ACTA UNIVERSITATIS LODZIENSIS
FOLIA CHIMICA 5, 1985

Stefania Taniewska-Osińska, Bartłomiej Pałecz

VISCOSITY MEASUREMENTS OF NaI AND KNO_3 SOLUTIONS IN WATER - THIOUREA MIXTURES AT VARIOUS TEMPERATURES

Density and viscosity measurements were made of NaI and KNO_3 solutions (concentration 1.0 mole electrolyte per 100^2 mole mixed solvent) in the temperature range of 293.15 - 313.15 K.

Introduction

The paper reports further results of our studies on the physico-chemical properties of aqueous solutions of urea derivatives [1,2]. The aim of the present investigation was to measure the density and viscosity of NaI and KNO_3 solutions in water-thiourea mixtures (TU) in the temperature range of 293.15 - 313.15 K. The results of such measurements may constitute basis for a discussion of the effect of electrolytes on the structure of the solvent.

Experimental procedure

Viscosity and density measurements were conducted using Ubbelohde viscosimeters and Lipkin's pycnometer (capacity ca. 15 cm^3) respectively. Both instruments were thermostated to an accuracy of $\pm$0.01 K. Analytically pure NaI (POCh Gliwice, Poland) was crystallized from a water - acetone mixture and dried at 333 K.

Analytically pure KNO_3 (POCh Gliwice, Poland) was crystallized from water and dried at 373 K.

Analytically pure thiourea (POCh Gliwice, Poland) was crystallized from ethyl alcohol and dried at 333 K.

All solutions were prepared by weight.

Results and discussion

The density values for water-thiourea mixtures with electrolytes obtained in this study are collected in Tables 1 and 2. As the concentration of the dissolved thiourea increases, so does the density of the solutions, but it decreases when the temperature is raised. From the density values obtained for the three-component solutions we calculated their volume expansibility coefficients (Table 3). As the content of the urea derivative in the solution increases, so does the volume expansibility coefficient for both electrolytes (Table 3) and its value is higher than for the binary system [3]. A possible reason for that may be a structure breaking effect of both electrolytes on the mixed solvent [4].

The dynamic viscosity values obtained for aqueous solutions of thiourea with NaI and KNO_3 are collected in Tables 1 and 2. Using the dynamic viscosities of water-thiourea systems [3] the relative viscosity values were calculated for the system under discussion, taking three - component solution as pseudobinary (Table 4).

As can be seen from the table, relative viscosity increases with increasing concentration and temperature (Table 4).

Basing on the relative viscosity values obtained, the temperature coefficients of relative viscosity ($\frac{\Delta \eta r}{\Delta T}$) were calculated, which turned out to have positive values for both three-component systems (Table 5). The positive temperature coefficients testify to a structure breaking effect of NaI and KNO_3 both on water and on binary systems of water-thiourea solvent [5]. An increase in the content of the thiourea derivative brings about a decrease of the $\frac{\Delta \eta r}{\Delta T}$ value, which indicates that the electrolyte exerts a stronger structure - breaking effect on pure water than on water - thiourea solution. This confirms the earlier suggestion [1,2] made on thermochemical grounds, about the structure-breaking effect of thiourea on water.

Table 1. Density and viscosity of NaI solutions in water-thiourea mixtures in the temperature range of 293,15 - 313,15 K.

m (TU)	293.15 K		298.15 K		303.15 K		313.15 K	
mol kg^{-1}	ϱ g cm^{-3}	η cP	ϱ g cm^{-3}	η cP	ϱ g cm^{-3}	η cP	ϱ g cm^{-3}	η cP
0.0000	1.0607	1.0101	1,0591	0.9018	1.0576	0.8024	1.0532	0.6735
0.1249	1.0630	1.0161	1.0612	0.9068	1.0596	0.8072	1.0550	0.6765
0.2409	1.0648	1.0203	1.0633	0.9115	1.0614	0.8103	1.0567	0.6799
0.4851	1.0691	1.0289	1.0674	0.9198	1.0654	0.8187	1.0606	0.6856
0.7120	1.0730	1.0368	1.0713	0.9274	1.0680	0.8250	1.0642	0.6911
0.7675	1.0741	1.0393	1.0722	0.9294	1.0699	0.8264	1.0650	0.6934
0.9203	1.0767	1.0445	1.0748	0.9343	1.0724	0.8320	1.0675	0.6976
1.0284	1.0786	1.0500	1.0767	0.9379	1.0742	0.8362	1.0693	0.7008

Table 2. Density and viscosity of KNO_3 solutions in water-thiourea mixtures in the temperature range of 293.15 - 313.15 K.

m (TU)	293.15 K		298.15 K		303.15 K		313.15 K	
mol kg^{-1}	ρ g cm^{-3}	η cP	ρ g cm^{-3}	η cP	ρ g cm^{-3}	η cP	ρ g cm^{-3}	η cP
0.0000	1.0317	0.9828	1.0301	0.8782	1.0287	0.7815	1.0245	0.6553
0.1249	1.0339	0.9863	1.0322	0.8811	1.0308	0.7852	1.0263	0.6580
0.2409	1.0360	0.9899	1.0343	0.8848	1.0328	0.7886	1.0284	0.6610
0.4851	1.0406	0.9952	1.0388	0.8919	1.0372	0.7948	1.0327	0.6667
0.7120	1.0448	1.0009	1.0430	0.8971	1.0411	0.7998	1.0366	0.6710
0.7675	1.0458	1.0033	1.0440	0.8988	1.0420	0.8003	1.0375	0.6735
0.9203	1.0486	1.0058	1.0467	0.9027	1.0447	0.8042	1.0402	0.6759
1.0284	1.0507	1.0069	1.0486	0.9063	1.0466	0.8057	1.0421	0.6789

Table 3. The valume expansibility coefficient (α) of NaI and KNO_3 in water - thiourea solutions.

m (TU) mol kg^{-1}	$\alpha \times 10^5$ / K^{-1}	
	TU-H_2O-NaI	TU-H_2O-KNO_3
0.0000	35.4	34.9
0.1249	37.7	36.4
0.2409	38.7	36.8
0.4851	39.9	38.1
0.7120	41.2	39.4
0.7675	42.5	39.8
0.9203	42.9	40.2
1.0284	43.3	41.1

Table 4. Relative viscosity of NaI and KNO_3 solutions in water-thiourea mixtures in the temperature range 293.15 - 313.15 K.

	η_r							
	KNO_3				NaI			
m (TU) mol kg^{-1}	293.15 K	298.15 K	303.15 K	313.15 K	293.15 K	298.15 K	303.15 K	313.15 K
0.0000	0.9809	0.9864	0.9924	1.0033	1.0080	1.0129	1.0189	1.0313
0.1249	0.9824	0.9873	0.9943	1.0043	1.0121	1.0160	1.0221	1.0326
0.2409	0.9839	0.9896	0.9959	1.0054	1.0141	1.0192	1.0233	1.0341
0.4851	0.9849	0.9920	0.9982	1.0073	1.0183	1.0230	1.0282	1.0358
0.7120	0.9864	0.9931	0.9995	1.0083	1.0218	1.0276	1.0309	1.0385
0.7675	0.9876	0.9932	0.9996	1.0102	1.0228	1.0282	1.0317	1.0400
0.9203	0.9883	0.9937	0.9998	1.0098	1.0244	1.0300	1.0334	1.0418
1.0284	0.9885	0.9939	0.9999	1.0103	1.0267	1.0308	1.0355	1.0425

Table 5. Temperature coefficients of relative viscosity of NaI and KNO_3 solutions in water - thiourea mixtures.

m (TU) mol kg^{-1}	$\frac{\Delta \eta_r}{\Delta t} \cdot 10^3 / K^{-1}$	
	NaI	KNO_3
0.0000	1.16	1.12
0.1249	1.03	1.10
0.2409	1.00	1.10
0.4851	0.88	1.10
0.7120	0.84	1.10
0.7675	0.95	1.10
0.9203	0.87	1.08
1.0284	0.80	1.09

References

1. S. Taniewska-Osińska, B. Pałecz, J. Chem. Thermodynamics, 12, 775 (1980)
2. S. Taniewska-Osińska, B. Pałecz, Acta. Univ. Lodz., Folia Chim., 1, 77 (1982)
3. B. Pałecz, Doctoral thesis, Łódź, University (1982)
4. A. Piekarska, Doctoral thesis, Łódź, University (1976)
5. M. Kaminsky, Z. Phys. Chem., 5, 154 (1955), 8, 173 (1956), 12, 206 (1957)

Department of Physical Chemistry
University of Łódź

Stefania Taniewska-Osińska, Bartłomiej Pałecz

POMIARY LEPKOŚCI ROZTWORÓW NaI I KNO_3 W MIESZANINACH WODA - TIOMOCZNIK W KILKU TEMPERATURACH

Zmierzono gęstości i lepkości roztworów NaI i KNO_3 o stężeniu 1.0 mol w 100 molach mieszanego rozpuszczalnika wodno-tiomocznikowego w przedziale temperatur 293.15 - 313.15 K.

Wyliczono $\frac{\Delta \eta_r}{\Delta T}$ oraz przedyskutowano jej zmiany dla obydwu badanych układów.