THE THERMAL CONDUCTIVITY DATA OF SOME BINARY GAS MIXTURES INVOLVING NONPOLAR POLYATOMIC GASES

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Experimental data of thermal conductivity of thirty two different gas pairs are analysed. Graphical plots are presented as a function of composition and at the temperature of measurement. Smooth values are tabulated for further use. This study has revealed the deficiencies of the existing data and has provided some clues for further plan of work on thermal conductivity measurements.

Thermal conductivity data is very useful for (*i*) a wide variety of design problems involving heat transfer and (*ii*) theoretical understanding of polyatomic molecules. Such data are somewhat rare and the deficiencies even for such cases are very significant at high temperatures. The available data on monatomic gases and their mixtures were analysed and interpreted by Gandhi and Saxena. An attempt was made by Gambhir and Saxena to discuss all the existing information regarding the thermal conductivity of some common nonpolar polyatomic gases. They also reported a table recommending in it the smoothed values of thermal conductivity as a function of temperature at an interval of 25°C and for O_2, N_2, H_2, CO_2, CO, NO, N_2O, CH_4 and D_2. In this article we consider thirty two different gas pairs for which experimental data are available as a function of composition at a particular temperature. In a few systems such information is available at several temperatures, but in general the information is scarce at high temperatures. These mixtures are either combinations of monatomic and polyatomic or polyatomic and polyatomic gases. There are several very specific purposes behind such a straight forward and laborious study. Firstly, this enables to have an assessment of the existing information as regards its reliability and accuracy. Finally we also report smoothed values for further use. We find that it has not been possible to form any opinion of some value regarding the various methods and techniques used, primarily because hardly any overlapping data are available on different techniques. In this respect the efforts of Gambhir and Saxena (to be published) deserves special mention. Secondly, several approximate, empirical and semi-theoretical procedures developed for computing thermal conductivity of mixtures, require thorough testing so that their use in those areas where direct measurements are not available may be made with some reliance. This study helps in such an adventures by providing smooth values. Thirdly, the discrepancies in the data for any system can be removed by suitably planning experiments. Fourthly, even the rigorous theories[1] of mixtures need thorough checking against reliable experimental information with a view to explore the implications of the different assumptions involved in the theoretical development. Fifthly, a careful critical survey of this type stands a fair chance of predicting some interesting and useful combinations of gas pairs for immediate future studies both from the view point of practical need and theoretical interest. This is of some value to us as a comprehensive effort is being made in this laboratory to experimentally measure the thermal conductivity of mixtures as a function of temperature and composition.

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EXPERIMENTAL DATA

The binary combinations, involving one of the components as a rare gas, considered here are O_2-*Ar*, N_2-*Ar* and H_2-*Ar* at 38°*C* of Srivastava & Srivastava[2]; O_2-*He*, O_2-*Ne*, O_2-*Kr* and O_2-*Xe* at 30°*C* and 45°*C* of Srivastava & Barua[3]; N_2-*He*, N_2-*Ne*, N_2-*Kr* and N_2-*Xe* at 30°*C* and 45°*C* of Barua[4]; H_2-*He*, H_2-*Ne*, H_2-*Kr* and H_2-*Xe* at 30°*C* and 45°*C* of Barua[5]; *He*-CH_4 at 316°*C*, *He*-CO_2 at 316°*C*, N_2-*He* at 104°*C* and 316°*C* and *Ar*-N_2 at 320°*C* of Cheung Bromley and Wilke[6]; *He*-CO_2, N_2-*He* and *Ne*-CO_2 at 0°*C* of Davidson & Music[7]; H_2-*Ar* at 0°*C* of Ibbs & Hirst[8] and *Ar*-N_2 at 0°*C* of Weber[9]. The experimental data of binary mixtures involving both components as polyatomic gases together with the corresponding pure components considered here are of Cheung Bromley and Wilke[6] for O_2-CO_2 (97°*C*), CH_4-C_3H_8 (95°*C*), CO_2-C_3H_8 (95°*C*) and N_2-O_2 (319°*C*); Weber[9] for H_2-CO_2 (0°*C*); Kornfeld & Hilferding[10] for H_2-CO_2 (25°*C*) and H_2-C_2H_4 (25°*C*); Ibbs & Hirst[8] for H_2-N_2O (0°*C*), N_2-H_2 (0°*C*) and H_2-*CO* (0°*C*); Keyes[11] for N_2-CO_2 (50°, 150°, 250° and 350°*C*); Rothman[12] for N_2-CO_2 (472°, 573°, 677° and 774°*C*); Westenberg & de Haas[13] for N_2-CO_2 (300°; 500° and 1000°*K*); Pereira & Raw[14] for N_2-N_2O, N_2-*NO*, O_2-N_2O all at 31·85°, 50·55°, 101·0°, 140·2° and 180·1°C and *NO*-N_2O (50·55°, 101·0°, 140·2° and 180·1°*C*), and Gray & Wright[15] for N_2-H_2 (25·3°, 74·8°, 99·1° and 149·3*C*°).

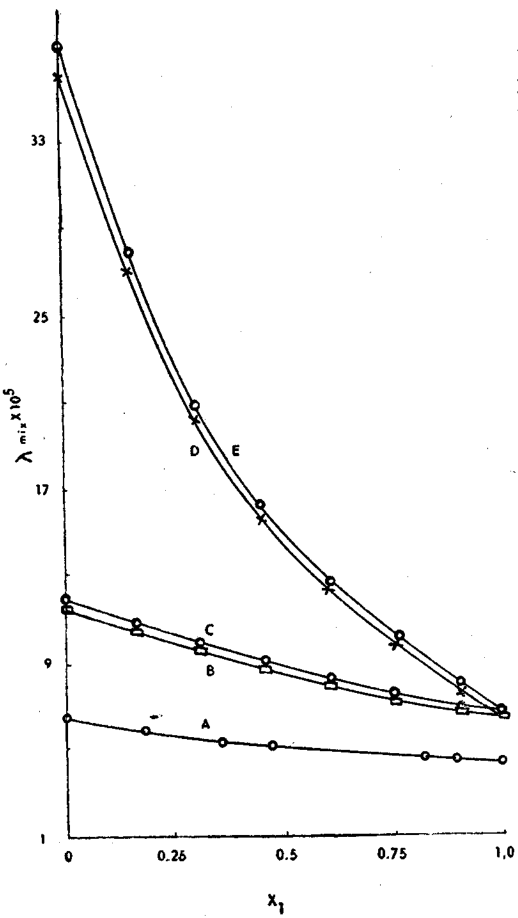

FIG. 1—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component). O, ☐, × are experimental points, continuous curves are smooth plots. Curves A, B, C, D and E refer to O_2—*Ar* (38°C), O_2—*Ne* (30°C), O_2—*Ne* (45°C), O_2—*He* (30°C) and O_2—*He* (45°C) respectively.

It is important to note here that only for two systems H_2-CO_2 and N_2-CO_2 data exist of more than one person to enable relative comparison of experimental data. For H_2-CO_2 (0°*C*) we have considered only the data of Weber[9]. Ibbs & Hirst[8] have also reported data for this system at this very temperature. The agreement between the two sets of values is good for composition greater than 60% of CO_2 but for lower values the Ibbs & Hirst[8] data are systematically smaller than that of Weber[9]. The disagreement is however, only a few per cent and can be accounted for by the experimental uncertainties. Westenberg & de Haas[13] have presented a comparison of N_2-CO_2 data of different workers, which shows the disparities to be around a few per cent. Thus on the basis of these comparisons and our previous experience we infer that one should off hand expect only an accuracy of a few per cent in the data of gas mixture conductivities. This is important for comparing the various calculated values with this data ; relative assessments are sensitively controlled by such considerations.

In Fig. 1 are shown the experimental plots of λ_{mix} *vs* composition of the heavier component (X_1) for O_2-*Ar*, O_2-*Ne* and O_2-*He*. For the last two systems data are at two temperatures 30°*C* and 45°*C* and both are plotted. The five curves depict a high degree of internal consistency and may be regarded as fairly reliable. The actual values plotted in curves *B* to *E* are the smooth values recommended by several workers [3]. These data were taken by a precision thermal conductivity cell of the hot-wire type using a thick-wire. This apparatus is preferable for measuring the temperature coefficient of thermal conductivity as the hot-wire also acts as a thermometer. This is also evident from the two sets of measurements on each system differing by 15°*C* only. The data exhibit in all cases the normal trend of variation with temperature and composition. λ_{mix} values increase with temperature and fall with the increase of heavier component in the mixture. The rate is more in the beginning but decreases as the proportion of the heavier component increases. The change in conductivity for a mixture whose components differ more in molecular weight is large and this is also exhibited from this figure. All these trends are in complete accord with the predictions of theory. The O_2-*He* system seems specially interesting for check of the empirical form employed to represent the composition variation of thermal conductivity.

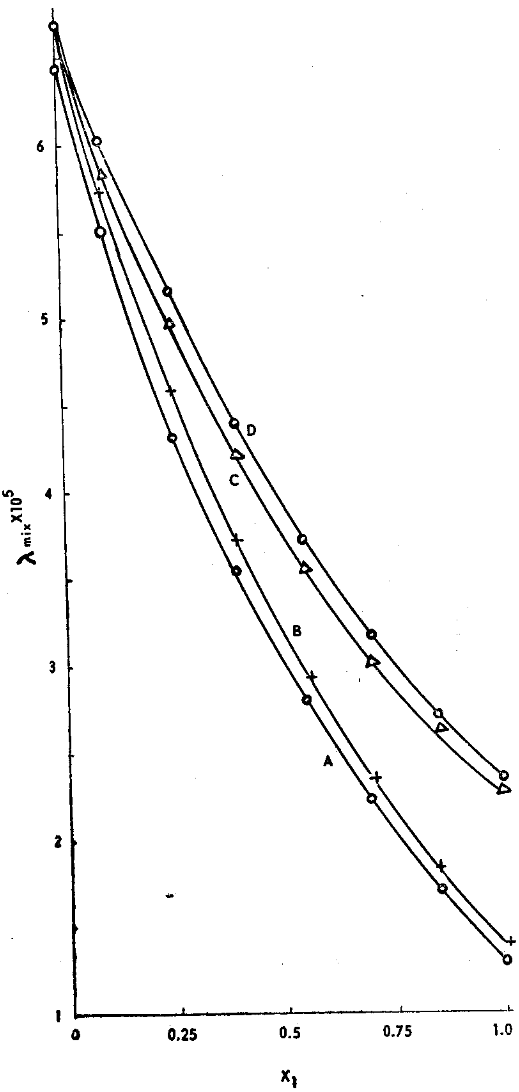

FIG. 2—Plots of λ_{mix} (cal cm^{-1} sec^{-1} deg^{-1}) *vs* X_1 (mole fraction of the heavier component). O, +, △ are experimental points, continuous curves are smooth plots. Curves A, B, C and D refer to O_2—*Xe* (30°C), O_2—*Xe* (45°C), O_2—*Kr* (30°C) and O_2—*Kr* (45°C) systems respectively.

In Fig. 2 are plotted the data of O_2-K_r and O_2-*Xe* systems both being at two temperatures. Here also all the comments of Fig. 1 apply and the various predictions of theory are further confirmed. Both these systems as well as the three of Fig. 1 show another interesting fact namely that as the rare gas combining with O_2 is changed in the order from *He* to *Xe*, the thermal conductivity systematically falls. This is to be observed for a fixed temperature and composition of the mixture.

This is a direct consequence of the periodic properties of elements and should be exhibited in systems permuting with elements which fall in the same category of iso-electronic configuration. In fact it may be mentioned that these plots can be used to estimate and predict the thermal conductivity of O_2—Rr system following the procedure suggested by Srivastava & Saxena[16] and Saxena [17].

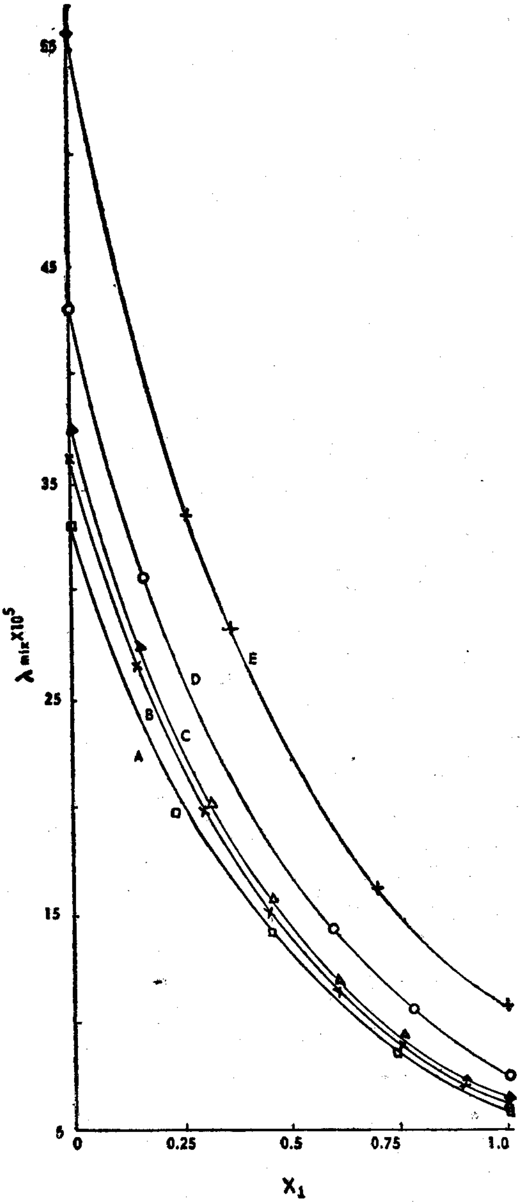

FIG. 3—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of N_2) for N_2—He system. ▢, ×, △, O, + are experimental points, continuous curves are smooth plots. Curves A, B, C, D-and E refer to 0, 30, 45, 104 and 316°C respectively.

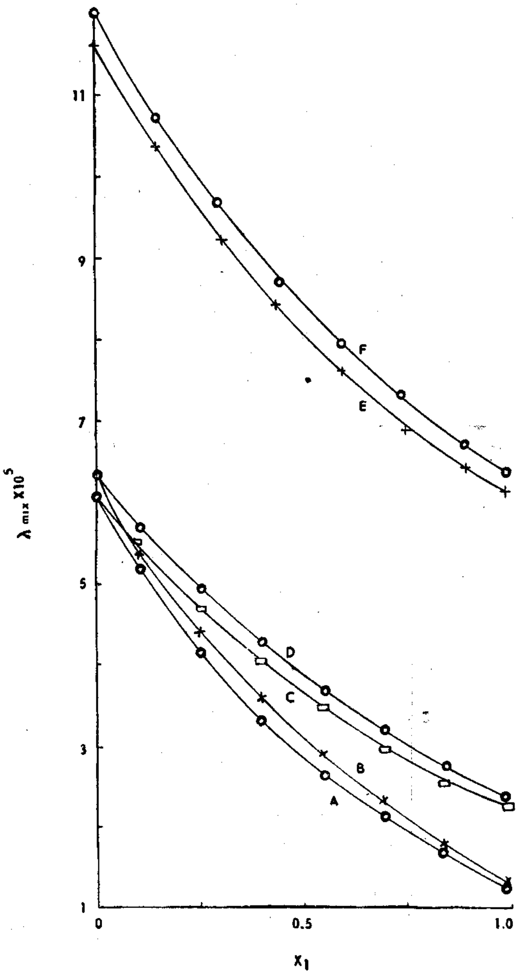

FIG. 4—Plots of λ_{mix} (cal cm—1 sec—1 deg—1). *vs* X_1 (mole fraction of the heavier component) Continuous curves are smooth plots O, ÷ ▢, × are experimental points. A, B, C, D, E and F refer to N_2—Xe (30°C), N_2—Xe, (45°C), N_2- Kr (30°C), N_2—Kr (45°C), N_2—Ne (30°C) and N_2—Ne (45°C) systems respectively.

In Fig 3 is plotted the data of N_2-He system. Fortunately, this system has been investigated by three different groups of workers [4,6,7] each reporting data as a function of composition and in all at five temperatures. All the curves are placed appropriately in the figure and seem to lend good confirmation on the results obtained using different techniques such as thick-wire variant of the hot-wire and co-axial cylinders. This system is also interesting as it offers a wide range of change in the conductivity values correspon-ding to the two pure components. As the relaxation properties of N_2 molecule are known

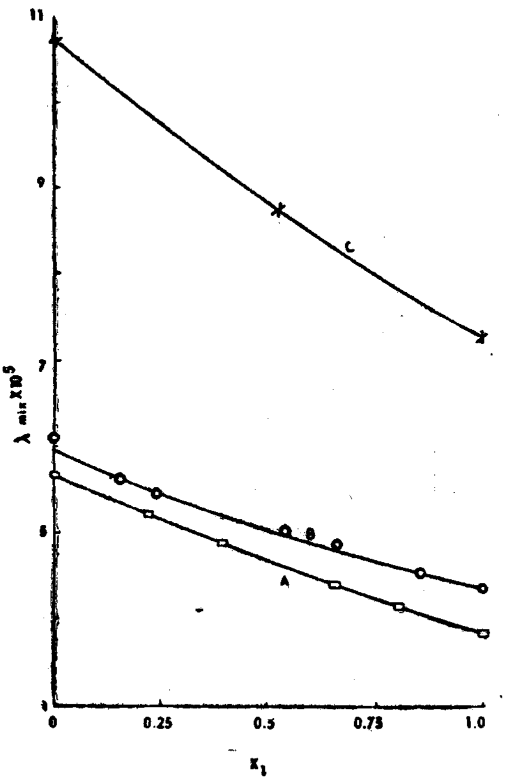

FIG. 5—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of *Ar*) for N_2—Ar system. O, ▢, × are experimental points, continuous curves are smooth plots. A, B and C curves refer to 0, 38 and 320°C respectively.

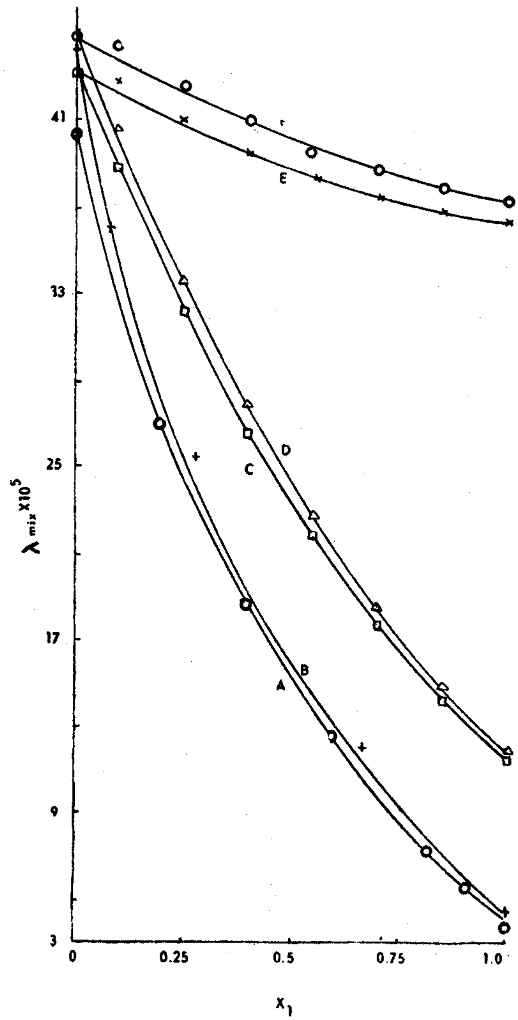

FIG. 6—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component). O, +, ▢, △, × are experimental points, continuous curves are smooth plots. Curves A, B, C, D, E and F refer to H_2—Ar (0°C), H_2—Ar (38°C), H_2—Ne (30°C), H_2—Ne (45°C), H_2—He (30°C) and H_2—He (45°C) respectively.

at such temperatures, a reasonable appreciation of the data is possible on the basis of theory. These data are going to be very appropriate in estimating the merits of the different computational procedures suggested by us and others.

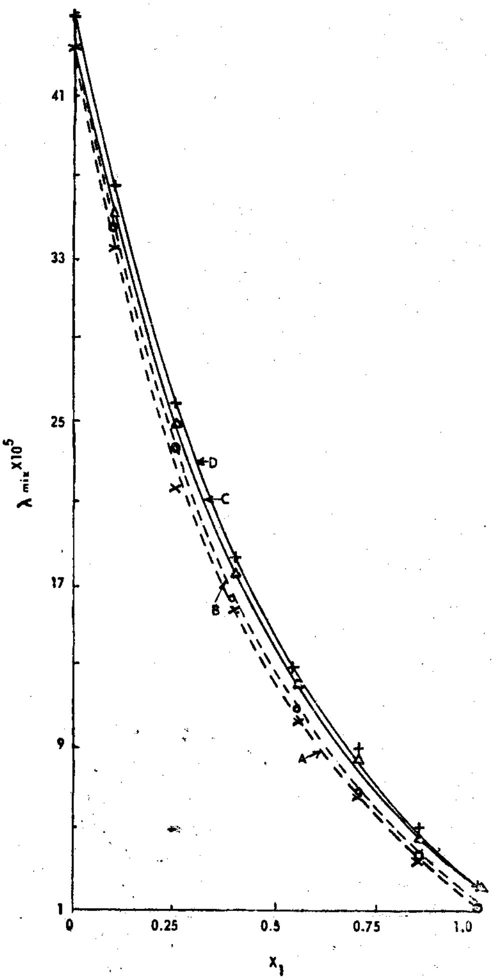

FIG. 7—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component) ×, O, △, +, are experimental points, broken and continuous curves are smooth plots. Broken curves A, B, and continuous curves C, D refer to H_2—Xe (30°C), H_2—Xe (45°C), H_2 —Kr (30°C) and H_2—Kr (45°C) systems respectively.

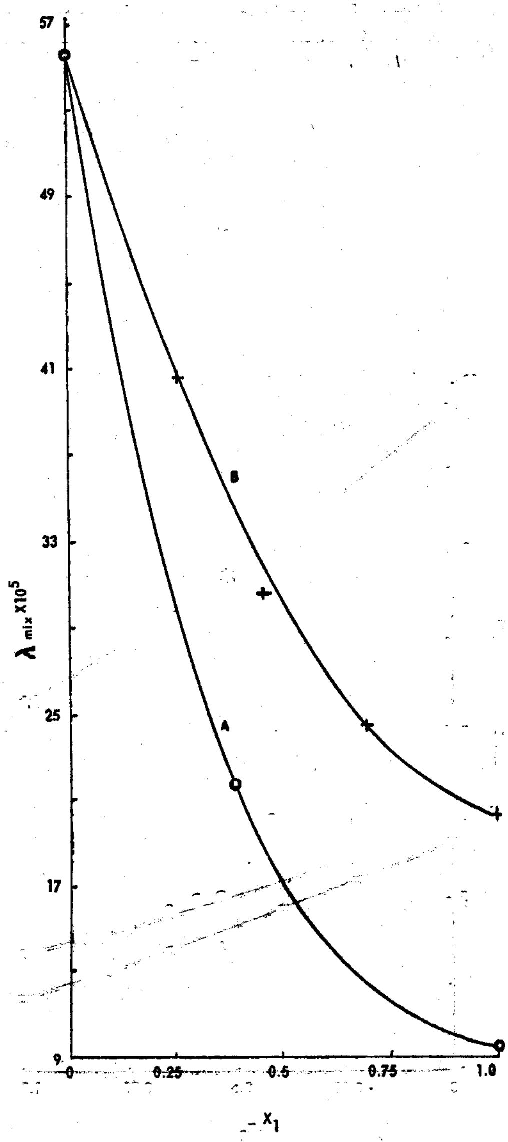

FIG. 8—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component). O, +, are experimental points, continuous curves are smooth plots. Curves A and B refer to He—CO_2 (316°C) and He—CH_4 (316°C) respectively.

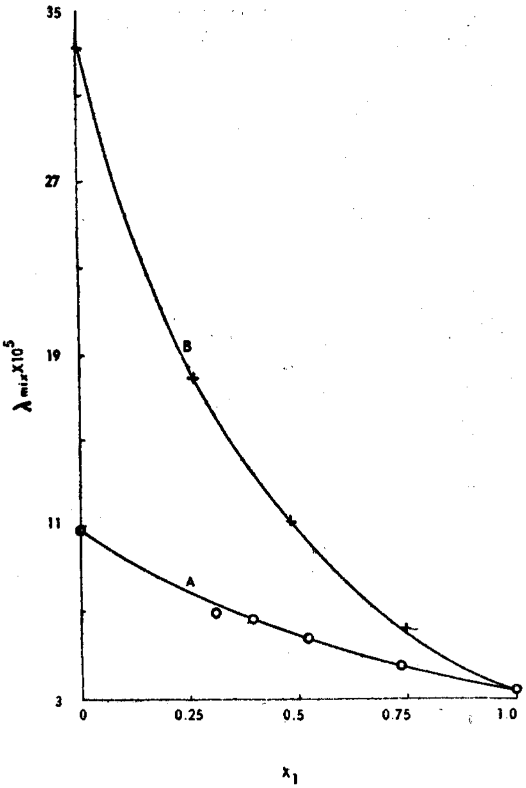

FIG. 9—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs.* X_1 (mole fraction of the heavier component) O, + are experimental points, continuous curves are smooth plots. Curves A and B refer to $Ne—CO_2$. (0°C) and $He—CO_2$ (0°C) respectively.

In Fig. 4 and 5 we consider the data on the remaining gas mixtures permuting out of N_2 and rare gases. N_2-Ne, N_2-Kr and N_2-Xe are considered in Fig 4 while N_2-Ar in Fig 5. All the data are on the whole quite satisfactory and follow the various trends predicted by theory. The data on the N_2-Ar system are particularly satisfactory as for the case of N_2-He system. This is because the data exist at three different temperatures though at the highest temperature, value of λ_{mix} is available only at a single composition. Indeed more measurements are needed for this system at properly distributed temperatures.

The binary systems of H_2 with He, Ne and Ar are considered in Fig. 6. λ_{mix} values are in general satisfactory except for H_2-Ar system. Here the scatter is quite pronounced and no precise interpretation is possible on its basis. The remaining two systems of H_2-Kr and H_2-Xe are displayed in Fig. 7. These also appear statisfactory. In general there is a paucity of experimental data at high temperatures of all the mixtures of H_2 with rare gases. There is some special interest in such investigations for H_2 molecule behaves in a manner which is understandable on the existing knowledge of thermal conductivity theories. This is because of the circumstance that rotational effects can be completely neglected for this gas because for as many as several hundred collisions equivalent time is required for rotational-translational equilibration.

We consider three more systems of rare gases with polyatomic gases namely He-CH_4, He-CO_2 and Ne-CO_2. These are plotted in Fig. 8 and 9. The data are reasonably satisfactory though more measurements will be very fruitful. It is important to notice in these diagrams that He-CH_4 has higher thermal conductivity than He-CO_2 at the same temperature (316°C) and composition, as also He-CO_2 relative to Ne-CO_2. The latter, of course, is easily understandable because thermal conductivity monotonically decreases with increasing mass of the rare gas. Further though the former trend is also not hard to understand as CH_4 is lighter than CO_2 but one can not expect such a dependence on mass when polyatomic molecules are involved because the heat transport properties are complicated by the relaxation properties of the molecules involved and no simple correlation exists with mass to predict such a behaviour for polyatomic molecules.

The plots of thermal conductivity versus composition are shown in Fig. 10 for a mixture composed of diatomic gases H_2 and N_2. The behaviour of this combination is not expected to be complicated, for relaxation of internal-translational energy enters into the system only through N_2. This indeed is depicted by Fig. 10 where λ_{mix} plots follow or exhibit on new trend and similar behaviours are observed for other mixtures involving monatomic-polyatomic gases. The data is available for five different temperatures in the range 0°—150°C. The data is consistent and will offer a good circumstance to check the theories of thermal conduction. Measurements, however, are necessary at still higher temperatures to bring the relaxation effects in a pronounced way.

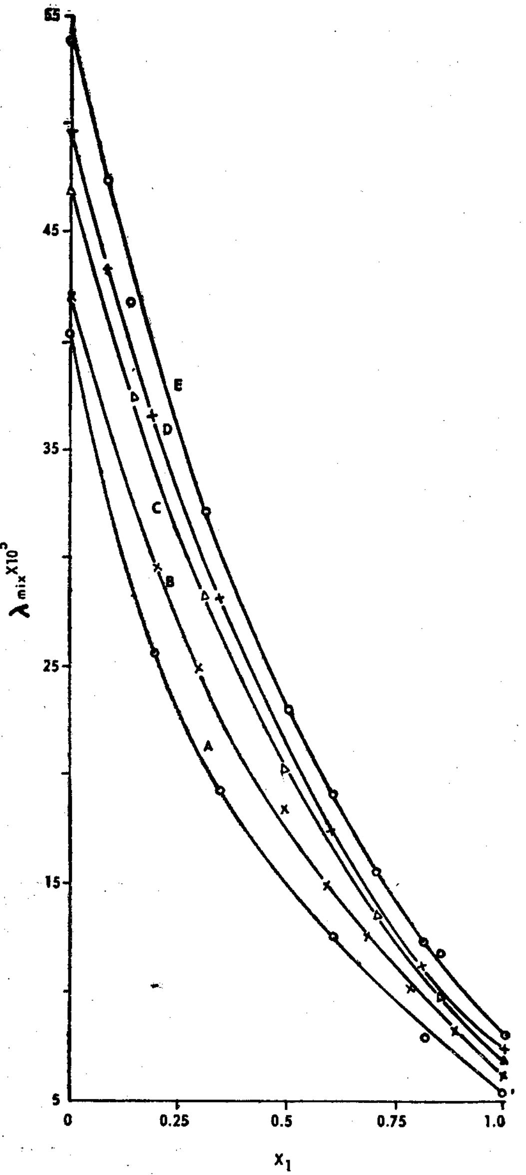

FIG. 10—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of N_2) for N_2—H_2 system$_2$
o, ×, △, + are experimental points, continuous curves are smooth plots. Curves A, B, C, D and E refer to 0, 25·3, 74·8, 99·1 and 149·3°C respectively.

In Fig. 11 we consider the two other mixtures of polyatomic gases. These are O_2-CO_2 and N_2-O_2. Both are somewhat conspicuous in their variation with composition. In the former λ_{mix} decreases with composition of the heavier component but the decrease is quite steep almost linear in contrast with the previous mixtures considered. The N_2-O_2

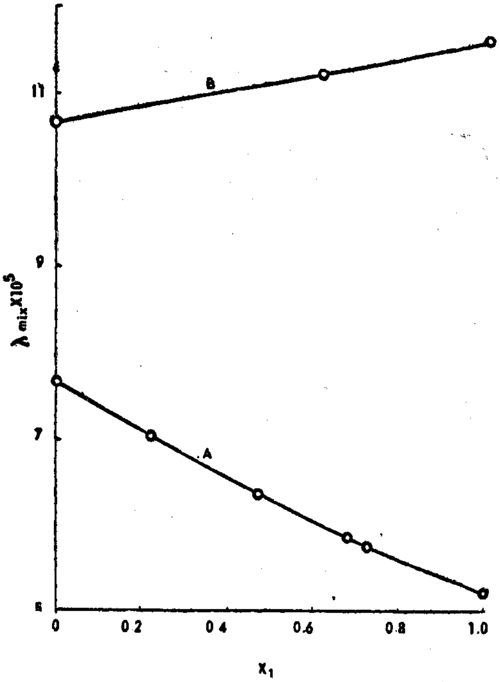

FIG. 11—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 mole fraction of the heavier component). o experimental points, continuous curves are smooth plots. A and B refer to O_2—CO_2 and N_2—O_2 system respectively.

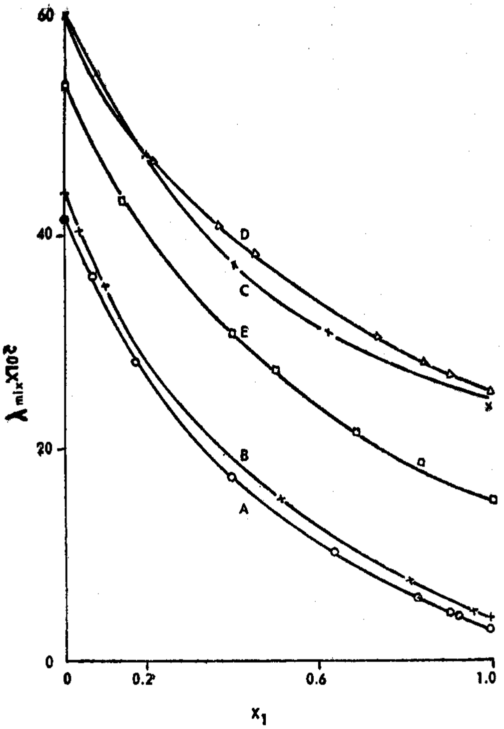

FIG. 12—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component) o, +, ☐, ×, △ experimental points, continuous curves are smooth plots. A, B, C, D and E refer to H_2—CO_2 (0°C), H_2—CO_2 (25°C), H_2—N_2O, H_2—CO, and H_2—C_2H_4 respectively. Scales for C and D along the ordinate have been displaced upwards by 20 units.

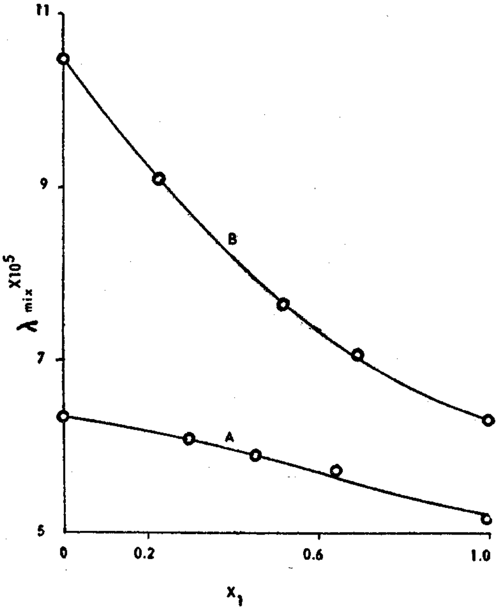

FIG. 13—Plots of λ_{mix} (cal cm -1 sec—1 deg—1) *vs* X_1 (mole fraction of the heavier component) Continuous curves are smooth plots, A and B refer to CO_2—C_3H_8 and CH_4—C_3H_8 systems respectively. o are experimental points. In A, X_1 refers to CO_2.

system is altogether different in the sense that here conductivity increases as the proportion of the heavier component is increased though normally as well as in all the mixtures considered so far it was the other way round. This should not be regarded, however, as an anomalous behaviour for the theory does explain this (Saxena *et al* [18]). In view of the unusual behaviour of this system and the availability of data at only one composition we recommend that this system should be investigated more elaborately. This is also a simple example of the part played by the internal degrees of freedom in controlling the thermal conductivity values.

In Fig. 12 we plot the data of λ_{mix} of five different gas pairs formed by the combination of H_2 with CO_2 (at 0° and 25°C), N_2O, CO and C_2H_4. In all cases the data are smooth in as much as they lie on a smooth curve and also follow the common behaviour of variation with respect to temperature and composition. Another very interesting point in this figure provides an opportunity to look into the part played by the internal degrees of freedom and intermolecular forces in controlling the thermal conductivity values. N_2O and CO_2, and N_2 and CO have equal molecular weights but they are slightly different otherwise. λ_{mix} values, therefore, should differ only because of molecular structural differences. Indeed some differences are observed but these being small are masked in their trends by the errors in the experimental data. We feel that such measurements should be performed over extended temperature ranges with a view to throw light on the behaviour and part played by the internal degrees of freedom of these molecules.

In Fig. 13 the data are plotted for two binary systems formed by the combination of propane with CO_2 and methane. The data are smooth. CH_4-C_3H_8 system also follows the general trend of variation with composition. CO_2 and C_3H_8 have almost equal molecular weights and therefore this system is interesting as any differences in λ_{mix} result only because of the differences in the structures of the molecules. Experiments lead to sufficiently different values for the pure components CO_2 and C_3H_8. The mixture exhibits a strange dependence with composition. The curve which is usually convex towards the origin is concave in this case. A heavy weight has been put on the experimental accuracy in making this comment. We are of the opinion that precise measurements be planned to throw further light on this point.

We next consider a system which probably is most investigated in heat transfer measurements. This is N_2-CO_2 and its data are plotted in Fig. 14, and 15. Much has been, said earlier in many publications regarding the change in trend of λ_{mix} values with composition as the temperature is increased. The two components N_2 and CO_2 have almost

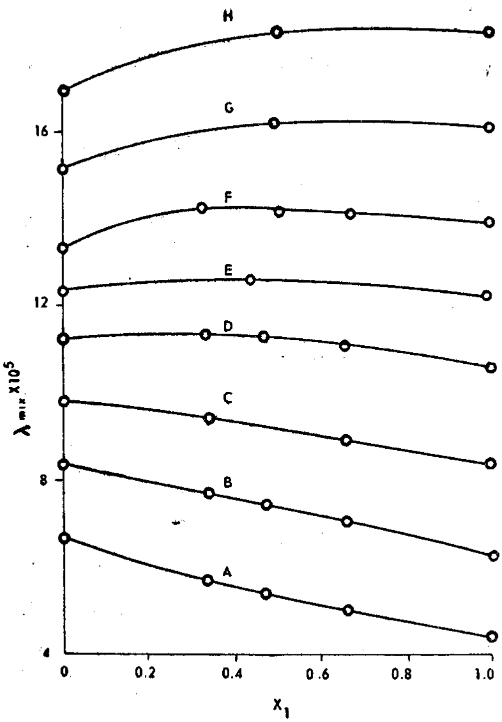

FIG. 14—Plots of λ_{mix} (cal cm^{-1} sec^{-1} deg^{-1}) *vs* X_1 (mole fraction of CO_2) for N_2—CO_2 system. Continuous curves are smooth plots, O are experimental points. Curves A, B, C, D, E, F, G and H refer to 50, 150, 250, 350, 472, 573, 677 and 774°C respectively.

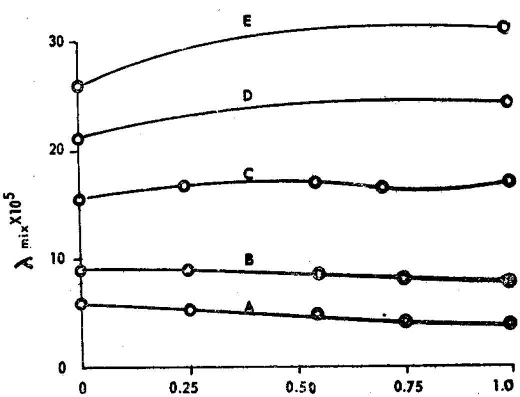

FIG. 15—Plots of λ_{mix} (cal cm^{-1} sec^{-1} deg^{-1}) *vs* X_1 (mole fraction of CO_2) for N_2—CO_2 system. Continuous curves are smooth plots, O are experimental points. Curves A to E refer to 300, 500, 1000, 1500 and 2000°K respectively. The last two curves are only calculated ones.

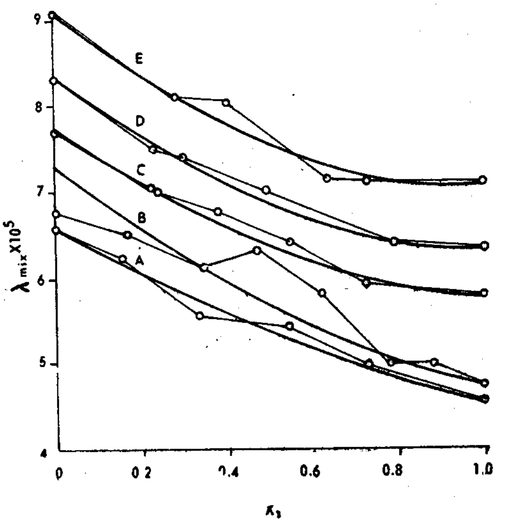

FIG. 16—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of N_2O) for N_2O—O_2 system Continuous curves are smooth plots, while broken line curves are obtained by joining the observed points indicated by o. Curves A to E refer to 31·85, 50·55, 101·0, 140·2 and 180·1°C respectively.

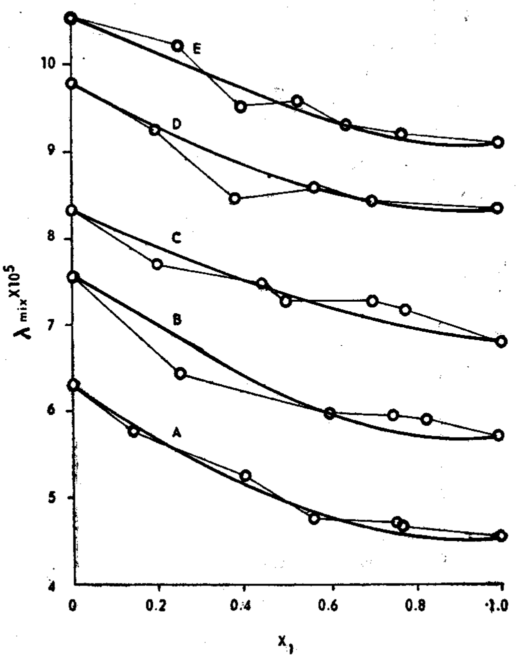

FIG. 17—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of N_2O) for N_2O—N_2 system Continuous curves are smooth plots, while the broken line curves are obtained by joining the observed points indicated by o. Curves A to E refer to 31·85, 50·55, 101·0, 140·2 and 180·1°C respectively. Curves B and C are displaced along the ordinate by one unit while D and E by two units.

equal thermal conductivity values and as the temperature of the mixture is increased, this trend which is convex towards origin at lower temperatures becomes convex at still higher temperatures. To sum up the discussion on this system we say that it is one of those systems where experiment has given lead to the theory. The theory of Saxena *et al*[18] is still to be applied to this system to see what further improvement, if any, results on the existing interpretation of data.

In Figs. 16-19, are shown the plots of λ_{mix} against composition for N_2O-O_2, N_2O-N N_2O-NO and NO-N_2 systems. In all cases we find that the exact experimental points do not lie on a smooth curve and we feel that this must be due to the errors in the experimental data. If this is accepted we find that these systems are otherwise normal and exhibit the usual variation with temperature and composition. Indeed it will be interesting to check some of these data on a more precise experimental set-up.

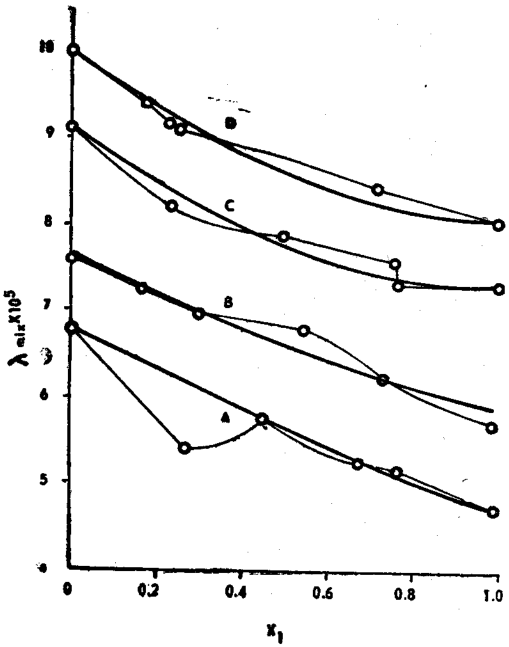

FIG 18—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of N_2O) for N_2O—NO system. Continuous curves are smooth plots, o experimental points. Curves A to D refer to 50·55, 101·0, 140·2 and 180·1°C respectively. Curves C and D are displaced along the ordinate by one unit in each case.

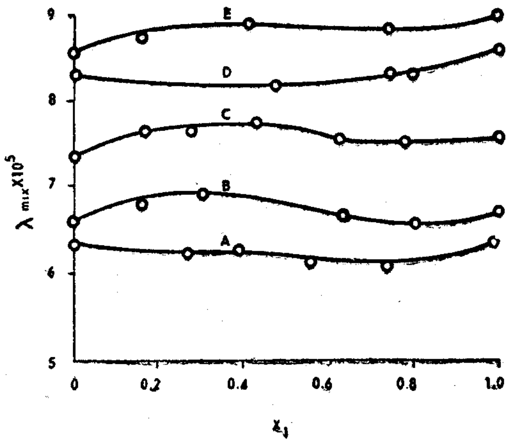

FIG. 19—Plots of λ_{mix} (cal cm—1 sec—1 deg—1) *vs* X_1 (mole fraction of NO) for NO—N_2 system. Continuous curves are smooth plots, o experimental points. Curves A to E refer to 31·85, 50·55, 101·0, 140·2 and 180·1°C respectively. Curve D has been displaced along the ordinate by half a unit.

TABLE 1

SMOOTH VALUES OF THERMAL CONDUCTIVITY IN CAL CM—1 SEC—1 DEG—1 AS A FUNCTION OF COMPOSITION AT A FEW TEMPERATURES FOR SOME BINARY GAS-PAIRS

Gas-Pairs	Temperature °C	X_1					
		0·0	0·2	0·4	0·6	0·8	1·0
O_2—He	30	36·4	24·5	17·0	12·3	8·88	6·44
	45	37·7	25·2	17·6	12·8	9·22	6·69
O_2—Ne	30	11·6	10·2	9·00	7·98	7·05	6·44
	45	12·0	10·5	9·32	8·24	7·32	6·69
O_2—Ar	38	6·46	5·66	5·20	4·88	4·59	4·35
O_2—Kr	30	6·44	5·23	4·20	3·36	2·70	2·25
	45	6·69	5·43	4·37	3·52	2·86	2·33
O_2—Xe	30	6·44	4·68	3·50	2·59	1·85	1·29
	45	6·69	4·94	3·71	2·73	1·97	1·35
N_2—He	0	33·2	22·3	15·7	11·1	7·82	5·78
	30	36·4	24·0	16·7	11·7	8·21	6·10
	45	37·6	24·9	17·2	12·1	8·65	6·57
	104	43·2	28·4	19·9	14·3	10·2	7·45
	316	55·6	37·4	26·7	19·2	13·7	10·6

TABLE 1—*contd.*

Gas-Pairs	Temperature °C	X 0·0	0·2	0·4	0·6	0·8	1·0
N_2—Ne	30	11·6	9·94	4·64	7·56	6·75	6·10
	45	12·0	10·3	9·04	7·92	7·04	6·35
N_2—Ar	0	5·66	5·28	4·89	4·51	4·17	3·85
	38	5·97	5·54	5·21	4·92	4·63	4·35
	320	10·7	9·91	9·16	8·45	7·83	7·29
N_2—Kr	30	6·10	4·96	4·04	3·32	2·72	2·25
	45	6·34	5·18	4·26	3·51	2·86	2·34
N_2—Xe	30	6·10	4·45	3·32	2·47	1·81	1·25
	45	6·34	4·71	3·61	2·68	1·93	1·34
H_2—He	30	43·2	41·2	39·5	38·0	36·9	36·3
	45	44·8	42·7	40·9	39·3	38·1	37·3
H_2—Ne	30	43·2	34·3	26·6	20·3	15·4	11·7
	45	44·8	35·6	27·8	21·3	16·0	12·0
H_2—Ar	0	40·4	27·0	18·7	12·7	7·75	3·90
	38	44·3	27·7	19·2	13·1	8·30	4·35
H_2—Kr	30	43·2	27·8	17·6	10·7	5·87	2·26
	45	44·8	28·9	18·3	11·2	6·18	2·35
H_2—Xe	30	43·2	26·1	15·8	9·24	4·72	1·26
	45	44·8	26·9	16·3	9·63	4·99	1·32
He—CH_4	316	55·6	43·8	34·0	27·2	22·6	20·3
He—CO_2	0	33·2	20·3	13·4	8·59	5·34	3·39
	316	55·6	33·8	21·2	14·2	10·8	9·58
Ne—CO_2	0	10·8	8·58	6·79	5·38	4·19	3·39
N_2—H_2	0	40·4	25·6	17·9	12·8	8·86	5·50
	25·3	42·1	29·8	21·0	15·0	10·1	6·20
	74·8	46·9	34·1	24·3	16·9	11·4	6·99
	99·1	49·7	35·9	25·8	17·8	11·6	7·40
	149·3	54·0	38·7	27·6	19·5	13·0	8·14
O_2—CO_2	97	7·66	7·08	6·55	6·06	5·63	5·22
N_2—O_2	319	10·7	10·9	11·0	11·2	11·4	11·6
H_2—CO_2	0	41·6	26·1	17·1	11·3	6·80	3·39
	25	43·7	27·9	18·6	12·6	7·90	4·08
N_2—N_2O	0	40·4	27·0	17·1	11·1	7·30	4·40
H_2—CO	0	40·4	27·2	19·3	13·4	8·80	5·30
H_2—C_2H_4	25	43·7	29·2	20·0	13·5	8·60	5·27
CO_2—C_3H_8	95	5·18	5·43	5·70	5·95	6·18	6·34
CH_4—C_3H_8	95	10·5	9·21	8·15	7·31	6·73	6·34
N_2—CO_2	50	6·64	6·03	5·50	5·05	4·70	4·34
	150	8·31	7·90	7·50	7·05	6·75	6·27
	250	9·83	9·58	9·30	9·00	8·68	8·36
	350	11·2	11·1	11·3	11·2	10·9	10·6
	472	12·3	12·5	12·6	12·5	12·4	12·2
	573	13·4	14·0	14·2	14·1	14·0	13·9
	677	15·1	15·9	16·2	16·3	16·2	16·1
	774	17·0	17·8	18·2	18·3	18·4	18·3
	27	6·13	5·50	5·00	4·40	4·00	3·39
	227	9·16	9·00	8·70	8·40	8·00	7·80
	727	15·7	16·4	16·8	16·7	16·0	16·8
O_2—N_2O	31·85	6·5	6·05	5·58	5·15	4·80	4·55
	50·55	7·29	6·60	5·98	5·45	5·03	4·72
	101·0	7·69	7·10	6·62	6·20	5·90	5·78
	140·2	8·33	7·68	7·13	6·68	6·38	6·32
	180·1	9·09	8·40	7·78	7·35	7·08	7·08

TABLE 1—*contd.*

Gas-Pairs	Temperature °C	X					
		0·0	0·2	0·4	0·6	0·8	1·0
N_2—N_2O	31·85	6·33	5·68	5·17	4·77	4·53	4·55
	50·55	6·58	5·95	5·43	4·97	4·73	4·72
	101·0	7·35	6·88	6·50	6·18	5·93	5·78
	140·2	7·80	7·30	6·85	6·53	6·33	6·32
	180·1	8·60	8·13	7·70	7·35	7·13	7·08
NO—N_2O	50·55	6·77	6·33	5·88	5·45	5·08	4·72
	101·0	7·62	7·20	6·80	6·45	6·15	5·90
	140·2	8·11	7·45	6·95	6·62	6·37	6·32
	180·1	9·01	8·35	7·88	7·43	7·22	7·08
N_2—NO	31·85	6·33	6·28	6·28	6·18	6·20	6·40
	50·55	6·58	6·90	6·92	6·73	6·60	6·77
	101·0	7·35	7·68	7·78	7·63	7·58	7·62
	140·2	7·80	7·68	7·68	7·75	7·90	8·11
	180·1	8·57	8·83	8·90	8·88	8·85	9·01

For further use of data on these systems we report in Table 1 smooth λ_{mix} values at fixed compositions at each of the temperature of experimental investigation. The graphical interpolation was done and equal weight was given to all the directly observed points. It is proposed to utilise the data and compare with the various theoretical predictions in a subsequent publication where consideration will also be given to the various approximate semi-theoretical and empirical procedures.

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