

NOTES

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The Chemical Behavior of Low Valence Sulfur Compounds. IV.*¹ The Solubility of Ammonium Thiosulfate in Aqueous Ammonia

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The solubility of ammonium thiosulfate in aqueous ammonia has been measured as an investigation concerning the preparation of ammonium sulfamate from ammonium thiosulfate by oxidation with compressed oxygen in aqueous ammonia solution. The solubility is not known except for the measurement at 15°C by E. Weitz.¹⁾ The solubility in water has been measured by W. C. Zeise,²⁾ E. Terres and F. Overdick³⁾ and W. Klempt, F. Brodhobb and H. Erlbach,⁴⁾ but the data are fairly scanty.

Experimental

Crystals of ammonium thiosulfate recrystallized from a very diluted aqueous ammonia solution had a purity of 95.27 wt% with 4.17 wt% adhered water. The solubility was measured by cloud method as follows: The crystals were enclosed in a glass tube of 8 mmϕ × 150 mm with aqueous ammonia and a glass agitator. The tube was heated in a glass water bath to dissolve the crystals as a homogeneous solution. After the dissolution, it was carefully cooled, especially with the cooling speed of 0.05 to 0.1°C/min near the cloud point, and the temperature was measured at which the crystals appeared. When the cloud point was determined within 0.05 to 0.2°C after several measurements, it was decided as saturation temperature. A thermometer graduated at 0.01°C intervals was used. It was calibrated with a standard thermometer.

Results and Discussion

The solubility data measured are shown in Fig. 1. The isothermal curves shown in Fig. 2 were made

by plotting the solubility against ammonia concentration in Fig. 1.

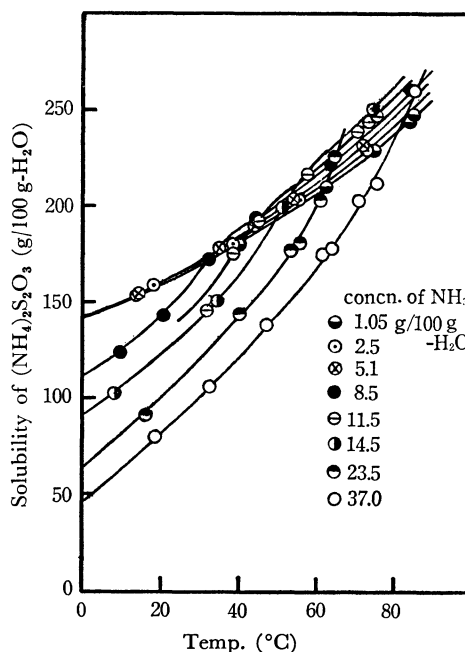


Fig. 1. Solubility of ammonium thiosulfate in aqueous ammonia (temperature-solubility curves).

As shown in Fig. 2, the solubility of ammonium thiosulfate increases with the increase of the ammonia concentration, reaches maximum and then decreases. The maximum point shifts toward the higher side of ammonia concentration with the rise in temperature. By means of X-ray diffraction it was observed that the bottom crystals in the low concentration of ammonia (undoubted ammonium thiosulfate) differ from those in the highly concentrated solution of aqueous ammonia should be an ammoniate of ammonium thiosulfate, because they decompose to ammonium thiosulfate on being stood in air for several hours.

*¹ Preceding paper, III. K. Naito, M. Yoshida, M. C. Shieh and T. Okabe, This Bulletin, **43**, 1365 (1970).

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1) E. Weitz, *Z. Elektrochem.*, **31**, 546 (1925).

2) W. C. Zeise, *Schw. J.*, **41**, 183 (1824).

3) E. Terres and E. Overdick, *Gas-Wasserfach*, **71**, 83 (1928).

4) W. Klempt, F. Brodhobb and H. Erlbach, *Ber. Ges. Kohlentechn.*, **3**, 493 (1931).

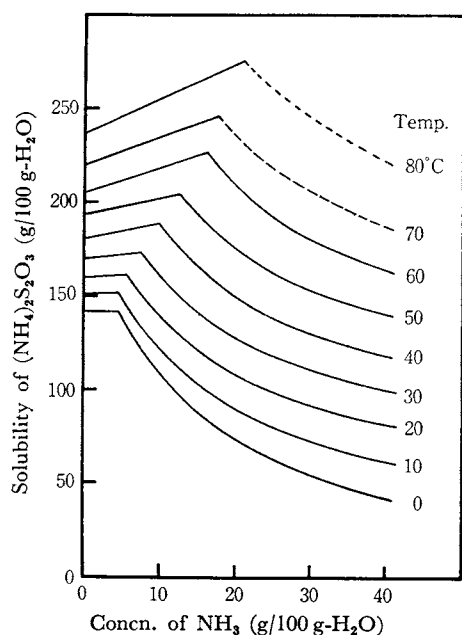


Fig. 2. Solubility of ammonium thiosulfate in aqueous ammonia (isothermal curves).

As elemental sulfur was liberated during the course of measurement at high temperature, the solubility of ammonium thiosulfate in pure water was estimated by extrapolating the solubility in aqueous ammonia to zero of ammonia concentration. The results are shown in Table 1 with those of the former investigators.

TABLE 1. THE SOLUBILITY OF AMMONIUM THIOSULFATE IN WATER

Temperature	Solubility (g/100 g-H ₂ O)		
	Present work	Literature	
0°C	143.8	153.8 ²⁾	160.4 ³⁾
20	158	—	181.7
25	162	178.6	—
30	167	—	—
35	172	204.3	—
40	179	—	204.9
50	190	—	—
60	204	—	226.8

2), 3): see Reference