Decomposition of Solid Ammonium Nitrate by γ-Ray

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When irradiated with ultraviolet light or ionizing radiation, solid metal nitrates are reported to decompose, producing nitrite and oxygen[1]. However, no investigation has been reported on the decomposition of ammonium nitrate. Recently, the authors carried out the irradiation of ammonium nitrate by γ-ray from 1000 Curie ^{60}Co source at the Institute of Physical and Chemical Research. Decomposition products in gaseous phase were analyzed by a mass spectrometer of CEC 21-103A type and the effect of salt addition on the rate of decomposition was studied.

The irradiation of the salt was carried out in vacuo at a dose rate of 4.4×10^5 r/h, at 23°C. The irradiated sample was washed into a clean beaker with CO_2 free water and the resulting solution was titrated for ammonium ion by the method of Marcali and Rieman[2].

On dissolving the irradiated salt in water, copious effervescence occurred, similar phenomenon was reported for some metal nitrates[1b,c,d].

TABLE I. DECOMPOSITION OF AMMONIUM NITRATE BY γ-RAY

Total dose (10^7r)		4.2	7.1	10.5	15.6
W/W_0*		0.99	0.98	0.97	0.97
Total dose (10^7r)		4.1	6.9	11.1	
	Salt** added				
W/W_0*	$LiNO_3$	0.98	0.97	0.98	
	$NaNO_3$	0.98	0.98	0.97	
	KNO_3	0.98	0.97	0.96	

* W: Mass of ammonium nitrate present
W_0: Initial mass of ammonium nitrate
** Concentration, 5 mol. %

In some case, the solution was divided into two parts, one was titrated for the ammonium ion and the other for the nitrate ion with sodium hydroxide after conversion of ammonium nitrate into nitric acid by passing H-form cation exchanger. The amount of NO_3^- was exactly equivalent to that of NH_4^+ plus added metal ion. NO_2^- was not detected, with the method of Griess[3], in contrast to the case of metal nitrates. Table I shows that the decomposition is accelerated by the addition of metal ion. At this stage, however, no definite conclusion may be drawn in this connection, as decomposition was not carried far enough to show the effect clearly.

Following peaks were found in the mass spectrogram of decomposition products in gaseous phase; 14, 16, 17, 18, 28, 29, 30, 32, 44 and by m/e. Main peaks were 18, 28, 30 and 44 by m/e and they are assigned to be H_2O, N_2, NO, and N_2O, respectively. This feature is qualitatively the same as that obtained for the thermal decomposition of the salt[4]. The effervescence is ascribed to the gas captured in the solid. The quantitative analysis is now being done. This, together with a detailed discussion of the above results, will be reported elsewhere.

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