



NEAR INFRARED ANALYZERS IN THE SNACK FOOD INDUSTRY

The Snack Food Industry is constantly designing new products to keep up with the changing tastes and preferences of consumers. Once a product is developed and put into routine manufacture, it becomes extremely important for the Snack Food producer to monitor and control the manufacturing process. Consistency and freshness are parameters we all associate with “tasting good”. Taste is what sells product. In order to confirm that production is packaged in a manner that guarantees freshness and consistency, Snack Food companies can implement a program of both continuous and near line quality control testing. Some of the basic parameters for which testing is done include moisture, oil, protein and flavoring addition. Moisture in the finished product is by far the most important parameter in assuring quality and freshness. Conventional analytical techniques for measuring moisture and oil are usually time consuming and can even require costly use and disposal of chemicals needed to perform the analysis.

Over the last decade, the Snack Food Industry has become familiar with the use of NIR (Near Infrared Reflection) bench top analyzers. These analyzers have been in use in the grain industry since the early 1970’s for the measurement of moisture, protein and oil in cereal products. These NIR devices were developed in conjunction with the USDA and Canadian Grain Commission to meet the demand for fast, reliable on site determinations of water and protein for payment purposes at grain terminals and grain elevators.

NIR analyzers were developed originally so that a sample had to be ground to a uniform particle size in order to make the measurements. This is a difficult requirement for the Snack Food manufacturer. There are many different types of products, some of which are quite high in oil content. Grinding and using a tiny sample are inherent problems in the snacks business. There is significant potential for sampling and measurement error.

However, NIR instruments have recently been developed that allow the snack food producer to measure both moisture and oil, the two parameters that influence consumer acceptance, without the need for any sample preparation. In fact, these NIR sensors can be used either on a bench-top for use as a quality control tool or actually on-line at the output of a fryer, tumbler, spray addition, etc. for automatic measurement and control.

Old NIR bench-top analyzers and the new NIR sensors employ the same fundamental, well-understood technology. There are a number of molecular bonds that absorb light in the near-infrared region of the spectrum. The common bonds are H-O-H for water, C-H for fats, flavorings and oils, and N-H for proteins. The absorption of light at wavelengths specific to these molecular bonds is proportional to the amount of water, fat or protein in the snack food being measured.

New NIR instruments can shine light directly onto whole products. In other words, there is no longer any need to grind the product and present the ground sample to the NIR device, in most cases. A large collection mirror in the sensor can capture the diffused reflected light coming off of the surface of the whole product and direct that returned light onto a lead sulfide element that measures the light intensity. In a near line configuration, the whole sample is placed onto a rotating turntable. The NIR sensor can then measure the moisture and oil as the sample is moving beneath the sensor. Thirty measurements per second can be averaged over several seconds to give a repeatable, accurate result. An on-line sensor can be placed over a production conveyor and make a continuous real-time measurement as the product is moving through the manufacturing process.

One US Snack Food manufacturer has implemented NIR Bench-Top sensors in a near-line configuration. This company makes a variety of products such as Potato Chips, Corn Products, Pretzels and Popcorn. There was a need to measure as

many as 12 products, essentially being produced at the same time. In one facility there was a need to measure moisture and oil in many different products from various lines. Each product needed to be measured at least once every half hour. There would be no practical way to accomplish this by using classical analytical techniques. A conventional moisture balance would require at least five minutes per sample and require some level of grinding and sample preparation. The oil analysis would require significantly more time, both in terms of assay time and sample preparation time. In addition, this company did not want to be saddled with use of troublesome solvents and reagents.

The solution was to use a series of modern Bench-Top NIR analyzers that can measure moisture and oil on product taken directly off of the process line. The whole sample is placed in a stainless steel bowl. The bowl is then placed onto the Bench-Top system, the sample is automatically rotated at the press of a button, and the system displays the percentage of moisture and oil within ten seconds. Because the sensor “sees” all of the various product surfaces during the sample rotation and because the sensor is making 30 measurements per second, the answer is both accurate and extremely repeatable. This company is now able to react to out of spec conditions more rapidly, greatly reducing the amount of waste and, most importantly, improving the product quality.

Another US manufacturer has chosen to rely more on continuous on-line measurements. This company has used an old NIR analyzer in their Quality Assurance Lab and was therefore familiar with the basic technology. They have installed new NIR sensors directly over their Potato Chip, Corn Chip and Tortilla lines. Again, the new style NIR sensors are making 30 measurements per second as the product is conveyed under the sensors. The sensors measure both moisture and oil continuously in real time about 20 feet from the outlet of the fryer. This, of course, completely eliminates the need for any routine sample handling and testing. The moisture and oil content are displayed continuously at the operator stations. Some care had to be taken to locate the sensors so that they were allowed to see a consistent flow of chips.

As this company made the gradual change from an off-line testing routine to total on-line measurements there were a series of people issues that needed to be addressed. In short, the operators had to “buy into” the new technology. What would happen if the new NIR sensor’s values did not match up with the Quality Assurance Lab’s values? What answer do you believe? When should the operator consider making an adjustment to residence time, for example? The answers to these questions were a while in working themselves out. The first step was to establish calibrations, comparing the on-line NIR gauge to the QA old NIR system. This was easily and quickly done. The values for the two devices, for both moisture and oil, matched up nicely. Correlation coefficients of .98 and low standard errors. The next step was to compare sample taken directly from the process line. The sample was grabbed immediately after having gone under the on-line NIR sensor. The values were recorded. The samples were then taken to the QA Lab and run on the old NIR system. The results were mixed. Some samples matched up well. Some did not. It turned out that the chips were not very homogenous, especially in oil content.

At this point, one of the operators made a suggestion. Why not take the analog output of the on-line NIR sensor and run it into a process chart recorder? Then grab samples only when the recorder indicated that the moisture or oil value was trending toward an out of specification level. Then grab samples and compare the on-line values to the lab values. This was magic. Once again, the correlation coefficient was at .98 and the standard errors were low. The operators learned to trust the on-line NIR sensor and to make changes based on their ability to see the trace on the recorder moving toward an out of spec condition.

Another interesting application at this company is the automatic control of flavoring addition for both Cheese Curls and Popcorn. A new NIR sensor is installed on a conveyor after a tumbler. The Tumbler applies the flavoring in the form of slurry. The NIR sensor actually measures the oil content of the slurry. The amount of oil in the slurry has a direct relationship to the total amount of flavoring being applied. The NIR sensor’s 4-20mA output is run into a process controller that automatically adjusts the amount of flavoring applied by manipulating a pump to a desired set point.

NIR analyzers have been assets to the Snack Food Industry for a number of years. They have been widely used and are an accepted method of analysis in many QA environments. The New generation of Bench-Top and On-Line NIR sensors have benefited from greatly improved detector and optical technologies. NIR sensors are now easy to calibrate, simple to use, and are reliable in difficult processing locations. They can not only make reliable measurements but can also be attached to plant control and data acquisition systems that make these measurement devices an even more valuable tool to help in the delivery of a high quality, consistent snack food product.