



## The Potential of Economic Model Predictive Control for Spray Drying Plants

Petersen, Lars Norbert; Poulsen, Niels Kjølstad; Niemann, Hans Henrik; Utzen, Christer; Jørgensen, John Bagterp

*Publication date:*  
2013

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Petersen, L. N., Poulsen, N. K., Niemann, H. H., Utzen, C., & Jørgensen, J. B. (2013). The Potential of Economic Model Predictive Control for Spray Drying Plants. Abstract from 18th Nordic Process Control Workshop, Oulu, Finland.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# The Potential of Economic Model Predictive Control for Spray Drying Plants

Lars Norbert Petersen<sup>\*,\*\*</sup> Niels Kjølstad Poulsen<sup>\*</sup>  
Hans Henrik Niemann<sup>\*\*\*</sup> Christer Utzen<sup>\*\*</sup>  
John Bagterp Jørgensen<sup>\*</sup>

*\* Department of Applied Mathematics and Computer Science,  
Technical University of Denmark, Kgs. Lyngby, Denmark (e-mail:  
{lnpe,nkpo,jbjo}@dtu.dk)*

*\*\* GEA Process Engineering A/S, Søborg, Denmark (e-mail:  
christer.utzen@gea.com)*

*\*\*\* Department of Electrical Engineering, Technical University of  
Denmark, Kgs. Lyngby, Denmark (e-mail: hhn@elektro.dtu.dk)*

---

## Abstract:

In 2015 the milk quota system in the European Union will be completely liberalized. As a result, analysts expect production of skimmed and whole milk powder to increase by 5-6% while its price will decline by about 6-7%. Multi-stage spray drying is the prime process for the production of food powders. The process is highly energy consuming and capacity depends among other factors on correct control of the dryer. Consequently efficient control and optimization of the spray drying process has become increasingly important to accommodate the future market challenges.

The goal of the presentation is to present our results regarding modeling of the process and how the efficiency and profitability can be lifted by introducing an economic optimizing MPC scheme.

Firstly, we develop a first-principle engineering model that can be used to simulate spray drying processes with high accuracy. The model can be adjusted to describe drying of various products and describes the complete drying process of a multi-stage spray dryer. The dryer is divided into three stages, the spray stage and two fluid bed stages. Each stage is assumed ideally mixed and described by mass- and energy balances. The model is able to predict outlet temperatures, the residual moisture and particle size of the product. We also give a novel approach to predict deposits due to stickiness of the powder. The model predictions are compared to datasets gathered at GEA Process Engineering's test facility. The identified model parameters are identified from data and the resulting model fits the data well.

Secondly, the effect of disturbances, ambient air humidity and solids content in the feed, is studied by simulation. We show that conventional control is insufficient at controlling the product quality as well as driving the plant to the most economic conditions. Furthermore, we show that the efficiency can be increased by correct adjustment of heat and inlet air flow at each stage.

The recent focus in research has shifted from reference tracking MPC to optimization of economic objective functions. We will discuss how this optimization can be performed by advanced process control techniques, such as Economic Model Predictive Control (E-MPC). We suggest adding an E-MPC based supervisory control layer on top of the contemporary PI-controllers. The strong interconnection between drying stages and process constraints are well suited for MPC.

*Keywords:* Spray drying, Multi-Stage dryer, Grey-box model, First-principles model

---