

Short communication

# Solubilities and enthalpies of solution of picric acid and picrates at 298.15 K in DMF, EtOH and acetic acid

Li Yang\*, Qin Pei, Tonglai Zhang, Jianguo Zhang, Yunling Cao

State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing 100081, China

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## Abstract

The enthalpies of solution of picric acid (PA) in DMF, EtOH and HOAc, potassium picrate (KPA) and  $\text{Pb}(\text{PA})_2 \cdot \text{H}_2\text{O}$  (lead picrate) in DMF have been determined by a calorimeter at 298.15 K. In addition, the solubilities of PA, KPA and  $\text{Pb}(\text{PA})_2 \cdot \text{H}_2\text{O}$  in the solvents of DMF, EtOH, HOAc and  $\text{H}_2\text{O}$  are measured.

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**Keywords:** Picric acid; Picrates; Enthalpies of solution; Thermokinetics; Calorimeter

## 1. Introduction

Although picric acid (PA) and picrates are some of the most important energetic materials [1–3]. No enthalpies of solution for PA and its salts of potassium and lead are known.

This paper presents experimental data for solubility solution enthalpies of PA and picrates of potassium and lead in deionized water, DMF (*N,N*-dimethylformamide), acetic acid (HOAc) and absolute ethanol (EtOH) at 298.15 K.

## 2. Experimental

### 2.1. Preparation of solutes and solvents

PA and potassium picrate (KPA) were prepared according to Ref. [4]. Lead picrate  $\text{Pb}(\text{PA})_2 \cdot \text{H}_2\text{O}$  was prepared according to Ref. [1]. The composition and structure of the picrates were determined by chemical analysis, elemental analysis, TG-DTG and IR spectra. Their purities were more than 99.5%. Before experiments, all the solutes were sifted through a 200-mesh sifter.

The solvents used are DMF, EtOH, HOAc and deionized water, the conductivity of the deionized water is  $6.25 \times 10^{-8} \text{ S cm}^{-1}$ , the others are of A.R. grade.

### 2.2. Equipment and experimental method

The calorimetric experiment was performed in a C80II calorimeter from Setaram, France operated at  $(298.15 \pm 0.01) \text{ K}$ . The calorimeter was calibrated by Joule effect before experiment, and each experiment was replicated at least six times.

The experimental precision and accuracy of the calorimeter was frequently checked by measurement of the enthalpies of solution of KCl (special purity) in deionized water at 298.15 K. The experimental value  $(17.20 \pm 0.06) \text{ kJ mol}^{-1}$  was in excellent agreement with the value  $(17.24 \pm 0.02) \text{ kJ mol}^{-1}$  [5]. The reaction solution/solvent was put into the stainless steel mixing with membrane vessel, which was made of PTFE (0.05 mm thick). After thermal equilibration for about 1 h, the containers of sample and reference were pushed down simultaneously, and the reaction heat rate measured for about 0.5 h.

## 3. Results and discussion

### 3.1. The solubility of solutes

The solubility of PA, KPA and  $\text{Pb}(\text{PA})_2 \cdot \text{H}_2\text{O}$  in DMF, EtOH, HOAc and deionized water, Table 1, were measured based on the standard determination of solubility (GJB WJI626-85) [6].

### 3.2. Enthalpies of solution

The molar enthalpies of solution at 298.15 K are given in Table 2. The enthalpy of solution is independent of the concen-

\* Corresponding author. Tel.: +86 10 68913818; fax: +86 10 68913818.  
E-mail address: [yangli\\_buct@sina.com](mailto:yangli_buct@sina.com) (L. Yang).

Table 1  
The solubility of PA, KPA and Pb(PA)<sub>2</sub>·H<sub>2</sub>O at 298.15 K

Solvent	Solubility (g 100 ml <sup>-1</sup> )		
	PA	KPA	Pb(PA) <sub>2</sub> ·H <sub>2</sub> O
H <sub>2</sub> O	0.254	0.892	0.706
EtOH	7.45	0.0560	0.850
HOAc	21.22	0.637	0.587
DMF	∞	33.16	17.86

Table 2  
Enthalpies of solution of PA, KPA and Pb(PA)<sub>2</sub>·H<sub>2</sub>O at 298.15 K

	<i>n</i> <sup>a</sup>	$\Delta_{\text{sol}}H_{\text{m}}$ (kJ mol <sup>-1</sup> )
PA in DMF	6	-15.97 ± 0.04 <sup>b</sup>
PA in HOAc	6	8.66 ± 0.19
PA in EtOH	6	9.53 ± 0.07
KPA in DMF	6	10.71 ± 0.05
Pb(PA) <sub>2</sub> ·H <sub>2</sub> O in DMF	6	-23.5 ± 0.1

<sup>a</sup> *n* = amount of substance of solute.

<sup>b</sup> Uncertainties are twice the standard deviation of the mean.

tration, so the obtained enthalpies of solution can be regarded as the enthalpies at infinite dilution.

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