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| Title       | A note on the stability of ammonium bicarbonate tablets                         |
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| Citation    | The Review of Physical Chemistry of Japan (1952), 22(1): 43-45                  |
| Issue Date  | 1952  |
| URL         | <a href="http://hdl.handle.net/2433/46679">http://hdl.handle.net/2433/46679</a> |
| Right       |   |
| Type        | Departmental Bulletin Paper   |
| Textversion | publisher   |

## A NOTE ON THE STABILITY OF AMMONIUM BICARBONATE TABLETS.

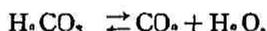
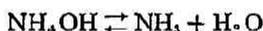
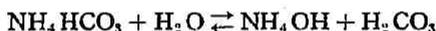
By RYO KIYAMA and SHIGERU MINOMURA.

### Introduction.

Ammonium bicarbonate decomposes slowly into gaseous ammonia, carbon dioxide and water at about 60° C under atmospheric pressure,<sup>(1)</sup> which combine again to form a crystalline, transparent sublimate of ammonium bicarbonate on cooling according to



The same decomposition begins at 40° in vacuum (10 mm Hg)<sup>(2)</sup> and ammonium bicarbonate completely change to a sublimate in the temperature range till 120°. It is found by measuring<sup>(3)</sup> the dissociation pressure of ammonium bicarbonate at 100° that the salt at the temperature in the gas phase is decomposed into its components for the most part. Moreover, there are also molecules combined from ammonia, carbon dioxide and water: ammonium bicarbonate is most probable. The vapour pressure<sup>(4), (5), (6)</sup> of a aqueous solution of ammonium bicarbonate has been measured and the following dissociation has been proposed:



On the other hand, as reported<sup>(7)</sup> previously in *This Journal*, it is found by measuring the decrease of weight in the atmospheric pressure at room temperature or chemical analysis that compressed ammonium bicarbonate tablets which is hardened by pressure is more stable than in the case of not being compressed and changes to urea by dehydration either at room or elevating temperature.

Now, to find the effect of compression and hardening on the stability of ammonium bicarbonate tablets at elevating temperatures (40, 50, 60°), the authors measured the vapour pressures at these temperatures every 15 minutes for 7 hours as to the tablets hardened under pressures (1 ~ 9,000 atm) and discussed the effect of hardening pressure.

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- (1) *Gmelins Hand. Anorg. Chem.*, System-nummer 23, 344 (1936)
  - (2) R. Escales and H. Koepke, *J. Prak. Chem.*, [2] 87, 274 (1913)
  - (3) Th. Paul, M. Landauer and F. Krüger, *Z. ang. Chem.*, 40, 1514, 1542 (1927)
  - (4) M. C. Bonnier, *Comptes rendus.*, 177, 685 (1923)
  - (5) K. Nishizawa, *J. Chem. Ind. Japan*, 23, 830 (1920)
  - (6) E. Terts and H. Weiser, *Z. Elektrochem. Chem.*, 27, 177 (1921)
  - (7) R. Kiyama and T. Yanagimoto, *This Journal*, 21, 32 (1951)

## Experimentals.

(1) **Material.** The sample was prepared by preserving commercial ammonium carbonate which was a mixture of  $\text{NH}_4\text{HCO}_3$  and  $(\text{NH}_4)_2\text{CO}_3 \cdot \text{H}_2\text{O}$  in a desiccator over conc sulphuric acid for a few days. The purity was checked by determining the total nitrogen and was over 99.9 %.

(2) **Procedure.** A vapour pressure at a fixed temperature was measured every 15 minutes for 7 hours as to a gramme of ammonium bicarbonate which was hardened in a moment under a definite pressure and at room temperature. The apparatus to compress the sample is the same as in the previous report<sup>(7)</sup> of *This Journal*.

## Experimental Results.

The vapour pressures at 40, 50 and 60°C are plotted against time (up to 7 hours) as to a gramme of ammonium bicarbonate tablet which were hardened in a moment under pressures, 1, 2,000, 5,000 and 9,000 atm at room temperature in Fig. 1. The

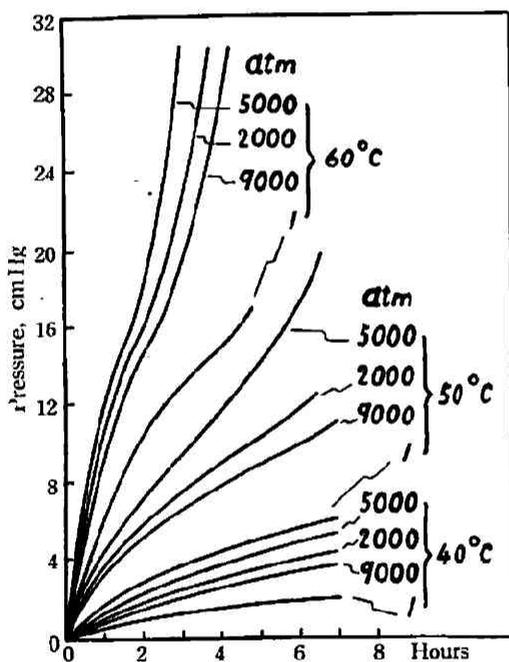


Fig. 1

dissociation rate results in increase in the order of 1, 9,000, 2,000 and 5,000 atm at each temperature. The vapour pressures at 50 and 60° have inflexion points at about 9.3 and 15.0 cm Hg, respectively and after the point the dissociation increases rapidly.

## Discussions.

The following matters can be summarized from the results mentioned above.

(1) The dissociation rate at a certain temperature increases in the order of 1, 9,000, 2,000 and 5,000 atm.

(2) The vapour pressure at a certain temperature has an inflexion point at a fixed pressure and after the point the dissociation increases rapidly.

Ammonium bicarbonate tablets compressed at room temperature contains urea and water, and the dissociation rate of the tablets at elevating temperature is more rapid than that of not being compressed, though the surface area<sup>(8)</sup> of the tablets is generally decreased by the hardening pressure. Therefore, it is found that the increase of the dissociation rate of the tablets is dependent on a certain amount of

(8) I. Shapiro and I. M. Kolihoff, *J. Colloid. Phys. Chem.*, **52**, 1319 (1948)

water contained in the tablets. On the other hand, the same fact was observed in a decomposition of sodium bicarbonate experimented by the author<sup>(9)</sup>. Sodium bicarbonate decomposes<sup>(10)</sup> on heating and the decomposition is greatly accelerated by adding a certain amount of water. As in the previous report<sup>(7)</sup>, the conversion to urea of ammonium bicarbonate compressed in a moment under 4,770 and 10,800 atm at room temperature is 2.34 and 1.04 % respectively. It might be concluded in conformity with this fact that the tablets compressed at 9,000 atm contain urea and water less than the tablets at 5,000 atm and the dissociation rate also decreases.

The authors are indebted to the Department of Education for the Grant to the Cooperative Research (The Fundamental Research on High Pressure Industries).

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(9) R. Kiyama, unpublished.

(10) R. M. Caven and H. J. Sand, *J. Chem. Soc. London*, **99**, 1359 (1911)