resonance frequency of a coating specimen alone; ρ_1, density of the coating material; v, acoustic velocity in the coating material; η, viscosity of the coating material; H, hysteresis constant; Q, Q-factor of a coating (film) specimen; ω, radian frequency; XYS + 1°30', cut of a piezoelectric cell in this study; C_{44}, shear modulus; and L_1, equivalent inductance of a piezoelectric cell.

LITERATURE CITED

1. I. G. Mikhailov and V. A. Solov'ev, "Use of compound piezoelectric vibrator for study of mechanical properties of polymers," Akust. Zh., 1, No. 4, 343-347 (1955).
2. W. Caydey, Piezoelectricity and Its Practical Applications [Russian translation], IL, Moscow (1949).
3. V. E. Savchenko, "Device for measuring equivalent resistance of quartz," Inventor's Certificate No. 202320, Byull. Izobret., No. 19 (1967).
4. V. E. Savchenko, "Theory of some applications for quartz resonators in measurement of nonelectrical quantities," in: Stekl. Volokn. Stekloplast., No. 3, 5 (1977).
5. W. P. Mason (ed.), Piezoelectric Crystals and Their Applications in Ultrasonics [Russian translation], IL, Moscow (1952), pp. 345-365.
6. A. N. Borovik, "Measuring viscosity of media with shear vibrations of plane piezoelectric resonators," Prib. Tekh. Eksp., No. 1, 184-185 (1976).
7. Schwartz, "Simple system with unicrystal compound oscillator for measuring internal friction and modulus of elasticity," Instruments Sci. Res., No. 2, 10-16 (1977).

THERMAL CONDUCTIVITY OF INERT GASES OVER A WIDE TEMPERATURE RANGE

A. G. Shashkov, N. A. Nesterov, and O. A. Kolenchits

UDC 536.23

We present the results of correcting and correlating experimental data on the thermal conductivity of inert gases in the temperature range 90-6000°K.

The thermal conductivity of monatomic gases at atmospheric pressure has been rather well investigated over a wide range of temperatures. The experimental material accumulated up to 1976 was systematized and correlated [1, 2] in the form of smoothed empirical relations or tables of reference data for temperatures up to ∿2000°K. In [3, 4] the high-temperature experimental data on the thermal conductivity of neon, argon, krypton, and xenon were correlated and represented by a power-law dependence on the temperature in the range from 500-800 to 5000°K. It was noted that the results of shock-tube measurements in [5-8] are systematically lower than values obtained by steady-state methods in the overlapping temperature range as a result of the improper use in [5-8] of a power-law dependence of the thermal conductivity on the temperature

$$\lambda = \lambda_0 \left(\frac{T}{T_0} \right)^b \tag{1}$$

with a constant value of the exponent in the temperature range 300-5000°K. On this basis the results in [5-8] were increased in the correlation by a certain amount for each gas [3, 4].

The presently available experimental data on the thermal conductivity of inert gases in the temperature range 90-6000°K plotted in Fig. 1 show definite regularities in the difference between the results obtained by steady and unsteady methods.

At temperatures above 1000°K there is a small (in principle within the 3-4% limits of experimental error), but systematic divergence of the data, with the values of the conduc-

Institute of Applied Physics, Academy of Sciences of the Belorussian SSR, Minsk.

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 43, No. 5, pp. 788-795, November, 1982. Original article submitted July 7, 1981.

0022-0841/82/4305-1253$07.50

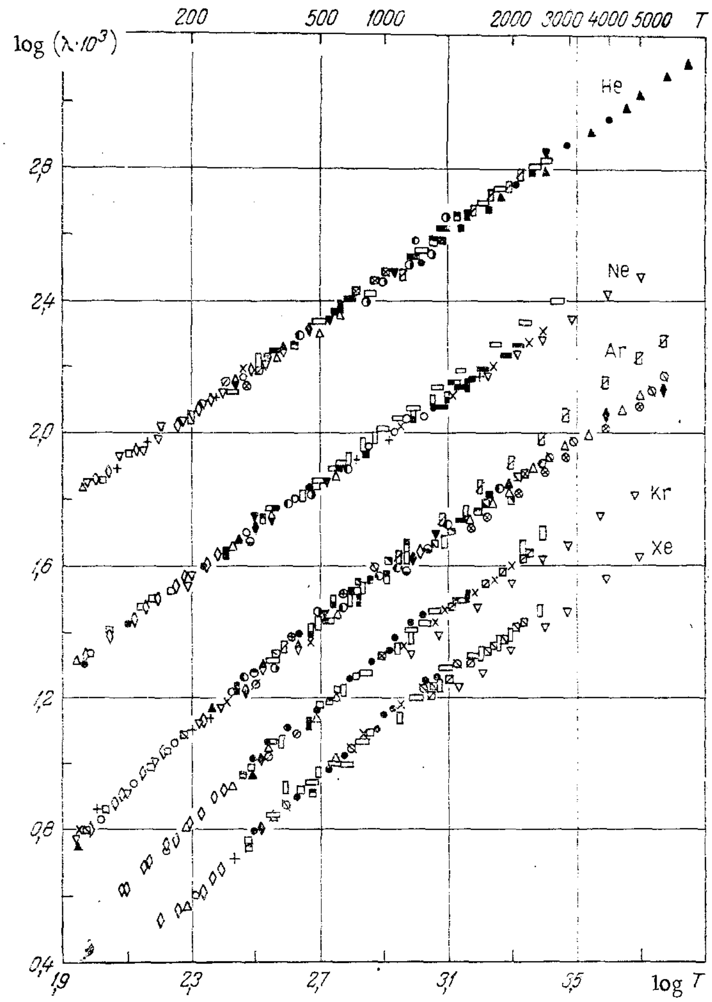

Fig. 1. Experimental temperature dependence of the thermal conductivity of inert gases (for notation see Fig. 2).

tivity found recently [21, 42, 43, 46, 61, 76] by the column method lying below the values obtained by using coaxial cylinders and hot-wire methods [29, 37, 38, 54, 75, 79, 80].

The values of the thermal conductivity measured at high temperatures by the shock-tube method diverge appreciably from the main mass of data in the overlapping temperature range 1500–2500°K: the data of Matula [5] for Ar and Xe; Collins et al. [6, 7] for He, Ne, Ar, Kr; the data of Zemlyanykh [8] for He are systematically lower (the data of [7] for He by ∿5%, data of [6] for Ne by ∿4%, data of [5, 8] for Ar by ∿5–6%, data of [6] for Kr by ∿11%, data of [5] for Xe by ∿12%) and the results of Saxena's shock-tube measurements [9] on the thermal conductivity of Ar and Ne are considerably higher.

The reasons for this divergence are apparently both the large error (10–20%) in the shock-tube measurements and the fact that the shock-tube experiments [5–9] were performed in the temperature range from 1000–1600 to 5000–6700°K, and the power law (1) approximating the behavior of the thermal conductivity in this temperature range was extended over a broader range because the authors used values of the reference point λ_0 at temperatures $T_0 \approx$ 300–320°K. Figure 1 shows that the deviations of the temperature dependence of the thermal conductivity of inert gases from a power law increase with increasing molecular weight of the gas, and that a power-law approximation is sufficiently accurate only over small temperature ranges.

Results [83] obtained for Ar by another variant of the shock-tube method (developed in the Thermodynamics Branch of the Institute of Thermomechanics of the Czechoslovak Academy of Sciences) in which a power-law approximation was not used agree satisfactorily with data obtained by steady-state methods in the overlapping temperature range (1500–2500°K). The values of the exponent in Eq. (1) to describe the results in [9] for neon and argon must be significantly larger (b_{Ne} = 0.75, b_{Ar} = 0.8) than in [5–8], probably because they were deter-

TABLE 1. Results of Correcting Experimental Data on the Thermal Conductivity of Inert Gases Obtained by the Shock-Tube Method in the Form of the Power Law $\lambda = \lambda_0(T/T_0)^b$

Gas	Reference	Temp. range, °K	b	Parameters of reference point [5-8]		Param. of ref. point corrected acc. to [1-4]		$\delta\lambda$, %
				T_0, K	λ_0, W m^{-1} K^{-1}	T_0', K	λ_0', W m^{-1} K^{-1}	
He	Collins, Greif [7]	1600—6700	0,69	320	0,159	1600	0,498	3,1
	Zemlyanykh [8]	1000—4000	0,70	300	0,149	1000	0,355	2,5
Ne	Collins, Menard [6]	1500—5000	0,637	300	0,0492	1500	0,143	4,1
Ar	Collins, Menard [6]	1500—5000	0,703	300	0,0177	1500	0,0560	2,0
	Matula [5]	1500—4800	0,68±0,01	300	0,0177	1500	0,0560	5,6
	Zemlyanykh [8]	1000—6000	0,71	300	0,0177	1000	0,0436	4,6
Kr	Collins, Menard [6]	1000—5000	0,695	300	0,00946	1000	0,0247	11,6
Xe	Matula [5]	1400—5000	0,72±0,01	303,15	0,00578	1400	0,0198	12,2

TABLE 2. Coefficients of Polynomials (3) Approximating the Experimental Temperature Dependence of the Thermal Conductivity of Inert Gases over a Wide Range of Temperatures

Gas	Temp. range, °K	$a_1 \cdot 10^3$	$a_2 \cdot 10^4$	$a_3 \cdot 10^7$	$a_4 \cdot 10^{11}$	$a_5 \cdot 10^{15}$	$a_6 \cdot 10^{19}$
He	90—273	27,51	4,912	—2,585			
	273—6700	48,50	3,5880	—0,6042	0,844	—0,47	
Ne	90—273	—1,816	3,0560	—7,516	100,7		
	273—5000	14,620	1,24700	—0,35360	0,7328	—0,582	
Ar	90—273	0,453	0,5940	0,297	—12,5		
	273—5000	2,136	0,57710	—0,21790	0,6466	—0,945	0,53
Kr	120—273	0,518	0,3027				
	273—5000	0,484	0,33531	—0,11121	0,2555	—0,216	
Xe	170—273	0,604	0,1644				
	273—5000	—0,059	0,20790	—0,06485	0,1499	—0,128	

mined from sparse experimental material; from 15 and 25 points in two series of measurements for Ar and 6 experimental points for Ne, as compared with 50-100 data points in [5-8].

The experimental values in [5-8] which are systematically too low can be corrected by limiting the range of application of the power law (1) to the temperature range of the shock-tube measurements, retaining the values of the exponent determined by the authors and using as a reference point a value λ_0' corresponding to the lower limit ($T_0' \approx$ 1000-1600°K) of the temperature range they investigated. Then the values of the thermal conductivity in [5-8] increase by the amount

$$\delta\lambda = \frac{\lambda_{corr} - \lambda_{exp}}{\lambda_{corr}} = 1 - \frac{\lambda_0}{\lambda_0'}\left(\frac{T_0'}{T_0}\right)^b, \qquad (2)$$

where λ_0 and T_0 are the parameters of the reference point used in [5-8], and λ_0' and T_0' are the corrected parameters of this point.

The values of $\delta\lambda$ listed in Table 1 show that the experimental results in [5-8] are increased on the average by 3% for He, 4% for Ne, 5% for Ar, 11.6% for Kr, and 12.2% for Xe, and in the overlapping temperature range they "join" with the data obtained by steady-state methods.

The shock-tube results in [5-8] corrected in this way and other experimental data (except for the results in [9]) were processed by the method of least squares and approximated by the polynomials

$$\lambda = \sum_{i=0}^{n} a_i T^{i-1} \qquad (3)$$

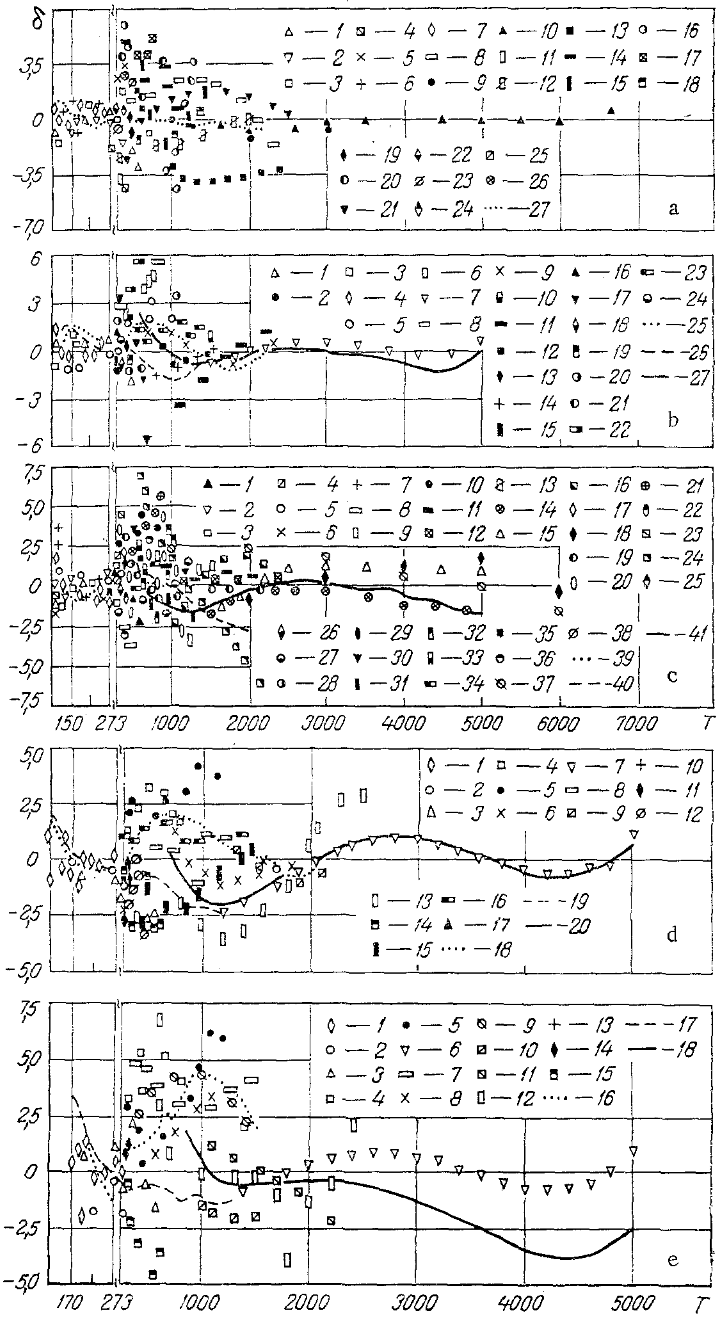

Fig. 2. Deviation of values of thermal conductivity gases from the results of correlation, $\delta=(\lambda-\lambda_{crl})/\lambda_{crl}$, %. **Experimental values:** a–*1*–[10]; *2*–[11]; *3*–[12]; *4*–[13, 14]; *5*–[15]; *6*–[16]; *7*–[17]; *8*–[18, 19]; *9*–[8], *10*–[7]; *11*–[20]; *12*–[21]; *13*–[22]; *14*–[23]; *15*–[24]; *16*–[25]; *17*–[26]; *18*–[27]; *19*–[28]; *20*–[29]; *21*–[30]; *22*–[31]; *23*–[32]; *24*–[33]; *25*–[50, 87]; *26*–[84]; b–1–[10]; *2*–[34]; *3*–[35]; *4*–[36]; *5*–[37, 38]; *6*–[26]; *7*–[6]; *8*–[9]; *9*–[39–41]; *10*–[42]; *11*–[43]; *12*–[44]; *13*–[45]; *14*–[46]; *15*–[47]; *16*–[31]; *17*–[48]; *18*–[49]; *19*–[50, 51]; *20*–[28]; *21*–[52]; *22*–[53]; *23*–[54]; *24*–[84]; c–1–[10]; *2*–[55]; *3*–[56]; 4–[13, 14]; *5*–[57]; *6*–[58]; 7–[59]; 8–[20]; 9–[60]; *10*–[26]; *11*–[61]; *12*–[42]; *13*–[9]; *14*–[5]; *15*–[6]; *16*–[43]; *17*–[17]; *18*–[8]; *19*–[62]; 20–[63]; *21*–[64]; *22*–[28, 65]; *23*–[49]; *24*–[66]; *25*–[67]; *26*–[68]; *27*–[69]; *28*–[70]; *29*–[31]; *30*–[71]; *31*–[72]; *32*–[73]; *33*–[34]; *34*–[74]; *35*–[32]; *36*–[29]; *37*–[83]; *38*–[84]; d–*1*–[36]; 2–[57]; *3*–[10]; *4*–[26]; *5*–[37, 38]; *6*–[61]; *7*–[6]; *8*–[75]; *9*–[43]; *10*–[47]; *11*–[67]; *12*–[65]; *13*–[76]; *14*–[77]; *15*–[78]; *16*–[72]; *17*–[84]; e–*1*–[17]; *2*–[57]; *3*–[10]; *4*–[26]; *5*–[37, 38]; *6*–[5]; *7*–[78]; *8*–[79]; *9*–[80]; *10*–[42]; *11*–[43]; *12*–[81]; *13*–[47]; *14*–[51]; *15*–[82]. **Recommended values:** a–*27*–[1]; b–*25*–[1]; *26*–[2]; *27*–[4]; c–*39*–[1]; *40*–[2]; *41*–[4]; d–*18*–[1]; *19*–[2]; *20*–[3]; e–*16*–[1]; *17*–[2]; *18*–[3]. *T*, K

in the temperature ranges 90-273 and 273-6000°K. The coefficients a_i of the empirical relations (3) are listed in Table 2.

The possible error in the values of the thermal conductivity calculated with Eq. (3) is: for helium, 1.5% for T < 273°K, 3% in the range T = 273-1200°K, 4% in the range 1200-2500°K, and 5% for T > 2500°K; for neon, 1.3% for temperatures below 273°K, 1.5% in the temperature range 273-1200°K, 2% in the temperature range 1200-2200°K, and 3% for T 2200°K; for argon, 3% for T = 90-100°K, 1.5% for T = 100-273°K, 2% for T = 273-1200°K, 3% in the range 1200-2500°K, 4% for T > 2500°K; for krypton, 1.5% for T < 273°K, 2% in the range 273-1200°K, 3% in the temperature range 1200-2500°K, and 4% for T > 2500°K; for xenon, 1.8% for T < 273°K, 2.5% for T = 273-1200°K, 3% for T = 1200-2500°K, and 5% for T > 2500°K.

The values of the thermal conductivity at 273°K calculated by using both polynomials agree within 0.2% for He and Ne, 0.3% for Ar, 0.9% for Kr, and 1.4% for Xe. These values lie within the limits of error of the correlated data indicated above.

Figure 2 shows the deviation $\delta = (\lambda - \lambda_{crl})/\lambda_{crl}$, % of the experimental data and the recommended values [1-4] from the results of the correlation presented. The spread of most of the experimental data is ∿3-4% for He, Ne, Ar, and Kr, and 5% for Xe; the maximum deviation of individual results from the correlated data does not exceed 6% for He, Ne, and Ar, 4% for Kr, and 7% for Xe.

The results of the correlation for helium are in very good agreement (±1%) with the values recommended in [1]; for neon the deviation from the values in [1, 2] does not exceed 1.5%; for argon the divergence from the data in [2] lies within the same limits, and the divergence from the data in [1] reaches 2.5% at T = 2000°K; for krypton the results of the correlation lie mainly between the values recommended in [1, 2]; the deviation does not exceed ±2.5%; for xenon the correlated data lie 1.5% above the values recommended in [2], while the results in [1] at T = 1000°K are 4% above the correlated values. Thus, except for the thermal conductivity of xenon in the temperature range 900-1500°K, the divergence does not exceed the errors of the values recommended in [1, 2].

For neon, argon, and krypton our correlated data agree within ±1.5% with the results of the correlation in [3, 4] for high temperatures; the values in [3, 4] are generally higher in the initial temperature range (500-800°K) due to the character of the power-law approximation of the experimental data in these papers. For xenon the divergence from the data in [1] increases to −3.5% for temperatures above 4000°K.

The results of the correlation (Table 2) of the thermal conductivity of inert gases in the temperature range 90-6000°K in the form of the empirical relations (3) are recommended for various technical applications.

LITERATURE CITED

1. N. B. Vargaftik, L. P. Filippov, A. A. Tarzimanov, and E. E. Totskii, Thermal Conductivity of Liquids and Gases [in Russian], Standartov, Moscow (1978).
2. V. A. Rabinovich et al., Thermophysical Properties of Neon, Argon, Krypton, and Xenon [in Russian], Standartov, Moscow (1976).
3. N. B. Vargaftik and Yu. D. Vasilevskaya, "Thermal conductivity of krypton and xenon at high temperatures to 5000°K," Inzh.-Fiz. Zh., 39, 852-858 (1980).
4. N. B. Vargaftik and Yu. D. Vasilevskaya, "High-temperature thermal conductivity of neon to 5000°K and argon to 6000°K," Inzh.-Fiz. Zh., 40, 473-481 (1981).
5. R. A. Matula, "High-temperature thermal conductivity of rare gases and gas mixtures," Trans. ASME, 90, Ser. C, J. Heat Transfer, 319-327 (1968).
6. D. J. Collins and W. A. Menard, "Measurement of the thermal conductivity of noble gases in the temperature range 1500 to 5000°K," Trans. ASME, 88, Ser. C, J. Heat Transfer, 52 (1966).
7. D. J. Collins, R. Greif, and A. E. Bryson, "Measurements of the thermal conductivity of helium in the temperature range 1600-6700°K," Int. J. Heat Mass Transfer, 8, 1209-1216 (1965).
8. Yu. P. Zemlyanykh, "Experimental study of the thermal conductivity of gases at high temperatures in a shock tube," Author's Abstract of Candidate's Dissertation, Odessa (1972).
9. S. C. Saxena, "Determination of the thermal conductivity of gases by shock-tube studies," High-Temp. Sci., 4, 517-540 (1972).
10. W. G. Kannuluik and E. H. Carman, "The thermal conductivity of rare gases," Proc. Phys. Soc., B65, 701-709 (1952).
11. H. L. Johnston and E. R. Grilly, "The thermal conductivities of eight common gases between 80 and 380°K," J. Chem. Phys., 14, 233-239 (1946).
12. I. F. Golubev and I. B. Shpagina, "Thermal conductivity of helium at temperatures from 273.65 to 21.5°K and pressures from 0.101 to 49.14 MN/m^2," Gasovaya Promyshlennost', No. 8, 40-42 (1966).

13. A. Eucken, "On the temperature dependence of the thermal conductivity of several gases," Phys. Z., 12, 1101-1107 (1911).
14. A. Eucken, "On the thermal conductivity, specific heat, and viscosity of GaSe," Phys. Z., 14, 324-332 (1913).
15. P. Mukhopadhyay and A. K. Barua, "Thermal conductivity of hydrogen—helium gas mixtures," Brit. J. Appl. Phys., 18, 635-640 (1967).
16. A. G. Karpushin and Kh. S. Seitov, "An arrangement for measuring the thermal conductivities of gases at reduced temperatures," in: Diffusion in Gases and Liquids [in Russian], Alma-Ata (1974), pp. 109-112.
17. A. G. Shashkov, N. A. Nesterov, V. M. Sudnik, and V. I. Aleinikova, "Experimental study of the thermal conductivity of inert gases at low temperatures," Inzh.-Fiz. Zh., 30, 671-679 (1976).
18. P. C. Jain and S. C. Saxena, "Transport properties of helium in the temperature range 400-2300°K," Chem. Phys. Lett., 36, 489-491 (1975).
19. B. J. Body, P. C. Jain, and S. C. Saxena, "Determination of thermal properties from steady-state heat transfer measurements on a heated tungsten wire in vacuum and helium gas," Trans. ASME, 97, Ser. C, J. Heat Transfer, 605-609 (1975).
20. A. G. Shashkov and F. P. Kamchatov, "Experimental determination of the thermal conductivity of binary gas mixtures," Inzh.-Fiz. Zh., 22, 843-849 (1972).
21. F. Faubert and G. Springer, "Measurement of the thermal conductivity of helium up to 2100°K by the column method," J. Chem. Phys., 58, 4080-4083 (1973).
22. D. L. Timrot and A. S. Umanskii, "Investigation of the thermal conductivity of helium in the temperature range 400-2400°K," Teplofiz. Vys. Temp., 3, 381-388 (1965).
23. N. B. Vargaftik and N. Kh. Zimina, "Thermal conductivity of helium at temperatures of 0-1000°C and pressures of 1-200 atm," At. Energ., 19, 300-303 (1965).
24. E. I. Marchenkov and A. G. Shashkov, "Investigation of the thermal conductivity of helium in the range 400-1500°K on an arrangement with a molybdenum measuring cell," Inzh.-Fiz. Zh., 26, 1089-1097 (1974).
25. D. L. Timrot and E. E. Totskii, "Dilatometric method for the experimental determination of the thermal conductivity of corrosive gases and vapors at high temperatures," Teplofiz. Vys. Temp., 3, 740-746 (1965).
26. L. S. Zaitseva, "Experimental study of the thermal conductivity of monatomic gases over a wide range of temperatures," Zh. Tekh. Fiz., 29, 497-505 (1959).
27. V. K. Saxena and S. C. Saxena, "Measurement of the thermal conductivity of helium using a hot-wire type of thermal diffusion column," Brit. J. Appl. Phys. (J. Phys. D) Ser. 2, 1, 1341-1351 (1968).
28. B. N. Srivastava and A. D. Gupta, "Thermal conductivity of binary mixtures of ammonia and inert gases," Brit. J. Appl. Phys., 18, 945-951 (1967).
29. N. B. Vargaftik, Yu. K. Vinogradov, and I. A. Khludnevskii, "Investigation of the thermal conductivity of gases by the method of periodic heating," in: Thermophysical Properties of Gases [in Russian], Moscow (1973), pp. 6-9.
30. B. J. Jody, S. C. Saxena, V. P. S. Nein, and R. A. Aziz, "Thermal conductivity of helium: A probe for the repulsive wall of the interatomic potential," J. Chem. Phys., 22, 53-58 (1977).
31. E. Thornton, "Viscosity and thermal conductivity of binary gas mixtures: xenon—krypton, xenon—argon, xenon—neon, and xenon—helium," Proc. Phys. Soc., 76, 104-112 (1960).
32. Kh. I. Amirkhanov, A. P. Adamov, and G. D. Gasanov, "Experimental investigation of the thermal conductivity of argon at low temperatures," Inzh.-Fiz. Zh., 22, 835-842 (1972).
33. M. P. Saxena and S. C. Saxena, "Measurement of the thermal conductivity of gases using thermal diffusion columns," Phys. Fluids, 99, 1595-1599 (1966).
34. F. G. Keyes, "Thermal conductivity of gases," Trans. ASME, 76, 809-816 (1954).
35. I. F. Golubev and I. B. Shpagina, "The thermal conductivity of neon at temperatures from −195.3 to 74.5°C and pressures up to 500 kg/cm², " Tr. GIAP No. 8, 91-98 (1971).
36. N. A. Nesterov and V. M. Sudnik, "On the question of the thermal conductivity of gaseous neon and krypton at reduced temperatures and atmospheric pressure," Inzh.-Fiz. Zh., 30, 863-867 (1976).
37. N. B. Vargaftik and L. V. Yakush, "Experimental investigation of the thermal conductivity of neon, krypton, and xenon over a wide temperature range," Inzh.-Fiz. Zh., 21, 491-499 (1977).
38. N. B. Vargaftik and L. V. Yakush, "Experimental investigation of the thermal conductivity of neon, krypton, and xenon," in: Thermophysical Properties of Gases [in Russian], Moscow (1970), pp. 9-13.

39. P. C. Jain and S. C. Saxena, "Thermal conductivity of neon in the temperature range 400-2400°K," Chem. Phys. Lett., 28, 454-456 (1974).
40. B. J. Jody and S. C. Saxena, "Thermal conductivity of neon from heat-transfer measurements in the continuum and temperature-jump regimes," Phys. Fluids, 18, 20-28 (1975).
41. V. P. S. Nein, R. A. Aziz, P. C. Jain, and S. C. Saxena, "Interatomic potentials and transport properties for neon, argon, and krypton," J. Chem. Phys., 65, 3242-3250 (1976).
42. G. S. Springer and E. W. Wingeier, "Thermal conductivity of neon, argon, and xenon at high temperatures," J. Chem. Phys., 59, 2747-2750 (1973).
43. L. P. Zarkova, "Experimental determination of the thermal conductivity of cesium and mercury vapors and inert gases," Author's Abstract of Candidate's Dissertation, Sofiya (1976).
44. V. K. Saxena and S. C. Saxena, "Measurement of the thermal conductivity of neon using hot-wire type thermal diffusion columns," J. Chem. Phys., 48, 5662-5666 (1968).
45. I. V. Sengers, W. T. Bolk, and C. I. Stigter, "Thermal conductivity of neon between 25 and 75°C at pressures up to 2600 atm," Physica, 30, 1018-1026 (1964).
46. P. C. Jain and S. C. Saxena, "An instrument for the measurement of thermal properties of gases and metal wires," J. Sci. Instrum., 7, 1023-1026 (1974).
47. H. Curie and A. Lepape, "Thermal conductivity of rare gases," J. Phys. Rad., 2, 392-397 (1931).
48. V. K. Saxena, M. P. Saxena, and S. C. Saxena, "Measurement of thermal conductivity of gases using thermal diffusion columns: neon," Ind. J. Phys., 49, 597-604 (1966).
49. G. P. Gupta and S. C. Saxena, "Pressure dependence of thermal conductivity of a hot-wire type of cell," Can. J. Phys., 45, 1418-1420 (1967).
50. J. M. Gandhi and S. C. Saxena, "Thermal conductivities of the gas mixtures D_2—H_2, D_2—Ne, and D_2—He—Ne," Brit. J. Appl. Phys., 18, 807-812 (1967).
51. J. M. Gandhi and S. C. Saxena, "Thermal conductivity of binary and ternary mixtures of helium, neon, and xenon," Mol. Phys., 12, 57-68 (1967).
52. R. Tufeu, B. Le Neindre, and P. Bury, "Experimental study of the thermal conductivity of neon," C. R. Acad. Sci. Paris, 271B, No. 13, 589-592 (1970).
53. T. N. Vasil'kovskaya and I. F. Golubev, "Thermal conductivity of neon at temperatures from 295 to 566°K and pressures from 1 to 400 bar," Tr. GIAP, No. 8, 99-101 (1971).
54. E. I. Marchenkov and V. I. Aleinikova, "Investigation of the thermal conductivity of neon and argon—neon mixtures at high temperatures," Inzh.-Fiz. Zh., 33, 848-856 (1977).
55. B. J. Bailey and K. Kellner, "The thermal conductivity of liquid and gaseous argon," Physica, 39, 444-462 (1968).
56. I. F. Golubev and I. B. Shpagina, "The thermal conductivity of argon at temperatures from —175.57 to 93.3°C and pressures from 1 to 500 kg/cm^2," in: The Chemistry and Technology of Nitrogen Fertilizers and Products of Organic Synthesis [in Russian], ONTI GIAP, No. 24 (1969), pp. 62-69.
57. F. G. Keyes, "Thermal conductivity of gases," Trans. ASME, 77, 1395-1396 (1955).
58. P. Mukhopadhyay and A. K. Barua, "Thermal conductivities of nitrogen—argon gas mixtures," Brit. J. Appl. Phys., 18, 1307-1310 (1967).
59. A. G. Karpushin and Kh. S. Sentov, "Cryostat for the study of the thermal conductivity of gases," in: Applied and Theoretical Physics [in Russian], Vol. 7, Alma-Ata (1975), pp. 13-16.
60. E. I. Marchenkov, "Investigation of the thermal conductivity of argon—helium mixtures and pure gases at high temperatures," Author's Abstract of Candidate's Dissertation, Minsk (1975), p. 32.
61. F. M. Faubert and G. S. Springer, "Measurement of the thermal conductivity of argon, krypton, and nitrogen in the range 800-2000°K," J. Chem. Phys., 57, 2333-2340 (1972).
62. S. H. P. Chen and S. C. Saxena, "Thermal conductivity of argon in the temperature range 350-2500°K," Mol. Phys., 29, 455-466 (1975).
63. Yu. A. Gorshkov and A. S. Umanskii, "Investigation of the thermal conductivity of argon by a pulse method," Teploenergetika, No. 10, 83-85 (1975).
64. N. V. Tsederberg, V. N. Popov, and N. A. Morozova, "Experimental investigation of the thermal conductivity of argon," Teploenergetika, No. 6, 82-87 (1960).
65. A. D. Gupta, "Thermal conductivity of binary mixtures of sulfur dioxide and inert gases," Int. J. Heat Mass Transfer, 10, 921-929 (1967).
66. D. A. Timrot and A. S. Umanskii, "Thermal conductivity of hydrogen and argon," Teplofiz. Vys. Temp., 4, 289-293 (1966).

67. R. S. Gambhir and S. C. Saxena, "Thermal conductivity of binary and ternary mixtures of krypton, argon, and helium," Mol. Phys., 11, 233-241 (1966).
68. B. M. Rosenbaum, S. Oshen, and G. Thodos, "Thermal conductivity of argon in the dense gaseous and liquid regions," J. Chem. Phys., 44, 2831-2838 (1966).
69. N. B. Vargaftik and N. Kh. Zimina, "Thermal conductivity of argon at high temperatures," Teplofiz. Vys. Temp., 2, 716-724 (1964).
70. A. Michels, I. V. Sengers, and L. Van de Klundert, "Thermal conductivity of argon at elevated densities," Physica, 29, 149-160 (1963).
71. R. G. Vines, "Measurement of the thermal conductivities of gases at high temperatures," Trans. ASME, 82, Ser. C, J. Heat Transfer, 48-52 (1960).
72. K. L. Schäfer and F. W. Reiter, "A method for measuring thermal conductivity at 1100°C," Z. Electrochem., 6, 1230-1235 (1957).
73. A. I. Rothman and L. A. Bromley, "High-temperature thermal conductivity of gases. Measurements of nitrogen, carbon dioxide, argon, and nitrogen—carbon dioxide mixtures at temperatures up to 775°C" Ind. Eng. Chem., 47, 889-906 (1955).
74. W. F. Schottky, "On the measurement of the thermal conductivity of gases at high temperatures," Z. Electrochem., 56, 889-892 (1952).
75. A. A. Voshchinin, V. V. Kerzhentsev, E. A. Studnikov, and L. V. Yakush," Experimental investigation of the thermal conductivity of krypton at high temperatures," Inzh.-Fiz. Zh., 28, 821-825 (1975).
76. P. C. Jain and S. C. Saxena, "Thermal conductivity of Krypton in the temperature range 400-2500°K," J. Chem. Phys., 63, 5052-5053 (1975).
77. R. Tufeu, B. Le Neindre, and P. Bury, "Experimental study of the thermal conductivity of krypton at high pressure," C. R. Acad. Sci. Paris, 273B, 61-64 (1971).
78. V. K. Saxena and S. C. Saxena, "Thermal conductivity of krypton and xenon in the temperature range 350-1500°K," J. Chem. Phys., 51, 3361-3368 (1969).
79. A. A. Voshchinin, V. V. Kerzhentsev, E. A Studnikov, and L. V. Yakush, "Measurement of the thermal conductivity of xenon at high temperatures," Izv. Vyssh. Uchebn. Zaved., Energ., No. 7, 88-93 (1975).
80. S. S. Bakulin, S. A. Ulybin, and S. P. Zherdev, "Experimental investigation of the thermal conductivity of xenon in a rarefied state at temperatures between 400 and 1400°K," Teplofiz. Vys. Temp., 13, 760-763 (1975).
81. B. J. Jody, S. C. Saxena, V. P. S. Nein, and R. A. Aziz, "Transport properties and interatomic potentials for xenon," High-Temp. Sci., 8, 343-352 (1976).
82. R. Tufeu, B. Le Neindre, and P. Bury, "Experimental Study of the thermal conductivity of xenon," C. R. Acad. Sci., Paris, 273B, 113-115 (1971).
83. V. Kmoníček, J. Maštovský, and J. Malešák, "Tepelná vodivost dusíku a argonu za vysokých teplot," Strojnícky časopis, 19, 348-358 (1968).
84. J. J. De Groot, J. Kestin, and H. Sookiazian, "Instrument to measure the thermal conductivity of gases," Physica, 75, 454-482 (1974).