When the consistency must be consistent

Manufacturing companies can realize large savings by having complete control of liquid flow properties. Today they use time-consuming analytical methods, but by installing a new Danish flow cell technology, it becomes possible to measure how for example a dressing or yogurt is flowing – online.

The consumer notices it immediately - if the texture of a food product is not as usual, something must be wrong. Ketchup should have the right ketchup effect, yoghurt should feel right in your mouth and cream cheese should spread in just the right way. It's all about the *rheology* of the food, i.e. the complex flow properties.

For producers of food and food ingredients the demands on quality represents a challenge: how can the flow properties of products be kept within narrow tolerances? The obvious answer is to measure the appropriate flow properties and through regulation of process parameters constantly keeping the process on track. The challenge is that today there are no are simple methods that provide information about the complex flow characteristics in real time.

Producers can control the flow properties of finished product through narrow raw material tolerances, a precisely controlled process and rheological control of the finished product in the QC laboratory. If the finished product does not comply with the specification, it can lead to reworking, re-mixting or perhaps to rejection.

The RheoStream™ technology from Fluidan ApS will provide the answer to these challenges. By constantly monitoring selected rheological parameters, it is possible to intervene in the process in time to keep it on track.

For food manufacturers, it becomes possible to reduce quality costs and improve productivity, while delivering a more consistent quality to customers and consumers.

"Our vision is to introduce a new simple tool for process optimization and control. It will transform rheological measurements from a daily nuisance into a mainstream process control parameter and will become a new cornerstone of manufacturer's control strategy", says Anders L. Østergård, CEO in Fluidan.

When viscosity is not the full story

Viscosity of a liquid is a measure of how much force that must be applied to a liquid to achieve a given flow rate. For some fluids, the ratio constant (including sugar solutions and oils) and the liquid has a well-defined viscosity, which today can be measured with reliable and accurate in-line viscometers.

However, when the properties of fluids are more complex, they cannot be adequately characterized by a viscometer. Complex liquids may be pseudoplastic, visco-elastic or thixotropic, or all of these properties simultaneously. In order to get information about these properties it is necessary to carry out time-consuming measurements on a laboratory rheometer.

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In the RheoStream apparatus a small side stream of liquid is pumped through two measuring cells and the complex rheological properties are calculated from a measurement of pressure differences in the cells.

This allows RheoStream to continually update the operator with information that makes it possible to intervene in the proces, manually or through a closed-loop control.

Control of food - but also other uses

The texture of a product is critical to the consumer experience and therefore the measurement of the complex rheology can help in many types of foods and drinks, such as sauces and dressings, fermented milk products, spreads, or juice concentrates.

To get the maximum benefit from rheological measurements in real time such information should be used directly to adjust the process. This could for example be an adjustment of the formulation or of the set-point of a homogenizer or mixing process, changing the pH, temperature, or process time.

In manufacturing, where the rheology changes during the process, the measurement may be used to monitor the process and to determine whether it is time to harvest a batch or to go to the next step. This is, for example, the case in the manufacture of food stabilizers such as pectin or xanthan gum.

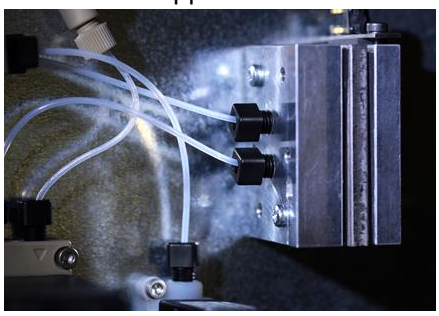
Application of RheoStream in manufacturing of pectin

When CP Kelco is extracting pectin from citrus peel, the variation in raw material quality a daily challenge. "Pectin is a natural food stabilizer which is why the demand is great. The market for citrus peel is limited and varies with the weather conditions and disease problems in, for example, South America. Nevertheless, we must produce products of constant quality that our customers can trust. When the quality of raw materials is variable, it is important for us to monitor the extraction process and know when enough is enough" says Tommy E. Pedersen, Principal Scientist at CP Kelco. The extraction process is complex and there are many possibilities to regulate the process, and this requires that meaningful data are available to steer by. As Tommy E. Pedersen puts it: "We have plenty of X's, but we lack some Y's".

”We have plenty of X’s, but we lack some Y’s”
Tommy E. Pedersen, Principal Scientist, CP Kelco

How RheoStream™ works

The new measurement method is based on a new flow cell technology, which is the central part of the RheoStream apparatus.



A small liquid stream flows through a linear channel, and then through a complex, curved channel (flow cell), and in both channels, a pressure drop is measured. The complex flow cell is designed specifically for the flow characteristic, which is critical for the company, and from these pressure drop measurements the rheological properties can be inferred. It gives customers exactly the values that will be useful to obtain the right flow behavior.
The device channels are cleaned regularly, and the method works best if the fluid does not have larger particles that can clog the flow channels.
The spent liquid is discharged as waste, so there is no problem with food hygiene.

Together with CP Kelco, Fluidan has made preliminary measurements of juice from the extraction of pectin. The measurements show that it is possible to quantify the degree of shear thinning and viscoelasticity of the juice.

The inventor of RheoStream, Fridolin Okkels (right)is testing the flow cell at CP Kelco with Jack Hansen. The flow cell and the measuring system is in the metal box.
(Photo: Michael B. Boesen)

RheoStream - a new technology under development

Fridolin Okkels, Physicist, PhD, for many years conducted research at DTU Nanotech aimed at optimizing the flow of liquids in microsystems - including fuel cells and catalyst particles. The research was based on mathematical models of fluid properties and a method for optimizing channel geometries. The invention of RheoStream was a logical but surprising new angle on the research: Now that you can calculate the pressure conditions that occur in a small complex channel, and this depends directly on the rheological parameters fed as input to the flow model, why not turn this upside down? By measuring the pressures, the rheological properties can be deduced - and furthermore, the channel geometry can be optimized to provide the best correlation between the pressure measured and the rheological parameter that you want to know. Thus the invention behind RheoStream was born.

The technology is patented by the Technical University of Denmark and Fluidan has obtained an exclusive license agreement.

Fluidan aims at developing and marketing a range of industrial measuring instruments based on the RheoStream technology. Work started in 2014 but gained momentum from the beginning of this year as the “Syddansk Teknologisk Innovation” invested in Fluidan. Fluidan now have built several pre-prototypes, which are used to verify the correlation to off-line laboratory measurements and to develop the reliability of the device.

"We are very happy to cooperate with CP Kelco, because it allows us to target the device development towards a use that will make sense for an end user," says Anders L. Østergård.