International Journal of Thermophysics, Vol. 11, No. 5, 1990

Viscosity and Thermal Conductivity of Binary Eutectics of Alkali Metals in the Vapor Phase

V. M. Anisimov,[1] N. I. Sidorov,[1] E. L. Studnikov,[1] Yu. V. Tarlakov,[1] and V. S. Yargin[1]

Received August 7, 1989

Values calculated for the dynamic viscosity and thermal conductivity are presented for vapors of binary eutectics of the alkali metals at temperatures from 800 to 1500 K and at pressures from 100 to 8×10^5 Pa. Data are presented for the vapors of the systems Li + Na, Na + Rb, Na + Cs, K + Rb, K + Cs, Na + K, and Rb + Cs. The values of the concentrations of the five components in the vapor phase of each binary eutectic are also presented. The accuracy of the calculated viscosities is estimated to be within 4–5% and the accuracy of the calculated thermal conductivities is estimated to be within 8–10%.

KEY WORDS: alkali metals; cesium; eutectics; lithium; metal vapors; potassium; rubidium; sodium; thermal conductivity; viscosity.

1. THEORY

This paper is concerned with the calculation of the transport properties of saturated and superheated vapors of binary eutectics of alkali metals. In the range of temperatures T from 800 to 1500 K and pressures P from 10^2 to 8×10^5 Pa, the vapors of these eutectics can be treated as ideal-gas mixtures consisting of atoms of the types Y and Z and of diatomic molecules of the types Y_2, Z_2, and YZ in chemical equilibrium through the dissociation reactions

$$Y + Y = Y_2, \qquad Z + Z = Z_2, \qquad Y + Z = YZ \tag{1}$$

The thermophysical properties of such vapor mixtures depend on the molar concentrations y_{Y_2}, y_{Z_2}, y_{YZ}, y_Y, and y_Z of the species. The equilibrium

[1] Moscow Aviation Institute, Volokolamskoye Shosse 4, 125871 Moscow, USSR.

composition of the vapor in turn is determined by the pressure and temperature and by the molar concentrations x_Y and x_Z of the metals in the liquid phase.

We have calculated the equilibrium composition of the vapor by solving the following system of equations:

$$\frac{y_Y^2}{y_{Y_2}} P = \exp\left(\frac{2\phi_Y - \phi_{Y_2}}{R} - \frac{D^0_{Y_2}}{RT}\right) \tag{2}$$

$$\frac{y_Z^2}{y_{Z_2}} P = \exp\left(\frac{2\phi_Z - \phi_{Z_2}}{R} - \frac{D^0_{Z_2}}{RT}\right) \tag{3}$$

$$\frac{y_Y y_Z}{y_{YZ}} P = \exp\left(\frac{\phi_Y + \phi_Z - \phi_{YZ}}{R} - \frac{D^0_{YZ}}{RT}\right) \tag{4}$$

$$y_{Y_2} + y_{Z_2} + y_{YZ} + y_Y + y_Z = 1 \tag{5}$$

$$\frac{2y_{Y_2} + y_{YZ} + y_Y}{2y_{Z_2} + y_{YZ} + y_Z} = \frac{x_Y P^0_Y(1 + y'_{Y_2})}{x_Z P^0_Z(1 + y'_{Z_2})} \tag{6}$$

Here ϕ_α is the reduced chemical potential of species α, D^0_β is the dissociation energy of molecule β, R is the gas constant, P^0_Y and P^0_Z are the partial vapor pressures of the metals Y and Z, x_Y and x_Z are the molar concentrations of the metals Y and Z in the liquid phase, and y'_{Y_2} and y'_{Z_2} are the molar concentrations of the diatomic molecules Y_2 and Z_2 in the saturated vapors of the *pure* alkali metals Y and Z. Equations (2)–(4) represent van't Hoff's law, Eq. (5) Dalton's law, and Eq. (6) Raoult's law.

In solving these equations the pressures were taken for lithium from Ref. 1, for sodium from Ref. 2, and for the other metals from Ref. 3. The chemical potentials ϕ_α were taken from Ref. 4. The dissociation energies D^0_Y and D^0_Z of the homonuclear molecules were taken from Ref. 5, and the dissociation energies D^0_{YZ} of the heteronuclear molecules from Ref. 4. For the superheated vapor states P^0_Y, P^0_Z, y'_{Y_2}, and y'_{Z_2} were calculated not at the actual temperature T, but at the temperature T_1 at saturation at the same pressure.

The dynamic viscosity η and the thermal conductivity λ were calculated on the basis of the kinetic theory of chemically reacting ideal gases [6, 7]. The cross section of the atom–atom and atom–molecule collisions, needed for the calculation of the transport properties, were determined from an analysis of the experimental data for the viscosity and thermal conductivity of the vapors of the pure alkali metals [8]. The other cross sections were determined by applying the combination rules of Ref. 6.

Table I. Viscosity η and Thermal Conductivity λ for Vapors of Binary Eutectics of Alkali Metals as a Function of Temperature (in K) and Pressure (in Pa)

Li + Na, $x_{Li} = 0.03$																
	$10^7\eta$, Pa · s								$10^4\lambda$, W · m^{-1} · K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.01	0.3	0.8	2	4	8	At saturation curve	0.001	0.01	0.3	0.8	2	4	8	At saturation curve
T_1	702	807	1037	1132	1239	1337	1454		702	807	1037	1132	1239	1337	1454	
T																
800	178							161	261							369
850	187	176						164	263	328						394
900	196	189						167	271	305						415
950	204	200						169	280	300						433
1000	213	210						171	291	302						448
1050	221	219	177					173	302	309	447					460
1100	229	228	195					175	313	318	416					468
1150	238	237	211	183				176	325	327	397	463				475
1200	246	245	225	200				179	336	338	387	442				480
1250	254	254	238	216	184			181	347	349	384	427	480			484
1300	263	262	249	231	201			183	359	360	385	418	466			487
1350	271	270	260	245	218	189		186	370	371	389	415	455	486		489
1400	279	279	270	257	233	206		189	382	382	395	415	448	478		491
1450	287	287	280	269	248	222		192	393	393	403	418	445	472		492
1500	296	295	289	280	261	237	206	195	404	404	412	423	445	469	490	493

Table I *(Continued)*

Na + K, $x_{Na} = 0.32$																
	$10^7\eta$, Pa·s								$10^4\lambda$, W·m^{-1}·K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.05	0.3	0.8	2	4	8	At saturation curve	0.001	0.05	0.3	0.8	2	4	8	At saturation curve
T_1	616	806	939	1033	1139	1235	1350		616	806	939	1033	1139	1235	1350	
T																
800	156							145	127							163
850	166	157						150	134	159						177
900	175	170						156	142	158						190
950	185	181	163					161	150	162	197					202
1000	194	192	178					165	158	167	193					212
1050	204	202	191	174				170	166	173	192	217				222
1100	213	212	204	189				174	174	180	194	214				231
1150	223	222	215	203	181			178	182	187	199	214	237			239
1200	232	232	226	216	196			182	190	195	204	216	236			247
1250	242	242	237	228	210	189		186	198	203	210	220	237	252		253
1300	252	251	247	240	224	204		190	205	210	217	225	239	252		260
1350	261	261	258	251	237	219		194	213	218	224	231	242	254		265
1400	271	270	268	262	250	233	209	198	221	226	231	237	247	257	268	270
1450	280	280	278	273	262	246	223	202	229	234	239	244	252	261	271	275
1500	290	290	288	283	274	259	237	206	237	242	247	251	258	266	275	280

Table I. *(Continued)*

Na + Rb, $x_{Na} = 0.18$																
	$10^7\eta$, Pa · s								$10^4\lambda$, W · m^{-1} · K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.05	0.3	0.8	2	4	8	At saturation curve	0.001	0.05	0.3	0.8	2	4	8	At saturation curve
T_1	560	738	864	954	1056	1150	1261		560	738	864	954	1056	1150	1261	
T																
800	210	202						191	77	87.2						100
850	222	217						198	81.5	87.9						106
900	234	230	213					205	86	90.2	106					112
950	246	244	230					212	90.5	93.5	104					118
1000	259	256	246	229				218	95	97.3	105	116				123
1050	271	269	261	247				224	99.6	101	107	116				128
1100	283	282	275	263	241			230	104	106	110	117	128			132
1150	295	294	289	279	259	236		236	109	110	113	119	128	136		136
1200	307	307	302	294	276	255		242	113	114	117	122	129	137		140
1250	320	319	315	308	293	272		248	118	119	121	125	131	138		143
1300	332	331	328	322	308	290	263	253	122	123	125	128	133	139	145	147
1350	344	343	341	335	323	306	281	259	127	128	130	132	136	142	147	150
1400	356	356	353	348	338	322	298	265	131	132	134	136	140	144	150	153
1450	368	368	366	362	352	338	315	271	135	137	138	140	144	147	152	156
1500	381	380	378	374	366	353	332	277	140	141	143	144	147	151	155	159

Table I. *(Continued)*

Na + Cs, $x_{Na} = 0.21$																
	$10^7\eta$, Pa·s								$10^4\lambda$, W·m^{-1}·K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.05	0.1	0.8	2	4	8	At saturation curve	0.001	0.05	0.1	0.8	2	4	8	At saturation curve
T_1	542	719	764	940	1045	1142	1258		542	719	764	940	1045	1142	1258	
T																
800	237	232	227					222	56.3	61.5	66					71.1
850	248	245	242					229	58.9	62.3	65.3					75.3
900	260	258	255					237	61.6	63.9	66					79.2
950	272	270	268	246				244	64.2	65.9	67.4	81.7				82.9
1000	283	282	280	262				251	66.8	68.2	69.3	80.4				86.5
1050	295	294	293	278	258			257	69.4	70.6	71.5	80.2	89.3			89.8
1100	306	306	305	292	275			264	72	73.1	73.8	80.8	88.6			92.9
1150	318	317	317	306	291	272		270	74.7	75.6	76.2	81.9	88.6	95.4		95.9
1200	330	329	328	320	307	289		276	77.3	78.2	78.7	83.5	89.2	95.4		98.8
1250	341	341	340	333	321	305		283	79.9	80.8	81.3	85.5	90.3	95.9		102
1300	353	352	352	346	335	321	298	289	82.5	83.4	83.9	87.6	91.9	96.8	103	104
1350	365	364	364	358	349	336	314	295	85.2	86.1	86.5	89.9	93.7	98.1	104	107
1400	376	376	375	371	363	350	330	302	87.9	88.8	89.2	92.4	95.7	99.7	105	109
1450	388	387	387	383	376	364	346	308	90.6	91.5	91.9	94.9	98	102	106	112
1500	399	399	399	395	388	378	361	315	93.3	94.2	94.6	97.5	100	104	108	114

Table I. *(Continued)*

K + Rb, $x_K = 0.33$																
	$10^7\eta$, Pa·s								$10^4\lambda$, W·m^{-1}·K^{-1}							
10^{-5}P(Pa)	0.001	0.01	0.3	0.8	2	4	8	At saturation curve	0.001	0.01	0.3	0.8	2	4	8	At saturation curve
T_1	564	655	866	955	1056	1149	1259		564	655	866	955	1056	1149	1259	
T																
800	207	204						184	80.3	83.6						108
850	219	217						190	85	87.3						115
900	231	229	205					196	89.7	91.6	114					122
950	243	241	222					201	94.4	96.2	113					127
1000	255	253	238	219				207	99.2	101	113	125				132
1050	267	266	253	236				212	104	106	115	125				137
1100	279	278	267	253	229			217	109	110	118	125	136			141
1150	291	290	280	268	247	222		222	113	115	121	127	137	144		144
1200	303	302	294	283	264	240		227	118	120	125	130	138	145		147
1250	315	314	306	298	280	258		232	123	125	130	134	140	146		150
1300	327	326	319	311	296	275	247	237	128	129	134	137	143	148	152	153
1350	340	338	332	325	311	292	265	242	132	134	139	141	146	150	155	156
1400	352	350	344	338	325	308	282	247	137	139	143	146	149	153	157	158
1450	364	362	356	351	339	323	299	253	142	144	148	150	153	157	160	161
1500	376	374	369	364	353	338	315	258	146	148	153	155	157	160	163	163

Table I. *(Continued)*

K + Cs, $x_K = 0.51$																
	$10^7\eta$, Pa·s								$10^4\lambda$, W·m^{-1}·K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.01	0.1	0.8	2	4	8	At saturation curve	0.001	0.01	0.1	0.8	2	4	8	At saturation curve
T_1	554	648	780	955	1059	1154	1268		554	648	780	955	1059	1154	1268	
T																
800	233	231	217					214	61.2	64.7	78.9					82.8
850	245	242	232					220	64.1	67.4	77.7					89.1
900	257	254	246					226	67.1	70.3	78.4					95
950	268	266	259					231	70.1	73.3	80.2					101
1000	280	278	272	247				237	73.1	76.4	82.6	99.7				106
1050	291	289	284	263				242	76.1	79.5	85.4	99.5				110
1100	303	301	296	278	257			247	79.1	82.6	88.3	100	111			115
1150	315	313	308	293	274			252	82.1	85.8	91.5	102	111			119
1200	326	324	320	306	289	268		257	85	88.9	94.7	104	112	119		122
1250	338	336	332	320	304	285		262	88	92.1	98	107	114	121		126
1300	349	348	344	333	319	301	275	267	91	95.3	101	110	116	122	128	129
1350	361	359	355	345	333	316	291	272	94	98.4	105	113	119	124	130	132
1400	373	371	367	358	346	331	307	277	97.1	102	108	116	122	127	132	136
1450	384	382	379	370	360	345	323	282	100	105	111	120	125	129	134	139
1500	396	394	390	382	373	359	338	288	103	108	115	123	128	132	137	142

Table I. *(Continued)*

Rb + Cs, $x_{Rb} = 0.47$																
	$10^7\eta$, Pa·s								$10^4\lambda$, W·m^{-1}·K^{-1}							
$10^{-5}P$ (Pa)	0.001	0.05	0.3	0.8	2	4	8	At saturation curve	0.001	0.05	0.3	0.8	2	4	8	At saturation curve
T_1	542	715	840	926	1027	1120	1231		542	715	840	926	1027	1120	1231	
T																
800	230	223						209	62.1	68.8						80.7
850	242	237	219					216	65.2	69.8	83.4					85.2
900	254	250	236					222	68.4	71.8	81.4					89.1
950	266	262	251	234				229	71.5	74.3	81.1	90				92.6
1000	278	275	266	252				235	74.7	77	82.1	89				95.6
1050	290	287	280	268	246			241	77.8	80	83.8	89.2	96.8			98.3
1100	301	299	293	283	264			247	80.9	83	86	90.2	96.6			101
1150	313	311	306	298	281	260		253	84.1	86.1	88.6	91.9	97.1	102		103
1200	325	323	319	312	297	277		259	87.2	89.3	91.4	94	98.3	102		105
1250	337	335	332	325	312	294	269	265	90.4	92.5	94.3	96.4	99.9	104	107	107
1300	349	347	344	338	327	310	286	271	93.5	95.7	97.3	99.1	102	105	108	109
1350	361	359	356	351	341	326	303	277	96.7	98.9	100	102	104	107	110	110
1400	372	371	369	364	355	341	319	283	99.8	102	104	105	107	109	111	112
1450	384	383	381	377	368	356	335	289	103	105	107	108	110	111	114	114
1500	396	395	393	389	382	370	351	296	106	109	110	111	113	114	116	115

Table II. Compositions of Vapors of Binary Eutectics of Alkali Metals: Mole Fractions of the Monoatomic and Diatomic Species at Various Temperatures and Pressures

Li + Na	T (K)	y_{Li_2}	y_{Na_2}	y_{LiNa}	y_{Li}	y_{Na}
$P = 10^3$ Pa	850	314×10^{-11}	244×10^{-4}	581×10^{-8}	317×10^{-7}	975.5×10^{-3}
	1150	645×10^{-13}	161×10^{-5}	300×10^{-9}	364×10^{-7}	998.4×10^{-3}
	1500	408×10^{-14}	251×10^{-6}	378×10^{-10}	366×10^{-7}	999.7×10^{-3}
$P = 3 \times 10^4$ Pa	1050	844×10^{-10}	856×10^{-4}	722×10^{-7}	137×10^{-6}	914.2×10^{-3}
	1250	176×10^{-10}	244×10^{-4}	210×10^{-7}	176×10^{-6}	975.3×10^{-3}
	1500	324×10^{-11}	742×10^{-5}	580×10^{-8}	188×10^{-6}	992.4×10^{-3}
$P = 4 \times 10^5$ Pa	1400	640×10^{-9}	120×10^{-3}	310×10^{-6}	523×10^{-6}	878.6×10^{-3}
	1450	517×10^{-9}	100×10^{-3}	262×10^{-6}	556×10^{-6}	898.7×10^{-3}
	1500	417×10^{-9}	841×10^{-4}	221×10^{-6}	585×10^{-6}	915×10^{-3}
	At saturation curve					
	800	535×10^{-11}	402×10^{-4}	901×10^{-8}	268×10^{-7}	959.8×10^{-3}
	1150	240×10^{-9}	118×10^{-3}	157×10^{-6}	228×10^{-6}	881.1×10^{-3}
	1500	200×10^{-8}	174×10^{-3}	697×10^{-6}	803×10^{-6}	824.6×10^{-3}

Na + K	T (K)	y_{Na_2}	y_{K_2}	y_{NaK}	y_{Na}	y_{K}
$P = 5 \times 10^3$ Pa	850	478×10^{-6}	186×10^{-4}	419×10^{-5}	611×10^{-4}	915.7×10^{-3}
	1200	241×10^{-7}	181×10^{-5}	325×10^{-6}	645×10^{-4}	933.3×10^{-3}
	1500	526×10^{-8}	549×10^{-6}	882×10^{-7}	647×10^{-4}	934.7×10^{-3}
$P = 8 \times 10^4$ Pa	1050	284×10^{-5}	519×10^{-4}	182×10^{-4}	102×10^{-3}	825×10^{-3}
	1250	866×10^{-6}	194×10^{-4}	646×10^{-5}	112×10^{-3}	860.8×10^{-3}
	1500	269×10^{-6}	768×10^{-5}	236×10^{-5}	116×10^{-3}	873.9×10^{-3}
$P = 8 \times 10^5$ Pa	1400	702×10^{-5}	758×10^{-4}	373×10^{-4}	150×10^{-3}	729.9×10^{-3}
	1450	592×10^{-5}	655×10^{-4}	321×10^{-4}	154×10^{-3}	742.1×10^{-3}
	1500	502×10^{-5}	569×10^{-4}	277×10^{-4}	158×10^{-3}	752.3×10^{-3}
	At saturation curve					
	800	759×10^{-6}	275×10^{-4}	629×10^{-5}	579×10^{-4}	907.5×10^{-3}
	1150	500×10^{-5}	704×10^{-4}	289×10^{-4}	119×10^{-3}	776.5×10^{-3}
	1500	105×10^{-4}	978×10^{-4}	527×10^{-4}	158×10^{-3}	681×10^{-3}

Na + Rb	T (K)	y_{Na_2}	y_{Rb_2}	y_{NaRb}	y_{Na}	y_{Rb}
$P = 10^2$ Pa	800	205×10^{-10}	392×10^{-6}	291×10^{-8}	203×10^{-5}	997.5×10^{-3}
	1150	669×10^{-12}	363×10^{-7}	206×10^{-9}	203×10^{-5}	997.9×10^{-3}
	1500	104×10^{-12}	953×10^{-8}	481×10^{-10}	204×10^{-5}	997.9×10^{-3}
$P = 2 \times 10^5$ Pa	1100	402×10^{-6}	741×10^{-4}	703×10^{-5}	295×10^{-4}	888.9×10^{-3}
	1300	137×10^{-6}	330×10^{-4}	301×10^{-5}	325×10^{-4}	931.4×10^{-3}
	1500	566×10^{-7}	172×10^{-4}	151×10^{-5}	336×10^{-4}	947.7×10^{-3}
$P = 8 \times 10^5$ Pa	1300	103×10^{-5}	106×10^{-3}	148×10^{-4}	447×10^{-4}	833.7×10^{-3}
	1400	704×10^{-6}	785×10^{-4}	109×10^{-4}	475×10^{-4}	862.3×10^{-3}
	1500	491×10^{-4}	596×10^{-4}	826×10^{-5}	494×10^{-4}	882.2×10^{-3}
	At saturation curve					
	800	789×10^{-7}	454×10^{-4}	194×10^{-5}	111×10^{-4}	941.5×10^{-3}
	1150	804×10^{-6}	105×10^{-3}	121×10^{-4}	353×10^{-4}	847.1×10^{-3}
	1500	211×10^{-5}	142×10^{-3}	264×10^{-4}	580×10^{-4}	771.5×10^{-3}

Table II. *(Continued)*

Na + Cs	T(K)	y_{Na_2}	y_{Cs_2}	y_{NaCs}	y_{Na}	y_{Cs}
$P = 5 \times 10^3$ Pa	800	931×10^{-8}	132×10^{-4}	615×10^{-6}	613×10^{-5}	980×10^{-3}
	1150	356×10^{-9}	150×10^{-5}	460×10^{-7}	664×10^{-5}	991.8×10^{-3}
	1500	558×10^{-10}	431×10^{-6}	106×10^{-7}	667×10^{-5}	992.9×10^{-3}
$P = 2 \times 10^5$ Pa	1050	467×10^{-6}	776×10^{-4}	116×10^{-4}	261×10^{-4}	884.1×10^{-3}
	1250	171×10^{-6}	345×10^{-4}	498×10^{-5}	316×10^{-4}	928.7×10^{-3}
	1500	580×10^{-7}	157×10^{-4}	207×10^{-5}	340×10^{-4}	948.2×10^{-3}
$P = 8 \times 10^5$ Pa	1300	110×10^{-5}	933×10^{-4}	211×10^{-4}	462×10^{-4}	838.3×10^{-3}
	1400	790×10^{-6}	704×10^{-4}	158×10^{-4}	503×10^{-4}	862.7×10^{-3}
	1500	570×10^{-6}	542×10^{-4}	120×10^{-4}	532×10^{-4}	879.9×10^{-3}
	At saturation curve					
	800	669×10^{-7}	407×10^{-4}	289×10^{-5}	906×10^{-5}	947.3×10^{-3}
	1150	823×10^{-6}	936×10^{-4}	175×10^{-4}	347×10^{-4}	853.3×10^{-3}
	1500	247×10^{-5}	125×10^{-3}	380×10^{-4}	640×10^{-4}	770.7×10^{-3}

K + Rb	T (K)	y_{K_2}	y_{Rb_2}	y_{KRb}	y_{K}	y_{Rb}
$P = 10^3$ Pa	800	118×10^{-6}	297×10^{-5}	136×10^{-5}	127×10^{-3}	868.2×10^{-3}
	1150	881×10^{-8}	277×10^{-6}	117×10^{-6}	128×10^{-3}	871.3×10^{-3}
	1500	207×10^{-8}	727×10^{-7}	306×10^{-7}	128×10^{-3}	871.5×10^{-3}
$P = 2 \times 10^5$ Pa	1100	484×10^{-5}	492×10^{-4}	369×10^{-4}	185×10^{-3}	723.9×10^{-3}
	1300	211×10^{-5}	219×10^{-4}	166×10^{-4}	200×10^{-3}	759.1×10^{-3}
	1500	107×10^{-5}	114×10^{-4}	870×10^{-5}	206×10^{-3}	772.7×10^{-3}
$P = 8 \times 10^5$ Pa	1300	804×10^{-5}	684×10^{-4}	573×10^{-4}	195×10^{-3}	671×10^{-3}
	1400	600×10^{-5}	509×10^{-4}	432×10^{-4}	205×10^{-3}	694.4×10^{-3}
	1500	455×10^{-5}	387×10^{-4}	331×10^{-4}	213×10^{-3}	710×10^{-3}
	At saturation curve					
	800	210×10^{-5}	314×10^{-4}	187×10^{-4}	151×10^{-3}	796.5×10^{-3}
	1150	740×10^{-5}	688×10^{-4}	542×10^{-4}	185×10^{-3}	684.4×10^{-3}
	1500	124×10^{-4}	917×10^{-4}	839×10^{-4}	197×10^{-3}	614.9×10^{-3}

K + Cs	T (K)	y_{K_2}	y_{Cs_2}	y_{KCs}	y_{K}	y_{Cs}
$P = 10^2$ Pa	800	953×10^{-8}	216×10^{-6}	711×10^{-7}	114×10^{-3}	885.4×10^{-3}
	1150	700×10^{-9}	238×10^{-7}	749×10^{-8}	114×10^{-3}	885.6×10^{-3}
	1500	164×10^{-9}	687×10^{-8}	209×10^{-8}	114×10^{-3}	885.6×10^{-3}
$P = 2 \times 10^5$ Pa	1100	128×10^{-4}	297×10^{-4}	347×10^{-4}	301×10^{-3}	621.4×10^{-3}
	1300	542×10^{-5}	138×10^{-4}	163×10^{-4}	320×10^{-3}	644×10^{-3}
	1500	270×10^{-5}	747×10^{-5}	883×10^{-5}	328×10^{-3}	653.1×10^{-3}
$P = 8 \times 10^5$ Pa	1300	229×10^{-4}	402×10^{-4}	572×10^{-4}	329×10^{-3}	550.2×10^{-3}
	1400	168×10^{-4}	302×10^{-4}	435×10^{-4}	344×10^{-3}	565.5×10^{-3}
	1500	126×10^{-4}	233×10^{-4}	337×10^{-4}	354×10^{-3}	576.4×10^{-3}
	At saturation curve					
	800	495×10^{-5}	197×10^{-4}	155×10^{-4}	226×10^{-3}	733.9×10^{-3}
	1150	199×10^{-4}	399×10^{-4}	510×10^{-4}	309×10^{-3}	580.3×10^{-3}
	1500	354×10^{-4}	491×10^{-4}	820×10^{-4}	345×10^{-3}	487.9×10^{-3}

Table II. *(Continued)*

Rb + Cs	T (K)	y_{Rb_2}	y_{Cs_2}	y_{RbCs}	y_{Rb}	y_{Cs}
$P = 10^2$ Pa	800	426×10^{-7}	124×10^{-7}	144×10^{-6}	329×10^{-3}	670.9×10^{-3}
	1150	394×10^{-8}	137×10^{-7}	161×10^{-7}	329×10^{-3}	671.1×10^{-3}
	1500	103×10^{-8}	394×10^{-8}	469×10^{-8}	329×10^{-3}	671.1×10^{-3}
$P = 2 \times 10^5$ Pa	1050	189×10^{-4}	264×10^{-4}	478×10^{-4}	391×10^{-3}	515.6×10^{-3}
	1250	807×10^{-5}	118×10^{-4}	217×10^{-4}	417×10^{-3}	541.8×10^{-3}
	1500	350×10^{-5}	536×10^{-5}	101×10^{-4}	427×10^{-3}	553.6×10^{-3}
$P = 8 \times 10^5$ Pa	1250	282×10^{-4}	361×10^{-4}	712×10^{-4}	389×10^{-3}	474.9×10^{-3}
	1400	180×10^{-4}	235×10^{-4}	471×10^{-4}	413×10^{-3}	498.8×10^{-3}
	1500	137×10^{-4}	181×10^{-4}	366×10^{-4}	422×10^{-3}	509.4×10^{-3}
				At saturation curve		
	800	103×10^{-4}	164×10^{-4}	258×10^{-4}	377×10^{-3}	570.3×10^{-3}
	1150	266×10^{-4}	351×10^{-4}	668×10^{-4}	386×10^{-3}	485.4×10^{-3}
	1500	393×10^{-4}	455×10^{-4}	983×10^{-4}	384×10^{-3}	432.7×10^{-3}

2. RESULTS

The values obtained for the viscosity η and the thermal conductivity λ of the vapors of the binary eutectics Li + Na, Na + K, Na + Rb, Na + Cs, K + Rb, K + CS, and Rb + Cs as a function of temperature and pressure are presented in Table I. The values obtained for the composition of these vapors as a function of temperature and pressure are presented in Table II. The calculations were performed for only one composition of the liquid phase. The concentrations x_Y and x_Z of the eutectic solutions were taken from Ref. 9. Experimental data for the composition of binary solutions with lithium are not available in the literature except for the system Li + Na. Hence, we did not calculate the transport coefficients of the vapors of the eutectics Li + K, Li + Rb, and Li + Cs.

In Figs. 1 and 2 we show the viscosity and the thermal conductivity of the vapor of the eutectic Na + K at various pressures as a function of temperature. It turns out that the dependence of the transport properties of the vapor of the binary eutectics on temperature and pressure is similar to that of the transport properties of the vapors of the pure alkali metals [8]. The viscosity decreases and the thermal conductivity increases with increasing pressure. This is the case not only for the vapor of Na + K but also for the vapors of the other eutectics.

The values of the viscosity and thermal conductivity of the vapors of Na + K differ little from the value of the viscosity and thermal conductivity of potassium vapors. For example, the viscosity of the vapor of the eutectics Na + K on the saturation line is only 2–3% larger than the viscosity

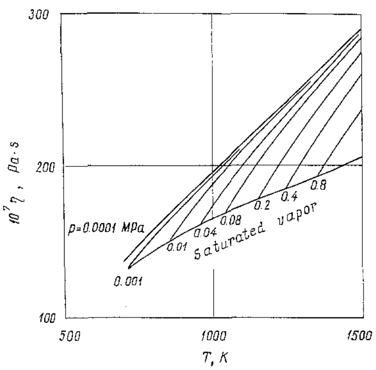

Fig. 1. Viscosity of the vapor of the eutectic Na + K as a function of temperature at various pressures.

of the vapor of pure potassium in the entire temperature range, while the thermal conductivity of Na + K and pure K are equal to within 10–13%. These small differences in the transport properties of the vapor of the eutectic Na + K and of the vapor of pure potassium is related to a predominant concentration of K and K_2 in the vapor mixture, as can be seen from Table II.

The values obtained for the viscosity have an estimated accuracy of 4–5% and those obtained for the thermal conductivity have an estimated accuracy of 8–10%.

Comprehensive tables for the viscosity and thermal conductivity of vapors of binary solutions of alkali metals have been published elsewhere [10].

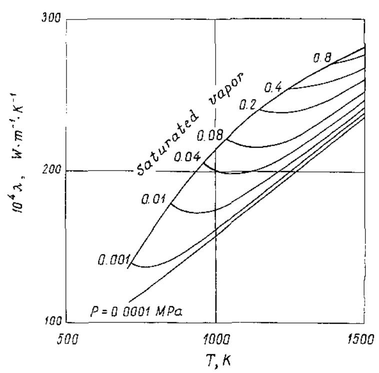

Fig. 2. Thermal conductivity of the vapor of the eutectic Na + K as a function of temperature at various pressures.

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