FOSS

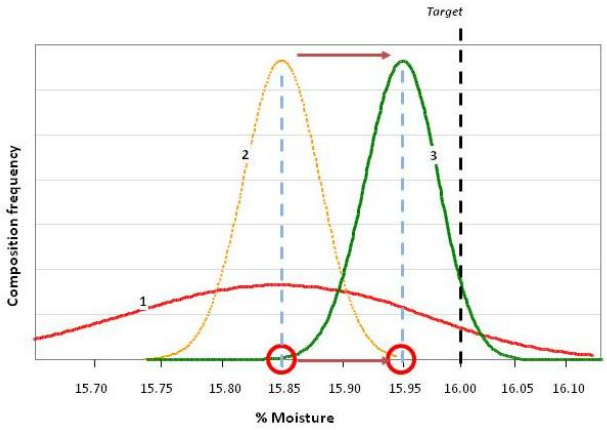
Application Note 47

ProFoss™
In-line Butter application

Continuous process monitoring in food manufacturing is becoming increasingly important. Consistent and high-quality standardized products manufactured at low cost are a key goal for competitive success in a global market.

The ProFoss helps you achieve this goal by reducing variation and streamlining your butter manufacturing process. The solution provides you with fast, accurate, and continuous results ´real-time' for critical process parameters like Moisture, SnF and Fat content.

You can use the results either for *manual* process regulation control of the butter churn or for *automatic* control by interfacing the instrument with your process regulation system.



With the ProFoss system, you can run your process with a production target much closer to the product specification giving you an increased yield with a consistent product quality over time.

Using ProFoss, the operator or the automatic process regulation system can immediately react to changes in the raw material or process. Even at start-up or recipe change, there is no need for calibration adjustment or large delays. You will get correct results with the first analysis and process regulation (optimisation) can start immediately.

With the ProFoss solution you can:

- Continuously track exactly how your process is performing instead of waiting for results from standard wet chemistry analysis in the laboratory.
- Control the manufacturing process to a precision limited only by your control system
- Detect not only the actual process situation but also predict possible future out-of-specification situations and react before they actually happen
- Identify what you have in the process line at any time – product type, mix of products, etc. thanks to the unique ProFoss qualification software. In-line process qualification is a 'lifeguard' to avoid production mistakes, and for preventing unreliable results to be used by your process regulation system.

In-line performance evaluation

This application note describes the results that can be expected when in-line analysing butter in the outlet of the butter churn using the ProFoss solution.

For an in-line solution it is important to measure the product composition as accurately as possible. But equally or even more important is the ability of the system to detect process variations (trends) quickly and reliably. The smaller the variation that can be detected (process variation detection limit), the better process regulation can be done and the production target can be moved closer to the product specification.

As measurements on the ProFoss are made at such short time intervals, corrections to production can be made much faster than with process monitoring using manual sampling and laboratory analysis where a time lag of several minutes or even hours is common. In-line measurements also minimise possible sampling errors, and the effect of production variation no longer has significant influence on the overall performance. Adjustment of a process is seldom based on a single sample manually collected - re-testing is required and this further increases the time lag in the regulation system. Using ProFoss the true production trend is obtained instantaneously.

The lowest level that a process regulation system can react on is the process detection limit of the monitoring system. We can define the process variation detection limit as the repeatability of the monitoring system. As traditional repeatability cannot be calculated on an in-line process instrument (different samples all the time) the best measure of repeatability is the standard deviation of differences between adjacent results – this is an estimate of the smallest process change that can be detected by the analyser. This figure is often 5 – 10 times smaller than the figure for the calibration accuracy calculated as Standard Error of Prediction (SEP).

Performance

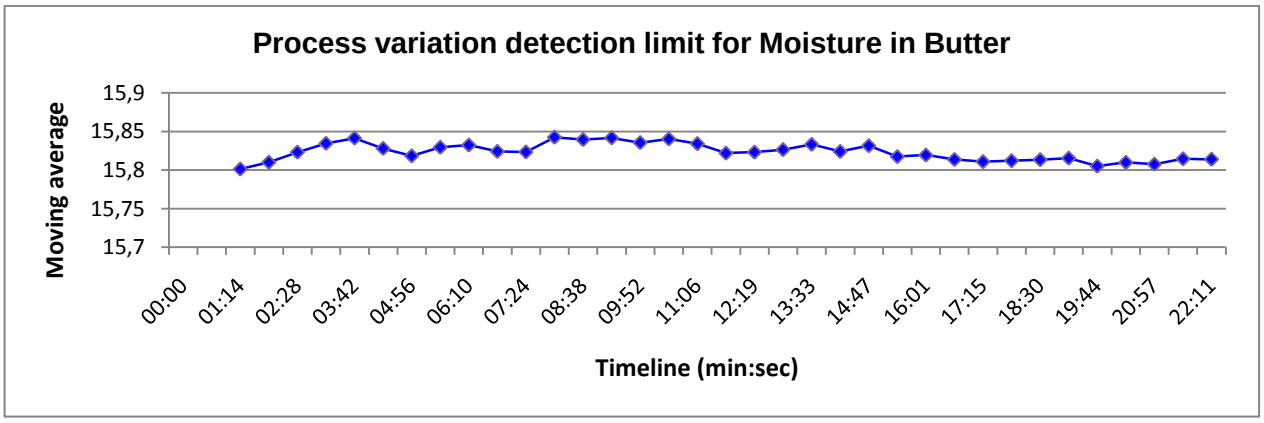
The process variation detection limit has been estimated based on the variance between 2 adjacent moving average measurements for a period of 20 minutes where the production process is as stable as possible.

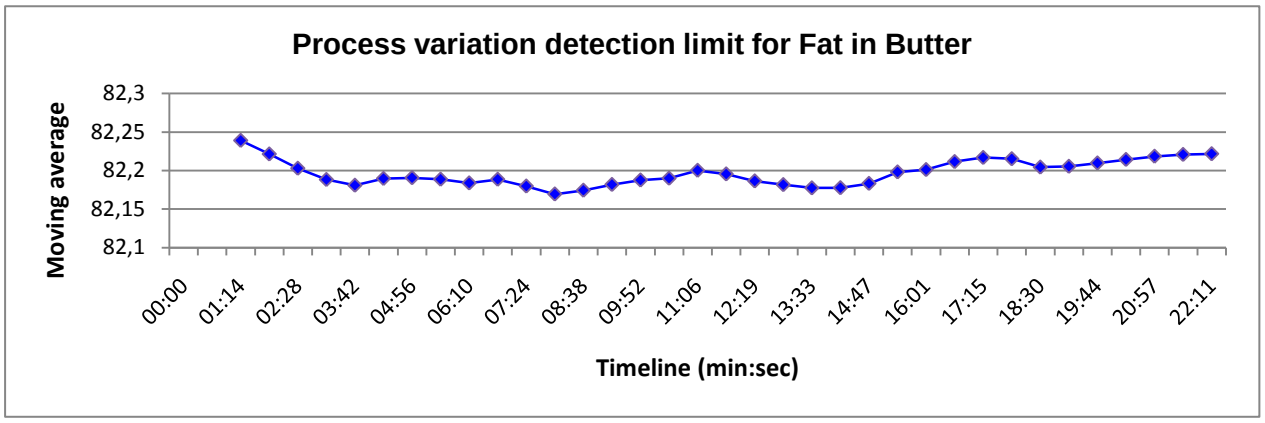
In the table below, a calculated process variation detection limit in terms of standard deviation of differences is given for all parameters including the calibration – Moisture, Fat and SNF.

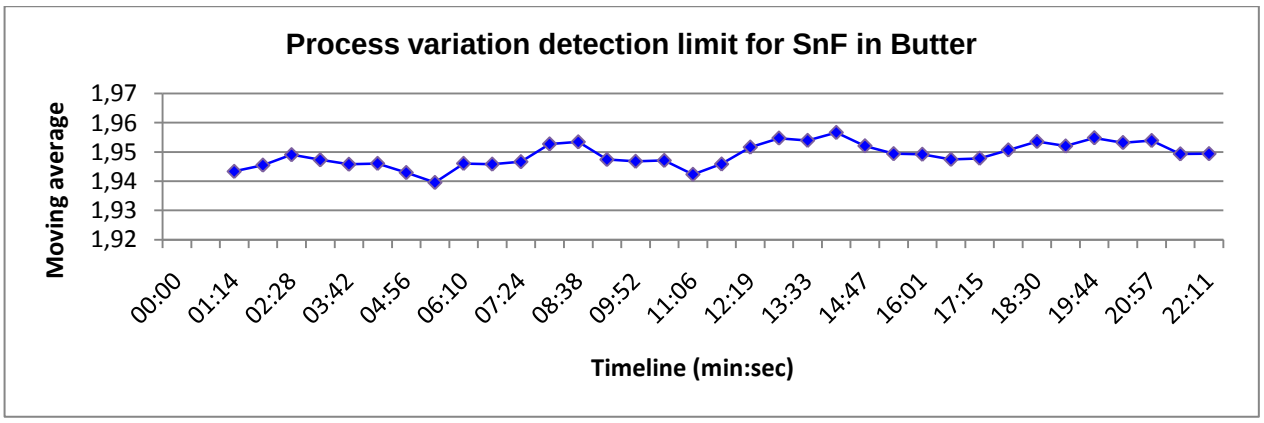
Process variation detection limits

Component	Salted and unsalted butter
Moisture	0.015
Fat	0.015
SNF	0.005

Process variation for Moisture, Fat and SnF is shown below on graphs covering a period of 20 minutes. During this period the production process is not 100% constant and concentration changes (trends) can easily be detected. Process variation trends for Moisture < 0.015%, Fat < 0.015% and SnF < 0.005% can easily be seen.







Samples used in the calibration

The calibration is based on different butter types – sweet/acid butter & salted/un-salted butter production data collected in EU. The calibration can be used for butter products covering the concentration range below.

The concentration range covered by this calibration can be seen in the table below.

Component	N	Min %	Max %
Moisture	8280	14.4	17.2
Fat	7711	81.6	83.6
SnF	7892	1.4	2.0

Performance

The calibrations for Moisture, Fat and SnF were developed using a PLS modelling.

The performance was evaluated using independent validation sets and the results are presented in the table below.

Calibration version: ProFoss Butter version 100

Component	Model	N	Acc. %	Min %	Max %	RSQ
Moisture	PLS	1465	0.046	14.4	16.2	0.88
Fat	PLS	1358	0.044	81.8	82.9	0.91
SnF	PLS	1390	0.014	1.5	2.0	0.98

N: Number of independent samples in the validation set.
Acc.: Independent test set accuracy expressed as Standard Error of Prediction (SEP) corrected for bias (1 SD absolute)*.
Min.: Minimum reference value.
Max.: Maximum reference value.
RSQ: Linear correlation between ProFoss results and reference results (here NIR).

* Accuracy of individual sets will depend on sampling, sample handling, reference method used and range. The performance example outlined in this note should only be regarded as a guideline for the expected performance of new installations. The performance of new installations will always depend on the uniformity of the flow and homogeneity of the product, as well as the reproducibility of the reference method used to verify the performance. An indication of the obtainable performance can be found as approximately 2 times the reproducibility of the reference method.

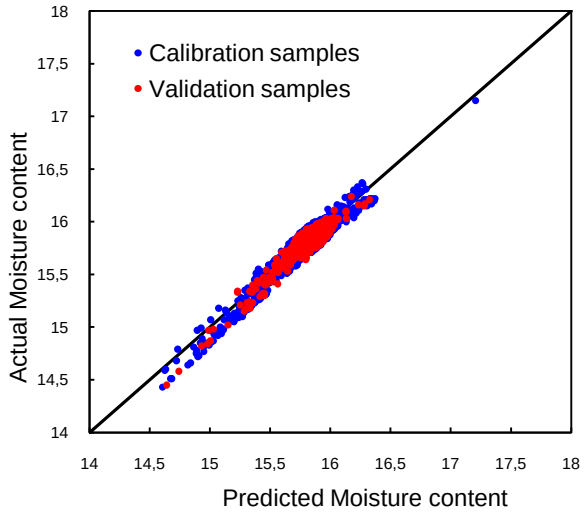
General:

The performance of the calibration has to be validated with your samples (minimum 25 samples with reference values) according to the **International Standard IDF 201/ISO 21543 – "**Milk products – Guidelines for application of near infrared spectrometry".

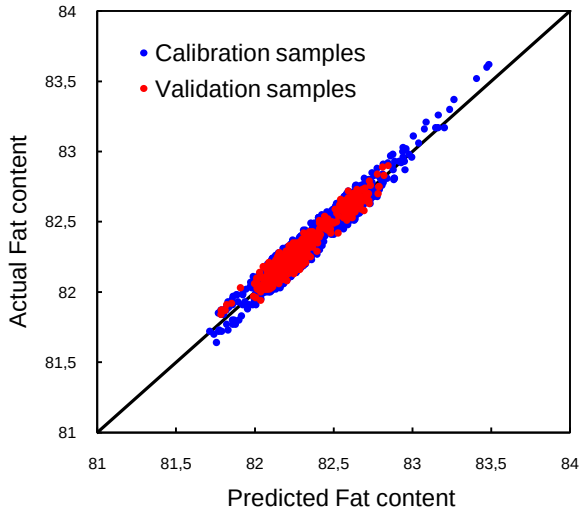
If the samples you are measuring exceed the stated calibration ranges, or have non-common variations of other components, this might influence the performance of the calibrations.

The graphs below show predicted results versus the reference ("actual") values for the independent validation sets.

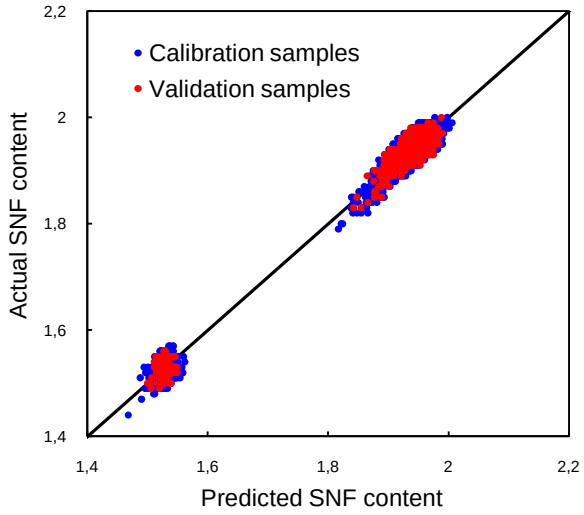
Moisture



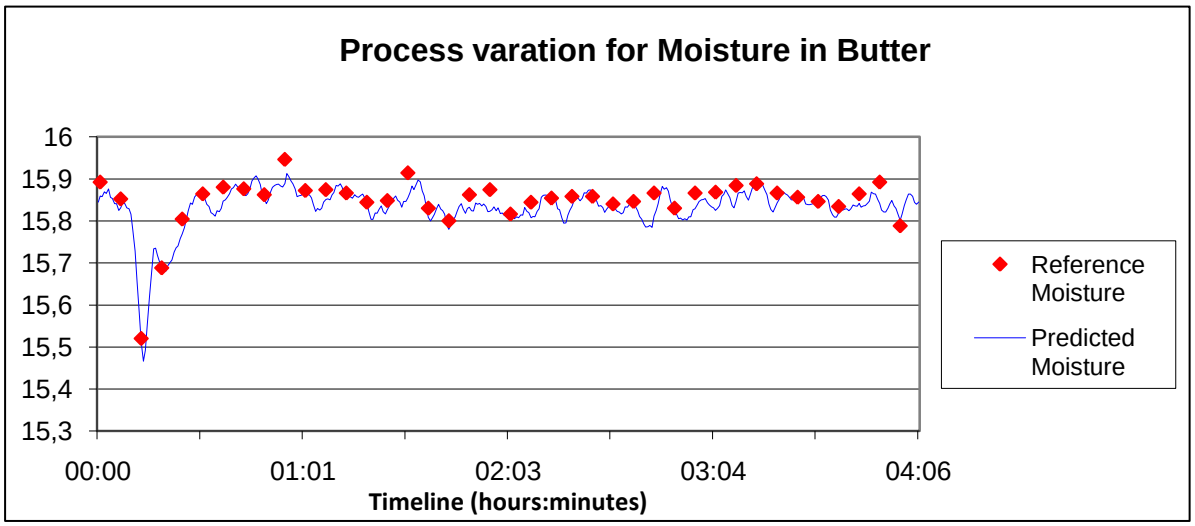
Fat

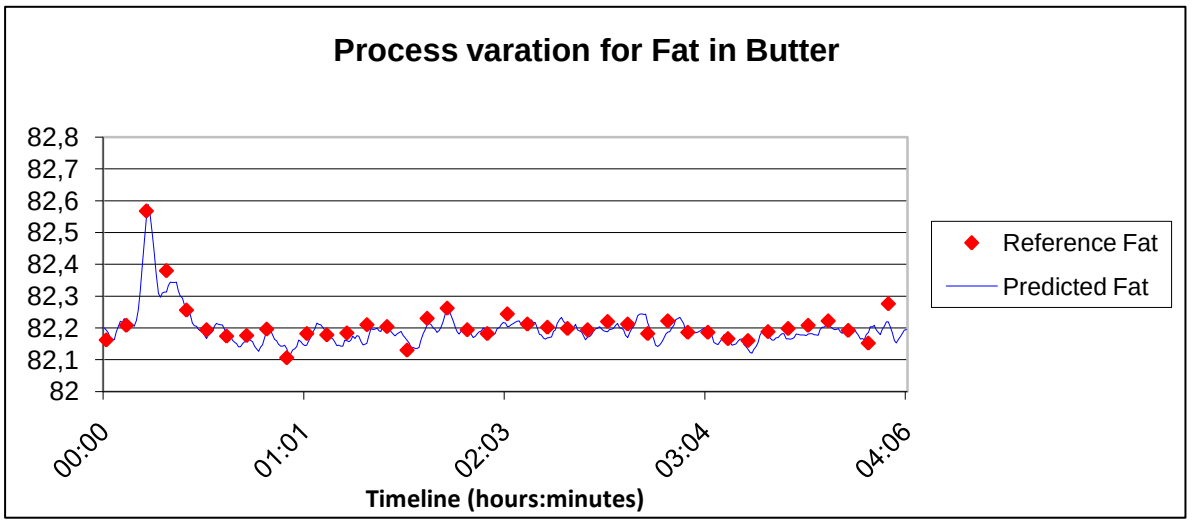


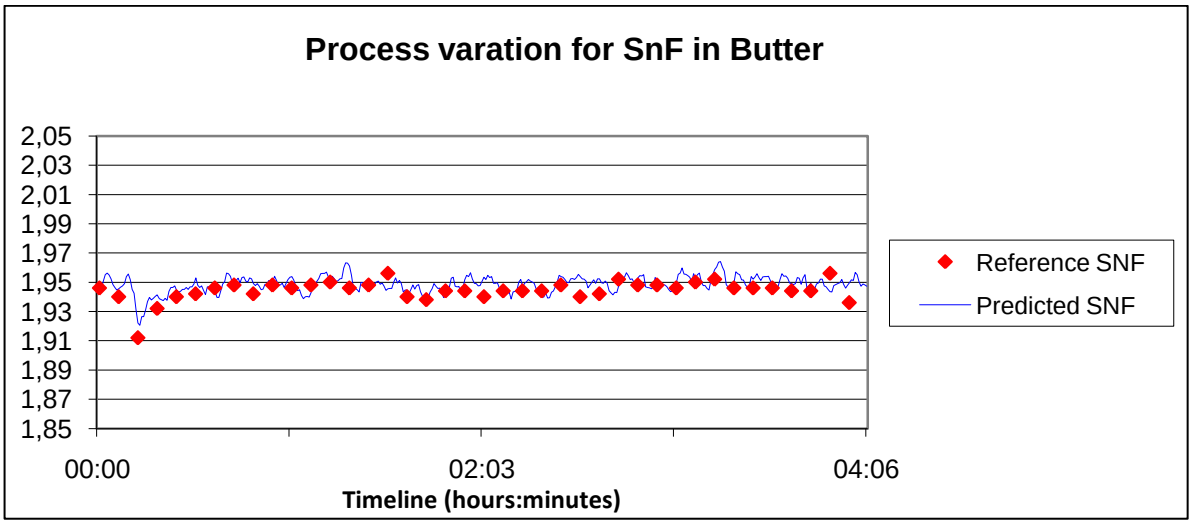
SNF



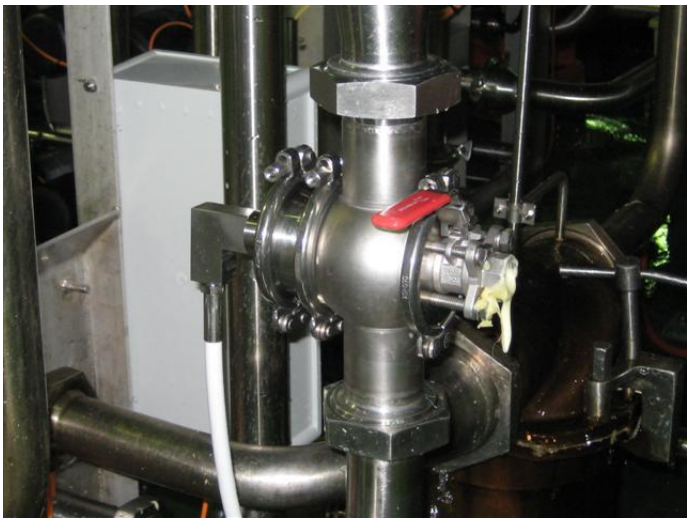
The graphs below show in-line predicted results (blue line) compared to laboratory results (red) in terms of moving average for a period of 4 hours.







Installation, measuring point, sensors and analysis



The ProFoss sensor should be installed at the outlet of the butter churn. Optimum measuring point is as close as possible to the butter churn outlet to be able to control the moisture addition regulation as close as possible to target.

Installation into a butter blend process line it is important to install the ProFoss sensor at a place where the butter blend product has been homogenised.

Measurements will be made with a Lateral transmittance interface directly installed into the production line with a standard GEA-Tuchenhagen access unit or a special FOSS designed flange welded into the existing process line.

Reference analysis method

We recommend you to evaluate the performance of the calibrations using the appropriate joint ISO/IDF standards methods according to the procedure described in IDF201.

The test sets used for evaluation of the performance were analysed by means of the following methods:

Sampling **ISO707/IDF50**. Milk and milk products – Guidance on sampling.

Validation **ISO21543/IDF 201: 2006**. Milk products – Guidelines for the application of near infrared spectrometry.

Moisture **ISO 3727-1: 2001/IDF 80-1:2001.** Butter – Determination of moisture, non-fat solids and fat contents – Part 1: Determination of moisture content (reference method).

Fat: **ISO 17189:2003/IDF 194:2003.** Butter, edible oil emulsions and spreadable fats – Determination of fat content (reference method) or ISO 3727-3: 2003/IDF 80-3:2003. Butter – Determination of moisture, non-fat solids and fat contents – Part 3: Calculation of fat content.

Solids-non-Fat: ISO 3727-2: 2001/IDF 80-2:2001. Butter – Determination of moisture, non-fat solids and fat contents – Part 2: Determination of non-fats solids content (reference method).

If an indirect reference method such as the FoodScan is used, it has to be fully calibrated and validated against a primary reference method.

Ordering information

P/N 60042673 ProFoss Butter calibration for Moisture, Fat and SnF.

Dedicated Analytical Solutions

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