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Design of helical heat exchangers affects liquid food processing

What is this research about?

A double-pipe helical heat exchanger is made up of a smaller pipe inside a larger pipe. The pipes are twisted into a double-helical shape (see figure 1). This pipe design is used in the processing of liquid foods. Liquid foods can move through a continuous operation where it undergoes heating and cooling before it is packaged. Food needs to be heated to make sure that it is free from microorganisms that could make people ill. This study looked at how uniform (or consistent) the temperature of liquid was as it moved through the exchanger.

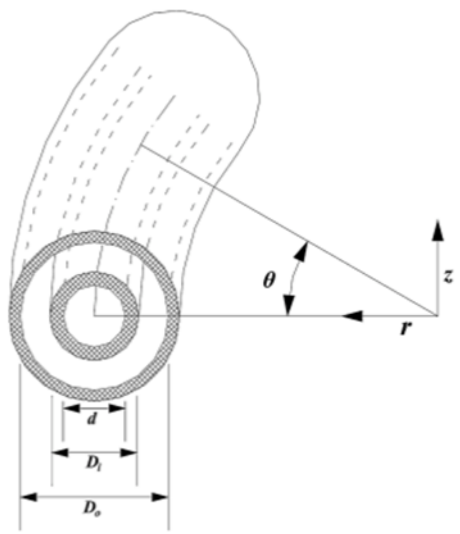

Fig. 1. Schematic of the geometry of heat exchanger and coordinate system.

What you need to know:

The research was conducted to give some insight into the best operating parameters for uniform heat treatment. Maximizing heat consistency is important for sterilization and retaining quality of liquid foods that use continuous processing.

The temperature and time distribution uniformity of the liquid is affected by the flow rate in the inner and outer tube and the size of the tubes.

The researchers model found that in order to adequately heat the fluid in the centre of the pipe for sterilization, the fluid near the walls was being over processed.

How can you use this research?

Food packagers can use this information to expand their knowledge on food heat-exchanger processes and improve the design of helical heat exchangers for the processing of liquid foods.

Public health and food safety organizations can use this information to stay current with the impacts of changing technology on food safety best practices.

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What did the researcher do?

The researcher set-up a model double-pipe helical exchanger. They ran a series of tests using four different mass flow rates for the inner tube and three flow rates for the outer tube. They ran the tests using a smaller and a larger version of each tube. The temperature of the pipes was set to 0° to study the cooling process and 80° to study heating process. The researcher tested parallel flow and counter-current flow. They calculated the residence time (time fluid spend in the pipe), residence time distribution, and heating uniformity.

What did the researchers find?

In the inner tube the researchers found:

- More uniform times and temperature with higher flow rate than lower flow rate
- More consistent times and temperature with smaller tube than larger tube
- Uniformity was lower when the flow rate in the outer tube was larger

In the outer tube the researchers found:

- More uniform time in larger tube than smaller tube
- More uniform times and temperature with higher flow rate than lower flow rate
- Uniformity was lower when the flow rate in the inner tube was increase

Heating uniformity in the inner tube tended to increase with increased flow rates. The researchers found that the cooling process was more uniform than the heating process. In order to adequately heat the fluid in the centre of the pipe for sterilization, the fluid near the walls was being over processed.

About the Researcher:

Dr. Timothy Rennie is a professor at the Kemptville Campus of the University of Guelph. Dr. Rennie can be reached by email at trennie@uoguelph.ca

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Keywords:

Double-pipe, heat exchanger, helical coil, residence time distribution, food processing, numerical analysis, lethality

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