Food processing companies usually require extremely precise control of their cooking oil. For example, it is claimed that the temperature of cooking oil used to cook potato chips cannot vary more than one or two degrees if the desired flavor is to be maintained.

USE OF HELICAL COIL HEATERS TO HEAT COOKING OIL

By Bob Harter and Scott Moore, Heatec, Inc

Here are some important things to consider if you plan to use a helical coil heater to heat cooking oil for food processing.

There are two ways to heat cooking oil with a helical coil heater:

1. Heat food-grade thermal fluid with the heater and circulate it through an external jacket on a vessel or kettle of cooking oil.

2. Instead of using thermal fluid, heat the cooking oil directly by circulating it through the helical coil inside the heater.

Use of thermal fluid has the advantage of very precise temperature control. This is achieved by valves that vary the flow of thermal fluid through the external heating jacket. Thus, temperature control of the thermal fluid does not rely entirely on the firing rate of the burner. Moreover, this system facilitates using a heater sized for a wide range of heat loads. So you should be able to precisely control the heat for numerous kettles one day and only one or two the next day.

The use of food-grade thermal fluid is a safety precaution. It is required even though it is unlikely that the fluid would ever come into contact with the food or its cooking oil. Nevertheless, the thermal fluid is being used to heat the exterior surfaces of the kettle. And there is a remote possibility that something could go awry, allowing some amount of fluid to find its way into the inside of the kettle before being discovered. Thus, use of food-grade thermal fluid should prevent any adverse effect if that ever happens.

Heating the cooking oil directly eliminates the need for a jacketed kettle. And it eliminates the need for thermal fluid. The cooking oil is simply heated and pumped in and out of the kettle itself.

Temperature control of the oil is achieved by modulating the firing rate of the burner. And while burners do not have infinite variations in their firing rate, they can do a great job if properly sized with suitable turn-down ratios.

Another consideration is the type of heater, whether vertical or horizontal, two-pass or three-pass. If the heater is used to heat thermal fluid it can be either vertical or horizontal, depending on the floor space available. Vertical heaters have a smaller foot print, which may be a deciding factor. And if the heater is used to heat the cooking oil directly, it must be a vertical in order to completely drain the cooking oil from it as frequently required.

Two-pass heaters have a single helical coil. Burner gases make two passes to heat the coil. They pass through the open central area of coil and travel back around its outer side before exiting the stack. Three-pass heaters have two helical coils. The gases make three passes around the coils before they exit the stack.

The choice between two-pass and three-pass is largely dependent on available space. Three-pass heaters are somewhat smaller for a given output. But their two coils

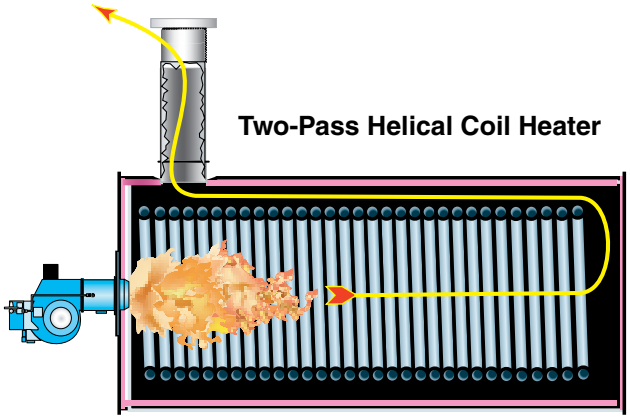
usually have a shorter life-expectancy than the single coil of a two-pass heater of comparable size.

Another consideration is the design of the helical coil heater itself. Some helical coil heaters are better-suited for food processing than others. This has to do mainly with the heater's flux rate. The lower the flux rate the longer the life of its heating coils and the fluid that passes through the coils.

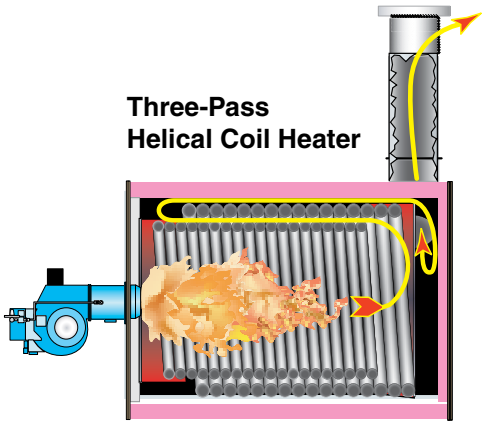
Flux rate is the number of square feet of coil surface area in relation to the Btu/hour output of the heater. The larger the coil surface area for a given output, the lower the flux rate. A larger surface area transmits the same quantity of heat or Btu as a smaller one, but does it at a lower temperature than coils with smaller surface areas. Flux rate is related to film temperature of the fluid flowing through the coil. And film temperature is related to the life of the fluid.

Film temperature is the temperature of the fluid in direct contact with the coil surface as it flows through the coil. As fluid flows through a heated coil, the portion of the stream in direct contact with the bare metal surfaces on the inside of the coil is heated to a higher temperature than the portion in the center of the stream. Consequently, the temperature of these surfaces is of concern. Lower flux rates means lower temperatures of these surfaces. So what is the optimum flux rate?

The optimum flux rate is one that minimizes breakdown of the fluid enabling it to have maximum life. And that depends on the fluid used. Fluids, including cooking oils, are available in a variety of film temperature ratings. So its not possible to cite one flux rate that works best for all applications.



Two-Pass Helical Coil Heater



Three-Pass Helical Coil Heater

However, here is a precaution about flux ratings cited by different heater manufacturers. Do not confuse radiant flux rate with average flux rate. Average flux rate is the average heat absorbed by the total surface area per square foot (both the radiant and convective sections). Radiant flux rate is the average heat absorbed by the surface area exposed to the burner flame per square foot (the radiant section only). The average flux rate will be lower and far more favorable than the radiant flux rate. So when you compare flux rates, make sure you are not comparing apples with oranges.

Incidentally, flux rates of two-pass heaters are virtually always more favorable than those of comparable three-pass heaters. Three pass heaters nearly always have a much smaller surface area subject to the radiant energy. The coil in a two-pass heater is usually larger and longer and has a much greater surface area subject to the radiant energy.

Another consideration is the matter of thermal efficiency. Thermal efficiency is directly related to the amount of fuel used. The higher the thermal efficiency the greater the fuel savings. Food processors should not buy a heater with a thermal efficiency lower than about 85 percent. Some heaters do even better, ranging up to 90 percent. Obtaining the higher efficiencies depends on heater design, the fuel used and whether the heater has a stack heat exchanger that captures exhaust gases that would otherwise be lost. Typically the direct heating of cooking oil is more efficient than using thermal fluid.

Last, but not least, maintenance is a consideration. Two of the hallmarks of helical coil heaters is the ease of maintenance and their long life. They require far less maintenance than systems that employ a boiler and use steam heating. And they don't require the presence of a licensed boiler operator while in operation.

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