Optimization of Milk Powder Production using MPC with Minimum Energy Consumption

Tuomas Latvala

Valio Oy, Osmankatu 2, 60100 Seinäjoki, Finland
phone +358 50 384 2712, tuomas.latvala@valio.fi

Antti Ojalehto
Valio Oy, Osmankatu 2, 60100 Seinäjoki, Finland
phone +358 50 384 2517, antti.ojalehto@valio.fi

Antti Pelkola
Neste Jacobs Oy, NAPCON Real Time Optimization, PO Box 310, FI-06101 Porvoo, Finland
phone +358 50 458 3768, telefax +358 10 458 7221, antti.pelkola@nestejacobs.com

Stefan Tötterman
Neste Jacobs Oy, NAPCON Real Time Optimization, Puutarhakatu 53, 20100 Turku, Finland
phone +358 50 458 9853, telefax +358 10 458 1200, stefan.totterman@nestejacobs.com

Keijo Yli-Opas
Neste Jacobs Oy, NAPCON Real Time Optimization, PO Box 310, FI-06101 Porvoo, Finland
phone +358 50 458 3204, telefax +358 10 458 7221, keijo.yli-opas@nestejacobs.com

KEY WORDS milk powder production, spray drying, evaporation, advanced process control multivariable model-predictive control, real time NIR analysis

ABSTRACT

In the food industry it is often preferable to produce milk in the form of powder. There are several reasons, such as changing market conditions, long distances of transportations for further processing and environmental circumstances. Milk powder as intermediate product creates also more freedom for flexible logistics.

Milk powder is traditionally dried in a large spray dryer with heated drying air to reach a desired powder moisture content. The spray dryer unit is a huge energy consumer and in principle not very energy efficient. In milk powder production skimmed milk is first concentrated to a desired solid content in an evaporator. In this process unit also a lot of energy is used to remove a big amount of water. In some cases these both process units are dynamically quite strongly coupled together via a limited intermediate volume.

Valio Oy in Seinäjoki, Finland, has recently accomplished an Advanced Process Control (APC) project to increase skimmed milk powder production in co-operation with its APC vendor, Neste Jacobs Oy. The basic idea was to maximize the production with minimum energy consumption using real time optimization with multivariable model-predictive control (MPC) technology. The combination of the evaporator and the spray dryer in the MPC system created highly potential improvements in the milk power production. The realized MPC system is designed to maximize the production by pushing continuously both units against dynamically varying process constraints as well as product quality constraints. The MPC solution utilizes measured and real time calculated process and product quality variables as controlled or constraint variables. Also the controlled

key product quality variables are provided by on-line near infrared (NIR) analyser. The MPC application is also equipped with a recipe system, which allows several product qualities to be produced with the same control structure.

The MPC application package has shown within long term production campaigns to be capable of keeping the production 10% higher than before the MPC installation. The operation of the plant is more stable and the drying batches are more equal to each other than before. After MPC installation it has become much easier for the control room operators to produce repeatable drying batches.

The paper is organised as follows: first the process is presented together with the client's expectations towards the real-time optimization and control. The control and optimization strategy is presented with some final performance examples such as normal production maximization and energy minimization at times when maximum production is not available. The MPC implementation projects steps and timeline are roughly outlined and finally project results are presented.