PROCESSING
INSIGHTS

How to make better soup – with mathematics

HEAT TRANSFER, PREPARED FOOD

Making a good soup is an art, but it is also a science. Tetra Pak has developed new mathematical models and tools for building tubular heat exchangers that will deliver the target temperature for particulate foods such as soups with a precision not previously possible.

A common practice for designers of heat exchangers is to use the same traditional calculation tools for food with particles as for food without. The problem is that the presence of particles changes the flow and heat dynamics significantly in a heat exchanger. New research by Tetra Pak has investigated exactly how particles affect heat transfer.

The research shows that some conventional formulas can result in deviations by as much as 12°C between the calculated outlet temperature and the actual measured temperature of particulate food leaving a heat exchanger. To avoid this, the heat exchanger is typically over-dimensioned.

On the other hand, if the actual temperature is much higher than expected, the particulate food can be partially destroyed with loss of flavour and colour. In terms of investment costs, the heat exchanger may be over-dimensioned for its purpose, and this is a waste of money and space.

The research, which was carried out over more than two years at Tetra Pak's Product Development Centre in Lund, Sweden, involved a group of about ten experts, including an external professor and research associates specializing in heat transfer at the University of Lund. Different kinds of particulate foods were tested, such as mango preparations, soup concentrates, chutneys and carrot slurries.

The findings clearly showed how the heat transfer coefficient varies in the presence of particles. As expected, the particles actually improve mixing in the tubes and therefore increase the overall heat transfer coefficient of the liquid phase.

Eliminate the guesswork

"The heat transfer coefficient expressing how efficiently the heat is transferred from the wall to the liquid has been known, but the heat transfer coefficient between the liquid and the particle has not been known," she adds. "People have been making educated guesses about this, or else we have been forced to do individual trials with every particulate product to work out these calculations. But with the research work we have done recently and presented in the white paper, we now have models for how that heat-transfer coefficient changes, depending on the particle size, particle concentration and the viscosity of the liquid."

Get the inside story here.

Learn more about Tetra Pak's new formula for calculating the heat transfer coefficient and more by subscribing to the Processing Inspiration newsletter.

A tool for optimizing process design

The influence of particles has now been quantified, and Tetra Pak has been able to devise a new heat-transfer coefficient formula for particles, and a new calculation tool for particulate food. The new tool is called PartCalc and has been validated by experimental data. It is now being used to help customers optimize their process design for particulate foods.

Tetra Pak's experiments show that the carrier liquid temperature of a variety of particulate foods leaving a heat exchanger, as calculated by PartCalc, deviates by less than 3°C on average from the actual temperature. This is a considerable improvement on traditional calculations, and gives a good correlation with actual temperatures, thus allowing Tetra Pak to more accurately dimension heat exchanger systems for particulate foods.

The potential benefits to the food processing industry include:

- » Improved food quality with assured food safety
- » Reduced operating and maintenance costs
- » Reduced product losses
- » Reduced environmental footprint

"A key factor in process design is to minimize heating without compromising food safety. This demands knowledge about heat transfer in particulate foods," says Helena Arph, Technology Specialist, Viscous and Particulate Foods at Tetra Pak in Lund, Sweden. She has been closely involved in the research work and presented papers on the findings.

Having trouble watching this video? Watch it here.