ENVIRONMENTAL AGEING OF BASIC COPPER NITRATE

Characterizing the Effects of Temperature and Humidity on the Physical Properties of BCN

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BASIC COPPER NITRATE

In the world's leading pyrotechnic airbag technology, a rapid reaction between Basic Copper Nitrate (BCN, Cu₂(OH)₃(NO₃)) and guanidine nitrate produces nitrogen gas, which inflates the airbag-producing life-saving results. Like most inorganic materials, BCN particles will coarsen when exposed to temperature and humidity over time. However, there is a lack of information available characterizing the impact of this coarsening process of BCN particles. The results herein provide a framework for understanding how humidity and temperature affects the physical properties of BCN, and specifically surface area. Finally, we present preliminary results on how packaging and changes in particle preparation can permit BCN material to resist ageing.

ACCELERATED BCN AGEING MODEL

A recently manufactured lot of BCN was aged for 5 days under a range of temperature (8-85 °C) and relative humidity (5-95% RH) conditions and analyzed using BET and SEM.

Changes in Surface Area with Ageing* (m²/g)						
Relative Humidity	95%	3.28		2.55	2.60	2.05
	75%		2.83	2.26	2.06	1.90
	50%	4.15	3.87	3.16	2.99	2.18
	25%		4.22	4.18	4.00	
	5%	4.56		4.54		4.10
		8 °C	25 °C	50 °C Temperature	65 °C	85 °C

*Data points were calculated by averaging the measurements of 5 independent samples



The measured dependence of surface area on temperature (T) and relative humidity (H) can be modeled using the expression below.

Surface Area = $3.24 - 1.81(H) - 0.84(T) - 0.18(HT) + 0.30(H^2) + 0.47(H^2T) + 0.96(H^3)$

AGEING OF RELATED MATERIALS

Ageing of BCN was compared to ammonium nitrate (NH₄NO₃), copper nitrate crystals (Cu(NO₃)₂·3H₂O), and copper oxide (CuO) under similar conditions. Samples of ammonium nitrate and copper nitrate crystals dissolved above 50 °C and 50% RH due to deliquesence and higher solubility.

Copper Oxide Ammonium Nitrate **Copper Nitrate Crystals** Solubility: Insoluble Solubility: 297 g/100 mL at 40 °C Solubility: 381 g/100 mL at 40 °C *suitable SEMs could not be taken at other conditions **30%** Decrease in Surface Area

IT DISSOLVES!

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Particle coarsening can also be inhibited by particle surface modification. Using accelerated the ageing method, we evaluated samples of BCN with low levels of various coatings.



BCN BCN Coating A Coating A (85 °C, 95% RH) (85 °C, 95% RH)

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BCN PARTICLE COARSENING



PACKAGING SOLUTIONS

To improve surface area stability, we evaluated 3 different packaging options on the relative time that manufactured BCN would remain within specification when stored in a warehouse without climate control.





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