Obtaining Accurate Viscosity Measurements For Food And Beverages

KROHNE

In the food processing industry, manufacturers are looking for two things: taste and texture. Texture is the “feeling” in the mouth when the product is eaten. It is usually assessed by measuring the product’s viscosity or “thickness,” the resistance of a fluid that is being deformed by either shear or tensile stress. Companies desire consistency, so a successful process will generate a product that is always the same. Controlling texture is difficult, and especially for non-Newtonian products it is a real challenge to effectively measure viscosity in-line. Flow rate, temperature and flow history affect viscosity, and managing viscosity of such products is not always an easy task.

Quality control labs are looking for ways to control viscosity more tightly so they can eliminate off-spec product. One method being used more frequently is a new type of in-line viscosity measurement device, which uses patented technology based on mixing principles applied to pipes. Bulk viscosity is measured on the whole fluid flow, which is re-homogenized by the action of in-line static mixers.

At a yogurt factory, the device was designed to control a smoothing valve on the white mass after maturation. The instrument is specially designed so that the shear rate applied to the yogurt is not higher than that applied in the empty pipe, creating a totally non-intrusive measuring process. Texture fluctuations have been reduced to a tenth of what they were and protein consumption is optimized by reducing texture fluctuations and by attaining the minimal required specifications.

Measuring viscosity of non-Newtonian fluids

It has always been difficult to measure the viscosity of non-Newtonian fluids, because their viscosity depends on the precise flow conditions in effect during measurement. The same fluids flowing at two different flow rates in a pipe can give two different viscosity measurements. Processes with non-Newtonian fluids passing through a pump, a filter, instruments with a smaller diameter than the pipe size or those flowing through a sampling valve may be significantly affected. For example, a yogurt sample removed from a process pipe or through a sampling valve may take several minutes (or more) to stabilize, and only after this time can you have a stable and repeatable viscosity measurement on a laboratory rheometer.

Measuring viscosity in yogurt

For yogurt, viscosity measures whether the product is lumpy or smooth, watery or too thick. A company may test a product and then adjust it to build the texture they want. But if not handled properly in the processing line, it will take much more energy and expensive raw materials to achieve the final desired texture. Operators may lack sufficient information to determine precisely how and why the variability came into the process and why it led to a product defect.

Take the example of a large yogurt factory that uses batch processing to mature its product. Once mature, operators empty the batch and pump the white mass to a packaging plant where it is cooled down before packaging. The high temperature is about 40°C in the tank, and it is cooled to about 20°C. Maturation stops when the product is cooled down. If it is too cool, the live enzyme will be killed and the quality of the product is affected, so maintaining the target temperature is extremely important.

Quality control personnel found that the quality of the white mass yogurt was not as stable after the maturation and cooling processes. Viscosity measures were done by sampling several production batches and the results showed significant fluctuations, particularly between the beginning, middle and end of a batch’s transfer process.

Data at the plant showed that the texture varied by plus or minus 25 percent for the same product produced in one month. The measurement method used involved taking a sample out of the line and bringing it to a laboratory to analyze. However, the very act of taking a sample out of the line affects the product. The product goes through the line in a pressure condition, so when passing through the sampling valve, the product is subjected to a shear rate that affects its texture. Analyses performed using two different offline instruments couldn’t give less than 10 percent difference between the two instruments.

Eliminating inconsistencies

The quality control group at the yogurt plant was seeking more information to understand the factors that generate defects and inconsistencies. They sought to continuously monitor viscosity during a batch transfer, after its cooling process, on a 3-inch diameter main production line. They installed a Viscoline CVL030S, made by KROHNE, Inc., made with stainless steel construction, no moving parts and no in-situ calibration required. The unit features a repeatability of 0.2 percent, resolution to 0.1 CP while meeting government policy on metrological traceability.

The fluid flows through a continuous pipe containing two low pressure drop static mixers. The sensor device measures the pressure drop at both static mixers by means of two differential pressure measurements: ΔP1 and ΔP2. Pipe flow rate, required to accurately determine the flow regime to which the viscosity is to be calculated, can be obtained from either an external data measurement or with a flow meter.

From the two pressure drop measurements and the flow rate reading, the fluid flow parameters are processed in the system, and the pipe line viscosity is determined. Every viscosity measurement is referred to a corresponding operating temperature. Thermal corrections can be applied when a measurement is required at a reference temperature. Such correction requires laboratory characterization.

With Viscoline installed in the mainline, the smoothing valve can be opened or closed in an automated fashion to achieve constant viscosity in real time. Leveling the texture fluctuations, the recipe can be adjusted upfront to get closer to the minimum specifications required. This reduces the consumption of expensive ingredients like proteins and results in a consistent, stable, uniform product that costs less money.

The new device gave operators the means to better control their process, as well as measure the impact of their corrective actions. They can standardize operations with all the operators on the line, allowing them to save money and get a uniform product that meets their quality standards.

http://www.foodmanufacturing.com/articles/2012/06/obtaining-accurate-viscosity-measurements-food-and-beverages