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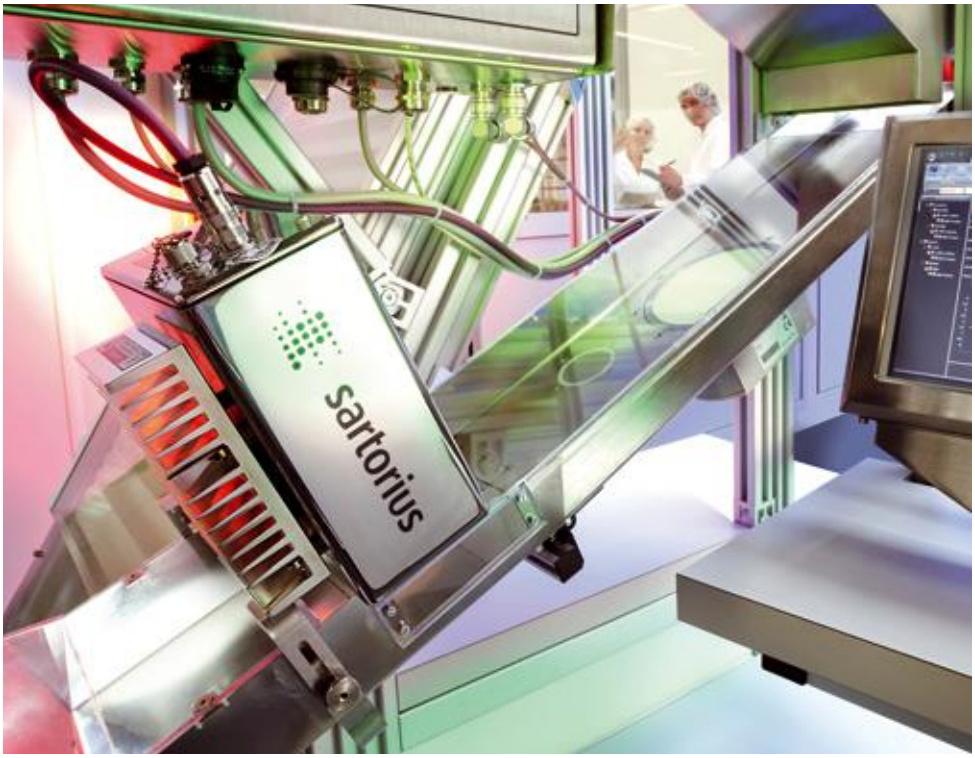
Cost Optimization and Extremely Fast Results in the Powdered Milk Production Process



Application Note

turning science into solutions

The moisture content of materials plays a very significant role both in the pharmaceutical and food industries, because it has a direct influence on product quality and the processing of semi-finished and end products.
NIR systems provide an optimal solution for quality assurance and an extremely high degree of cost-effectiveness.

Particularly in the food industry, which involves many different pourable products as semi-finished and end products, the moisture content of materials determines the extent to which a product can be processed and stored, and is often an important factor in terms of quality. If the moisture content of certain raw materials is too high, they can become sticky and clumps may form. Clumps pose significant problems during both storage and transport. On the other hand, if materials are too dry, they may not mix well or may be difficult to process mechanically. Furthermore, the cost of products or raw materials is often calculated by their weight, which also depends on the moisture content of the materials. Other factors that play an important role in the milk-processing industry are the protein, fat, and lactose content. For example, the fat content is very important when processing powdered milk, because a very high fat content may cause the powder to clump, which then clogs the production system. Furthermore, it is extremely important to maintain the concentration of ingredients at the levels required by the customer, in order to achieve consistent product quality. For this same reason the protein content must also be monitored in the production of powdered milk. The specific level required depends on the recipe; this level must be adjusted by adding protein powder to the treated milk for the spray drying process and checked once the drying process is complete.

Process Control Using Conventional Methods is Not Always Ideal

Usually, regardless of whether the moisture content of the materials is the only parameter that must be monitored and controlled, or whether other factors such as protein and fat content must also be taken into account, the measurement technology used only allows for random samples to be monitored. Taking moisture content measurement as an example, it is easy to see why conventional methods are not always the optimal solution for controlling a process and therefore are only suitable for optimizing the use of raw ingredients to a limited extent.
The conventional process for determining the moisture content of a material is known as the oven drying method, during which up to 24 hours are required for analysis. In this method, a sample is dried and then weighed to calculate the weight lost during the process. A faster tool than the oven is a drying scale, which dries the sample directly on the scale using a radiant heater or microwaves and then measures the weight lost. Other conventional methods include "analytical" methods, such as Karl Fischer titration, the calcium carbide method, and the phosphorus pentoxide method; however, these methods require more complicated equipment than thermogravimetric methods. These processes are also water-selective, meaning they detect only the water content and not total moisture levels, in contrast to thermogravimetric methods. The aforementioned methods have considerable disadvantages: they only work with relatively small sample quantities and therefore are not sufficiently representative, they damage or modify the sample to be analyzed, and the analysis takes several minutes or more. For these reasons these methods are only suitable for random sample measurements. Complete monitoring of the entire process with full documentation or even direct, fully-automatic process control is not possible with these methods. In a production phase with a high throughput, this means that several tons of a product with the wrong moisture content may be produced before this is corrected within the process.

From Liquid Milk to Powder

At many points in the production of powdered milk, it is essential that important information can be obtained quickly and reliably. The composition of liquid milk has an effect on the price it can fetch, meaning that concentration levels must be determined as quickly as possible in order to ensure a fair price and also safeguard the processor of the milk. To achieve a constant protein level in the powdered milk (this level must be set for the target market), protein must often be artificially added during production for countries with very poor sources of protein available, such as those in Africa or Central Asia. The protein content of the raw milk must be determined in order to know exactly how much protein to add. It is also important to determine the fat content of the milk, because this will have a direct effect on the fat content of the powdered milk. The type of spray nozzles used in the spray drying process must also be selected to suit the milk being treated. If the powdered milk is spray dried first, it is important to check the fat, protein, and moisture content in order to maintain the required concentrations in the product.

The Right Technology for Process Control
For reliable and very fast process control, the important product-relevant parameters must be able to be determined simultaneously within the process, in order to replace conventional time-consuming measurement methods. Furthermore, the measurement technology must be able to be easily integrated into the process without affecting or damaging the product being checked. The system must also be able to communicate with process control systems. NIR spectroscopy exactly meets all of these specifications, particularly for the production of powdered milk. The PMD500 device series makes it possible for important product parameters, such as moisture, protein, fat, and even lactose content, to be determined very quickly and simultaneously using just one system and without touching or damaging the product. Depending on its application, the system uses a combination of different sensor types, from color spectrometers and video cameras to an NIR spectrometer, all enclosed in just one sensor housing. This device series is also able to measure many more parameters; it is even possible to generate an image analysis for counting black spots or determining surface distributions.

The solution described here is significantly different from the conventional solutions previously available on the market. For example, the sensor system is resistant to vibrations, which often occur in food production systems due to sieves or vibrating conveyors. It is easy to see just how resistant this device series is against vibrations by looking at how this series works with a rotating mixer. In this case, the system is fitted with a Bluetooth antenna and battery pack, and can check ingredient concentration levels and the homogeneity of the mixture during the mixing process without the sensor being damaged or the measurements becoming unreliable. The exceptional flexibility of this device series means they can be widely used in the production of powdered milk, because both the liquid milk and the end product, powdered milk, can be monitored in terms of the parameters mentioned previously. Process reliability is guaranteed by the system, not only because of its numerous potential application areas, but also due to its process-specific features. For example, if a light goes out in the sensor, this will never cause the measurement system as a whole to fail, since the lights are fitted with two redundant lamps which automatically switch when one goes out. The user is notified with an error message on the monitor, so that a bulb change can be arranged.

NIR spectroscopy and imaging with the PMD500 for use in the powdered milk production process.

Even the ambient conditions pose no problems for this sensor system. It can be used in ambient temperatures of up to 80°C, meets the requirements for protection class IP65, and has a European ATEX certification as standard.

Summary: Cost Optimization is Possible with Online Control
Optimizing the moisture content by just 0.1% for a product worth approx. EUR 400 per metric ton means an increase in profit of EUR 400,000 at a production rate of one million metric tons per year. Furthermore, this process measurement technology helps to achieve constant protein levels and maintain fat content levels with the objective of ensuring consistent product quality.

Important Facts for Users
- Parameters such as moisture content can be checked online with the PMD500 device series, allowing for reliable and problem-free process monitoring.
- This solution is a good choice for optimizing the use of raw materials and ensuring that ingredient concentration levels meet the specified thresholds. Due to the slow offline analysis of conventional systems, the tolerance range was previously considerably larger than with the PMD500 series, which allows the target values to be checked directly as part of the process.
- Optimizing the moisture content of a product by just 0.1% can already provide significant increases in profit.

The NIR Process Analyzer from Sartorius is ideal for measuring various qualitative and quantitative parameters in milliseconds.

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