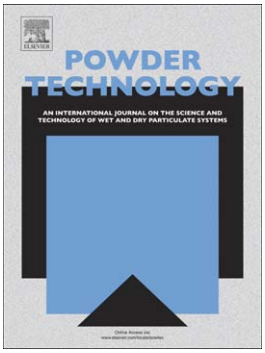

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Alvaro R. Videla, Catalina Polanco, Nestor Escalona

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Phenomenological Model of the Effect of Organic Polymer Addition on the Control of Ammonium Nitrate Caking

Alvaro R Videla [a], Catalina Polanco[b], Nestor Escalona[c]
[a] Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Macul. Santiago, Chile. 7820436. +56 2 2354 5895. avidela@ing.puc.cl. Corresponding author
[b] Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Macul. Santiago, Chile. 7820436. +56 9 9826 5886. cipolanc@uc.cl
[c] Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Macul. Santiago, Chile. 7820436. +56 2 2354 5895. neescalona@ing.puc.cl

Abstract

The agglomeration, or caking, problem reduces the quality and handling of ammonium nitrate prill. Usually, covering the prill with an organic polymer restrains this phenomenon, but limitations in concentration and dosage definition under variable conditions is difficult, making a deeper understanding of the effect this additive has on caking needed. This study shows how experimental data can be used to model caking, including adsorption and nucleation processes as influenced by relative humidity (RH). Water adsorption by ammonium nitrate conforms to a Brunauer–Emmett–Teller (BET) adsorption model, which depends on RH and the percentage of total area cover by the anti-caking agent (ξ). The caking conformation fits a Classical Nucleation Theory (CNT) model which depends on adsorption and ξ for values of relative humidity between 35 and 60%, and ξ between 0 and 60% at a constant temperature of 25°C. The caking compressive strength (σ) can then be estimated with the model based on ξ and RH. The model is validated with experimental data containing samples taken over a three-month period in the area of interest in the north of Chile. The results show that it is possible to minimize caking at an acceptable value by increasing ξ and/or diminishing RH. The main conclusion of the study shows that ξ decreases caking in two ways: 1) it reduces water adsorption and the formation of liquid bridges between particles; and 2) it inhibits nucleation and recrystallization, which avoids the solidification of liquid bridges in dry conditions.

Keywords: Coating, Caking, BET Model, CNT Model, Ammonium Nitrate Prill