High resolution diode array process analysis in flour milling

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Introduction

Processing industries have for years relied on laboratory methods to optimise the efficiency of their production lines. Using traditional wet chemistry methods, the time lag between sampling and results made it very difficult to use the analytical information in an efficient way. Introduction of near infrared (NIR) instrumentation in laboratories or at-line was a great leap forward, significantly reducing the time from sampling to result; therefore, enabling better process control. The routines required for sampling from the process flow remains a major limitation—sampling can typically only be done a few times per day. The new ProFoss High Resolution diode array analyser delivers the high accuracy of laboratory NIR in a true continuous inline mode, thus enabling instant feedback to the production staff.

Materials and methods

The performance of the ProFoss analyser was validated in a flour-mill. Measurements were made on the finished flour quality. At this point 6 different types of flour were produced – switches between the types were made with ~6 hour production intervals. The unit was installed by welding an interface flange into the side-wall of a pipe located after the last sifter in the milling process (Figure 1).

The analyser was attached and operation of the analyser was done from the control room. Measurements were made directly on the flour flowing freely in the pipe—no bypass was used. The speed of the flour passing over the measuring window was ~10 m s^{-1}.

All reference data was generated on an Infratec 1241 using the FOSS ANN calibration for wheat flour. Calibrations were done with ISIcal, a new intelligent calibration tool that is used together with the ProFoss unit. ISIcal supports non-experts to develop their own calibrations—the tool automatically optimises the calibration algorithms by selecting the most reliable model for future use. Prior to installation in the process the analyser was used in the laboratory to measure 52 flour samples. These data formed the basis for the calibration later developed when measurements were collected in the process. Data from measurements made in the laboratory were finally mixed with the process data to obtain the final calibration. Figure 2 illustrates the spectra obtained before and after using scatter correction to the spectral pre-processing procedure.

The ability to mix laboratory and process data is an advantage, as the time used to stabilise and expand the calibration is kept at a minimum.

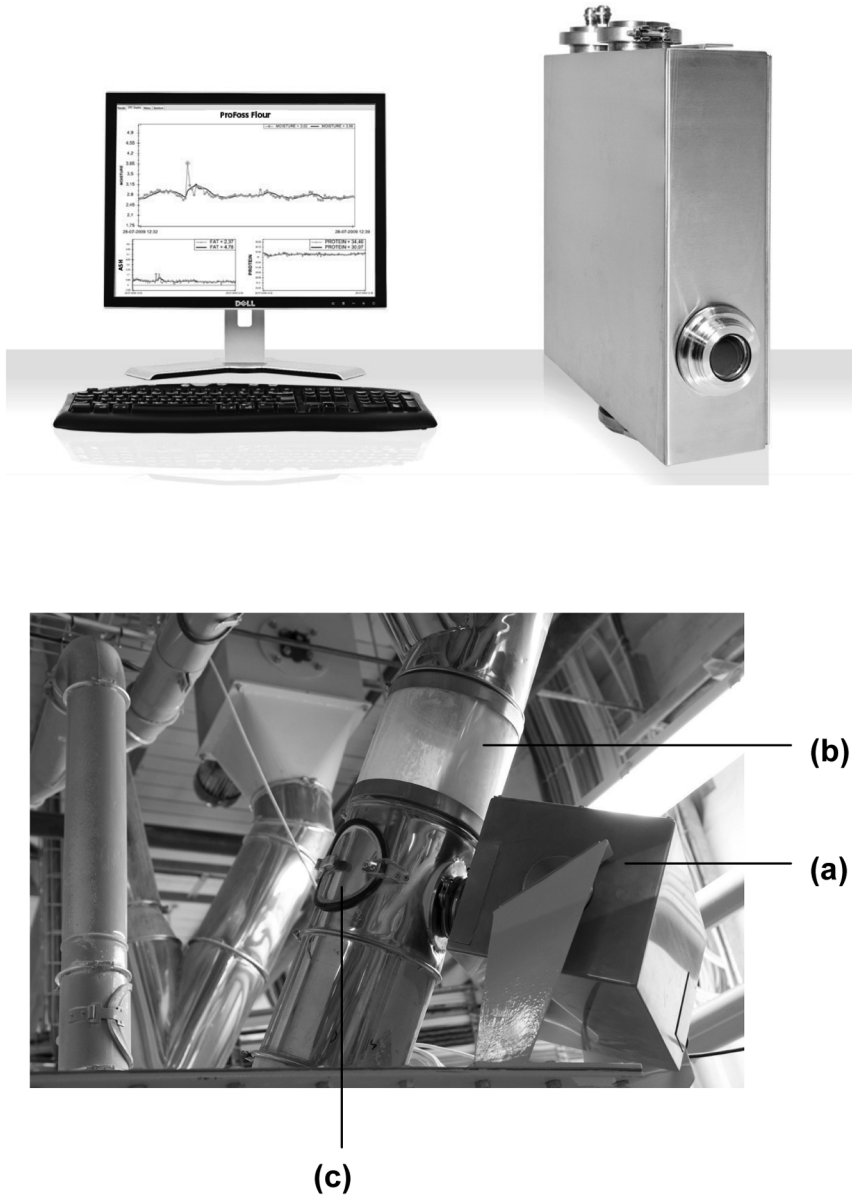

Figure 1. ProFoss analyser (top). ProFoss analyser (a) attached to the ductwork in the flour mill (b). Samples for reference analysis were taken from the door in the ductwork (c). Samples for reference testing were collected at the door opposite to the sensor.

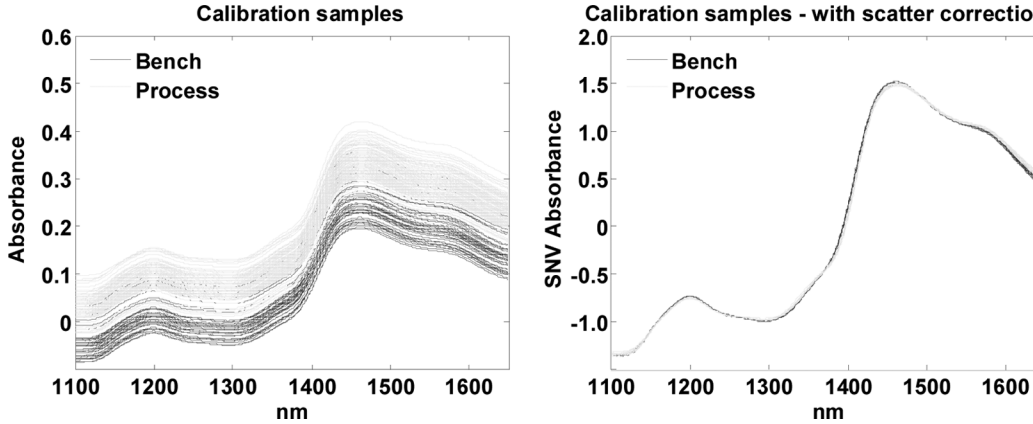

Figure 2. Absorbance spectra of calibration samples without scatter correction (left) and with scatter correction (right). After applying scatter correction (SNV) to the data they overlap nicely.

Results and discussion

The results obtained show that the ProFoss analyser has the ability to perform with a high accuracy that is close to what can be achieved using laboratory instrumentation (Table 1).

Advantages that can be obtained with real time measurements using ProFoss are: Optimal use of expensive wheat qualities, consistent flour quality, production close to target specifications, and increased yield.

Table 1. Statistical evaluation of ProFoss analysis of flour in a commercial mill.

Constit.	Range	Calib. Samples*	Valid. samples	Accuracy, *SEP*
Ash	0.46% – 0.67%	155	49	0.024%
Protein	8.2% – 15.3%	154	49	0.15%
Moisture	12.2% – 15.5%	148	49	0.08%

* Calib. = calibration; valid. = validation