Steam-jet agglomeration of skim-milk powder: influence of the process parameters.
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To cite this version:
Mathieu Person, Bernard Cuq, Agnès Duri-Bechemilh, Cécile Le Floch-Fouéré, Pierre Schuck, et al.. Steam-jet agglomeration of skim-milk powder: influence of the process parameters.. 8. International Granulation Workshop, Jun 2017, Sheffield, United Kingdom. 2017. hal-01547545

HAL Id: hal-01547545
https://hal.archives-ouvertes.fr/hal-01547545
Submitted on 26 Jun 2017

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Steam-jet agglomeration is used in the dairy industry in order to obtain instant powders with improved rehydration.

Quality control of industrial products remains experimental and empirical:

- Steam-jet agglomeration = black box process (closed, fast, random collisions).
- Instant properties = multi-factorial causes (structure, composition, physicochemical state).

Few scientific studies on dairy powders agglomeration and mainly performed with other technologies → lack of knowledge.

How can we study and identify the key process parameters that should be controlled?

A steam-jet agglomeration pilot plant was developed:

Two process parameters were studied: the steam/powder ratio ($R_{SP}$) and the drying time ($t_D$).

One factorial design was realized in triplicate:

Characterization of the agglomerates: Circularity, Feret diameter, mechanical strength, water content and wetting time.

Statistical analysis: linear model after standardization of the data.

Structure of the pilot plant agglomerates:

- Raw material (left): Skim-milk powder
- Pilot plant agglomerate (middle): porous structure, irregular shape
- Industrial agglomerate (right): dense structure, spherical shape, regular surface

Influence of the process parameters:

1. Steam/Powder ratio: more liquid bridges comes with more steam available, leading to larger agglomerates.
2. Drying time: increasing the drying time leads to the formation of dry and brittle agglomerates.
3. Interaction: instant properties mechanisms are complex → difficult to identify a key process parameter to control.

A steam-jet granulation pilot plant was developed during this study:

- During the agglomeration step, the steam/powder ratio controls the extent of granulation in the studied range of values.
- The drying step is crucial for the storage evolution to prevent microbial growth, caking or breakage.
- Further studies are needed to understand the instant properties mechanisms.

This pilot plant will allow to study:

- The agglomeration mechanisms → hydrotextural diagram (solid volume fraction vs water content).
- The interactions between the raw material properties, the process parameters and the product properties.
- The correlations between the agglomerates properties to understand the mechanisms of the instant properties (multivariate data analysis).

Conclusions

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