AZƏRBAYCAN MİLLİ ELMLƏR AKADEMİYASININ XƏBƏRLƏRİ
Fizika-riyaziyyat və texnika elmləri seriyası, fizika və astronomiya 2006 №2

VAPOR PRESSURE OF THE (LITHIUM BROMIDE + LITHIUM CHLORIDE + METHANOL) SYSTEM

JAVID T. SAFAROV

Friedrich - Alexander - Universität Erlangen - Nürnberg,
Egerlandstr. 3, D-91058 Erlangen, GERMANY

Experimental vapor pressure p of LiBr/LiCl+CH_3OH solutions at T=(298.15÷323.15) K in the three mole fraction rates of salts were studied. Investigations were carried out for the LiBr/LiCl(2/1)+CH_3OH in w_{CH_3OH} =(0.73341÷0.96550), for the LiBr/LiCl (1/1)+CH_3OH in w_{CH_3OH} =(0.73341÷0.98245) and for the LiBr/LiCl (1/2)+CH_3OH in w_{CH_3OH} =(0.76246÷0.98514) mass fractions of methanol. The Antoine-type equation was used for to fit the experimental vapor pressure results.

The experiments for the investigation of the vapor pressure of LiBr/LiCl + CH_3OH solutions were carried out at T=(298.15 to 323.15) K for the application of them in absorption refrigeration systems. The use of CH_3OH as solvent enables one to replace aqueous solutions at temperatures below the freezing point of water.

Only one publication with the vapor pressure investigations of these systems [1] was found in the literature. Aker *et al*. [1] were reported the vapor pressure results of these systems only for the LiBr/LiCl(1/2)+CH_3OH solutions. The uncertainty of the measurements was ±0.03cmHg. The experiments were carried out by static method at T=(308.15 to 362.85)K and w=(0.678 to 0.800) mass fractions of methanol.

The experiments to determine the vapor pressure of LiBr/LiCl+CH_3OH were performed in a glass cell by using a static method [2]. The experimental set up consisted of a bolted-top cell with internal volume of 95.64 cm^3 placed in a water bath, which is kept at constant temperature (±0.02 K) using a thermostat. The temperature inside the cell was measured by a platinum resistance thermometer PT-100 (Type 42441-V100), connected to the signal conditioner Kelvimat Type 4303, with an accuracy of ±0.01K. The experimental uncertainty of pressure is Δp=±10Pa. The experimental vapor pressure results are assessed as reliable to within an average uncertainty Δp=±0.05 % according to test measurements [2].

Methanol (w>0.998), LiBr (w>0.995) and LiCl (w>0.995) were purchased from Merck. Both salts were used without further purification, however, each salt was dried in a special cell by prolonged heating at 413.15 K and the vacuum being renewed by pumping at frequent intervals for 24 h prior to use. The cell is kept at room temperature under vacuum for 12 hours. The solutions were prepared by mass using a BP 221 S electronic scale (Sartorius AG) with resolution of 0.0001 g and the uncertainties of preparation of solutions were max. 0.02%.

In this work, the vapor pressure of LiBr/LiCl +CH_3OH solutions at T=(298.15 to 323.15) K and at three mole fraction rates were carried out: for the LiBr/LiCl (2/1) + CH_3OH in w_{CH_3OH} =(0.73341÷0.96550); for the LiBr/LiCl(1/1)+CH_3OH in w_{CH_3OH} =(0.73341÷0.98245) and for the LiBr/LiCl(1/2)+CH_3OH in w_{CH_3OH} =(0.76246÷0.98514) mass fraction of methanol. The obtained vapor pressure values are listed in Table 1.

Table 1.
Experimental Vapor Pressure *p* Values of LiBr/LiCl +CH_3OH Solutions.

T/K	298.15	303.15	308.15	313.15	318.15	323.15
w/(mass fraction) *p*/Pa						
LiBr/LiCl (2/1)+CH_3OH						
0.96550	16550	21355	27291	34605	43491	54279
0.94499	16261	20987	26826	34022	42766	53384
0.93212	16035	20700	26465	33571	42209	52699
0.91099	15620	20171	25798	32736	41173	51423
0.87525	14784	19101	24442	31031	39047	48792
0.85999	14350	18547	23742	30153	37955	47443
0.85432	14150	18299	23437	29782	37510	46913
0.83567	13519	17494	22420	28507	35925	44957
0.80940	12461	16155	20744	26426	33366	41833
0.79765	11891	15440	19856	25333	32035	40226
0.76085	9661	12639	16375	21049	26816	33924
0.73341	7776	10239	13352	17273	22148	28198
LiBr/LiCl (1/1)+CH_3OH						
0.98245	16708	21557	27547	34925	43889	54770
0.96455	16463	21243	27150	34425	43266	54000
0.94966	16226	20939	26763	33937	42655	53239
0.92618	15726	20303	25960	32931	41406	51700
0.90547	15095	19508	24971	31708	39911	49884
0.88949	14499	18753	24022	30528	38455	48103
0.87858	13993	18120	23240	29568	37291	46701
0.85323	12715	16495	21194	27013	34129	42816
0.83476	11779	15300	19683	25118	31774	39910
0.81586	10813	14068	18128	23170	29356	36932
0.79894	10034	13070	16862	21577	27370	34472
0.73955	7519	9839	12752	16392	20887	26427
LiBr/LiCl (1/2)+CH_3OH						
0.98514	16690	21535	27520	34893	43851	54726
0.96941	16414	21180	27068	34322	43136	53836
0.94587	15960	20598	26328	33388	41967	52383
0.91842	15262	19706	25199	31970	40203	50202
0.90138	14627	18909	24210	30754	38721	48412
0.87964	13601	17605	22570	28706	36188	45300
0.85343	12150	15751	20221	25757	32516	40762
0.83793	11277	14628	18792	23951	30255	37950
0.81586	10040	13045	16785	21427	27110	34058
0.76246	7500	9795	12670	16258	20675	26108

The experimental vapor pressure results were compared with the available literature results [1]. Our results agree with the results of Aker *et al*. [1] within $\Delta p = \pm 2.5\%$.

The plot of the vapor pressure results of LiBr/LiCl (1/2) + CH_3OH solutions versus mass fraction *w* of methanol at different temperatures together with literature values [1] are shown in Fig. 1.

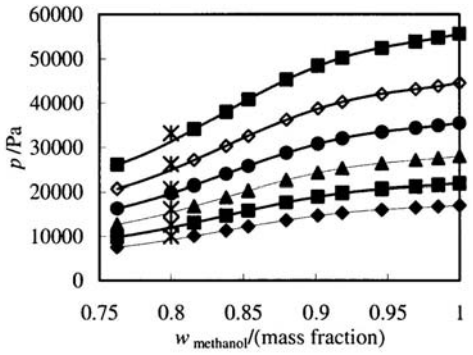
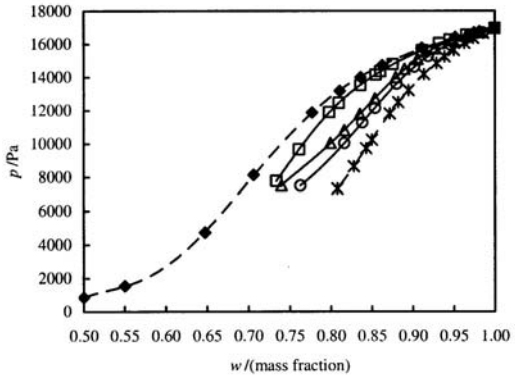


Fig.1.
Plot of vapor pressure p of LiBr/LiCl (1/2) + CH_3OH solutions versus mass fraction w of methanol: ♦- 298.15K; ■- 303.15K; ▲- 308.15K; ●- 313.15K; ◊- 318.15K; □- 323.15K; *- Aker *et al.*[3] at T=(298.15÷323.15)K; ___ Antoine-type equation).

The plot of vapor pressure results of LiBr/LiCl +CH_3OH solutions at T=298.15K versus mass fraction w of methanol are shown in Figure 2. The experimental vapor pressure results of LiBr+CH_3OH and LiCl+CH_3OH solutions in the Fig.2 were taking from Ref. [3].



The various forms of Antoine-type equation were successfully applied for the fitting of experimental vapor pressure values of aqueous and non-aqueous electrolyte solutions [4-15].

Fig.2.
Plot of vapor pressure p of LiBr/LiCl+CH_3OH solutions at T=298.15K versus mass fraction w of methanol: ♦- LiBr+CH_3OH[3]; □- LiBr/LiCl(2/1)+CH_3OH; Δ- LiBr/LiCl(1/1)+CH_3OH; ○- LiBr/LiCl (1/2)+CH_3OH; *- LiCl+CH_3OH[3]; _ _ Antoine equation; __ Antoine-type equation.

The experimental vapor pressure results of the investigated solutions were fitted to the Antoine-type equation, which express vapor pressure as a function of temperature and mass fraction of methanol:

$$\lg[p(\mathrm{Pa})] = A + B/[(T/\mathrm{K}) - 43.15], \quad (1)$$

where p is the vapor pressure, T absolute temperature, and w the mass fraction of methanol. The empirical coefficients A and B determined by the least-squares method and depend from the mass fraction of methanol:

$$A = \sum_{j=0}^{5} a_i \cdot (10^2 \cdot w)^i, \quad (2)$$

$$B = \sum_{j=0}^{5} b_i \cdot (10^2 \cdot w)^i, \quad (3)$$

The coefficients a_i and b_i are listed in Table 2. The average percent deviation is:

$$APD = \frac{\sum_{1}^{n} \sqrt{\left(\frac{p_{exp.} - p_{\mathrm{cal.}}}{p_{exp.}} \cdot 100 \right)^2}}{n}, \quad (4)$$

where p_{exp} is the experimental vapor pressure values; p_{cal} is the vapor pressure values obtained by fitting of Antoine-type equation; n is number of total experimental points. The average percent deviations for the investigated solutions are:

for the LiBr/LiCl (2/1)+CH_3OH-0.015 %;
for the LiBr/LiCl (1/1)+CH_3OH –0.013 %;
for the LiBr/LiCl (1/2)+CH_3OH– 0.015 %.

The plot of vapor pressure p of LiBr/LiCl(1/1)+CH_3OH solutions at various mass fractions w of methanol are shown in Fig.3. As shown in Fig.3, the lg(p/Pa) against 1/(T/K-43.15) relation for the given concentration was linear over the pressure and temperature ranges measured.

Table 2.

The Coefficients a_i and b_i of Equations (2) and (3).

i	a_i	b_i
LiBr/LiCl (2/1) + CH_3OH		
0	-2356.806676	628166.38303732
1	140.4200084	-37662.09586383
2	-3.317759111	895.7714439
3	0.0390353534	-10.5976241
4	$-2.2876765\cdot10^{-4}$	0.0624008952
5	$5.343894\cdot10^{-7}$	$-1.4636333\cdot10^{-4}$
LiBr/LiCl (1/1) + CH_3OH		
0	779.171732	-319805.1382632
1	-44.257052	18536.247186312
2	1.01411141	-430.642011
3	-0.011568003	4.98601895
4	$6.569363257\cdot10^{-5}$	-0.0287576161
5	$-1.485938\cdot10^{-7}$	$6.6087215\cdot10^{-5}$
LiBr/LiCl (1/2) + CH_3OH		
0	1971.667736	-581576.97505
1	-109.272781	32746.94493172
2	2.4269274531	-738.16293
3	-0.026867226	8.30240465
4	$1.4826822\cdot10^{-4}$	-0.0465825563
5	$-3.2632522\cdot10^{-7}$	$1.0428903\cdot10^{-4}$

Experimental vapor pressure p of LiBr/LiCl + CH_3OH solutions at T=(298.15÷323.15)K in the three mole fraction rates of salts were reported at the first time. Experimental vapor pressure data are satisfactorily correlated using the Antoine-type equation.

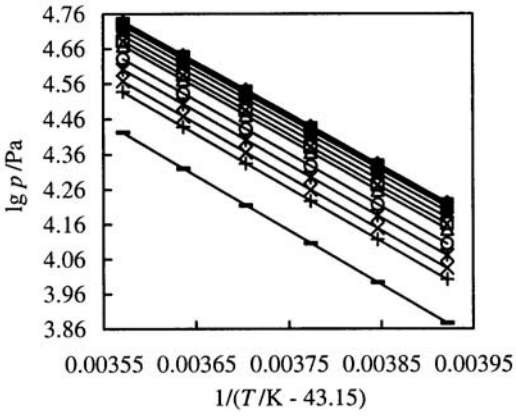


Fig.3.

Plot of vapor pressure p of LiBr/LiCl (1/1) + CH_3OH solutions at various mass fractions w of methanol versus temperature T: ♦- w=0.98245; ■- w=0.96455; ▲- w=0.94966; ●- w=0.92618, ◊- w=0.90547; □- w=0.88949; Δ- w=0.87858; ○- w=0.85323; *- w=0.83476; x- w=0.81586; +- w=0.79894; _ - w=0.73955; __ Antoine-type equation.

Acknowledgments

Author thanks the Alexander von Humboldt Foundation of Germany for the supporting his research stay at the Rostock University of Germany and Prof. Andreas Heintz, Prof. Egon Hassel, Dr. Sergey Verevkin, Dr. Eckard Bich (Rostock University, Germany) for support of experimental and theoretical works.

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LİTİUM BROMİD + LİTİUM XLORİD + METANOL QARIŞIĞININ BUXAR TƏZYİQİ

C.T. SƏFƏROV

LiBr/LiCl+CH_3OH qarışığının T=(298.15÷323.15) K və duzların üç mol fraksiyası nisbətində təcrübi olaraq buxar təzyiqi p öyrənilmişdir. Təcrübələr LiBr/LiCl(2/1)+CH_3OH qarışığı üçün metanolun w_{CH_3OH} =(0.73341÷0.96550), LiBr/LiCl(1/1)+CH_3OH üçün w_{CH_3OH} =(0.73341÷0.98245) və LiBr/LiCl(1/2)+ CH_3OH üçün w_{CH_3OH} = (0.76246÷0.98514) kütlə nisbətlərində aparılmışdır. Buxar təzyiqinin təcrübi qiymətlərini təsvir etmək üçün Antuan tipli tənlikdən istifadə olunmuşdur.

ДАВЛЕНИЕ ПАРА СИСТЕМЫ ЛИТИЕВЫЙ БРОМИД + ЛИТИЕВЫЙ ХЛОРИД + МЕТАНОЛ

Д.Т. САФАРОВ

Было изучено экспериментальное давление пара p растворов LiBr/LiCl+CH_3OH при T=(298.15÷323.15)K в трех мольных фракциях солей. Исследования были выполнены для LiBr/LiCl(2/1)+CH_3OH при w_{CH_3OH} =(0.73341÷0.96550), для LiBr/LiCl(1/1)+CH_3OH при w_{CH_3OH} =(0.73341÷0.98245) и для LiBr/LiCl(1/2)+CH_3OH при w_{CH_3OH} =(0.76246÷0.98514) массовых фракциях метанола. Уравнения типа Антуана использовались для описания экспериментальных результатов давления пара.

Редактор: А.Гарибов