6310	615	24.2267	622	23.6483	630	23.2724	637	1098
620	25.6925	608	24.2889	615	23.7113	622	23.3361	630	1116
630	25.7533	599	24.3504	605	23.7735	612	23.3991	619	1134
640	25.8132	591	24.4109	597	23.8347	603	23.4610	610	1152
650	25.8723	583	24.4706	588	23.8950	594	23.5220	601	1170
660	25.9306	577	24.5294	582	23.9544	588	23.5821	594	1188
670	25.9883	568	24.5876	574	24.0132	580	23.6415	585	1206
680	26.0451	562	24.6450	567	24.0712	572	23.7000	577	1224
690	26.1013	555	24.7017	560	24.1284	565	23.7577	571	1242
700	26.1568	549	24.7577	553	24.1849	559	23.8148	563	1260
710	26.2117	543	24.8130	547	24.2408	551	23.8711	556	1278
720	26.2660	536	24.8677	540	24.2959	544	23.9267	549	1296
730	26.3196	530	24.9217	534	24.3503	538	23.9816	543	1314
740	26.3726	524	24.9751	527	24.4041	531	24.0359	535	1332
750	26.4250	518	25.0278	522	24.4572	526	24.0894	529	1350
760	26.4768	512	25.0800	516	24.5098	519	24.1423	523	1368
770	26.5280	506	25.1316	509	24.5617	513	24.1946	516	1386
780	26.5786	502	25.1825	505	24.6130	508	24.2462	512	1404
790	26.6288	496	25.2330	499	24.6638	502	24.2974	506	1422
800	26.6784		25.2829		24.7140		24.3480		1440

Table 16.22/2 Entropy of Nitric Oxide S/R

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
800	26.6784	2407	25.2829	2420	24.7140	2433	24.3480	2448	1440
850	26.9191	2291	25.5249	2302	24.9573	2314	24.5928	2325	1530
900	27.1482	2185	25.7551	2195	25.1887	2204	24.8253	2213	1620
950	27.3667	2092	25.9746	2098	25.4091	2107	25.0466	2115	1710
1000	27.5759	2004	26.1844	2010	25.6198	2017	25.2581	2024	1800
1050	27.7763	1925	26.3854	1931	25.8215	1935	25.4605	1941	1890
1100	27.9688	1850	26.5785	1855	26.0150	1860	25.6546	1865	1980
1150	28.1538	1782	26.7640	1786	26.2010	1790	25.8411	1794	2070
1200	28.3320	1719	26.9426	1722	26.3800	1725	26.0205	1728	2160
1250	28.5039	1659	27.1148	1662	26.5525	1665	26.1933	1668	2250
1300	28.6698	1604	27.2810	1607	26.7190	1610	26.3601	1613	2340
1350	28.8302	1552	27.4417	1555	26.8800	1557	26.5214	1559	2430
1400	28.9854	1504	27.5972	1505	27.0357	1508	26.6773	1510	2520
1450	29.1358	1457	27.7477	1459	27.1865	1460	26.8283	1462	2610
1500	29.2815	1415	27.8936	1417	27.3325	1419	26.9745	1420	2700
1550	29.4230	1374	28.0353	1375	27.4744	1376	27.1165	1378	2790
1600	29.5604	1335	28.1728	1337	27.6120	1338	27.2543	1339	2880
1650	29.6939	1298	28.3065	1299	27.7458	1301	27.3882	1302	2970
1700	29.8237	1266	28.4364	1267	27.8759	1267	27.5184	1268	3060
1750	29.9503	1231	28.5631	1232	28.0026	1233	27.6452	1234	3150
1800	30.0734	1201	28.6863	1202	28.1259	1203	27.7686	1204	3240
1850	30.1935	1172	28.8065	1172	28.2462	1172	27.8890	1173	3330
1900	30.3107	1143	28.9237	1144	28.3634	1145	28.0063	1145	3420
1950	30.4250	1115	29.0381	1114	28.4779	1117	28.1208	1118	3510
2000	30.5365	1091	29.1495	1094	28.5896	1092	28.2326	1092	3600
2050	30.6456	1067	29.2589	1066	28.6988	1067	28.3418	1068	3690
2100	30.7523	1042	29.3655	1043	28.8055	1044	28.4486	1044	3780
2150	30.8565	1020	29.4698	1021	28.9099	1021	28.5530	1021	3870
2200	30.9585	998	29.5719	998	29.0120	999	28.6551	999	3960
2250	31.0583	978	29.6717	979	29.1119	978	28.7550	980	4050
2300	31.1561		29.7696		29.2097		28.8530		4140

Table 16.22/2 Entropy of Nitric Oxide

S/R

T °K	10 atm	40 atm	70 atm	100 atm	T °R
2300	31.1561 958	29.7696 958	29.2097 959	28.8530 959	4140
2350	31.2519 939	29.8654 939	29.3056 940	28.9489 940	4230
2400	31.3458 921	29.9593 922	29.3996 922	29.0429 922	4320
2450	31.4379 904	30.0515 903	29.4918 903	29.1351 903	4410
2500	31.5283 887	30.1418 888	29.5821 888	29.2254 888	4500
2550	31.6170 870	30.2306 870	29.6709 870	29.3142 871	4590
2600	31.7040 855	30.3176 855	29.7579 856	29.4013 856	4680
2650	31.7895 840	30.4031 840	29.8435 840	29.4869 840	4770
2700	31.8735 824	30.4871 825	29.9275 825	29.5709 825	4860
2750	31.9559 811	30.5696 811	30.0100 811	29.6534 811	4950
2800	32.0370 797	30.6507 797	30.0911 798	29.7345 798	5040
2850	32.1167 784	30.7304 784	30.1709 784	29.8143 784	5130
2900	32.1951 771	30.8088 771	30.2493 771	29.8927 772	5220
2950	32.2722 759	30.8859 759	30.3264 759	29.9699 759	5310
3000	32.3481	30.9618	30.4023	30.0458	5400

Conversion Factors

To convert tabulated value of	To	Having the dimensions indicated below	Multiply by
S/R	S	cal $mole^{-1}$ $^oK^{-1}$ (or $^oC^{-1}$)	1.98719
		cal g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	0.0662220
		joules g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	0.277074
		Btu $(lb\ mole)^{-1}$ $^oR^{-1}$ (or $^oF^{-1}$)	1.98588
		Btu lb^{-1} $^oR^{-1}$ (or $^oF^{-1}$)	0.0661785

Table 16.22 Enthalpy and Entropy of Nitric Oxide

The Property Tabulated

The enthalpy and entropy of nitric oxide are tabulated in the dimensionles forms $(H - E_0^\circ)/RT_0$ and S/R as functions of temperature in $^\circ K$ and $^\circ R$ and of pressure in atmospheres. T_0 is the temperature of the ice point, 273.16$^\circ K$ and H_0 is the enthalpy of the ideal gas at 0$^\circ K$.

The values tabulated were obtained by combining values for the ideal gas from Table 16.10 of this series with differences between real and ideal based on thermodynamic relations and data on the virial coefficients consistent with Table 16.20 of this series.

The effect of dissociation is not included in this table.

Reliability of the Table

The accuracy of the tabulated values varies with temperature and pressure. It is difficult to arrive at a definite estimate in the present case, as the P-V-T data have considerable scattering and can be fitted only approximately. Also the theoretical representation of the intermolecular force law cannot be regarded as satisfactory, since there are the influences of weak chemical bonding between molecules. It seems likely that the differences between real and ideal properties must be regarded as uncertain by many percent.

Interpolation

Linear interpolation between successive tabulated temperatures at the same pressure is in general adequate for both enthalpy and entropy. Linear interpolation in the pressure direction is similarly valid in the enthalpy table. Linear interpolation is also in general adequate in the entropy table, provided the independent variable is the logarithm of the pressure rather than the pressure itself. The entries have, however, been spaced to permit Lagrangian interpolation directly in pressure.

Conversion Factors

The functions in this table have been expressed in dimensionless form. In order that they may be easily converted to any system of units, conversion factors are listed for frequently used units at the end of each table.

U. S. Department of Commerce National Bureau of Standards

The NBS-NACA Tables of Thermal Properties of Gases

Table 16.24 Specific Heat of Nitric Oxide

Cp/R

by

Harold W. Woolley

June 1953

Table 16.24 Specific Heat of Nitric Oxide

T °K	Pressure 1 atm		.4 atm		.7 atm		1 atm		C_p/R T °R
150	3.7615	-253	3.7960	-386	3.8321	-531	3.8711	-699	270
160	3.7362	-214	3.7574	-280	3.7790	-350	3.8012	-425	288
170	3.7148	-184	3.7294	-222	3.7440	-261	3.7587	-300	306
180	3.6964	-163	3.7072	-187	3.7179	-210	3.7287	-234	324
190	3.6801	-144	3.6885	-159	3.6969	-175	3.7053	-191	342
200	3.6657	-127	3.6726	-138	3.6794	-149	3.6862	-159	360
210	3.6530	-112	3.6588	-120	3.6645	-128	3.6703	-136	378
220	3.6418	-98	3.6468	-105	3.6517	-111	3.6567	-117	396
230	3.6320	-85	3.6363	-90	3.6406	-95	3.6450	-101	414
240	3.6235	-74	3.6273	-78	3.6311	-82	3.6349	-86	432
250	3.6161	-65	3.6195	-68	3.6229	-72	3.6263	-75	450
260	3.6096	-56	3.6127	-59	3.6157	-61	3.6188	-65	468
270	3.6040	-47	3.6068	-49	3.6096	-52	3.6123	-54	486
280	3.5993	-36	3.6019	-39	3.6044	-42	3.6069	-43	504
290	3.5957	-29	3.5980	-31	3.6002	-32	3.6026	-34	522
300	3.5928	-21	3.5949	-23	3.5970	-24	3.5992	-27	540
310	3.5907	-15	3.5926	-16	3.5946	-18	3.5965	-19	558
320	3.5892	-6	3.5910	-8	3.5928	-9	3.5946	-10	576
330	3.5886	1	3.5902	1	3.5919	0	3.5936	-2	594
340	3.5887	11	3.5903	9	3.5919	8	3.5934	8	612
350	3.5898	15	3.5912	14	3.5927	13	3.5942	12	630
360	3.5913	21	3.5926	21	3.5940	20	3.5954	19	648
370	3.5934	29	3.5947	28	3.5960	27	3.5973	26	666
380	3.5963	35	3.5975	34	3.5987	34	3.5999	33	684
390	3.5998	40	3.6009	39	3.6021	38	3.6032	38	702
400	3.6038	43	3.6048	43	3.6059	43	3.6070	42	720
410	3.6081	50	3.6091	50	3.6102	48	3.6112	48	738
420	3.6131	55	3.6141	54	3.6150	54	3.6160	53	756
430	3.6186	60	3.6195	59	3.6204	59	3.6213	59	774
440	3.6246	66	3.6254	66	3.6263	65	3.6272	64	792
450	3.6312		3.6320		3.6328		3.6336		810

Cp/R

Table 16.24 Specific Heat of Nitric Oxide

T °K	Pressure .1 atm		Pressure 1 atm		T °R
450	3.6312	68	3.6336	67	810
460	3.6380	70	3.6403	70	828
470	3.6450	75	3.6473	74	846
480	3.6525	77	3.6547	75	864
490	3.6602	81	3.6622	80	882
500	3.6683	83	3.6702	82	900
510	3.6766	85	3.6784	85	918
520	3.6851	87	3.6869	86	936
530	3.6938	89	3.6955	88	954
540	3.7027	90	3.7043	89	972
550	3.7117	91	3.7132	91	990
560	3.7208	93	3.7223	92	1008
570	3.7301	94	3.7315	93	1026
580	3.7395	93	3.7408	94	1044
590	3.7488	95	3.7502	94	1062
600	3.7583	95	3.7596	95	1080
610	3.7678	95	3.7691	94	1098
620	3.7773	96	3.7785	96	1116
630	3.7869	96	3.7881	95	1134
640	3.7965	95	3.7976	95	1152
650	3.8060	95	3.8071	94	1170
660	3.8155	95	3.8165	95	1188
670	3.8250	94	3.8260	94	1206
680	3.8344	94	3.8354	93	1224
690	3.8438	93	3.8447	93	1242
700	3.8531	93	3.8540	93	1260
710	3.8624	92	3.8633	91	1278
720	3.8716	91	3.8724	91	1296
730	3.8807	90	3.8815	90	1314
740	3.8897	90	3.8905	90	1332
750	3.8987	88	3.8995	87	1350
760	3.9075	88	3.9082	88	1368
770	3.9163	87	3.9170	87	1386
780	3.9250	85	3.9257	85	1404
790	3.9335	85	3.9342	84	1422
800	3.9420		3.9426		1440

T °K	Pressure .1 atm		Pressure 1 atm		T °R
800	3.9420	788	3.9426	787	1440
900	4.0208	678	4.0213	677	1620
1000	4.0886	581	4.0890	581	1800
1100	4.1467	493	4.1471	492	1980
1200	4.1960	421	4.1963	420	2160
1300	4.2381	361	4.2383	361	2340
1400	4.2742	311	4.2744	311	2520
1500	4.3053	269	4.3055	268	2700
1600	4.3322	236	4.3323	236	2880
1700	4.3558	208	4.3559	208	3060
1800	4.3766	184	4.3767	184	3240
1900	4.3950	165	4.3951	165	3420
2000	4.4115	148	4.4116	148	3600
2100	4.4263	135	4.4264	135	3780
2200	4.4398	124	4.4399	124	3960
2300	4.4522	113	4.4523	113	4140
2400	4.4635	105	4.4636	104	4320
2500	4.4740	98	4.4740	98	4500
2600	4.4838	92	4.4838	92	4680
2700	4.4930	86	4.4930	86	4860
2800	4.5016	82	4.5016	82	5040
2900	4.5098	77	4.5098	77	5220
3000	4.5175		4.5175		5400

Table 16.24 Specific Heat of Nitric Oxide

Cp/R

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
150	3.8711		4.69		7.2				270
		-699		-57		-24	6.1		
160	3.8012		4.118		4.80			-15	288
		-425		-188		-60	4.63		
170	3.7587		3.930		4.20			-46	306
		-300		-88		-22	4.166		
180	3.7287		3.8424		3.981			-175	324
		-234		-516		-97	3.991		
190	3.7053		3.7908		3.884			-89	342
		-191		-358		-58			
200	3.6862		3.7550		3.8260		3.9019		360
		-159		-274		-405		-569	
210	3.6703		3.7276		3.7855		3.8450		378
		-136		-218		-305		-405	
220	3.6567		3.7058		3.7550		3.8045		396
		-117		-179		-243		-310	
230	3.6450		3.6879		3.7307		3.7735		414
		-101		-150		-200		-249	
240	3.6349		3.6729		3.7107		3.7486		432
		-86		-126		-166		-206	
250	3.6263		3.6603		3.6941		3.7280		450
		-75		-110		-142		-175	
260	3.6188		3.6493		3.6799		3.7105		468
		-65		-93		-121		-149	
270	3.6123		3.6400		3.6678		3.6956		486
		-54		-78		-102		-127	
280	3.6069		3.6322		3.6576		3.6829		504
		-43		-65		-85		-106	
290	3.6026		3.6257		3.6491		3.6723		522
		-34		-52		-72		-89	
300	3.5992		3.6205		3.6419		3.6634		540
		-27		-43		-59		-75	
310	3.5965		3.6162		3.6360		3.6559		558
		-19		-33		-48		-62	
320	3.5946		3.6129		3.6312		3.6497		576
		-10		-23		-36		-49	
330	3.5936		3.6106		3.6276		3.6448		594
		-2		-14		-25		-36	
340	3.5934		3.6092		3.6251		3.6412		612
		+8		-3		-13		-24	
350	3.5942		3.6089		3.6238		3.6388		630
		+12		+3		-7		-16	
360	3.5954		3.6092		3.6231		3.6372		648
		19		10		+2		-7	
370	3.5973		3.6102		3.6233		3.6365		666
		26		19		11		+3	
380	3.5999		3.6121		3.6244		3.6368		684
		33		25		18		11	
390	3.6032		3.6146		3.6262		3.6379		702
		38		32		25		18	
400	3.6070		3.6178		3.6287		3.6397		720
		42		36		30		24	
410	3.6112		3.6214		3.6317		3.6421		738
		48		42		37		32	
420	3.6160		3.6256		3.6354		3.6453		756
		53		49		43		38	
430	3.6213		3.6305		3.6397		3.6491		774
		59		53		49		44	
440	3.6272		3.6358		3.6446		3.6535		792
		64		61		56		51	
450	3.6336		3.6419		3.6502		3.6586		810

Table 16.24 Specific Heat of Nitric Oxide

C_p/R

T °K	Pressure 1 atm	4 atm	7 atm	10 atm	T °R
450	3.6336	3.6419	3.6502	3.6586	810
	67	62	59	55	
460	3.6403	3.6481	3.6561	3.6641	828
	70	66	62	58	
470	3.6473	3.6547	3.6623	3.6699	846
	74	71	67	63	
480	3.6547	3.6618	3.6690	3.6762	864
	75	72	69	66	
490	3.6622	3.6690	3.6759	3.6828	882
	80	77	74	71	
500	3.6702	3.6767	3.6833	3.6899	900
	82	79	75	72	
510	3.6784	3.6846	3.6908	3.6971	918
	85	81	79	76	
520	3.6869	3.6927	3.6987	3.7047	936
	86	84	81	79	
530	3.6955	3.7011	3.7068	3.7126	954
	88	86	84	81	
540	3.7043	3.7097	3.7152	3.7207	972
	89	87	84	83	
550	3.7132	3.7184	3.7236	3.7290	990
	91	88	86	84	
560	3.7223	3.7272	3.7322	3.7374	1008
	92	91	89	86	
570	3.7315	3.7363	3.7411	3.7460	1026
	93	91	89	88	
580	3.7408	3.7454	3.7500	3.7548	1044
	94	92	91	88	
590	3.7502	3.7546	3.7591	3.7636	1062
	94	93	91	90	
600	3.7596	3.7639	3.7682	3.7726	1080
	95	93	91	89	
610	3.7691	3.7732	3.7773	3.7815	1098
	94	93	92	90	
620	3.7785	3.7825	3.7865	3.7905	1116
	96	94	93	92	
630	3.7881	3.7919	3.7958	3.7997	1134
	95	94	92	91	
640	3.7976	3.8013	3.8050	3.8088	1152
	95	93	92	91	
650	3.8071	3.8106	3.8142	3.8179	1170
	94	94	93	91	
660	3.8165	3.8200	3.8235	3.8270	1188
	95	93	92	91	
670	3.8260	3.8293	3.8327	3.8361	1206
	94	93	91	90	
680	3.8354	3.8386	3.8418	3.8451	1224
	93	92	92	91	
690	3.8447	3.8478	3.8510	3.8542	1242
	93	92	91	89	
700	3.8540	3.8570	3.8601	3.8631	1260
	93	92	90	90	
710	3.8633	3.8662	3.8691	3.8721	1278
	91	92	90	89	
720	3.8724	3.8754	3.8781	3.8810	1296
	91	89	89	88	
730	3.8815	3.8843	3.8870	3.8898	1314
	90	88	88	87	
740	3.8905	3.8931	3.8958	3.8985	1332
	90	89	88	88	
750	3.8995	3.9020	3.9046	3.9073	1350
	87	87	87	85	
760	3.9082	3.9107	3.9133	3.9158	1368
	88	87	86	86	
770	3.9170	3.9194	3.9219	3.9244	1386
	87	86	85	84	
780	3.9257	3.9280	3.9304	3.9328	1404
	85	85	84	83	
790	3.9342	3.9365	3.9388	3.9411	1422
	84	84	83	83	
800	3.9426	3.9449	3.9471	3.9494	1440

Table 16.24 Specific Heat of Nitric Oxide C_p/R

T °K	Pressure 1 atm		4 atm		7 atm		10 atm		T °R
800	3.9426		3.9449		3.9471		3.9494		1440
		787		781		776		770	
900	4.0213		4.0230		4.0247		4.0264		1620
		677		674		670		667	
1000	4.0890		4.0904		4.0917		4.0931		1800
		581		577		575		572	
1100	4.1471		4.1481		4.1492		4.1503		1980
		492		491		489		486	
1200	4.1963		4.1972		4.1981		4.1989		2160
		420		419		417		416	
1300	4.2383		4.2391		4.2398		4.2405		2340
		361		359		358		357	
1400	4.2744		4.2750		4.2756		4.2762		2520
		311		310		309		308	
1500	4.3055		4.3060		4.3065		4.3070		2700
		268		268		267		267	
1600	4.3323		4.3328		4.3332		4.3337		2880
		236		235		235		234	
1700	4.3559		4.3563		4.3567		4.3571		3060
		208		207		207		206	
1800	4.3767		4.3770		4.3774		4.3777		3240
		184		184		183		183	
1900	4.3951		4.3954		4.3957		4.3960		3420
		165		164		164		163	
2000	4.4116		4.4118		4.4121		4.4123		3600
		148		148		147		147	
2100	4.4264		4.4266		4.4268		4.4270		3780
		135		135		135		134	
2200	4.4399		4.4401		4.4403		4.4404		3960
		124		123		123		124	
2300	4.4523		4.4524		4.4526		4.4528		4140
		113		113		113		112	
2400	4.4636		4.4637		4.4639		4.4640		4320
		104		105		104		105	
2500	4.4740		4.4742		4.4743		4.4745		4500
		98		98		98		97	
2600	4.4838		4.4840		4.4841		4.4842		4680
		92		91		92		92	
2700	4.4930		4.4931		4.4933		4.4934		4860
		86		86		85		85	
2800	4.5016		4.5017		4.5018		4.5019		5040
		82		82		82		82	
2900	4.5098		4.5099		4.5100		4.5101		5220
		77		77		77		77	
3000	4.5175		4.5176		4.5177		4.5178		5400

Table 16.24 Specific Heat of Nitric Oxide

C_p/R

T °K	Pressure 10 atm	40 atm	70 atm	100 atm	T °R
160	10.04 -541				288
170	4.63 -46				306
180	4.166 -175	13.17 -580			324
190	3.991 -89	7.37 -185			342
200	3.9019 -569	5.519 -770	10.56 -363		360
210	3.8450 -405	4.749 -340	6.93 -144	11.4 -40	378
220	3.8045 -310	4.409 -170	5.49 -61	7.4 -15	396
230	3.7735 -249	4.239 -103	4.88 -30	5.85 -73	414
240	3.7486 -206	4.136 -69	4.58 -17	5.12 -35	432
250	3.7280 -175	4.067 -53	4.412 -104	4.77 -19	450
260	3.7105 -149	4.014 -42	4.308 -73	4.58 -11	468
270	3.6956 -127	3.972 -35	4.235 -57	4.47 -8	486
280	3.6829 -106	3.937 -30	4.178 -46	4.39 -6	504
290	3.6723 -89	3.907 -26	4.132 -39	4.33 -5	522
300	3.6634 -75	3.881 -22	4.093 -35	4.28 -4	540
310	3.6559 -62	3.859 -20	4.058 -30	4.24 -4	558
320	3.6497 -49	3.839 -17	4.028 -27	4.20 -3	576
330	3.6448 -36	3.822 -15	4.001 -25	4.17 -3	594
340	3.6412 -24	3.8071 -126	3.976 -22	4.14 -3	612
350	3.6388 -16	3.7945 -109	3.9544 -193	4.110 -26	630
360	3.6372 -7	3.7836 -93	3.9351 -171	4.084 -23	648
370	3.6365 +3	3.7743 -76	3.9180 -151	4.061 -21	666
380	3.6368 11	3.7667 -62	3.9029 -131	4.040 -19	684
390	3.6379 18	3.7605 -49	3.8898 -115	4.021 -18	702
400	3.6397 24	3.7556 -39	3.8783 -101	4.003 -15	720
410	3.6421 32	3.7517 -26	3.8682 -83	3.988 -14	738
420	3.6453 38	3.7491 -15	3.8599 -62	3.974 -12	756
430	3.6491 44	3.7476 -6	3.8537 -65	3.962 -11	774
440	3.6535 51	3.7470 +5	3.8472 -44	3.951 -9	792
450	3.6586	3.7475	3.8428	3.942	810

Table 16.24 Specific Heat of Nitric Oxide C_p/R

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
450	3.6586	55	3.7475	11	3.8428	-31	3.942	-7	810
460	3.6641	58	3.7486	18	3.8397	-26	3.935	-7	828
470	3.6699	63	3.7504	25	3.8371	-16	3.928	-6	846
480	3.6762	66	3.7529	32	3.8355	-5	3.922	-4	864
490	3.6828	71	3.7561	37	3.8350	1	3.918	-3	882
500	3.6899	72	3.7598	37	3.8351	0	3.915	-4	900
510	3.6971	76	3.7635	47	3.8351	16	3.911	-2	918
520	3.7047	79	3.7682	52	3.8367	23	3.909	-1	936
530	3.7126	81	3.7734	56	3.8390	28	3.908	0	954
540	3.7207	83	3.7790	58	3.8418	32	3.908	1	972
550	3.7290	84	3.7848	62	3.8450	37	3.9087	12	990
560	3.7374	86	3.7910	65	3.8487	42	3.9099	17	1008
570	3.7460	88	3.7975	67	3.8529	45	3.9116	22	1026
580	3.7548	88	3.8042	69	3.8574	48	3.9138	26	1044
590	3.7636	90	3.8111	71	3.8622	52	3.9164	30	1062
600	3.7726	89	3.8182	72	3.8674	51	3.9194	29	1080
610	3.7815	90	3.8254	74	3.8725	58	3.9223	41	1098
620	3.7905	92	3.8328	76	3.8783	59	3.9264	41	1116
630	3.7997	91	3.8404	78	3.8842	64	3.9305	51	1134
640	3.8088	91	3.8482	76	3.8906	59	3.9356	38	1152
650	3.8179	91	3.8558	78	3.8965	63	3.9394	48	1170
660	3.8270	91	3.8636	78	3.9028	64	3.9442	49	1188
670	3.8361	90	3.8714	79	3.9092	65	3.9491	51	1206
680	3.8451	91	3.8793	78	3.9157	67	3.9542	53	1224
690	3.8542	89	3.8871	80	3.9224	67	3.9595	55	1242
700	3.8631	90	3.8951	79	3.9291	67	3.9650	54	1260
710	3.8721	89	3.9030	79	3.9358	69	3.9704	57	1278
720	3.8810	88	3.9109	78	3.9427	68	3.9761	57	1296
730	3.8898	87	3.9187	78	3.9495	68	3.9818	57	1314
740	3.8985	88	3.9265	79	3.9563	69	3.9875	59	1332
750	3.9073	85	3.9344	77	3.9632	68	3.9934	59	1350
760	3.9158	86	3.9421	78	3.9700	69	3.9993	59	1368
770	3.9244	84	3.9499	77	3.9769	68	4.0052	59	1386
780	3.9328	83	3.9576	75	3.9837	68	4.0111	59	1404
790	3.9411	83	3.9651	76	3.9905	68	4.0170	60	1422
800	3.9494		3.9727		3.9973		4.0230		1440

Table 16.24 Specific Heat of Nitric Oxide

C_p/R

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
800	3.9494	770	3.9727	714	3.9973	652	4.0230	585	1440
900	4.0264	667	4.0441	627	4.0625	585	4.0815	540	1620
1000	4.0931	572	4.1068	544	4.1210	512	4.1355	478	1800
1100	4.1503	486	4.1612	466	4.1722	446	4.1833	426	1980
1200	4.1989	416	4.2078	400	4.2168	382	4.2259	364	2160
1300	4.2405	357	4.2478	345	4.2550	334	4.2623	320	2340
1400	4.2762	308	4.2823	298	4.2884	287	4.2943	278	2520
1500	4.3070	267	4.3121	259	4.3171	251	4.3221	243	2700
1600	4.3337	234	4.3380	228	4.3422	222	4.3464	215	2880
1700	4.3571	206	4.3608	201	4.3644	196	4.3679	191	3060
1800	4.3777	183	4.3809	178	4.3840	174	4.3870	170	3240
1900	4.3960	163	4.3987	161	4.4014	157	4.4040	153	3420
2000	4.4123	147	4.4148	144	4.4171	141	4.4193	138	3600
2100	4.4270	134	4.4292	131	4.4312	129	4.4331	126	3780
2200	4.4404	124	4.4423	121	4.4441	119	4.4457	117	3960
2300	4.4528	112	4.4544	111	4.4560	109	4.4574	107	4140
2400	4.4640	105	4.4655	103	4.4669	101	4.4681	100	4320
2500	4.4745	97	4.4758	96	4.4770	94	4.4781	93	4500
2600	4.4842	92	4.4854	90	4.4864	89	4.4874	88	4680
2700	4.4934	85	4.4944	84	4.4953	84	4.4962	82	4860
2800	4.5019	82	4.5028	81	4.5037	80	4.5044	80	5040
2900	4.5101	77	4.5109	76	4.5117	75	4.5124	74	5220
3000	4.5178		4.5185		4.5192		4.5198		5400

Table 16.24 Specific Heat at Constant Pressure of Nitric Oxide

The Property Tabulated

The specific heat of nitric oxide at constant pressure is tabulated in the dimensionless form Cp/R as a function of temperature in ^{o}K and ^{o}R and of pressure in atmospheres.

The specific-heat values were obtained by combining the ideal-gas specific-heat values from Table 16.10 of this series with differences between real and ideal based on thermodynamic formulas and the virial coefficients used for Table 16.20 of this series.

The effect of dissociation is not included in this table.

Reliability of the Tables

The accuracy of the tabulated values may be expected to vary with temperature and pressure. The error in $Cp - C_p^o$ may amount to several percent due to uncertainties in the data and lack of knowledge of the intermolecular potential.

Figure 1 shows experimental values of the specific heat as compared with the calculated values. The experimental values are due to Heuse [2], Eucken and d'Or [1] and Partington and Shilling [3]. The values due to Eucken and d'Or are shown as computed originally and also as recomputed using the present P-V-T correlation.

Interpolation

The error produced by linear interpolation varies throughout the table, but does not in general exceed one eighth of the second difference, so that for most of the table linear interpolation is adequate.

Conversion Factors

The function in the table has been expressed in dimensionless form. In order that it may be easily converted to any system of

units, conversion factors are listed for the frequently used units. For other conversion factors see Table 1.30 of this series.

Conversion Factors

To convert tabulated value of	To	Having the dimensions indicated below	Multiply by
Cp/R	Cp	cal $mole^{-1}$ ^oK (or $^oC^{-1}$)	1.98719
		cal g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	0.0662220
		joules g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	0.277074
		Btu $(lb\ mole)^{-1}$ $^oR^{-1}$ (or $^oF^{-1}$)	1.98588
		Btu lb^{-1} $^oR^{-1}$ (or $^oF^{-1}$)	0.0661785

REFERENCES

[1] A. Eucken and L. d'Or, Die Molwärme des gas förmigen Stickoxyd bei tiefen Temperaturen, Nachr. Ges. Wiss. Göttingen, 1932, 107 (1932).

[2] W. Heuse, Die spezifische Wärme von Argon und einigen mehratomigen Gasen. Ann. Physik, 59, 86 (1919).

[3] J. R. Partington and W. G. Shilling, The Specific Heats of Nitrous and Nitric Oxides, Phil. Mag. 45, 416 (1923).

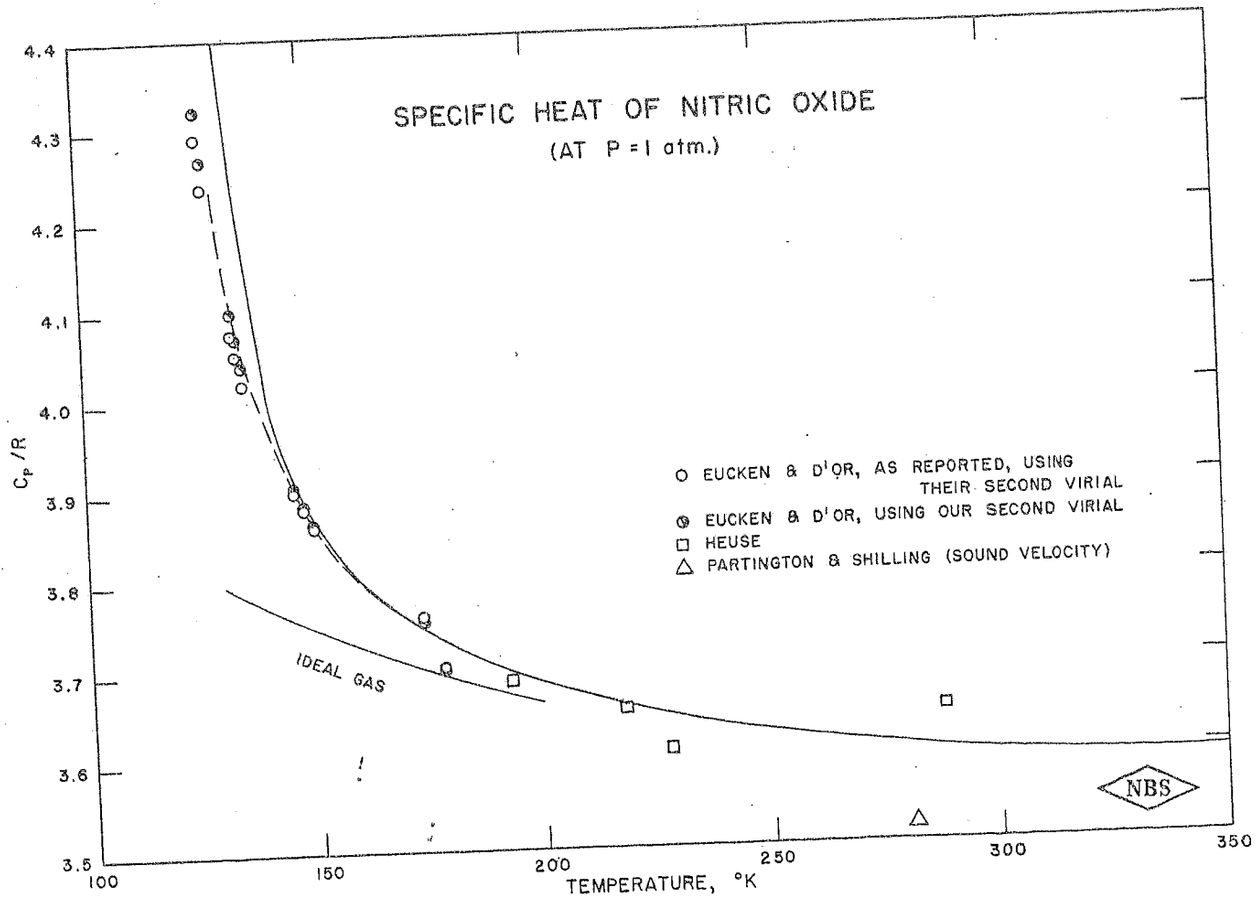

FIG. 1.

U. S. Department of Commerce National Bureau of Standards

The NBS - NACA Tables of Thermal Properties of Gases

Table 16.26 Specific Heat Ratio of Nitric Oxide

γ

by

Harold W. Woolley

June 1953

Table 16.26 Specific Heat Ratios of Nitric Oxide γ

T °K	Pressure .1 atm	1 atm	10 atm		T °R
150	1.364	1.371			270
160	1.367	1.374	1.456	-12	288
170	1.370	1.376	1.444	-7	306
180	1.372	1.378	1.437	-3	324
190	1.374	1.379	1.434	-3	342
200	1.376	1.381	1.431	-4	360
210	1.377	1.382	1.427	-3	378
220	1.379	1.383	1.424	-3	396
230	1.380	1.384	1.421	-2	414
240	1.382	1.385	1.419	-2	432
250	1.383	1.386	1.417		450
260	1.384	1.386	1.415		468
270	1.385	1.387	1.413		486
280	1.385	1.387	1.412		504
290	1.386	1.388	1.410		522
300	1.386	1.388	1.409		540
310	1.386	1.388	1.407		558
320	1.387	1.388	1.406		576
330	1.386	1.388	1.405		594
340	1.386	1.388	1.404		612
350	1.386	1.388	1.402		630
360	1.386	1.387	1.401		648
370	1.386	1.387	1.399		666
380	1.385	1.386	1.398		684
390	1.385	1.386	1.397		702
400	1.384	1.385	1.396		720
410	1.383	1.385	1.394		738
420	1.383	1.384	1.393		756
430	1.382	1.383	1.392		774
440	1.381	1.382	1.390		792
450	1.380	1.381	1.389		810

Table 16.26 Specific Heat Ratios of Nitric Oxide γ

T °K	Pressure .1 atm	1 atm	10 atm	T °R
450	1.380	1.381	1.389	810
460	1.379	1.380	1.387	828
470	1.378	1.379	1.386	846
480	1.377	1.378	1.385	864
490	1.376	1.377	1.383	882
500	1.375	1.376	1.382	900
510	1.374	1.375	1.380	918
520	1.372	1.373	1.378	936
530	1.371	1.372	1.377	954
540	1.370	1.371	1.376	972
550	1.369	1.369	1.374	990
560	1.368	1.368	1.372	1008
570	1.366	1.367	1.371	1026
580	1.365	1.365	1.369	1044
590	1.364	1.364	1.368	1062
600	1.363	1.363	1.367	1080
610	1.361	1.362	1.365	1098
620	1.360	1.360	1.364	1116
630	1.359	1.359	1.362	1134
640	1.358	1.358	1.361	1152
650	1.356	1.357	1.360	1170
660	1.355	1.355	1.359	1188
670	1.354	1.354	1.357	1206
680	1.353	1.353	1.356	1224
690	1.352	1.352	1.355	1242
700	1.351	1.351	1.354	1260
710	1.349	1.350	1.352	1278
720	1.348	1.349	1.351	1296
730	1.347	1.347	1.350	1314
740	1.346	1.346	1.348	1332
750	1.345	1.345	1.347	1350
760	1.344	1.344	1.346	1368
770	1.343	1.343	1.345	1386
780	1.342	1.342	1.344	1404
790	1.341	1.341	1.343	1422
800	1.340	1.340	1.342	1440

Table 16.26 Specific Heat Ratios of Nitric Oxide

T °K	Pressure .1 atm	1 atm	10 atm	T °R
800	1.340 -9	1.340 -9	1.342 -9	1440
900	1.331 -7	1.331 -7	1.333 -8	1620
1000	1.324 -6	1.324 -6	1.325 -6	1800
1100	1.318 -5	1.318 -5	1.319 -6	1980
1200	1.313 -4	1.313 -4	1.313 -4	2160
1300	1.309	1.309	1.309	2340
1400	1.305	1.305	1.306	2520
1500	1.303	1.302	1.303	2700
1600	1.300	1.300	1.300	2880
1700	1.298	1.298	1.298	3060
1800	1.296	1.296	1.296	3240
1900	1.295	1.295	1.295	3420
2000	1.293	1.293	1.293	3600
2100	1.292	1.292	1.292	3780
2200	1.291	1.291	1.291	3960
2300	1.290	1.290	1.290	4140
2400	1.289	1.289	1.289	4320
2500	1.288	1.288	1.288	4500
2600	1.287	1.287	1.287	4680
2700	1.286	1.286	1.286	4860
2800	1.286	1.286	1.286	5040
2900	1.285	1.285	1.285	5220
3000	1.284	1.284	1.284	5400

Table 16.26 Specific Heat Ratios of Nitric Oxide

T °K	Pressure 10 atm	40 atm	70 atm	100 atm	T °R
					γ
170	1.444 -7				306
180	1.437 -3				324
190	1.434 -3				342
200	1.431	1.632 -27	1.976 -149		360
210	1.427	1.605 -19	1.827 -51		378
220	1.424	1.586 -18	1.776 -36	2.006 -89	396
230	1.421	1.568 -15	1.740 -28	1.922 -40	414
240	1.419	1.553 -14	1.712 -25	1.882 -34	432
250	1.417	1.539 -12	1.687 -23	1.848 -32	450
260	1.415	1.527 -10	1.664 -21	1.816 -30	468
270	1.413	1.517 -10	1.643 -19	1.786 -28	486
280	1.412	1.507 -9	1.624 -18	1.758 -27	504
290	1.410	1.498 -8	1.606 -16	1.731 -24	522
300	1.409	1.490 -7	1.590 -15	1.707 -24	540
310	1.407	1.483 -7	1.575 -14	1.683 -21	558
320	1.406	1.476 -7	1.561 -12	1.662 -20	576
330	1.405	1.469 -5	1.549 -11	1.642 -18	594
340	1.404	1.464 -6	1.538 -11	1.624 -17	612
350	1.402	1.458 -5	1.527 -10	1.607 -15	630
360	1.401	1.453 -4	1.517 -9	1.592 -14	648
370	1.399	1.449 -5	1.508 -8	1.578 -13	666
380	1.398	1.444 -4	1.500 -8	1.565 -12	684
390	1.397	1.440 -4	1.492 -7	1.553 -12	702
400	1.396	1.436	1.485 -8	1.541 -11	720
410	1.394	1.432	1.477 -6	1.530 -10	738
420	1.393	1.429	1.471 -6	1.520 -9	756
430	1.392	1.425	1.465 -6	1.511 -8	774
440	1.390	1.422	1.459 -5	1.503 -9	792
450	1.389	1.419	1.454	1.494	810

Table 16.26 Specific Heat Ratios of Nitric Oxide γ

T °K	Pressure 10 atm	40 atm	70 atm		100 atm		T °R
450	1.389	1.419	1.454	-5	1.494	-7	810
460	1.387	1.415	1.449	-5	1.487	-8	828
470	1.386	1.412	1.444	-5	1.479	-6	846
480	1.385	1.409	1.439	-4	1.473	-7	864
490	1.383	1.407	1.435	-5	1.466	-6	882
500	1.382	1.404	1.430		1.460	-5	900
510	1.380	1.401	1.427		1.455	-6	918
520	1.378	1.399	1.423		1.449	-5	936
530	1.377	1.396	1.419		1.444	-5	954
540	1.376	1.394	1.415		1.439	-5	972
550	1.374	1.392	1.412		1.434	-4	990
560	1.372	1.389	1.408		1.430	-5	1008
570	1.371	1.387	1.405		1.425	-4	1026
580	1.369	1.385	1.402		1.421	-4	1044
590	1.368	1.383	1.399		1.417	-4	1062
600	1.367	1.380	1.396		1.413		1080
610	1.365	1.378	1.393		1.410		1098
620	1.364	1.376	1.390		1.406		1116
630	1.362	1.374	1.388		1.402		1134
640	1.361	1.373	1.385		1.399		1152
650	1.360	1.371	1.383		1.396		1170
660	1.359	1.369	1.381		1.394		1188
670	1.357	1.367	1.378		1.390		1206
680	1.356	1.365	1.376		1.388		1224
690	1.355	1.364	1.374		1.385		1242
700	1.354	1.362	1.372		1.382		1260
710	1.352	1.360	1.370		1.380		1278
720	1.351	1.359	1.368		1.378		1296
730	1.350	1.357	1.366		1.375		1314
740	1.348	1.356	1.365		1.373		1332
750	1.347	1.355	1.363		1.371		1350
760	1.346	1.353	1.361		1.369		1368
770	1.345	1.352	1.359		1.367		1386
780	1.344	1.350	1.357		1.365		1404
790	1.343	1.349	1.356		1.363		1422
800	1.342	1.348	1.354		1.361		1440

Table 16.26 Specific Heat Ratios of Nitric Oxide

γ

T °K	Pressure 10 atm	40 atm	70 atm	100 atm	T °R
800	1.342 -9	1.348 -11	1.354 -13	1.361 -15	1440
900	1.333 -8	1.337 -9	1.341 -10	1.346 -11	1620
1000	1.325 -6	1.328 -7	1.331 -8	1.335 -9	1800
1100	1.319 -5	1.321 -6	1.323 -6	1.326 -7	1980
1200	1.313 -4	1.315 -4	1.317 -5	1.319 -6	2160
1300	1.309	1.311	1.312	1.313	2340
1400	1.306	1.307	1.308	1.309	2520
1500	1.303	1.304	1.304	1.305	2700
1600	1.300	1.301	1.302	1.302	2880
1700	1.298	1.299	1.299	1.300	3060
1800	1.296	1.297	1.297	1.297	3240
1900	1.295	1.295	1.295	1.295	3420
2000	1.293	1.293	1.293	1.294	3600
2100	1.292	1.292	1.292	1.292	3780
2200	1.291	1.291	1.291	1.291	3960
2300	1.290	1.290	1.290	1.290	4140
2400	1.289	1.289	1.289	1.289	4320
2500	1.288	1.288	1.288	1.288	4500
2600	1.287	1.287	1.287	1.287	4680
2700	1.286	1.286	1.286	1.286	4860
2800	1.286	1.285	1.285	1.285	5040
2900	1.285	1.285	1.285	1.285	5220
3000	1.284	1.284	1.284	1.284	5400

Table 16.26 Specific Heat Ratio of Nitric Oxide

The Property Tabulated

The specific heat ratio $\gamma = C_p/C_v$ of nitric oxide is tabulated as a function of temperature in ^oK and ^oR and of pressure in atmospheres. The effect of dissociation is not included in this table.

To obtain the values of γ for this table, the value of C_p/R as given in Table 16.24 of this series was combined with

$$\frac{C_p - C_v}{R} = \frac{[Z + T(\delta Z/\delta T)_p]^2}{[Z - P(\delta Z/\delta P)_T]^2}$$

in which the values of Z and its derivatives are consistent with Table 16.20.

Reliability of the Table

The values of γ are thought to be uncertain by several percent of their departures from values for the ideal gas. As these departures are of moderate magnitude for much of the table, all tabulated values are still considered fairly reliable.

Interpolation

Linear interpolation is valid in this table, except at the lowest temperatures and highest pressures. Since in these ranges the tabulated values are somewhat uncertain, it is likely that the values obtained by linear interpolation are as reliable as the table throughout.

U. S. Department of Commerce National Bureau of Standards

The NBS - NACA Tables of Thermal Properties of Gases

Table 16.32 Sound Velocity in Nitric Oxide

a/a_0

by

Harold W. Woolley

June 1953

Table 16.32 Sound Velocity in Nitric Oxide a/a_0

T °K	Pressure .1 atm		1 atm		10 atm		T °R
150	.735	25	.731	26			270
160	.760	24	.757	25			288
170	.784	24	.782	24	.751	32	306
180	.808	23	.806	23	.783	28	324
190	.831	22	.829	23	.811	27	342
200	.853	21	.852	22	.838	24	360
210	.874	22	.874	21	.862	23	378
220	.896	20	.895	21	.885	23	396
230	.916	20	.916	20	.908	22	414
240	.936	20	.936	20	.930	21	432
250	.956	20	.956	19	.951	21	450
260	.976	18	.975	19	.972	20	468
270	.994	19	.994	19	.992	20	486
280	1.013	18	1.013	18	1.012	19	504
290	1.031	18	1.031	18	1.031	18	522
300	1.049	17	1.049	17	1.049	18	540
310	1.066	18	1.066	17	1.067	18	558
320	1.084	16	1.083	17	1.085	17	576
330	1.100	17	1.100	17	1.102	17	594
340	1.117	16	1.117	16	1.119	17	612
350	1.133	16	1.133	16	1.136	16	630
360	1.149	16	1.149	16	1.152	16	648
370	1.165	15	1.165	15	1.168	16	666
380	1.180	15	1.180	16	1.184	16	684
390	1.195	15	1.196	15	1.200	15	702
400	1.210	15	1.211	15	1.215	15	720
410	1.225	15	1.226	14	1.230	15	738
420	1.240	14	1.240	14	1.245	14	756
430	1.254	14	1.254	14	1.259	14	774
440	1.268	14	1.268	14	1.273	14	792
450	1.282		1.282		1.287		810

a_o = 323.64 m/sec = 1061.8 ft/sec

Table 16.32 Sound Velocity in Nitric Oxide a/a_0

T °K	Pressure 1. atm		1 atm		10 atm		T °R
450	1.282	13	1.282	14	1.287	14	810
460	1.295	27	1.296	27	1.301	28	828
480	1.322	27	1.323	26	1.329	26	864
500	1.349	25	1.349	26	1.355	25	900
520	1.374	25	1.375	25	1.380	26	936
540	1.399	25	1.400	24	1.406	24	972
560	1.424	23	1.424	24	1.430	24	1008
580	1.447	24	1.448	23	1.454	24	1044
600	1.471	23	1.471	23	1.478	22	1080
620	1.494	22	1.494	23	1.500	23	1116
640	1.516	22	1.517	22	1.523	22	1152
660	1.538	22	1.539	22	1.545	22	1188
680	1.560	22	1.561	21	1.567	22	1224
700	1.582	20	1.582	22	1.589	21	1260
720	1.602	21	1.604	20	1.610	20	1296
740	1.623	21	1.624	20	1.630	21	1332
760	1.644	20	1.644	21	1.651	20	1368
780	1.664	20	1.665	20	1.671	20	1404
800	1.684	96	1.685	96	1.691	96	1440
900	1.780	92	1.781	91	1.787	91	1620
1000	1.872	87	1.872	87	1.878	87	1800
1100	1.959	83	1.959	83	1.965	82	1980
1200	2.042	80	2.042	80	2.047	80	2160
1300	2.122	77	2.122	77	2.127	77	2340
1400	2.199	75	2.199	76	2.204	76	2520
1500	2.274	72	2.275	71	2.280	71	2700
1600	2.346	70	2.346	71	2.351	71	2880
1700	2.416	68	2.417	68	2.422	67	3060
1800	2.484	67	2.485	67	2.489	67	3240
1900	2.551	65	2.552	64	2.556	65	3420
2000	2.616	63	2.616	63	2.621	63	3600
2100	2.679	62	2.679	63	2.684	62	3780
2200	2.741	61	2.742	60	2.746	60	3960
2300	2.802	59	2.802	59	2.806	59	4140
2400	2.861	58	2.861	58	2.865	58	4320
2500	2.919	56	2.919	57	2.923	57	4500
2600	2.975	56	2.976	55	2.980	55	4680
2700	3.031	55	3.031	56	3.035	56	4860
2800	3.086	54	3.087	53	3.091	53	5040
2900	3.140	52	3.140	53	3.144	52	5220
3000	3.192		3.193		3.196		5400

a_o = 323.64 m/sec = 1061.8 ft/sec

Table 16.32 Sound Velocity in Nitric Oxide a/a_0

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
450	1.287	14	1.307	13	1.329	15	1.355	15	810
460	1.301	28	1.320	28	1.344	28	1.370	30	828
480	1.329	26	1.348	28	1.372	28	1.400	28	864
500	1.355	25	1.376	26	1.400	27	1.428	27	900
520	1.380	26	1.402	26	1.427	26	1.455	26	936
540	1.406	24	1.428	24	1.453	25	1.481	25	972
560	1.430	24	1.452	25	1.478	24	1.506	25	1008
580	1.454	24	1.477	23	1.502	24	1.531	23	1044
600	1.478	22	1.500	23	1.526	23	1.554	24	1080
620	1.500	23	1.523	23	1.549	23	1.578	22	1116
640	1.523	22	1.546	22	1.572	22	1.600	23	1152
660	1.545	22	1.568	22	1.594	22	1.623	21	1188
680	1.567	22	1.590	21	1.616	21	1.644	21	1224
700	1.589	21	1.611	22	1.637	21	1.665	21	1260
720	1.610	20	1.633	20	1.658	21	1.686	20	1296
740	1.630	21	1.653	21	1.679	20	1.706	21	1332
760	1.651	20	1.674	20	1.699	20	1.727	20	1368
780	1.671	20	1.694	20	1.719	19	1.747	19	1404
800	1.691	96	1.714	96	1.738	95	1.766	94	1440
900	1.787	91	1.810	90	1.833	90	1.860	88	1620
1000	1.878	87	1.900	86	1.923	85	1.948	85	1800
1100	1.965	82	1.986	82	2.008	82	2.033	80	1980
1200	2.047	80	2.068	80	2.090	79	2.113	77	2160
1300	2.127	77	2.148	76	2.169	75	2.190	76	2340
1400	2.204	76	2.224	74	2.244	73	2.266	72	2520
1500	2.280	71	2.298	71	2.317	72	2.338	70	2700
1600	2.351	71	2.369	70	2.389	68	2.408	69	2880
1700	2.422	67	2.439	68	2.457	67	2.477	66	3060
1800	2.489	67	2.507	66	2.524	66	2.543	64	3240
1900	2.556	65	2.573	63	2.590	63	2.607	63	3420
2000	2.621	63	2.636	63	2.653	63	2.670	62	3600
2100	2.684	62	2.699	62	2.716	61	2.732	61	3780
2200	2.746	60	2.761	60	2.777	60	2.793	60	3960
2300	2.806	59	2.821	59	2.837	58	2.853	58	4140
2400	2.865	58	2.880	57	2.895	57	2.911	56	4320
2500	2.923	57	2.937	57	2.952	56	2.967	56	4500
2600	2.980	55	2.994	55	3.008	55	3.023	55	4680
2700	3.035	56	3.049	54	3.063	54	3.078	53	4860
2800	3.091	53	3.103	54	3.117	54	3.131	54	5040
2900	3.144	52	3.157	53	3.171	52	3.185	52	5220
3000	3.196		3.210		3.223		3.237		5400

a_o = 323.64 m/sec = 1061.8 ft/sec

Table 16.32 Sound Velocity in Nitric Oxide a/a_0

T °K	Pressure 10 atm		40 atm		70 atm		100 atm		T °R
									306
170	.751	32							324
180	.783	28							342
190	.811	27							
									360
200	.838	24	.772	41	.681	70			378
210	.862	23	.813	35	.751	53			396
220	.885	23	.848	31	.804	44	.770	56	414
230	.908	22	.879	28	.848	37	.826	46	432
240	.930	21	.907	27	.885	33	.872	39	
									450
250	.951	21	.934	25	.918	30	.911	35	468
260	.972	20	.959	24	.948	28	.946	32	486
270	.992	20	.983	23	.976	27	.978	30	504
280	1.012	19	1.006	22	1.003	25	1.008	28	522
290	1.031	18	1.028	21	1.028	24	1.036	26	
									540
300	1.049	18	1.049	21	1.052	23	1.062	25	558
310	1.067	18	1.070	20	1.075	22	1.087	24	576
320	1.085	17	1.090	19	1.097	22	1.111	23	594
330	1.102	17	1.109	19	1.119	20	1.134	22	612
340	1.119	17	1.128	18	1.139	20	1.156	21	
									630
350	1.136	16	1.146	18	1.159	19	1.177	21	648
360	1.152	16	1.164	17	1.178	19	1.198	20	666
370	1.168	16	1.181	17	1.197	18	1.218	19	684
380	1.184	16	1.198	17	1.215	17	1.237	18	702
390	1.200	15	1.215	16	1.232	18	1.255	18	
									720
400	1.215	15	1.231	15	1.250	16	1.273	17	738
410	1.230	15	1.246	16	1.266	16	1.290	17	756
420	1.245	14	1.262	15	1.282	16	1.307	16	774
430	1.259	14	1.277	15	1.298	15	1.323	16	792
440	1.273	14	1.292	15	1.313	16	1.339	16	
									810
450	1.287		1.307		1.329		1.355		

a_0 = 323.64 m/sec = 1061.8 ft/sec

Table 16.32 Sound Velocity in Nitric Oxide

The Property Tabulated

The relative sound velocity, a/a_o, for a sound of low frequency in nitric oxide is tabulated as a function of temperature in ^oK and ^oR and of pressure in atmospheres. The sound velocity is represented by a, while a_o represents the value of a at the standard conditions of 0^oC and one atmosphere pressure. The values of the velocities are calculated from the ratios of specific heats, γ, the temperature, T, molecular weight, M, and compressibility factor, Z, and its derivatives. The values are obtained from the theoretical relation:

$$a = Z\sqrt{\frac{RT\gamma}{M[Z - P(\partial Z/\partial P)_T]}}$$

R is the gas constant in appropriate units and M is the molecular weight, 30.008. The values tabulated are for equilibrium conditions as far as internal molecular energy, intermolecular energies and kinetic energies are concerned and thus do not apply at very high frequencies. The effect of dissociation has not been included, so that the values are not strictly for zero frequency as would correspond to full equilibrium conditions at the highest temperatures.

Reliability of the Tables

The accuracy of the values tabulated varies with temperature and pressure. The uncertainty is roughly the same as that for γ in terms of departures from ideal gas values. It is thought that the uncertainty may amount to several percent of this departure.

The effect of dissociation is probably quite small, except for the low pressures at the highest temperatures covered. Below the very high temperatures, at which dissociation is appreciable, the table is more precise with increasing temperatures as the gas becomes more ideal.

Figure 1 shows the departures of the experimental values of the velocity of sound, from the values tabulated here. The data included are by Masson [3], Partington and Shilling [4], van Itterbeek and Thys [5], and Kneser [2]. Data by Bender [1] are omitted as they appear to have been affected by relaxation effects occurring at higher frequencies. Masson's measurements were made with a vibrating reed, Partington and Shilling's with a Kundt's tube, yielding the ratio of the wave lengths of sound in nitric oxide to that in dry air. Their values, as shown in the figure are based on this ratio and on the velocity of sound in air, according to Table 2.32 of this series.

Interpolation

Linear interpolation is valid throughout this table in that values so obtained appear to be reliable to within the accuracy of the table.

Conversion Factors

The tabulated quantity has been expressed in dimensionless form. Conversion factors are listed at the bottom of each page in ft sec^{-1} and meter sec^{-1}. For conversion to other units see Table 1.30 of this series.

REFERENCES

[1] D. Bender, Ultraschallgeschwindigkeiten in Stickstoff, Stickoxyd und Kohlenoxyd zwischen 20 und 200°C, gemessen mit einem neuen verfahren. Ann. d. Phys. 38, 199 (1940).

[2] H. O. Kneser, Schallabsorption, spezifische Wärme und Einstelldauer des Elektronenspins in Stickoxyd. Ann. Physik. 39, 261 (1941).

[3] A. Masson, On the velocity of sound in solids, liquids, and elastic fluids, and on the correlation of the physical properties of bodies. Phil. Mag. 13, 533 (1857).

[4] J. R. Partington and W. G. Shilling, The specific heats of nitrous and nitric oxides, Phil. Mag. 45, 416 (1923).

[5] A. van Itterbeek and L. Thys, Measurements on the velocity and the absorption of sound in gaseous nitric oxide in a magnetic field. Physica, 5, 640 (1938).

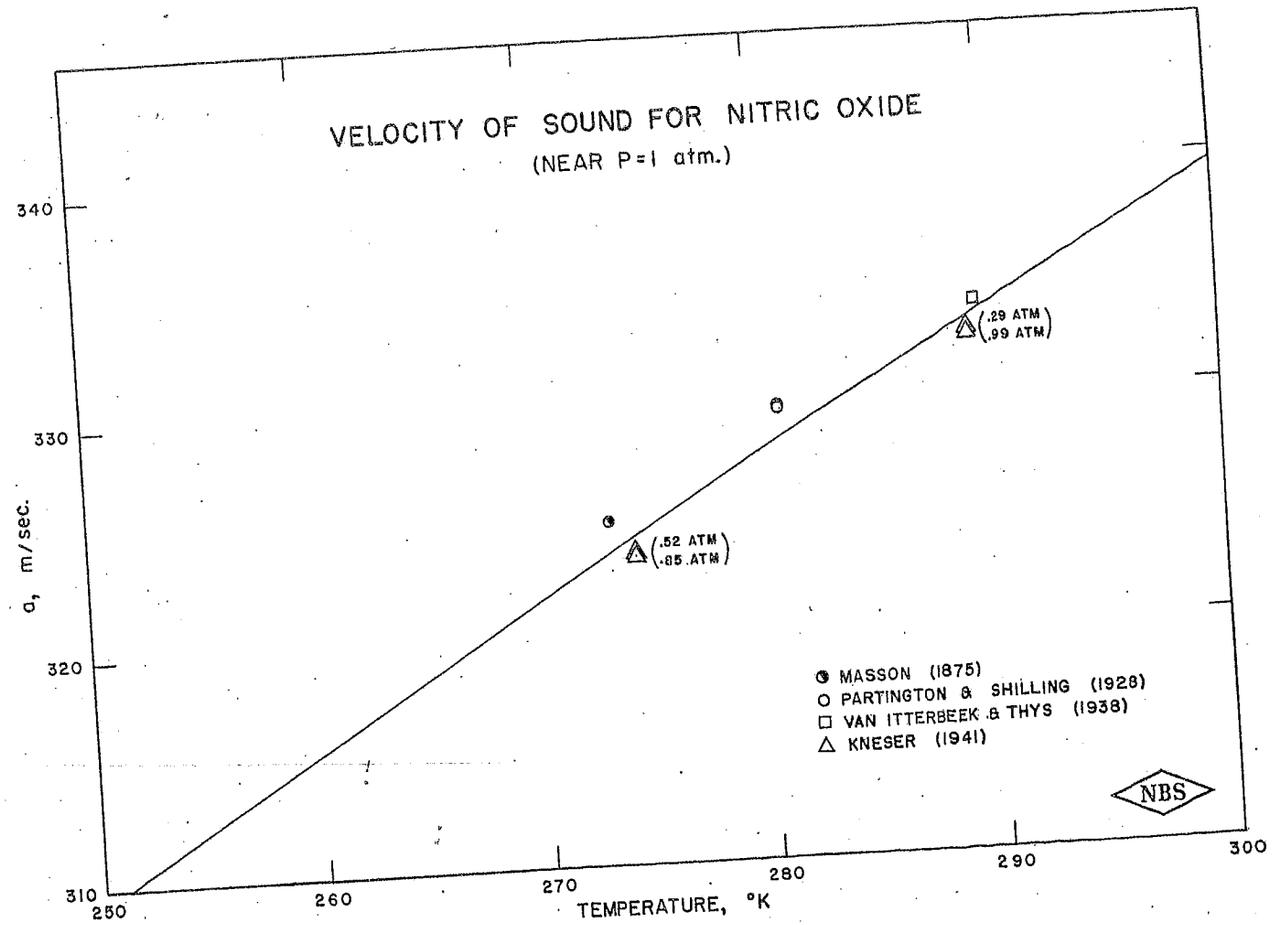

FIGURE 1.

U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 16.39 Coefficients of Viscosity of Nitric Oxide

Compiled by

Joseph Hilsenrath

Preliminary Issue
December 1950

Table 16.39 Coefficients of Viscosity of Nitric Oxide

The Property Tabulated

The absolute and kinematic viscosities of gaseous nitric oxide are given in this table for temperatures from 100°K to 1500°K (180°R to 2700°R) at one atmosphere pressure.

The absolute viscosity is given in the dimensionless form η/η_0 relative to the viscosity at 273.16°K and one atmosphere pressure, which is assumed to be 1792 x 10^{-7} poises. This value is in close agreement with the determination by Johnston and McCloskey [3], who found the viscosity to be 1790 x 10^{-7} poises at 273.16°K, based on the value 1833.0 x 10^{-7} poises as the viscosity of dry air at 296.1°K.

The viscosities in Table 16.39/1 were calculated using the Lennard-Jones potential, as applied by Hirschfelder, Bird, and Spotz [2], in which the potential energy of interaction between the two molecules is given by

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

where ϵ_m is the maximum energy of attraction and r_o is the low velocity collision diameter. The coefficient of viscosity for a single gas is given by

$$\eta \cdot 10^7 = \frac{266.93\ V}{r_o^2\ W^{(2)}(2)} \sqrt{MT}$$

where M is the molecular weight, T is the temperature in degrees Kelvin, and V and $W^{(2)}(2)$ are functions of kT/ϵ. Hirschfelder, et al [2], have calculated the collision integrals needed for the computation of the transport properties, and have suggested the parameters for 45 gases. For nitric oxide they are $\epsilon/k = 119$, and $r_o = 3.47$. The computation was based on these constants and was facilitated by the use of Bromley's adaptation [1] of the Hirschfelder tables.

There is little evidence of the variation of the viscosity of nitric oxide with pressure.

The dimensionless form ν/ν_0 of the kinematic viscosity listed in Table 16.39/2 was obtained by dividing each entry of Table 16.39/1 by the appropriate value of ρ/ρ_0 from Table 16.18.

Reliability of the Table

The absolute viscosities fit the limited experimental data of Webser and Müller [4] and those of Johnston and McCloskey [3] well within 1%. The values above 300°K are extrapolated beyond the experimental range and are believed reliable within 2%.

The kinematic viscosities are equally reliable.

Interpolation

Linear interpolation is valid in this table.

Conversion Factors

The function in this table has been expressed in dimensionless form. In order that it may be converted readily to any system of units, conversion factors are listed for the frequently used units. For conversion factors not listed here, see Table 1.30 of this series.

CONVERSION FACTORS

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply By
η/η_0	η	poise or g (M) sec^{-1} cm^{-1}	1792.0×10^{-7}
		kg (M) hr^{-1} m^{-1}	6.4512×10^{-2}
		lb (F) sec ft^{-2}	3.7428×10^{-7}
		lb (M) sec^{-1} ft^{-1}	1.2041×10^{-5}
		lb (M) hr^{-1} ft^{-1}	4.3350×10^{-2}

REFERENCES

[1] LeRoy A. Bromley, "Calculation of gas viscosity as a function of temperature," U. S. Atomic Energy Comm., UCRL-525 (1949).

[2] J. O. Hirschfelder, R. B. Bird, E. L. Spotz, Viscosity and other physical properties of gases and gas mixtures, Trans. ASME, 48,921 (1949).

[3] H. L. Johnston and K. E. McCloskey, Viscosity of common gases from 90° absolute to room temperature, J. Phys. Chem., 44,1038 (1940).

[4] R. Webser and Fr. Müller, Die innere Reiburg von Gasen und Dämpfen und ihre Messung. Kolloid Beihefte 52,165 (1941).

Table 10.39/1 Coefficient of Viscosity for Nitric Oxide

T °K	η/η_0		T °R
100	.3906	398	180
110	.4304	394	198
120	.4698	389	216
130	.5087	384	234
140	.5471	379	252
150	.5850	372	270
160	.6222	366	288
170	.6588	360	306
180	.6948	352	324
190	.7300	348	342
200	.7648	342	360
210	.7990	332	378
220	.8322	328	396
230	.8650	320	414
240	.8970	317	432
250	.9287	311	450
260	.9598	305	468
270	.9903	300	486
280	1.0203	298	504
290	1.0501	292	522
300	1.0793	285	540
310	1.1078	283	558
320	1.1361	277	576
330	1.1638	273	594
340	1.1911	27	612
350	1.218	27	630
360	1.245	26	648
370	1.271	26	666
380	1.297	26	684
390	1.323	25	702
400	1.348		720

T °K	η/η_0		T °R
400	1.348	25	720
410	1.373	25	738
420	1.398	24	756
430	1.422	24	774
440	1.446	24	792
450	1.470	24	810
460	1.494	24	828
470	1.518	23	846
480	1.541	23	864
490	1.564	23	882
500	1.587	22	900
510	1.609	23	918
520	1.632	22	936
530	1.654	22	954
540	1.676	22	972
550	1.698	21	990
560	1.719	22	1008
570	1.741	21	1026
580	1.762	21	1044
590	1.783	21	1062
600	1.804	21	1080
610	1.825	20	1098
620	1.845	21	1116
630	1.866	21	1134
640	1.887	20	1152
650	1.907	20	1170
660	1.927	19	1188
670	1.946	20	1206
680	1.966	20	1224
690	1.986	20	1242
700	2.006	20	1260
710	2.026	20	1278
720	2.046	19	1296
730	2.065	19	1314
740	2.084	19	1332
750	2.103	19	1350
760	2.122	18	1368
770	2.140	19	1386
780	2.159	19	1404
790	2.178	18	1422
800	2.196		1440

T °K	η/η_0		T °R
800	2.196	19	1440
810	2.215	18	1458
820	2.233	19	1476
830	2.252	18	1494
840	2.270	18	1512
850	2.288	18	1530
860	2.306	18	1548
870	2.324	18	1566
880	2.342	17	1584
890	2.359	18	1602
900	2.377	17	1620
910	2.394	17	1638
920	2.411	18	1656
930	2.429	17	1674
940	2.446	17	1692
950	2.463	18	1710
960	2.481	17	1728
970	2.498	17	1746
980	2.515	16	1764
990	2.531	17	1782
1000	2.548	17	1800
1010	2.565	17	1818
1020	2.582	17	1836
1030	2.599	17	1854
1040	2.616	16	1872
1050	2.632	17	1890
1060	2.649	16	1908
1070	2.665	16	1926
1080	2.681	17	1944
1090	2.698	16	1962
1100	2.714	16	1980
1110	2.730	16	1998
1120	2.746	17	2016
1130	2.763	16	2034
1140	2.779	16	2052
1150	2.795	16	2070
1160	2.811	16	2088
1170	2.827	15	2106
1180	2.842	16	2124
1190	2.858	16	2142
1200	2.874		2160

Table 16.39/2 Coefficient of Kinematic Viscosity for Nitric Oxide

T °K	ν/ν_0		T °R
100	.1310	351	180
110	.1661	355	198
120	.2016	369	216
130	.2385	389	234
140	.2774	412	252
150	.3186	435	270
160	.3621	459	288
170	.4080	480	306
180	.4560	502	324
190	.5062	53	342
200	.559	54	360
210	.613	56	378
220	.669	59	396
230	.728	60	414
240	.788	62	432
250	.850	63	450
260	.913	66	468
270	.979	67	486
280	1.046	69	504
290	1.115	71	522
300	1.186	72	540
310	1.258	74	558
320	1.332	75	576
330	1.407	77	594
340	1.484	8	612
350	1.56	8	630
360	1.64	8	648
370	1.72	9	666
380	1.81	8	684
390	1.89	9	702
400	1.98		720

T °K	ν/ν_0		T °R
400	1.98	8	720
410	2.06	9	738
420	2.15	9	756
430	2.24	9	774
440	2.33	10	792
450	2.43	9	810
460	2.52	10	828
470	2.62	9	846
480	2.71	10	864
490	2.81	10	882
500	2.91	10	900
510	3.01	10	918
520	3.11	10	936
530	3.21	11	954
540	3.32	10	972
550	3.42	11	990
560	3.53	11	1008
570	3.64	11	1026
580	3.75	11	1044
590	3.86	11	1062
600	3.97	11	1080
610	4.08	11	1098
620	4.19	12	1116
630	4.31	12	1134
640	4.43	12	1152
650	4.55	11	1170
660	4.66	12	1188
670	4.78	12	1206
680	4.90	12	1224
690	5.02	13	1242
700	5.15	12	1260
710	5.27	13	1278
720	5.40	13	1296
730	5.53	12	1314
740	5.65	13	1332
750	5.78	13	1350
760	5.91	13	1368
770	6.04	13	1386
780	6.17	14	1404
790	6.31	13	1422
800	6.44		1440

T °K	ν/ν_0		T °R
800	6.44	14	1440
810	6.58	13	1458
820	6.71	14	1476
830	6.85	14	1494
840	6.99	14	1512
850	7.13	14	1530
860	7.27	14	1548
870	7.41	15	1566
880	7.56	14	1584
890	7.70	14	1602
900	7.84	15	1620
910	7.99	14	1638
920	8.13	15	1656
930	8.28	15	1674
940	8.43	15	1692
950	8.58	15	1710
960	8.73	15	1728
970	8.88	16	1746
980	9.04	15	1764
990	9.19	15	1782
1000	9.34	16	1800
1010	9.50	16	1818
1020	9.66	16	1836
1030	9.82	15	1854
1040	9.97	16	1872
1050	10.13	17	1890
1060	10.30	16	1908
1070	10.46	15	1926
1080	10.61	17	1944
1090	10.78	16	1962
1100	10.94	17	1980
1110	11.11	17	1998
1120	11.28	17	2016
1130	11.45	16	2034
1140	11.61	17	2052
1150	11.78	17	2070
1160	11.95	17	2088
1170	12.12	17	2106
1180	12.29	18	2124
1190	12.47	18	2142
1200	12.65		2160

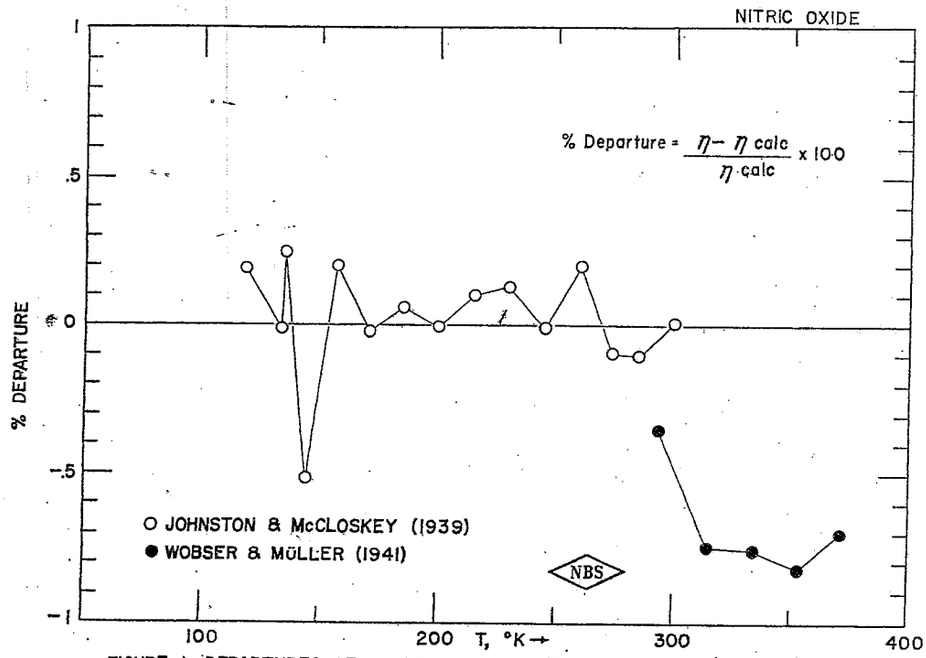

FIGURE 1. DEPARTURES OF EXPERIMENAL VISCOSITIES FROM TABLE 16.39

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, *Secretary*

NATIONAL BUREAU OF STANDARDS
E. U. Condon, *Director*

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 16.42 Nitric Oxide

July 1951

Thermal Conductivity

k/k_0

Compiled by R. L. Nuttall

FOREWORD

This is one of a series of tables of Thermal Properties of Gases being compiled at the National Bureau of Standards at the suggestion and with the cooperation of the National Advisory Committee for Aeronautics. Recent advances in methods of propulsion and the high speeds attained thereby have emphasized the importance of accurate data on thermal properties of wind-tunnel and jet-engine gases. It is the purpose of the project on Thermal Properties of Gases to make a critical compilation of existing published and unpublished data, and to present such data in convenient form for application. The loose-leaf form has been chosen as being most convenient, and revisions are anticipated as new data become available.

The dimensionless character of the tables and their general format should facilitate calculations in aerodynamics, heat-transfer, and jet-engine problems. Suggestions for the extension or improvement of these tables are desired as well as information regarding unpublished data. Information and other correspondence regarding these tables should be addressed to *Joseph Hilsenrath*, Heat and Power Division, National Bureau of Standards.

Table 16.42 Thermal Conductivity of Nitric Oxide

T	k/k_0	Δ	T
°K			°R
120	.4546	374	216
130	.4920	371	234
140	.5291	372	252
150	.5663	368	270
160	.6031	367	288
170	.6398	364	306
180	.6762	360	324
190	.7122	358	342
200	.7480	352	360
210	.7832	349	378
220	.8181	347	396
230	.8528	344	414
240	.8872	341	432
250	.9213	342	450
260	.9555	341	468
270	.9896	338	486
280	1.0234	338	504
290	1.0572	335	522
300	1.0907	335	540
310	1.1242	333	558
320	1.1575	332	576
330	1.1907	331	594
340	1.2238	330	612
350	1.2568	329	630
360	1.2897	328	648
370	1.3225	328	666
380	1.3553		684

CONVERSION FACTORS

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
k/k_0	k	cal cm^{-1} sec^{-1} $°K^{-1}$	5.674×10^{-5}
		Btu ft^{-1} hr^{-1} $°R^{-1}$	1.372×10^{-2}
		watts cm^{-1} $°K^{-1}$	2.374×10^{-4}

TABLE 16.42 THERMAL CONDUCTIVITY OF NITRIC OXIDE

THE PROPERTY TABULATED

This table gives in dimensionless form as a function of temperature in degrees Kelvin and degrees Rankine, the thermal conductivity of nitric oxide. The tabulated values are the smooth values of Johnston and Grilly [2]. They have been made dimensionless by dividing by $k_0 = 5.674 \times 10^{-5}$ cal cm^{-1} sec^{-1} $°C^{-1}$, which is the thermal conductivity of nitric oxide at 0°C and 1 atmosphere. These values apply at low to moderate pressures.

RELIABILITY OF THE TABLE

The values given in this table are considered to be reliable within 0.3%. The accompanying graph shows the deviations of the tabulated values from experimental data to be about 0.2%.

INTERPOLATION

Linear interpolation is valid in this table.

CONVERSION FACTORS

The function in this table has been expressed in dimensionless form. In order that it may be converted readily to any system of units, conversion factors are listed for the frequently used units. For conversion factors not listed here see Table 1.30 of this series.

REFERENCES

[1] A. Eucken, The thermal conductivity, the specific heat, and the viscosity of gases, Physik. Z. 14, 324 (1913).

[2] H. L. Johnston and E. R. Grilly, An improved hot-wire cell for accurate measurements of thermal conductivities of gases over a wide temperature range, J. Chem. Phys. 14, 219 (1946).

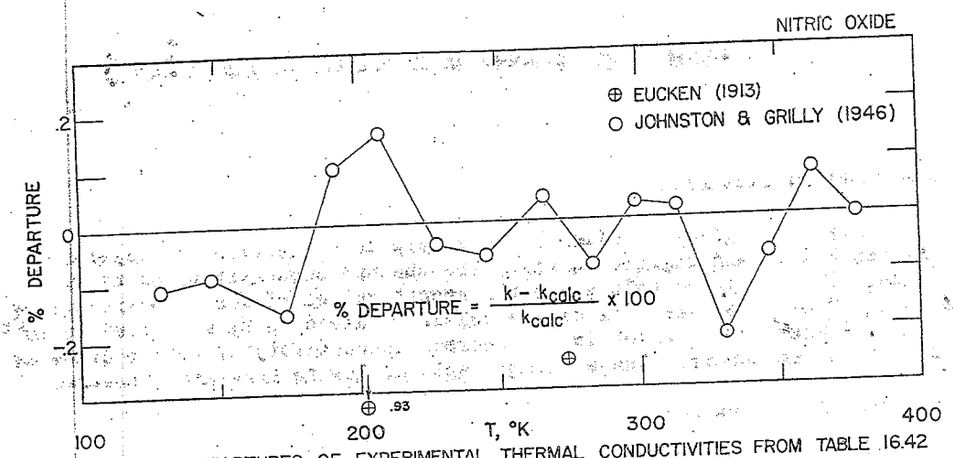

FIGURE I. DEPARTURES OF EXPERIMENTAL THERMAL CONDUCTIVITIES FROM TABLE 16.42

U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 16.50 Vapor Pressure of Nitric Oxide

Compiled by

Robert L. Powell

Reissue
1953

TABLE 16.50/1 VAPOR PRESSURE OF SOLID NITRIC OXIDE

T °K	$\log_{10}$P mm Hg*	Δ	P mm Hg	P atm	P psia	T °R
75	8.55034		0.0355	.000047	0.00069	135.0
		.15299				
76	8.70333		0.0505	.000066	0.00098	136.8
		.14900				
77	8.85233		0.0712	.000094	0.00138	138.6
		.14517				
78	8.99750		0.0994	.000131	0.00192	140.4
		.14149				
79	9.13899		0.1377	.000181	0.00266	142.2
		.13794				
80	9.27693		0.1892	.000249	0.00366	144.0
		.13452				
81	9.41145		0.2579	.000339	0.00500	145.8
		.13125				
82	9.54270		0.3489	.000459	0.00675	147.6
		.12806				
83	9.67076		0.4686	.000617	0.00906	149.4
		.12504				
84	9.79580		0.6249	.000822	0.01208	151.2
		.12203				
85	9.91783		0.8276	.001089	0.01600	153.0
		.11921				
86	0.03704		1.089	.001433	0.02106	154.8
		.11647				
87	0.15351		1.424	.001874	0.02754	156.6
		.11382				
88	0.26733		1.851	.002436	0.03579	158.4
		.11125				
89	0.37858		2.391	.003146	0.04623	160.2
		.10878				
90	0.48736		3.072	.004042	0.05940	162.0
		.10638				
91	0.59374		3.924	.005163	0.07588	163.8
		.10406				
92	0.69780		4.987	.006561	0.09643	165.6
		.10182				
93	0.79962		6.304	.008295	0.1219	167.4
		.09967				
94	0.89929		7.930	.01043	0.1533	169.2
		.09784				
95	0.99713		9.934	.01307	0.1921	171.0
		.9583				
96	1.09296		12.39	.01630	0.2396	172.8
		.9387				
97	1.18683		15.38	.02024	0.2974	174.6
		.9196				
98	1.27879		19.00	.02500	0.3674	176.4
		.9012				
99	1.36891		23.48	.03089	0.4540	178.2
		.8834				
100	1.45725		28.66	.03771	0.5542	180.0
		.8660				
101	1.54385		34.98	.04603	0.6764	181.8
		.8492				
102	1.62877		42.54	.05597	0.8226	183.6
		.8328				
103	1.71205		51.53	.06780	0.9964	185.4
		.8170				
104	1.79375		62.19	.08183	1.2026	187.2
		.8016				
105	1.87391		74.80	.09842	1.4464	189.0
		.7865				
106	1.95256		89.65	.11796	1.7336	190.8
		.7721				
107	2.02977		107.10	.14092	2.0710	192.6
		.7578				
108	2.10555		119.91	.16778	2.4657	194.4
		.7441				
109	2.17996		151.34	.19913	2.9265	196.2
		.7307				

*To convert to Log_{10}P(atm) subtract 2.88081
To convert to Log_{10}P(psia) subtract 1.71361

TABLE 16.50/2 VAPOR PRESSURE OF LIQUID NITRIC OXIDE

T °K	Log_{10} P mm Hg *	Δ	P mm Hg	P atm	P psia	T °R
						196.2
109	(2.18489)	6286				
110	2.24775	6160	176.91	.23278	3.4209	198.0
111	2.30935	6038	203.87	.26825	3.9422	199.8
112	2.36973	5917	234.28	.30826	4.5303	201.6
113	2.42890	5801	268.47	.35325	5.1914	203.4
114	2.48691	5688	306.84	.40374	5.9334	205.2
115	2.54379	5577	349.78	.46024	6.7637	207.0
116	2.59956	5470	397.71	.52330	7.6905	208.8
117	2.65426	5365	451.09	.59354	8.7227	210.6
118	2.70791	5262	510.40	.67158	9.8696	212.4
119	2.76053	5163	576.14	.75808	11.141	214.2
120	2.81216	5066	648.87	.85378	12.547	216.0
121	2.86282	4970	729.16	.95942	14.100	217.8
122	2.91252	4877	817.56	1.0757	15.809	219.6
123	2.96129	4789	914.72	1.2036	17.688	221.4
124	3.00918	4700	1021.4	1.3439	19.751	223.2
125	3.05618	4614	1138.1	1.4975	22.007	225.0
126	3.10232	4530	1265.7	1.6654	24.475	226.8
127	3.14762	4448	1404.8	1.8484	27.165	228.6
128	3.19210	4367	1556.3	2.0478	30.094	230.4
129	3.23577	4289	1721.0	2.2645	33.279	232.2
130	3.2787	421	1900	2.500	36.74	234.0
131	3.3208	414	2093	2.754	40.47	235.8
132	3.3622	406	2303	3.030	44.53	237.6
133	3.4028	400	2528	3.326	48.88	239.4
134	3.4428	392	2772	3.647	53.60	241.2
135	3.4820	386	3034	3.992	58.67	243.0
136	3.5206	378	3316	4.363	64.12	244.8
137	3.5584	373	3617	4.759	69.94	246.6
138	3.5957	366	3942	5.187	76.23	248.4
139	3.6323	359	4288	5.642	82.92	250.2
140	3.6682	354	4658	6.129	90.07	252.0
141	3.7036	348	5054	6.650	97.73	253.8
142	3.7384	341	5475	7.204	105.9	255.6
143	3.7725	336	5922	7.792	114.5	257.4
144	3.8061	331	6399	8.420	123.7	259.2
145	3.8392		6906	9.087	133.5	261.0

*The figure in parenthesis is an extrapolated value to facilitate interpolation down to the triple point.

TABLE 16.50/2 VAPOR PRESSURE OF LIQUID NITRIC OXIDE (Continued)

T °K	$Log_{10}P$ mm Hg		P mm Hg	P atm	P psia	T °R
145	3.8392	325	6906	9.087	133.5	261.0
146	2.8717	319	7442	9.792	143.9	262.8
147	3.9036	314	8009	10.538	154.9	264.6
148	3.9350	309	8600	11.32	166.3	266.4
149	3.9659	304	9245	12.16	178.8	268.2
150	3.9963	299	9915	13.05	191.7	270.0
151	4.0262	294	10620	13.97	205.4	271.8
152	4.0556	289	11370	14.96	219.9	273.6
153	4.0845	285	12150	15.99	234.9	275.4
154	4.1130	280	12970	17.07	250.8	277.2
155	4.1410	275	13840	18.21	267.6	279.0
156	4.1685	271	14740	19.39	285.0	280.8
157	4.1956	267	15690	20.64	303.4	282.6
158	4.2223	262	16680	21.95	322.5	284.4
159	4.2485	258	17720	23.32	342.7	286.2
160	4.2743	254	18810	24.75	363.7	288.0
161	4.2997	251	19940	26.24	385.6	289.8
162	4.3248	246	21130	27.80	408.6	291.6
163	4.3494	242	22360	29.42	432.4	293.4
164	4.3736	238	23640	31.11	457.1	295.2
165	4.3974	235	24970	32.86	482.8	297.0
166	4.4209	231	26360	34.68	509.7	298.8
167	4.4440	228	27800	36.58	537.6	300.6
168	4.4668	224	29300	38.55	566.6	302.4
169	4.4892	220	30850	40.59	596.5	304.2
170	4.5112	217	32450	42.70	627.5	306.0
171	4.5329	214	34110	44.88	659.6	307.8
172	4.5543	210	35830	47.14	692.8	309.6
173	4.5753	207	37610	49.49	727.3	311.4
174	4.5960	204	39500	51.97	763.8	313.2
175	4.6164	201	41340	54.39	799.4	315.0
176	4.6365	197	43300	56.97	837.3	316.8
177	4.6562	195	45310	59.62	876.2	318.6
178	4.6757	192	47390	62.36	916.4	320.4
179	4.6949	189	49530	65.17	957.8	322.2
180	4.7138		51740	68.08	1000.5	324.0

TABLE 16.50/3 FIXED POINTS OF NITRIC OXIDE

	T		P		
	°K	°R	mm Hg	atm	psia
Triple Point	109.49	197.08	164.38	0.21629	3.1786
Boiling Point	121.36	218.45	760.00	1.00000	14.696
Critical Point	180.	324.	51740.	68.08	1000.

Table 16.50 The Vapor Pressure of Nitric Oxide

Property Tabulated

The vapor pressures of solid nitric oxide are tabulated by 1°K intervals from 75°K to 109°K in table 16.50/1, those of the liquid from 110°K to the critical temperature, 180°K, in table 16.50/2. The temperatures and pressures of the triple point, boiling point, and critical point are given in table 16.50/3. The values are based primarily on the results of Johnston and Giauque [6] in 1929 for the range from 94°K to 123°K. The less accurate measurements by Henglein and Krüger and Adwentowski at temperatures below and above this range were adjusted to fit the data of Johnston and Giauque.

The vapor pressures of the solid nitric oxide from 75°K to 94°K were computed from the formula

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-867.4}{T-0.2^\circ K} + 10.1466, \quad (75^\circ < T < 94^\circ),$$

suggested (without the -0.2°K) by Henglein and Krüger [4] in 1923. The 0.2 °K correction in the denominator is needed to bring the values of Henglein and Krüger into agreement at 94°K with the values of Johnston and Giauque. The vapor pressures of the solid from 94°K to the triple point, 109.49°K, were computed from

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-867}{T} + 0.00076\ T + 10.05125, \quad (94 < T < 109.49),$$

given by Johnston and Giauque. The vapor pressures of the liquid were computed from

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-840}{T} - 0.719570\ T + 10.675644, \quad (109.49 < T < 180).$$

This equation is based on the determinations of Johnston and Giauque from 109.49°K to 123°K and the values given by Adwentowski [1] in 1910 from 144°K to 180°K. The latter were adjusted to fit the former near the boiling point by correcting the temperatures of Adwentowski by approximately 1°K.

Reliability

A principal source of error is the impurity of the samples in the earlier work. The large scatter of data at the higher pressures may indicate relatively poor temperature control and measurement. The estimated errors of the tabulated values for the vapor pressure of the solid from 75°K to 94°K are 0.5°K. The values for the solid vapor pressure from 94°K to 109.49°K and the liquid from 109.49°K to 125°K are based on the work of Johnston and Giauque and are reliable to within 0.05°K. Above 125°K the estimated errors increase rapidly to 3°K. The critical temperature is uncertain by 2°K.

Interpolation

In the temperature range 95°K to 125°K, where the tables are most precise, linear interpolation is recommended in the $\log_{10} P$ column. Outside of this temperature range interpolation in the pressure columns will yield values as reliable as those tabulated.

REFERENCES

[1] K. Adwentowski, Ueber das Verhalten des Stickoxyds bei niederen Temperaturen, Ion, 2,1 (1910). Zeitschrift fur kompr. und fluss. Gase, 13,1 and 19 (1910). Acad. des Sciences- Cracovie- Bull. Int., 742 (1909).

[2] Gray, H. W., The atomic weight of nitrogen, J. Chem. Soc., 87,1601 (1905).

[3] Goldschmidt, H., Der Dampfdruck des Stickoxyds, Zeitschrift für Physik, 20,159 (1923).

[4] Henglein, F. A., Chemische Konstanten und kritische Daten, Zeitschrift für anorg. und allg. Chemie, 114,234 (1920).

[5] Henglein, F. A., and Krüger, H., Dampfdruckmessungen von Stickoxyd, Zeitschrift für anorg. und allg. Chemie, 130,181 (1923).

[6] Johnston, H. L. and Giauque, W. F., The heat capacity of nitric oxide ... Vapor pressures ... The entropy ... J. Am. Chem. Soc., 512,3194 (1929).

[7] Olszewski, K., Liquefaction et solidification du formene et du deutoxyde d'azote, Comptes Rendus, 100,940 (1885).

[8] Pickering, S. F., A review of the critical constants of various gases, NBS Sci. Papers, 541, vol. 21,597 (1926).

[9] Travers, Experimental Study of Gases, 1901, London, Macmillan.

U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

THE NBS-NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 16.50 Vapor Pressure of Nitric Oxide

Compiled by

Robert L. Powell

Reissue
1953

TABLE 16.50/1 VAPOR PRESSURE OF SOLID NITRIC OXIDE

T °K	$\log_{10}$P mm Hg*	Δ	P mm Hg	P atm	P psia	T °R
75	8.55034	.15299	0.0355	.000047	0.00069	135.0
76	8.70333	.14900	0.0505	.000066	0.00098	136.8
77	8.85233	.14517	0.0712	.000094	0.00138	138.6
78	8.99750	.14149	0.0994	.000131	0.00192	140.4
79	9.13899	.13794	0.1377	.000181	0.00266	142.2
80	9.27693	.13452	0.1892	.000249	0.00366	144.0
81	9.41145	.13125	0.2579	.000339	0.00500	145.8
82	9.54270	.12806	0.3489	.000459	0.00675	147.6
83	9.67076	.12504	0.4686	.000617	0.00906	149.4
84	9.79580	.12203	0.6249	.000822	0.01208	151.2
85	9.91783	.11921	0.8276	.001089	0.01600	153.0
86	0.03704	.11647	1.089	.001433	0.02106	154.8
87	0.15351	.11382	1.424	.001874	0.02754	156.6
88	0.26733	.11125	1.851	.002436	0.03579	158.4
89	0.37858	.10878	2.391	.003146	0.04623	160.2
90	0.48736	.10638	3.072	.004042	0.05940	162.0
91	0.59374	.10406	3.924	.005163	0.07588	163.8
92	0.69780	.10182	4.987	.006561	0.09643	165.6
93	0.79962	.09967	6.304	.008295	0.1219	167.4
94	0.89929	.09784	7.930	.01043	0.1533	169.2
95	0.99713	.9583	9.934	.01307	0.1921	171.0
96	1.09296	.9387	12.39	.01630	0.2396	172.8
97	1.18683	.9196	15.38	.02024	0.2974	174.6
98	1.27879	.9012	19.00	.02500	0.3674	176.4
99	1.36891	.8834	23.48	.03089	0.4540	178.2
100	1.45725	.8660	28.66	.03771	0.5542	180.0
101	1.54385	.8492	34.98	.04603	0.6764	181.8
102	1.62877	.8328	42.54	.05597	0.8226	183.6
103	1.71205	.8170	51.53	.06780	0.9964	185.4
104	1.79375	.8016	62.19	.08183	1.2026	187.2
105	1.87391	.7865	74.80	.09842	1.4464	189.0
106	1.95256	.7721	89.65	.11796	1.7336	190.8
107	2.02977	.7578	107.10	.14092	2.0710	192.6
108	2.10555	.7441	119.91	.16778	2.4657	194.4
109	2.17996	.7307	151.34	.19913	2.9265	196.2

*To convert to $\log_{10}$P(atm) subtract 2.88081
To convert to $\log_{10}$P(psia) subtract 1.71361

TABLE 16.50/2 VAPOR PRESSURE OF LIQUID NITRIC OXIDE

T °K	$\log_{10}$ P mm Hg *	Δ	P mm Hg	P atm	P psia	T °R
						196.2
109	(2.18489)	6286	176.91	.23278	3.4209	198.0
110	2.24775	6160	203.87	.26825	3.9422	199.8
111	2.30935	6038	234.28	.30826	4.5303	201.6
112	2.36973	5917	268.47	.35325	5.1914	203.4
113	2.42890	5801	306.84	.40374	5.9334	205.2
114	2.48691	5688				
115	2.54379	5577	349.78	.46024	6.7637	207.0
116	2.59956	5470	397.71	.52330	7.6905	208.8
117	2.65426	5365	451.09	.59354	8.7227	210.6
118	2.70791	5262	510.40	.67158	9.8696	212.4
119	2.76053	5163	576.14	.75808	11.141	214.2
120	2.81216	5066	648.87	.85378	12.547	216.0
121	2.86282	4970	729.16	.95942	14.100	217.8
122	2.91252	4877	817.56	1.0757	15.809	219.6
123	2.96129	4789	914.72	1.2036	17.688	221.4
124	3.00918	4700	1021.4	1.3439	19.751	223.2
125	3.05618	4614	1138.1	1.4975	22.007	225.0
126	3.10232	4530	1265.7	1.6654	24.475	226.8
127	3.14762	4448	1404.8	1.8484	27.165	228.6
128	3.19210	4367	1556.3	2.0478	30.094	230.4
129	3.23577	4289	1721.0	2.2645	33.279	232.2
130	3.2787	421	1900	2.500	36.74	234.0
131	3.3208	414	2093	2.754	40.47	235.8
132	3.3622	406	2303	3.030	44.53	237.6
133	3.4028	400	2528	3.326	48.88	239.4
134	3.4428	392	2772	3.647	53.60	241.2
135	3.4820	386	3034	3.992	58.67	243.0
136	3.5206	378	3316	4.363	64.12	244.8
137	3.5584	373	3617	4.759	69.94	246.6
138	3.5957	366	3942	5.187	76.23	248.4
139	3.6323	359	4288	5.642	82.92	250.2
140	3.6682	354	4658	6.129	90.07	252.0
141	3.7036	348	5054	6.650	97.73	253.8
142	3.7384	341	5475	7.204	105.9	255.6
143	3.7725	336	5922	7.792	114.5	257.4
144	3.8061	331	6399	8.420	123.7	259.2
145	3.8392		6906	9.087	133.5	261.0

*The figure in parenthesis is an extrapolated value to facilitate interpolation down to the triple point.

TABLE 16.50/2 VAPOR PRESSURE OF LIQUID NITRIC OXIDE (Continued)

T °K	$Log_{10}P$ mm Hg		P mm Hg	P atm	P psia	T °R
145	3.8392	325	6906	9.087	133.5	261.0
146	3.8717	319	7442	9.792	143.9	262.8
147	3.9036	314	8009	10.538	154.9	264.6
148	3.9350	309	8600	11.32	166.3	266.4
149	3.9659	304	9245	12.16	178.8	268.2
150	3.9963	299	9915	13.05	191.7	270.0
151	4.0262	294	10620	13.97	205.4	271.8
152	4.0556	289	11370	14.96	219.9	273.6
153	4.0845	285	12150	15.99	234.9	275.4
154	4.1130	280	12970	17.07	250.8	277.2
155	4.1410	275	13840	18.21	267.6	279.0
156	4.1685	271	14740	19.39	285.0	280.8
157	4.1956	267	15690	20.64	303.4	282.6
158	4.2223	262	16680	21.95	322.5	284.4
159	4.2485	258	17720	23.32	342.7	286.2
160	4.2743	254	18810	24.75	363.7	288.0
161	4.2997	251	19940	26.24	385.6	289.8
162	4.3248	246	21130	27.80	408.6	291.6
163	4.3494	242	22360	29.42	432.4	293.4
164	4.3736	238	23640	31.11	457.1	295.2
165	4.3974	235	24970	32.86	482.8	297.0
166	4.4209	231	26360	34.68	509.7	298.8
167	4.4440	228	27800	36.58	537.6	300.6
168	4.4668	224	29300	38.55	566.6	302.4
169	4.4892	220	30850	40.59	596.5	304.2
170	4.5112	217	32450	42.70	627.5	306.0
171	4.5329	214	34110	44.88	659.6	307.8
172	4.5543	210	35830	47.14	692.8	309.6
173	4.5753	207	37610	49.49	727.3	311.4
174	4.5960	204	39500	51.97	763.8	313.2
175	4.6164	201	41340	54.39	799.4	315.0
176	4.6365	197	43300	56.97	837.3	316.8
177	4.6562	195	45310	59.62	876.2	318.6
178	4.6757	192	47390	62.36	916.4	320.4
179	4.6949	189	49530	65.17	957.8	322.2
180	4.7138		51740	68.08	1000.5	324.0

TABLE 16.50/3 FIXED POINTS OF NITRIC OXIDE

	T		P		
	°K	°R	mm Hg	atm	psia
Triple Point	109.49	197.08	164.38	0.21629	3.1786
Boiling Point	121.36	218.45	760.00	1.00000	14.696
Critical Point	180.	324.	51740.	68.08	1000.

Table 16.50 The Vapor Pressure of Nitric Oxide

Property Tabulated

The vapor pressures of solid nitric oxide are tabulated by 1°K intervals from 75°K to 109°K in table 16.50/1, those of the liquid from 110°K to the critical temperature, 180°K, in table 16.50/2. The temperatures and pressures of the triple point, boiling point, and critical point are given in table 16.50/3. The values are based primarily on the results of Johnston and Giauque [6] in 1929 for the range from 94°K to 123°K. The less accurate measurements by Henglein and Krüger and Adwentowski at temperatures below and above this range were adjusted to fit the data of Johnston and Giauque.

The vapor pressures of the solid nitric oxide from 75°K to 94°K were computed from the formula

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-867.4}{T-0.2^\circ K} + 10.1466, \quad (75^\circ < T < 94^\circ),$$

suggested (without the -0.2°K) by Henglein and Krüger [4] in 1923. The 0.2 °K correction in the denominator is needed to bring the values of Henglein and Krüger into agreement at 94°K with the values of Johnston and Giauque. The vapor pressures of the solid from 94°K to the triple point, 109.49°K, were computed from

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-867}{T} + 0.00076\,T + 10.05125, \quad (94 < T < 109.49),$$

given by Johnston and Giauque. The vapor pressures of the liquid were computed from

$$\text{Log}_{10}P \text{ (mm Hg)} = \frac{-840}{T} - 0.719570\,T + 10.675644, \quad (109.49 < T < 180).$$

This equation is based on the determinations of Johnston and Giauque from 109.49°K to 123°K and the values given by Adwentowski [1] in 1910 from 144°K to 180°K. The latter were adjusted to fit the former near the boiling point by correcting the temperatures of Adwentowski by approximately 1°K.

Reliability

A principal source of error is the impurity of the samples in the earlier work. The large scatter of data at the higher pressures may indicate relatively poor temperature control and measurement. The estimated errors of the tabulated values for the vapor pressure of the solid from 75°K to 94°K are 0.5°K. The values for the solid vapor pressure from 94°K to 109.49°K and the liquid from 109.49°K to 125°K are based on the work of Johnston and Giauque and are reliable to within 0.05°K. Above 125°K the estimated errors increase rapidly to 3°K. The critical temperature is uncertain by 2°K.

Interpolation

In the temperature range 95°K to 125°K, where the tables are most precise, linear interpolation is recommended in the $\log_{10} P$ columns. Outside of this temperature range interpolation in the pressure columns will yield values as reliable as those tabulated.

REFERENCES

[1] K. Adwentowski, Ueber das Verhalten des Stickoxyds bei niederen Temperaturen, Ion, 2,1 (1910). Zeitschrift fur kompr. und fluss. Gase, 13,1 and 19 (1910). Acad. des Sciences- Cracovie- Bull. Int., 742 (1909).

[2] Gray, R. W., The atomic weight of nitrogen, J. Chem. Soc., 87,1601 (1905).

[3] Goldschmidt, H., Der Dampfdruck des Stickoxyds, Zeitschrift für Physik, 20,159 (1923).

[4] Henglein, F. A., Chemische Konstanten und kritische Daten, Zeitschrift für anorg. und allg. Chemie, 114,234 (1920).

[5] Henglein, F. A., and Kruger, H., Dampfdruckmessungen von Stickoxyd, Zeitschrift für anorg. und allg. Chemie, 130,181 (1923).

[6] Johnston, H. L. and Giauque, W. F., The heat capacity of nitric oxide ... Vapor pressures ... The entropy ... J. Am. Chem. Soc., 512,3194 (1929).

[7] Olszewski, K., Liquefaction et solidification du formene et du deutoxyde d'azote, Comptes Rendus, 100,940 (1885).

[8] Pickering, S. F., A review of the critical constants of various gases, NBS Sci. Papers, 541, vol. 21,597 (1926).

[9] Travers, Experimental Study of Gases, 1901, London, Macmillan.

U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

THE NBS - NACA TABLES OF THERMAL PROPERTIES OF GASES

Table 1.30 Conversion Factors

Table 1.30/4a CONVERSION FACTORS FOR UNITS OF LENGTH*

Multiply by approxriate entry to obtain → / ↓	cm	mm	μ	mμ	Å
1 Centimeter (cm)	1	10	10^4	10^7	10^8
1 Millimeter (mm)	10^{-1}	1	10^3	10^6	10^7
1 Micron (μ)	10^{-4}	10^{-3}	1	10^3	10^4
1 Millimicron (mμ)	10^{-7}	10^{-6}	10^{-3}	1	10
1 Angstrom Unit (Å)	10^{-8}	10^{-7}	10^{-4}	10^{-1}	1

Table 1.30/4b CONVERSION FACTORS FOR UNITS OF LENGTH

Multiply by appropriate entry to obtain → / ↓	cm	m	in	ft	yd
1 cm	1	0.01	0.3937	0.032808333	0.010936111
1 m	100.	1	39.37	3.2808333	1.0936111
1 in	2.5400051	0.025400051	1	0.083333333	0.027777778
1 ft	30.480061	0.30480061	12.	1	0.33333333
1 yd	91.440183	0.91440183	36.	3.	1

* The conversion factors in Tables 1.30/4a - 1.30/4k are reproduced from "Selected Values of Properties of Hydrocarbons", NBS Circular C461, November, 1947.

Table 1.30/4c CONVERSION FACTORS FOR UNITS OF AREA

Multiply ↓ by appropriate entry to obtain →	cm^2	m^2	sq in	sq ft	sq yd
1 cm^2	1	10^{-4}	0.15499969	1.0763867 $\times 10^{-3}$	1.1959853 $\times 10^{-4}$
1 m^2	10^4	1	1549.9969	10.763867	1.1959853
1 sq in	6.4516258	6.4516258 $\times 10^{-4}$	1	6.9444444 $\times 10^{-3}$	7.7160494 $\times 10^{-4}$
1 sq ft	929.03412	0.092903412	144.	1	0.11111111
1 sq yd	8361.3070	0.83613070	1296.	9.	1

Table 1.30/1.d CONVERSION FACTORS FOR UNITS OF VOLUME

Multiply ↓ by appropriate entry to obtain →	ml	liter	gal
1 cm^3	0.9999720	0.9999720×10^{-3}	2.6417047×10^{-4}
1 cu in.	16.38670	1.638670×10^{-2}	4.3290043×10^{-3}
1 cu ft	28316.22	28.31622	7.4805195
1 ml	1	0.001	2.641779×10^{-4}
1 liter	1000.	1	0.2641779
1 gal	3785.329	3.785329	1

Table 1.30/1.d CONVERSION FACTORS FOR UNITS OF VOLUME (Continued)

Multiply ↓ by appropriate entry to obtain →	cm^3	cu in.	cu ft
1 cm^3	1	0.061023378	3.5314455×10^{-5}
1 cu in.	16.387162	1	5.7870370×10^{-4}
1 cu ft	28317.017	1728.	1
1 ml	1.000028	0.06102509	3.531544×10^{-5}
1 liter	1000.028	61.02509	0.03531544
1 gal	3785.4345	231.	0.13368056

Table 1.30/4e CONVERSION FACTORS FOR UNITS OF MASS

Multiply by appropriate entry to obtain → / ↓	g	kg	lb	metric ton	ton
1 g	1	10^{-3}	2.2046223×10^{-3}	10^{-6}	1.1023112×10^{-6}
1 kg	10^{3}	1	2.2046223	10^{-3}	1.1023112×10^{-3}
1 lb	453.59243	0.45359243	1	4.5359243×10^{-4}	0.0005
1 metric ton	10^{6}	10^{3}	2204.6223	1	1.1023112
1 ton	907184.86	907.18486	2000.	0.90718486	1

Table 1.30/4f CONVERSION FACTORS FOR UNITS OF DENSITY

Multiply by appropriate entry to obtain → / ↓	g/cm^3	g/ml	lb/cu in	lb/cu ft	lb/gal
1 g/cm^3	1	1.000028	0.036127504	62.428327	8.3454535
1 g/ml	0.9999720	1	0.03612649	62.42658	8.345220
1 lb/cu in	27.679742	27.68052	1	1728.	231.
1 lb/cu ft	0.016018369	0.01601882	5.7870370×10^{-4}	1	0.13368056
1 lb/gal	0.11982572	0.1198291	4.3290043×10^{-3}	7.4805195	1

Table 1.30/g CONVERSION FACTORS FOR UNITS OF PRESSURE

Multiply by appropriate entry to obtain → / ↓	dyne/cm^2	bar	atm	kg(wt)/cm^2
1 dyne/cm^2	1	10^{-6}	0.9869233 x10^{-6}	1.0197162 x10^{-6}
1 bar	10^6	1	0.9869233	1.0197162
1 atm	1013250.	1.013250	1	1.0332275
1 kg(wt)/cm^2	980665.	0.980665	0.9678411	1
1 mm Hg	1333.2237	1.3332237 x10^{-3}	1.3157895 x10^{-3}	1.3595098 x10^{-3}
1 in. Hg	33863.95	0.03386395	0.03342112	0.03453162
1 lb(wt)/sq in.	68947.31	0.06894731	0.06804570	0.07030669

Table 1.30/ g CONVERSION FACTORS FOR UNITS OF PRESSURE (continued)

Multiply by appropriate entry to obtain → / ↓	mm Hg	in. Hg	lb(wt)/sq in.
1 dyne/cm^2	7.500617×10^{-4}	2.952993×10^{-5}	1.4503830×10^{-5}
1 bar	750.0617	29.52993	14.503830
1 atm	760.	29.92120	14.696006
1 kg(wt)/cm^2	735.5592	28.95897	14.223398
1 mm Hg	1	0.03937	0.019336850
1 in. Hg	25.40005	1	0.4911570
1 lb(wt)/sq in.	51.71473	2.036009	1

Table 1.30/4h CONVERSION FACTORS FOR UNITS OF ENERGY

Multiply by appropriate entry to obtain → / ↓	g mass (energy equiv)	abs. joule	int. joule	cal
1 g mass(energy equiv)	1	8.98656×10^{13}	8.98508×10^{13}	2.14784×10^{13}
1 abs. joule	1.112772×10^{-14}	1	0.999835	0.239006
1 int. joule	1.112956×10^{-14}	1.000165	1	0.239045
1 cal	4.65584×10^{-14}	4.1840	4.1833	1
1 I.T. cal	4.65888×10^{-14}	4.18674	4.18605	1.000654
1 BTU	1.174019×10^{-11}	1055.040	1054.866	252.161
1 int. kilowatt-hr	4.00664×10^{-8}	3,600,594.	3,600,000.	860,563.
1 horsepower-hr	2.98727×10^{-8}	2,684,525.	2,684,082.	641,617.
1 ft-lb(wt)	1.508720×10^{-14}	1.355821	1.355597	0.324049
1 cu ft - lb(wt)/sq in	2.17256×10^{-12}	195.2382	195.2060	46.6630
1 liter-atm	1.127548×10^{-12}	101.3278	101.3111	24.2179

Table 1.30/1.h CONVERSION FACTORS FOR UNITS OF ENERGY (continued)

Multiply by appropriate entry to obtain → / ↓	I.T. cal	BTU	int.kilowatt-hr	horsepower-hr
1 g mass(energy equiv)	2.14644×10^{13}	8.51775×10^{10}	2.49586×10^{7}	3.34754×10^{7}
1 abs.joule	0.238849	0.947831×10^{-3}	2.77732×10^{-7}	3.72505×10^{-7}
1 int.joule	0.238889	0.947988×10^{-3}	2.777778×10^{-7}	3.72567×10^{-7}
1 cal	0.999346	3.96573×10^{-3}	1.162030×10^{-6}	1.558562×10^{-6}
1 I.T. cal	1	3.96832×10^{-3}	1.162791×10^{-6}	1.559582×10^{-6}
1 BTU	251.996	1	2.93018×10^{-4}	3.93008×10^{-4}
1 int.kilowatt-hr	860,000.	3412.76	1	1.341241
1 horsepower-hr	641,197.	2544.48	0.745578	1
1 ft-lb(wt)	0.323837	1.285089×10^{-3}	3.76555×10^{-7}	5.05051×10^{-7}
1 cu ft - lb(wt)/sq in	46.6325	0.1850529	5.42239×10^{-5}	7.27273×10^{-5}
1 liter-atm	24.2021	0.0960417	2.81420×10^{-5}	3.77452×10^{-5}

Table I.30/1.h CONVERSION FACTORS FOR UNITS OF ENERGY (continued)

Multiply ↓ by appropriate entry to obtain →	ft-lb(wt)	cu ft-lb(wt)/sq in.	liter-atm
1 g mass(energy equiv)	6.62814×10^{13}	4.60287×10^{11}	8.86880×10^{11}
1 abs. joule	0.737561	5.12195×10^{-3}	9.86896×10^{-3}
1 int. joule	0.737682	5.12279×10^{-3}	9.87058×10^{-3}
1 cal	3.08595	2.14302×10^{-2}	4.12917×10^{-2}
1 I.T. cal	3.08797	2.14443×10^{-2}	4.13187×10^{-2}
1 BTU	778.156	5.40386	10.41215
1 int. kilowatt-hr	2,655,656.	18442.06	35534.1
1 horsepower-hr	1,980,000.	13750.	26493.5
1 ft-lb(wt)	1	6.94444×10^{-3}	1.338054×10^{-2}
1 cu ft - lb(wt)/sq in	144.	1	1.926797
1 liter-atm	74.7354	5.18996	1

e.1.30/.i CONVERSION FACTORS FOR UNITS OF MOLECULAR ENERGY

Multiply by appropriate entry to obtain → / ↓	erg/molecule	abs.joule/mole	int.joule/mole
1 erg/molecule	1	6.02283×10^{16}	6.02184×10^{16}
1 abs.joule/mole	1.660349×10^{-17}	1	0.999835
1 int.joule/mole	1.660623×10^{-17}	1.000165	1
1 cal/mole	6.94690×10^{-17}	4.18400	4.1833
1 abs.electron-volt/molecule	1.601992×10^{-12}	96485.3	96469.4
1 int.electron-volt/molecule	1.602521×10^{-12}	96517.1	96501.2
1 wave no.(cm^{-1})	1.985776×10^{-16}	11.95999	11.95802

Table 1.30/4i CONVERSION FACTORS FOR UNITS OF MOLECULAR ENERGY (continued)

Multiply by appropriate entry to obtain → / ↓	cal/mole	abs.electron-volt/molecule	int.electron-volt/molecule	wave no. (cm^{-1})
1 erg/molecule	1.439491×10^{16}	6.24222×10^{11}	6.24017×10^{11}	5.03581×10^{15}
1 abs.joule/mole	0.239006	1.036427×10^{-5}	1.036086×10^{-5}	8.36121×10^{-2}
1 int.joule/mole	0.239046	1.036599×10^{-5}	1.036257×10^{-5}	8.36259×10^{-2}
1 cal/mole	1	4.33641×10^{-5}	4.33498×10^{-5}	0.349833
1 abs.electron-volt/molecule	23060.5	1	0.999670	8067.34
1 int.electron-volt/molecule	23068.1	1.000330	1	8070.00
1 wave no.(cm^{-1})	2.85851	1.239567×10^{-4}	1.239158×10^{-4}	1

Table 1.30/4j CONVERSION FACTORS FOR UNITS OF SPECIFIC ENERGY

Multiply ↓ by appropriate entry to obtain →	abs.joule/g	int.joule/g	cal/g	I.T. cal/g	BTU/lb
1 abs.joule/g	1	0.999835	0.239006	0.238849	0.429929
1 int.joule/g	1.000165	1	0.239045	0.238889	0.430000
1 cal/g	4.1840	4.1833	1	0.999346	1.798823
1 I.T. cal/g	4.18674	4.18605	1.000654	1	1.8
1 BTU/lb	2.32597	2.32558	0.555919	0.555556	1

Table 1.30/4k CONVERSION FACTORS FOR UNITS OF SPECIFIC ENERGY PER DEGREE

Multiply ↓ by appropriate entry to obtain →	abs.joule/ g deg C	int.joule/ g deg C	cal/ g deg C	I.T. cal/ g deg C	BTU/ lb deg F
1 abs.joule/g deg C	1	0.999835	0.239006	0.238849	0.238849
1 int.joule/g deg C	1.000165	1	0.239045	0.238889	0.238889
1 cal/g deg C	4.1840	4.1833	1	0.999346	0.999346
1 I.T. cal/g deg C	4.18674	4.18605	1.000654	1	1
1 BTU/lb deg F	4.18674	4.18605	1.000654	1	1

Table 1.30/2 CONVERSION FACTORS FOR UNITS OF VISCOSITY *

Multiply ↓ by appropriate entry to obtain →	Centipoise	Poise	g_F sec cm^{-2}	lb_F sec in^{-2}
Centipoise	1	$1x10^{-2}$	$1.0197x10^{-5}$	$1.4504x10^{-7}$
Poise	$1.x10^{2}$	1	$1.0197x10^{-3}$	$1.4504x10^{-5}$
g_F sec cm^{-2}	$9.8067x10^{4}$	$9.8067x10^{2}$	1	$1.4224x10^{-2}$
lb_F sec in^{-2}	$6.8947x10^{6}$	$6.8947x10^{4}$	$7.0305x10^{1}$	1
lb_F sec ft^{-2}	$4.7880x10^{4}$	$4.7880x10^{2}$	$4.8823x10^{-1}$	$6.9445x10^{-3}$
lb_F hr in^{-2}	$2.4821x10^{10}$	$2.4821x10^{8}$	$2.5310x10^{5}$	$3.6000x10^{3}$
lb_F hr ft^{-2}	$1.7237x10^{8}$	$1.7237x10^{6}$	$1.7577x10^{31}$	$2.5001x10^{1}$
g_M sec^{-1} cm^{-1}	$1x10^{2}$	1	$1.0197x10^{-3}$	$1.4504x10^{-5}$
lb_M sec^{-1} in^{-1}	$1.7858x10^{4}$	$1.7858x10^{2}$	$1.8210x10^{-1}$	$2.5901x10^{-3}$
lb_M sec^{-1} ft^{-1}	$1.4882x10^{3}$	$1.4882x10^{1}$	$1.5175x10^{-2}$	$2.1585x10^{-4}$
lb_M hr^{-1} in^{-1}	4.9605	$4.9605x10^{-2}$	$5.0582x10^{-5}$	$7.1947x10^{-7}$
lb_M hr^{-1} ft^{-1}	$4.1338x10^{-1}$	$4.1338x10^{-3}$	$4.2152x10^{-6}$	$5.9957x10^{-8}$

* Based on G. A. Hawkins, H. L. Solberg, and W. L. Sibbitt, Units and conversion factors for absolute viscosity. Power Plant Eng. Nov. 1941.

Table 1.30/4 CONVERSION FACTORS FOR UNITS OF VISCOSITY (continued)

Multiply by appropriate entry to obtain → / ↓	lb_F sec ft^{-2}	lb_F hr in^{-2}	lb_F hr ft^{-2}	g_M sec^{-1} cm^{-1}
Centipoise	2.0886×10^{-5}	4.0289×10^{-11}	5.8016×10^{-9}	1×10^{-2}
Poise	2.0886×10^{-3}	4.0289×10^{-9}	5.8016×10^{-7}	1
g_F sec cm^{-2}	2.0482	3.9510×10^{-6}	5.6895×10^{-4}	9.8067×10^{2}
lb_F sec in^{-2}	1.4400×10^{2}	2.7778×10^{-4}	4.0000×10^{-2}	6.8947×10^{4}
lb_F sec ft^{-2}	1	1.9290×10^{-6}	2.7778×10^{-4}	4.7880×10^{2}
lb_F hr in^{-2}	5.1841×10^{5}	1	1.4400×10^{2}	2.4821×10^{8}
lb_F hr ft^{-2}	3.6001×10^{3}	6.9446×10^{-3}	1	1.7237×10^{6}
g_M sec^{-1} cm^{-1}	2.0886×10^{-3}	4.0289×10^{-9}	5.8016×10^{-7}	1
lb_M sec^{-1} in^{-1}	3.7298×10^{-1}	7.1948×10^{-7}	1.0360×10^{-4}	1.7858×10^{2}
lb_M sec^{-1} ft^{-1}	3.1083×10^{-2}	5.9958×10^{-8}	8.6339×10^{-6}	1.4882×10^{1}
lb_M hr^{-1} in^{-1}	1.0361×10^{-4}	1.9985×10^{-10}	2.8779×10^{-8}	4.9605×10^{-2}
lb_M hr^{-1} ft^{-1}	8.6339×10^{-6}	1.6655×10^{-11}	2.3983×10^{-9}	4.1336×10^{-3}

Table 1.30/2 CONVERSION FACTORS FOR UNITS OF VISCOSITY (continued)

Multiply By Appropriate Entry To Obtain → / ↓	$lb_M sec^{-1} in^{-1}$	$lb_M hr^{-1} ft^{-1}$	Slug $sec^{-1} in^{-1}$	Slug $hr^{-1} ft^{-1}$
Centipoise	5.5998×10^{-5}	2.4191	1.7405×10^{-6}	7.5188×10^{-2}
Poise	5.5998×10^{-3}	2.4191×10^{2}	1.7405×10^{-4}	7.5188
g_F sec cm^{-2}	5.4916	2.3723×10^{5}	1.7068×10^{-1}	7.3733×10^{3}
lb_F sec in^{-2}	3.8609×10^{2}	1.6679×10^{7}	1.2000×10^{1}	5.1840×10^{5}
lb_F sec ft^{-2}	2.6812	1.1583×10^{5}	8.3335×10^{-2}	3.6000×10^{3}
lb_F hr in^{-2}	1.3899×10^{6}	6.0044×10^{10}	4.3199×10^{4}	1.8662×10^{9}
lb_F hr ft^{-2}	9.6524×10^{3}	4.1698×10^{8}	3.0000×10^{2}	1.2960×10^{7}
g_M sec^{-1} cm^{-1}	5.5998×10^{-3}	2.4191×10^{2}	1.7405×10^{-4}	7.5188
lb_M sec^{-1} in^{-1}	1	4.3200×10^{4}	3.1081×10^{-2}	1.3427×10^{3}
lb_M sec^{-1} ft^{-1}	8.3333×10^{-2}	3.6000×10^{3}	2.5902×10^{-3}	1.1189×10^{2}
lb_M hr^{-1} in^{-1}	2.7778×10^{-4}	1.2000×10^{1}	8.6337×10^{-6}	3.7297×10^{-1}
lb_M hr^{-1} ft^{-1}	2.3148×10^{-5}	1	7.1946×10^{-7}	3.1081×10^{-2}

TEMPERATURE INTERCONVERSION TABLE

°K	°C	°F	°R
0.	-273.16	-459.69	0.
3.16	-270.	-454.00	5.69
5.38	-267.78	-450.	9.69
5.55	-267.61	-449.69	10.
10.	-263.16	-441.69	18.00
10.94	-262.22	-440.	19.69
11.11	-262.05	-439.69	20.
13.16	-260.	-436.00	23.69
16.49	-256.67	-430.	29.69
16.67	-256.49	-429.69	30.
20.	-253.16	-423.69	36.00
22.05	-251.11	-420.	39.69
22.22	-250.94	-419.69	40.
23.16	-250.	-418.00	41.69
27.60	-245.56	-410.	49.69
27.78	-245.38	-409.69	50.
30.	-243.16	-405.69	54.00
33.16	-240.	-400.	59.69
33.33	-239.83	-399.69	60.
38.72	-234.44	-390.	69.69
38.89	-234.27	-389.69	70.
40.	-233.16	-387.69	72.00
43.16	-230.	-382.00	77.69
44.27	-228.89	-380.	79.69
44.44	-228.72	-379.69	80.
49.83	-223.33	-370.	89.69
50.	-223.16	-369.69	90.
53.16	-220.	-364.00	95.69
55.38	-217.78	-360.	99.69
55.56	-217.60	-359.69	100.
60.	-213.16	-351.69	108.00
60.94	-212.22	-350.	109.69
61.11	-212.05	-349.69	110.
63.16	-210.	-346.00	113.69
66.49	-206.67	-340.	119.69
66.67	-206.49	-339.69	120.
70.	-203.16	-333.69	126.00
72.05	-201.11	-330.	129.69
72.22	-200.94	-329.69	130.
73.16	-200.	-328.00	131.69
77.60	-195.56	-320.	139.69
77.78	-195.38	-319.69	140.
80.	-193.16	-315.69	144.00
83.16	-190.	-310.	149.69
83.33	-189.83	-309.69	150.
88.72	-184.44	-300.	159.69
88.89	-184.27	-299.69	160.
90.	-183.16	-297.69	162.00
93.16	-180.	-292.00	167.69
94.27	-178.89	-290.	169.69
94.44	-178.72	-289.69	170.
99.83	-173.33	-280.	179.69
100.	-173.16	-279.69	180.
100.	-173.16	-279.69	180.
103.16	-170.	-274.00	185.69
105.38	-167.78	-270.	189.69
105.56	-167.60	-269.69	190.
110.	-163.16	-261.69	198.00
110.96	-162.20	-260.	199.69
111.11	-162.05	-259.69	200.
113.16	-160.	-256.00	203.69
116.49	-156.67	-250.	209.69
116.67	-156.49	-249.69	210.
120.	-153.16	-243.69	216.00
122.05	-151.11	-240.	219.69
122.22	-150.94	-239.69	220.
123.16	-150.	-238.00	221.69
127.60	-145.56	-230.	229.69
127.78	-145.38	-229.69	230.
130.	-143.16	-225.69	234.00
133.16	-140.	-220.	239.69
133.33	-139.83	-219.69	240.
136.72	-134.44	-210.	249.69
138.89	-134.27	-209.69	250.
140.	-133.16	-207.69	252.00
143.16	-130.	-202.00	257.69
144.27	-128.89	-200.	259.69
144.44	-128.72	-199.69	260.
149.83	-123.33	-190.	269.69
150.	-123.16	-189.69	270.
153.16	-120.	-184.00	276.69
155.38	-117.78	-180.	279.69
155.56	-117.60	-179.69	280.
160.	-113.16	-171.69	288.00
160.94	-112.22	-170.	289.69
161.11	-112.05	-169.69	290.
163.16	-110.	-166.00	293.69
166.49	-106.67	-160.	299.69
166.67	-106.49	-159.69	300.
170.	-103.16	-153.69	306.00
172.05	-101.11	-150.	309.69
172.22	-100.94	-149.69	310.
173.16	-100.	-148.00	311.69
177.60	-95.56	-140.	319.69
177.78	-95.38	-139.69	320.
180.	-93.16	-135.69	324.00
183.16	-90.	-130.	329.69
183.33	-89.83	-129.69	330.
188.72	-84.44	-120.	339.69
188.89	-84.27	-119.69	340.
190.	-83.16	-117.69	342.00
193.16	-80.	-112.00	347.69
194.27	-78.89	-110.	349.69
194.44	-78.72	-109.69	350.
199.83	-73.33	-100.	359.69
200.	-73.16	-99.69	360.
200.	-73.16	-99.69	360.
203.16	-70.	-94.00	365.69
205.38	-67.78	-90.	369.69
205.56	-67.60	-89.69	370.
210.	-63.16	-81.69	378.00
210.94	-62.22	-80.	379.69
211.11	-62.05	-79.69	380.
213.16	-60.	-76.00	383.69
216.41	-56.67	-70.	389.69
216.67	-56.49	-69.69	390.
220.	-53.16	-63.69	396.00
222.05	-51.11	-60.	399.69
222.22	-50.94	-59.69	400.
223.16	-50.	-58.00	401.69
227.60	-45.56	-50.	409.69
227.78	-45.38	-49.69	410.
230.	-43.16	-45.69	414.00
233.16	-40.	-40.	419.69
233.33	-39.83	-39.69	420.
238.72	-34.44	-30.	429.69
238.89	-34.27	-29.69	430.
240.	-33.16	-27.69	432.00
243.16	-30.	-22.00	437.69
244.27	-28.89	-20.	439.69
244.44	-28.72	-19.69	440.
249.83	-23.33	-10.	449.69
250.	-23.16	-9.69	450.
253.16	-20.	-4.00	455.69
255.38	-17.78	0.	459.69
255.56	-17.60	+.31	460.
260.	-13.16	8.31	468.00
260.94	-12.22	10.	469.69
261.11	-12.05	10.31	470.
263.16	-10.	14.00	473.69
266.49	-6.67	20.	479.69
266.67	-6.49	20.31	480.
270.	-3.16	26.31	486.00
272.05	-1.11	30.	489.69
272.22	-.94	30.31	490.
273.16	0.	32.00	491.69
277.60	+4.44	40.	499.69
277.78	4.62	40.31	500.
280.	6.84	44.31	504.00
283.16	10.	50.	509.69
283.33	10.17	50.31	510.
288.72	15.56	60.	519.69
288.89	15.73	60.31	520.
290.	16.84	62.31	522.00
293.16	20.	68.00	527.69
294.27	21.11	70.	529.69
294.44	21.28	70.31	530.
299.83	26.67	80.	539.69
300.	26.84	80.31	540.
300.	26.84	80.31	540.
303.16	30.	86.00	545.69
305.38	32.22	90.	549.69
305.56	32.40	90.31	550.
310.	36.84	96.31	559.00
310.94	37.78	100.	559.69
311.11	37.95	100.31	560.
313.16	40.	104.00	563.69
316.41	43.33	110.	569.69
316.67	43.51	110.31	570.
320.	46.84	116.31	576.00
322.05	48.89	120.	579.69
322.22	49.06	120.31	580.
323.16	50.	122.00	581.69
327.60	54.44	130.	589.69
327.78	54.62	130.31	590.
330.	56.84	134.31	594.00
333.16	60.	140.	599.69
333.33	60.17	140.31	600.
338.72	65.56	150.	609.69
338.89	65.73	150.31	610.
340.	66.84	152.31	612.00
343.16	70.	158.00	617.69
344.27	71.11	160.	619.69
344.44	71.28	160.31	620.
349.83	76.67	170.	629.69
350.	76.84	170.31	630.
353.16	80.	176.00	635.69
355.38	82.22	180.	639.69
355.56	82.40	180.31	640.
360.	86.84	188.31	648.00
360.94	87.78	190.	649.69
361.11	87.95	190.31	650.
363.16	90.	194.00	653.69
366.49	93.33	200.	659.69
366.67	93.51	200.31	660.
370.	96.84	206.31	666.00
372.05	98.89	210.	669.69
372.22	99.06	210.31	670.
373.16	100.	212.00	671.69
377.60	104.44	220.	679.69
377.78	104.62	220.31	680.
380.	106.84	224.31	684.00
383.16	110.	230.	689.69
383.33	110.17	230.31	690.
388.72	115.56	240.	699.69
388.89	115.73	240.31	700.
390.	116.84	242.31	702.00
393.16	120.	248.00	707.69
394.27	121.11	250.	709.69
394.44	121.28	250.31	710.
399.83	126.67	260.	719.69
400.	126.84	260.31	720.
400.	126.84	260.31	720.
403.16	130.	266.00	725.69
405.38	132.22	270.	729.69
405.56	132.40	270.31	730.
410.	136.84	278.31	738.00
410.94	137.78	280.	739.69
411.11	137.95	280.31	740.
413.16	140.	284.00	743.69
416.41	143.33	290.	749.69
416.67	143.51	290.31	750.
420.	146.84	296.31	756.00
422.05	148.89	300.	759.69
422.22	149.06	300.31	760.
423.16	150.	302.00	761.69
427.60	154.44	310.	769.69
427.78	154.62	310.31	770.
430.	156.84	314.31	774.00
433.16	160.	320.	779.69
433.33	160.17	320.31	780.
438.72	165.56	330.	789.69
438.89	165.73	330.31	790.
440.	166.84	332.31	792.00
443.16	170.	338.00	797.69
444.27	171.11	340.	799.69
444.44	171.28	340.31	800.
449.83	176.66	350.	809.69
450.	176.84	350.31	810.
453.16	180.	356.00	815.69
455.38	182.22	360.	819.69
455.56	182.40	360.31	820.
460.	186.84	368.31	828.00
460.94	187.78	370.	829.69
461.11	187.95	370.31	830.
463.16	190.	374.00	833.69
466.49	193.33	380.	839.69
466.67	193.51	380.31	840.
470.	196.84	386.31	846.00
472.05	198.89	390.	849.69
472.22	199.06	390.31	850.
473.16	200.	392.00	851.69
477.60	204.44	400.	859.69
477.78	204.62	400.31	860.
480.	206.84	404.31	864.00
483.16	210.	410.	869.69
483.33	210.17	410.31	870.
488.72	215.56	420.	879.69
488.89	215.73	420.31	880.
490.	216.84	422.31	882.00
493.16	220.	428.00	887.69
494.27	221.11	430.	889.69
494.44	221.28	430.31	890.
499.83	226.67	440.	899.69
500.	226.84	440.31	900.

°K °C	°R °F
1	1.8
2	3.6
3	5.4
4	7.2
5	9.0
6	10.8
7	12.6
8	14.4
9	16.2
10	18.0

°R °F	°K °C
1	0.56
2	1.11
3	1.67
4	2.22
5	2.78
6	3.33
7	3.89
8	4.44
9	5.00
10	5.56
11	6.11
12	6.67
13	7.22
14	7.78
15	8.33
16	8.89
17	9.44
18	10.00

Prepared by the Thermal Tables Project, Thermodynamics Section, National Bureau of Standards and reprinted from Report 1192: "Density and Compressibility of Air" by W. S. Benedict and Joseph Hilsenrath.

TEMPERATURE INTERCONVERSION TABLE (Continued)

°K	°C	°F	°R
500.	226.84	440.31	900.
503.16	230.	446.00	905.69
505.38	232.22	450.	909.68
505.56	232.40	450.31	910.
510.	236.84	458.31	919.00
510.94	237.76	460.	919.69
511.11	237.95	460.31	920.
513.16	240.	464.00	923.69
516.41	243.33	470.	929.69
516.67	243.51	470.31	930.
520.	246.84	476.31	936.00
522.05	248.89	480.	939.69
522.22	249.06	480.31	940.
523.16	250.	482.00	941.69
527.60	254.44	490.	949.69
527.78	254.62	490.31	950.
530.	256.84	494.31	954.00
533.16	260.	500.	959.69
533.33	260.17	500.31	960.
538.72	265.56	510.	969.69
538.89	265.73	510.31	970.
540.	266.84	512.31	972.00
543.16	270.	518.00	977.69
544.27	271.11	520.	979.69
544.44	271.28	520.31	980.
549.83	276.66	530.	989.69
550.	276.84	530.31	990.
553.16	280.	536.00	995.69
555.38	282.22	540.	999.69
555.56	282.40	540.31	1000.
560.	286.84	548.31	1008.00
560.94	287.78	550.	1009.68
561.11	287.95	550.31	1010.
563.16	290.	554.00	1013.69
566.49	293.33	560.	1019.69
566.67	293.51	560.31	1020.
570.	296.84	566.31	1026.00
572.05	298.89	570.	1029.69
572.22	299.06	570.31	1030.
573.16	300.	572.00	1031.69
577.60	304.44	580.	1039.69
577.78	304.62	580.31	1040.
580.	306.84	584.31	1044.00
583.16	310.	590.	1049.69
583.33	310.17	590.31	1050.
588.72	315.56	600.	1058.69
588.89	315.73	600.31	1060.
590.	316.84	602.31	1062.00
593.16	320.	608.00	1067.69
594.27	321.11	610.	1069.69
594.44	321.28	610.31	1070.
599.83	326.67	620.	1079.69
600.	326.84	620.31	1080.

°K	°C	°F	°R
600.	326.84	620.31	1080.
603.16	330.	626.00	1085.69
605.38	332.22	630.	1089.68
605.56	332.40	630.31	1090.
610.	336.84	638.31	1098.00
610.94	337.78	640.	1099.68
611.11	337.95	640.31	1100.
613.16	340.	644.00	1103.69
616.41	343.33	650.	1109.69
616.67	343.51	650.31	1110.
620.	346.84	656.31	1116.00
622.05	348.89	660.	1119.69
622.22	349.06	660.31	1120.
623.16	350.	662.00	1121.69
627.60	354.44	670.	1129.69
627.78	354.62	670.31	1130.
630.	356.84	674.31	1134.00
633.16	360.	680.	1139.69
633.33	360.17	680.31	1140.
638.72	365.56	690.	1149.69
638.89	365.73	690.31	1150.
640.	366.84	692.31	1152.00
643.16	370.	698.00	1157.69
644.27	371.11	700.	1159.69
644.44	371.28	700.31	1160.
649.83	376.66	710.	1169.69
650.	376.84	710.31	1170.
653.16	380.	716.00	1175.69
655.38	382.22	720.	1179.69
655.56	382.40	720.31	1180.
660.	386.84	728.31	1188.00
660.94	387.78	730.	1189.69
661.11	387.95	730.31	1190.
663.16	390.	734.00	1193.69
666.49	393.33	740.	1199.69
666.67	393.51	740.31	1200.
670.	396.84	746.31	1206.00
672.05	398.89	750.	1209.69
672.22	399.06	750.31	1210.
673.16	400.	752.00	1211.69
677.60	404.44	760.	1219.69
677.78	404.62	760.31	1220.
680.	406.84	764.31	1224.00
683.16	410.	770.	1229.69
683.33	410.17	770.31	1230.
688.72	415.56	780.	1239.69
688.89	415.73	780.31	1240.
690.	416.84	782.31	1242.00
693.16	420.	788.00	1247.69
694.27	421.11	790.	1249.69
694.44	421.28	790.31	1250.
699.83	426.67	800.	1259.67
700.	426.84	800.31	1260.

°K	°C	°F	°R
700.	426.84	800.31	1260.
703.16	430.	806.00	1265.69
705.38	432.22	810.	1269.69
705.56	432.40	810.31	1270.
710.	436.84	818.31	1278.00
710.94	437.78	820.	1279.69
711.11	437.95	820.31	1280.
713.16	440.	824.00	1283.69
716.41	443.33	830.	1289.69
716.67	443.51	830.31	1290.
720.	446.84	836.31	1296.00
722.05	448.89	840.	1299.69
722.22	449.06	840.31	1300.
723.16	450.	842.00	1301.69
727.60	454.44	850.	1309.69
727.78	454.62	850.31	1310.
730.	456.84	854.31	1314.00
733.16	460.	860.	1319.69
733.33	460.17	860.31	1320.
738.72	465.56	870.	1329.69
738.89	465.73	870.31	1330.
740.	466.84	872.31	1332.00
743.16	470.	878.00	1337.69
744.27	471.11	880.	1339.69
744.44	471.28	880.31	1340.
749.83	476.66	890.	1349.69
750.	476.84	890.31	1350.
753.16	480.	896.00	1355.69
755.38	482.22	900.	1359.69
755.56	482.40	900.31	1360.
760.	486.84	908.31	1368.00
760.94	487.78	910.	1369.69
761.11	487.95	910.31	1370.
763.16	490.	914.00	1373.69
766.49	493.33	920.	1379.69
766.67	493.51	920.31	1380.
770.	496.84	926.31	1386.00
772.05	498.89	930.	1389.69
772.22	499.06	930.31	1390.
773.16	500.	932.00	1391.69
777.60	504.44	940.	1399.69
777.78	504.62	940.31	1400.
780.	506.84	944.31	1404.00
783.16	510.	950.	1409.69
783.33	510.17	950.31	1410.
788.72	515.56	960.	1419.69
788.89	515.73	960.31	1420.
790.	516.84	962.31	1422.00
793.16	520.	968.00	1427.69
794.27	521.11	970.	1429.69
794.44	521.28	970.31	1430.
799.83	526.67	980.	1439.69
800.	526.84	980.31	1440.

°K	°C	°F	°R
800.	526.84	980.31	1440.
803.16	530.	986.00	1445.69
805.38	532.22	990.	1449.69
805.56	532.40	990.31	1450.
810.	536.84	998.31	1458.00
810.94	537.78	1000.	1458.69
811.11	537.95	1000.31	1460.
813.16	540.	1004.00	1463.69
816.41	543.33	1010.	1469.69
816.67	543.51	1010.31	1470.
820.	546.84	1016.31	1476.00
822.05	548.89	1020.	1479.69
822.22	549.06	1020.31	1480.
823.16	550.	1022.00	1481.69
827.60	554.44	1030.	1489.69
827.78	554.62	1030.31	1490.
830.	556.84	1034.31	1494.00
833.16	560.	1040.	1499.69
833.33	560.17	1040.31	1500.
838.72	565.56	1050.	1509.69
838.89	565.73	1050.31	1510.
840.	566.84	1052.31	1512.00
843.16	570.	1058.00	1517.69
844.27	571.11	1060.	1519.69
844.44	571.28	1060.31	1520.
849.83	576.66	1070.	1529.69
850.	576.84	1070.31	1530.
853.16	580.	1076.00	1535.69
855.38	582.22	1080.	1539.69
855.56	582.40	1080.31	1540.
860.	586.84	1088.31	1548.00
860.94	587.78	1090.	1549.69
861.11	587.95	1090.31	1550.
863.16	590.	1094.00	1553.69
866.48	593.33	1100.	1559.69
866.67	593.51	1100.31	1560.
870.	596.84	1106.31	1566.00
872.05	598.89	1110.	1569.69
872.22	599.06	1110.31	1570.
873.16	600.	1112.00	1571.69
877.60	604.44	1120.	1579.69
877.78	604.62	1120.31	1580.
880.	606.84	1124.31	1584.00
883.16	610.	1130.	1589.69
883.33	610.17	1130.31	1590.
888.72	615.56	1140.	1599.69
888.89	615.73	1140.31	1600.
890.	616.84	1142.31	1602.00
893.16	620.	1148.00	1607.69
894.27	621.11	1150.	1609.69
894.44	621.28	1150.31	1610.
899.83	626.67	1160.	1619.68
900.	626.84	1160.31	1620.

°K	°C	°F	°R
900.	626.84	1160.31	1620
903.16	630.	1166.00	1625.69
905.38	632.22	1170.	1629.69
905.56	632.40	1170.31	1630.
910.	636.84	1178.31	1638.00
910.94	637.78	1180.	1639.69
911.11	637.95	1180.31	1640.
913.16	640.	1184.00	1643.69
916.41	643.33	1190.	1649.69
916.67	643.51	1190.31	1650.
920.	646.84	1196.31	1656.00
922.05	648.89	1200.	1659.69
922.22	649.06	1200.31	1660.
923.16	650.	1202.00	1661.69
927.60	654.44	1210.	1669.69
927.78	654.62	1210.31	1670.
930.	656.84	1214.31	1674.00
933.16	660.	1220.	1679.69
933.33	660.17	1220.31	1680.
938.72	665.56	1230.	1689.69
938.89	665.73	1230.31	1690.
940.	666.84	1232.31	1692.00
943.16	670.	1238.00	1697.69
944.27	671.11	1240.	1699.69
944.44	671.28	1240.31	1700.
949.83	676.66	1250.	1709.69
950.	676.84	1250.31	1710.
953.16	680.	1256.00	1715.69
955.38	682.22	1260.	1719.69
955.56	682.40	1260.31	1720.
960.	686.84	1268.31	1722.00
960.94	687.78	1270.	1729.69
961.11	687.95	1270.31	1730.
963.16	690.	1274.00	1733.69
966.49	693.33	1280.	1739.69
966.67	693.51	1280.31	1740.
970.	696.84	1286.31	1746.00
972.05	698.89	1290.	1749.60
972.22	699.06	1290.31	1750.
973.16	700.	1292.00	1751.69
977.60	704.44	1300.	1758.69
977.78	704.62	1300.31	1760.
980.	706.84	1304.31	1764.00
983.16	710.	1310.	1769.69
983.33	710.17	1310.31	1770.
988.72	715.56	1320.	1779.69
988.89	715.73	1320.31	1780.
990.	716.84	1322.31	1782.00
993.16	720.	1328.00	1787.69
994.27	721.11	1330.	1789.68
994.44	721.28	1330.31	1790.
999.83	726.67	1340.	1799.60
1000.	726.84	1340.31	1800.

°K °C	°R °F
1	1.8
2	3.6
3	5.4
4	7.2
5	9.0
6	10.8
7	12.6
8	14.4
9	16.2
10	18.0

°R °F	°K °C
1	0.56
2	1.11
3	1.67
4	2.22
5	2.78
6	3.33
7	3.89
8	4.44
9	5.00
10	5.56
11	6.11
12	6.67
13	7.22
14	7.78
15	8.33
16	8.89
17	9.44
18	10.00

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.00). Information on calibration services and fees can be found in NBS Circular 483, Testing by the National Bureau of Standards (25 cents). Both are available from the Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.