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EFFECT OF MAGNETIC FIELD ON ENTHALPY OF SOLUTION OF KCl IN WATER

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Abstract

The enthalpies of solution of potassium chloride (KCl) in water and magnetically treated water (magnetized water) have been measured at 298.15 K using a LKB-8700 precision solution calorimeter. From the experimental results, it was observed that the effect of magnetic field on the enthalpy of solution is measurable. This is probably due to the distortion of the hydrogen bond of water resulting from magnetic treatment.

Keywords: enthalpy of solution, magnetic field, potassium chloride

Introduction

The effect of magnetic field has been used widely in many scientific and technological fields. In recent years scientists have paid much attention to this field for both theoretical and practical purposes. Publications on this topic increase steadily every year. It has been known that some physico-chemical properties of magnetized water are different from those of untreated water [1–4]. The effects of magnetic field on the properties of aqueous solution of KCl have been reported [5–7]. However, its effect on enthalpies of solution of this compound have not been found in the literature.

In this paper, the enthalpies of solution of KCl in magnetically treated and untreated water are reported.

Experimental

KCl (N. B. S. Standard Reference Material 918) was dried at 773.15 K for 5 h in a platinum crucible and then stored in a desiccator for use. Water was redistilled.

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Apparatus and procedures A KG-30/230 magnetic treating equipment constructed by The Institute of Physics, Academia Sinica, was used. Strength of the magnetic field was 0.8T for the treatment of water. The diameter of the tube in which water flowed was 5 mm, and the flow rate of water was 5.5 m/min. Each calorimetric measurement was completed within 4 h after the treatment of water.

LKB-8700 precision solution calorimeter equipped with a 100 ml reaction vessel was used in this study and medium stirring speed was used. Detail of the apparatus and procedures were described in literature [8]. The temperature of the thermostat was maintained at 295.150±0.002 K with circulating water of 294.15±0.1 K. The room temperature was 294.15±0.5 K. The sample of KCl was added to a glass ampoule carefully avoiding any adhesion of the sample to the neck of the ampoule. Then the ampoule was stopped with a plastic plug and sealed with wax. 50.00±0.02 g of water was filled into the reaction vessel. Each run was divided into three periods, they were the fore-period (5 min), the reaction-period (15 min), and the after-period (5 min). Electrical calibrations were carried out before and after breaking the ampoule, and the average value of the two calibrations was used as the energy equivalent of calorimeter. In order to reduce the systematic error of the experiment, the temperature increases of the calibration and the solution experiment was controlled to be as close as possible.

Results and discussions

In the calculation of enthalpies of solution, the molecular weights of KCl and water were 74.5513 and 18.01528 g/mole, respectively, and the densities of KCl, water, and air were respectively 1.988, 0.99707 and 0.0012 g/cm^3.

The enthalpies of solution of KCl in water and magnetized water are given in Table 1 where m is molality of KCl in solution; T_m stands for the average of the initial and final temperatures of the reaction experiment, and ΔH_{T_m} is the molar enthalpy of solution of the solute corresponding to the average temperature and experimental concentration; ΔH_{25} denotes the enthalpies of solution corrected to 298.15 K according to following formula [9],

$$\Delta H_{25} = \Delta H_{T_m} + (C_{\Phi_{ml}} - C_{pms})(298.15 - T_m) \quad (1)$$

where $C_{\Phi_{ml}}$ and C_{pms} stand for the apparent molar heat capacity of the dissolved KCl at the given concentration and the molar heat capacity of undissolved KCl, respectively [10, 11]. The enthalpy of vaporization of water into the air space of the ampoule, which was less than 0.1 J for each experiment, was neglected in the calculations.

The enthalpies of solution at 298.15 K and 0.2775 m($\Delta H'_{25}$) were also calculated based on experimental concentration (m), ΔH_{25} listed in Table 1 and the enthalpy of dilution of the KCl solution [12]. The results are also listed in Table 1. The effect of magnetic field on the enthalpy of dilution of KCl solution was assumed to be negligible in the calculations. It is believed that the error resulted from the correction of the dilution enthalpy is not noticeable because the enthalpy of dilution is much smaller than the enthalpy of solution in the concentration range.

Table 1 Enthalpies of solution of KCl in water and magnetically treated water

No.	m	T_m /K	ΔH_{T_m} /J·mol^{-1}	ΔH_{25} /J·mol^{-1}	$\Delta H'_{25}$ /J·mol^{-1}
			Magnetically treated water		
1	0.1359	294.89	18093	17609	17597
2	0.1374	294.89	18079	17610	17598
3	0.1411	294.80	18094	17597	17584
4	0.1373	294.82	18098	17603	17590
5	0.0825	294.96	18095	17621	17636
av.					17601±9*
			Untreated water		
1	0.1410	294.84	17975	17483	17470
2	0.1368	294.93	17950	17472	17460
3	0.0715	295.07	17918	17551	17538
4	0.0626	294.97	18004	17532	17569
av.					17509±26*

*Standard mean deviation

The results in Table 1 show that the difference of the enthalpies of solution of KCl in water and the magnetically treated water is measurable. It means that the effect of magnetic field on solution property of KCl in water can be measured energetically. The reason for this unusual energy change might be due to the distortion of hydrogen bonds of water molecules caused by the magnetic field.

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Zusammenfassung — Mittels eines Präzisions-Lösungskalorimeters vom Typ LKB-8700 wurde bei 298.15 K die Enthalpie der Lösung von Kaliumchlorid (KCl) in Wasser und in magnetisch behandelten (magnetisiertem) Wasser gemessen. Anhand der experimentellen Ergebnisse wurde festgestellt, daß der Einfluß des magnetischen Feldes auf die Enthalpie der Lösung meßbar ist. Dies ist wahrscheinlich das Ergebnis der durch die magnetische Behandlung erfolgenden Störung der Wasserstoffbindung des Wassers.