APPLICATIONS NOTE

AN-01-15362-02-2015-03

Nordson Measurement & Control

Moisture, Fat and Protein in Dairy Powders

The Need for On-line and At-line Measurements

Moisture measurement and control are very important during the final processing stages of turning liquid dairy concentrates into powder to ensure optimal product quality and operating efficiency. With rapid, dependable real-time measurement and feedback of the moisture content to the process controller, the process can be safely operated close to the upper specification limit for final moisture. This enables manufacturers to produce a highly consistent, within specification, top-quality product that complies with food safety and other regulatory requirements.

In a world where food yields from manufacturing processes have become ever more important, improved control of the final drying stages minimizes production scrap or rework and also offers significant financial benefits, particularly:

- Increased production yields through not over drying (and potentially damaging) the product
- Reduced energy costs with a positive impact to the plant's carbon footprint by optimizing the high-energy intensive spray drying and fluid bed after-drying and cooling stages

Additional measurements of fat and protein for confirmatory monitoring of many dairy products allows for a "right first time" approach, further reducing re-work/re-blending, start-up times and energy costs.

Conventional analytical technologies for measuring moisture, fat and protein in QC labs provide accurate measurements at "snapshot" intervals in time and usually take many minutes or hours to perform on a small sample (typically a few grams). Often, this leads to very poor verification of on-going process control and potentially inefficient operation. This technique can also be costly to maintain and requires the use of chemicals which ultimately need to be disposed of.

On-line measurements of critical parameters such as Moisture, Fat and Protein in real-time using the Nordson Series 9 Near-Infrared (NIR) gauge (Figure 1) generate continuous, highly accurate and representative measurements of the dairy powder allowing for better process control and optimization.

Figure 1. *Series 9 NIR on-line gauge*

For processes where installation of on-line gauging is not practical, the NEW InfraLab Series 9 Top Loader at-process analyzer (Figure 2) is an effective alternative that provides a rapid (5 seconds) at-line measurement on representative large grab samples.

With no special skill required to operate, the InfraLab Top Loader provides process vision far beyond that of conventional testing.

Figure 2. *InfraLab Series 9 Top Loader At-Process Analyzer*

This level of feedback is simply not possible using small grab samples analyzed in a conventional laboratory, as illustrated in Figure 3.

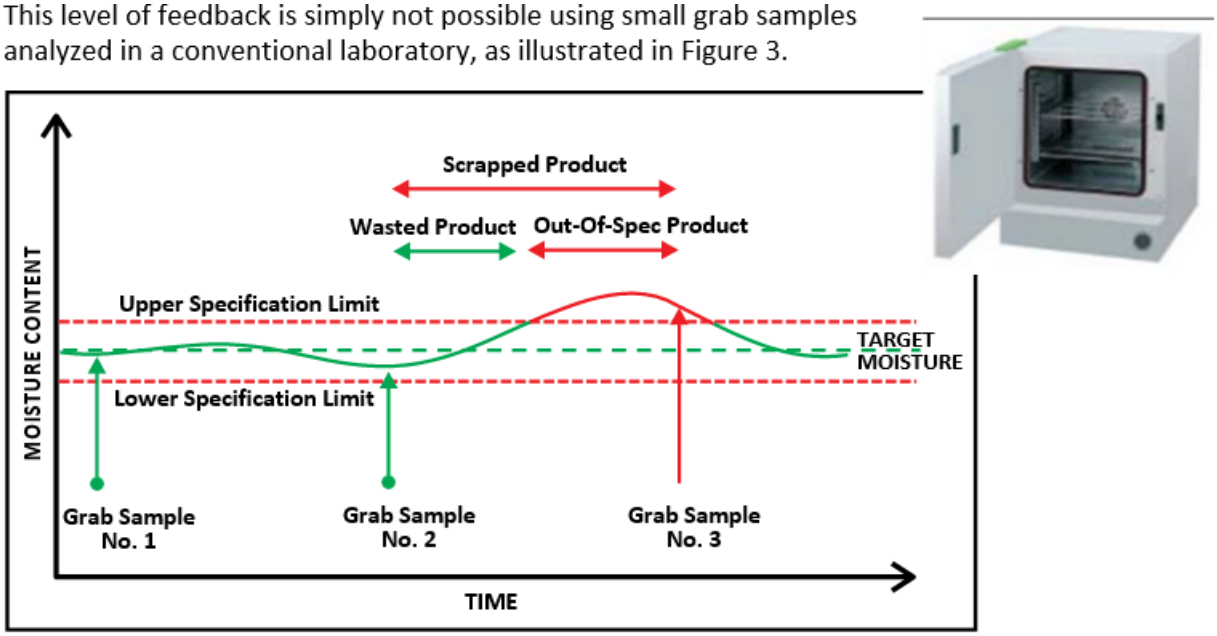


Figure 3. *Feedback from grab samples analyzed by conventional laboratory oven method*

Figure 3 shows what can happen when the moisture content of the product is measured by taking small grab samples. The dotted horizontal green line represents the target moisture content and the red dotted lines indicate the upper and lower specification limits. The first two grab samples show the process is producing product within specification but grab sample 3 lies outside the upper specification limit. A decision now has to be made on how much product needs to be scrapped or re-worked. In addition, the process cannot be confidently operated close to the upper moisture specification limit since the feedback is too slow.

Figure 4 shows an identical process, but this time with an on-line moisture measurement which can be linked directly to the process control system. In this case, the moisture content of the product can be tracked in real time and steps can be taken early to ensure product is produced within specification

With good process capability, operators can confidently control the moisture content closer to the upper specification limit and realize the significant benefits mentioned earlier.

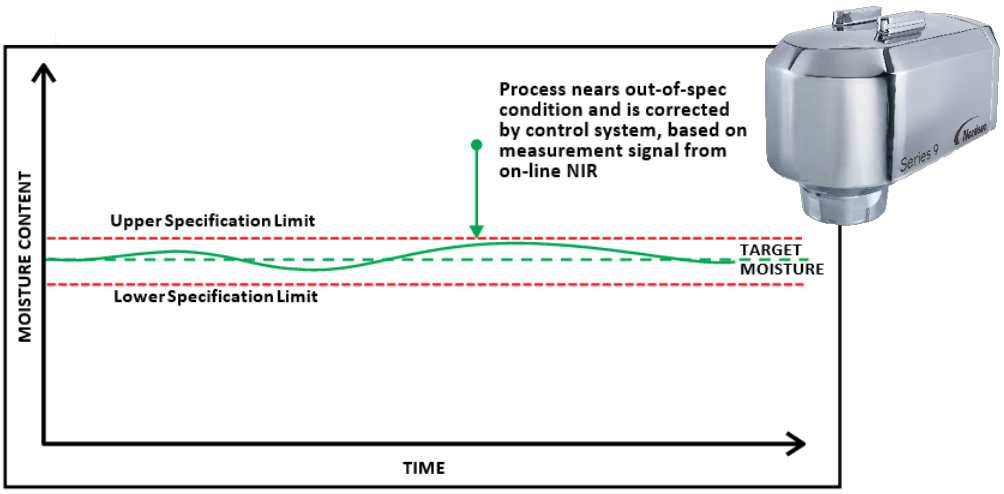


Figure 4. *Real-time, on-line measurement*

Applications and Measurement Performance

Nordson gauging solutions:

- Incorporate patented opto-electronic technology designed to withstand demanding processing environments and provide robust linear measurements
- Self-compensate for factors such as aging of the internal source lamp and are not affected by ambient light or environmental temperature changes within their operating temperature range
- Provide consistent measurements over long periods of operation and do not require constant re-adjustment after commissioning

Achieving this capability is made possible through significant work in applications engineering, enabling Nordson to deliver off-the-shelf, linear measurement algorithms that are desensitized to the effects of seasonal changes and do not drift over time. Table 1 includes a list of an example set of NDC-developed measurements. Several charts are also shown in Figure 5 that demonstrate Nordson gauge measurement performance against primary reference methods.

Product	Component	Accuracy
Skim, Full Fat, Replacer Fat Powders, Infant Formulation	Moisture 0-5% Fat 10-40% Protein 10-35%	±0.1 ±0.25 ±0.6
Casein Powder	Moisture 5-12%	±0.2
Whey (WPC)	Moisture 0.5-5% Protein 10-35%	±0.2 ±0.2
Lactose Powder	Moisture 0.5-5%	±0.2
Non-Dairy Creamers	Moisture 0-5% Fat 10-40%	±0.1 ±0.3

Table 1. *Representative examples of Nordson-developed algorithms*

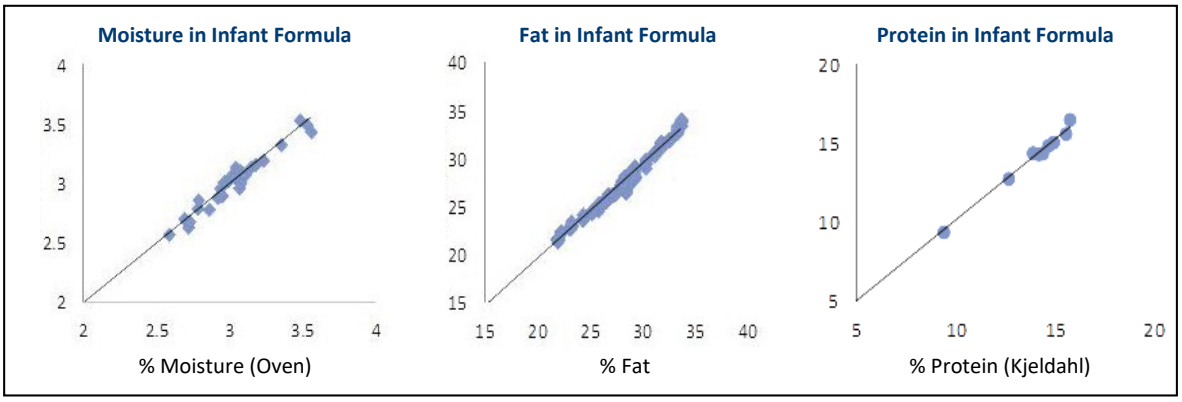


Figure 5. *Nordson gauge measurement performance against primary reference methods*

Note: *Near-Infrared measurement is a secondary correlative technique and requires an adjustment of the measurement output in order to agree with the primary reference method of the site. NDC proprietary linear measurement algorithms deliver stable and repeatable readings "out of the box".*

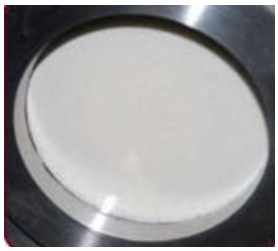
A simple adjustment of the gauge trim to the primary reference method of the site delivers accurate and robust absolute measurements of moisture, fat and protein.

Measurement Location for On-line Gauges

Nordson NIR-based technology can be easily integrated into the production process via a PLC to capture accurate and reliable measurements.

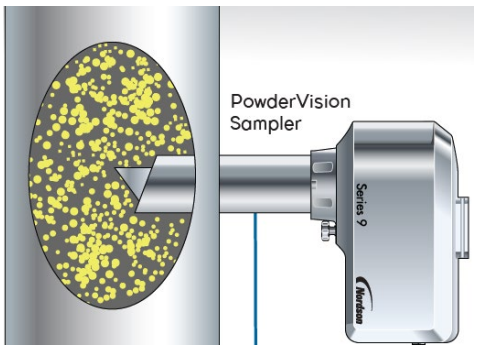
The gauge must be located as close, as practically possible, to the drying stages to provide responsive feedback to the process controller. However, good product presentation to the gauge is important and a measurement location needs to be selected where it is possible to “extract” samples for periodic, comparative checking of the gauge against the site primary reference method. Generally, the gauge will be installed after the final drying process (typically spray drying followed by fluid bed drying/cooling) either:

1. Through a **Sapphire Window** located at the exit of the Vibro Sifter or other location where consistent powder flow can be observed. See installation configurations.



OR

2. By capturing product in the Nordson **PowerVision** sampling cup mounted in the gravity-fed pipework, measuring it and then ejecting it back into the process with compressed air. See installation configurations.



Example–Potential Installation Configurations

Figure 6 highlights possible measurement locations after the spray drying process.

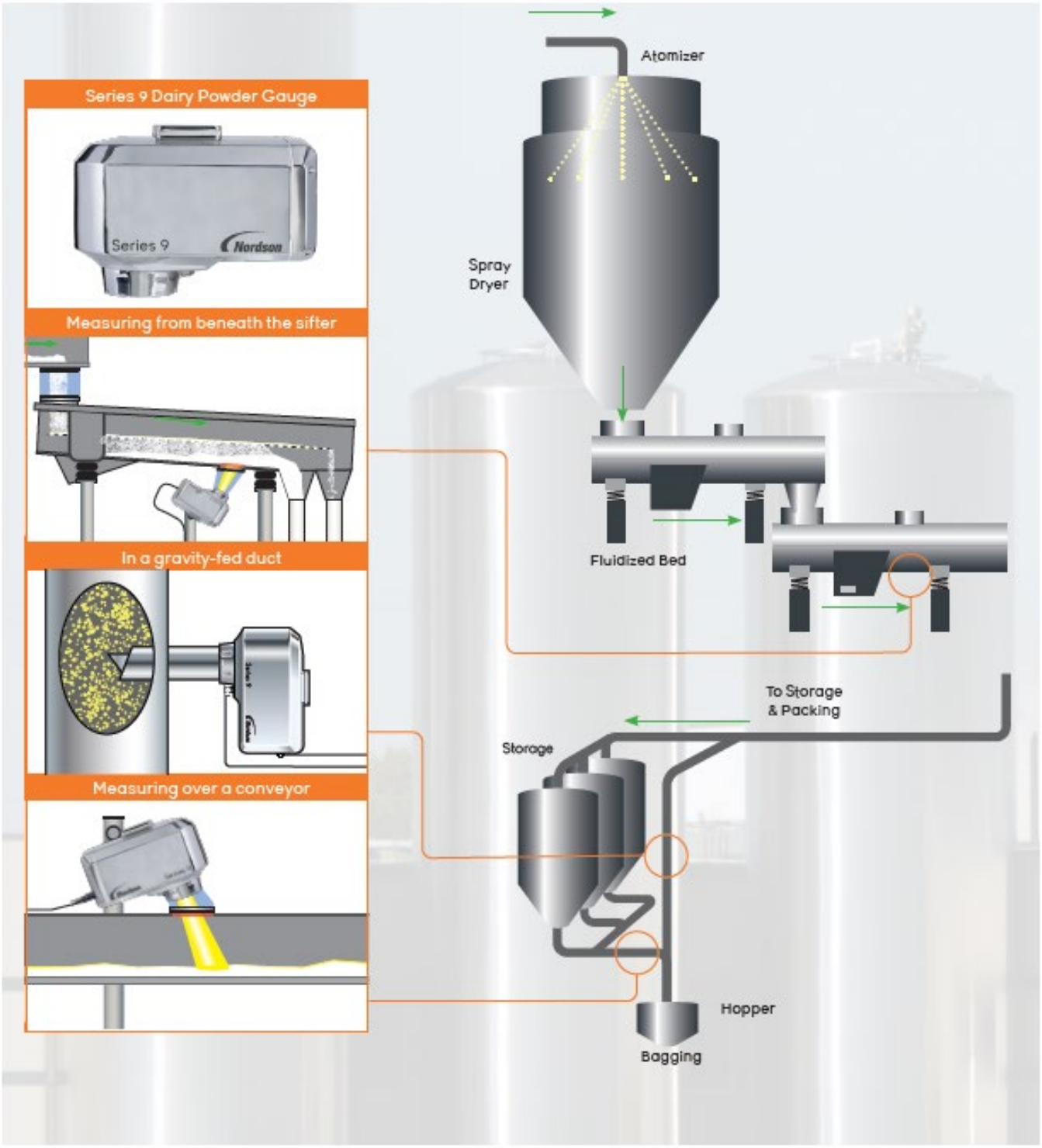


Figure 6. Optimized product presentation at key measurement locations in dairy powder processing

APPLICATIONS NOTE

Summary

Nordson's solutions bring measurable process benefits in terms of energy savings, increased productivity and operational efficiencies by avoiding the delays associated with sending samples to a laboratory. Furthermore, Nordson solutions enable organizations to produce higher quality products more consistently.

Nordson's applications-engineered measurement solutions offer a number of advantages to dairy powder producers:

- Increase product yield and consistency by not over drying
- Realize energy savings and reduce the risk of potentially damaging product by not over processing
- Nordson gauges are optimized for applications, making them easy to adjust to site reference methods
- Linear algorithms engineered for the product, parameter and operational range
- Robust, state-of-the-art optics and electronics design
- Long-lasting stability: no need for re-calibration
- Highly dependable operation: unaffected by ambient conditions
- Best performance: accuracy, precision, speed and signal-to-noise
- Fastest ROI and lowest cost of ownership
- Lifetime partnership philosophy with customers to cooperatively develop solutions and improve competitiveness
- Peace of mind knowing that you are working with stable, reliable organization for the long term.

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