

Harnessing the power of Complete Thermal Exchange Technology

By Larry McKee, Energy Specialist

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Record-high energy prices continue their grip, and it appears there's no relief in sight.

From food processing to hotel laundries, every application that utilizes hot water feels the pinch. Natural gas and crude oil prices have more than doubled from a year ago, and fuel oil prices are expected to increase again over the upcoming winter. These conditions have plumbing engineers and maintenance supervisors scrambling for alternatives in hot water generation to conserve energy and contain costs. One technology that's generating widespread interest is Complete Thermal Exchange or CTE.

CTE has only been on the market since 2002, but it has its roots in the science of direct-contact water heating, which has evolved considerably over the past 25 years. CTE technology involves the multiple passing of water with combustion gasses or the heat that's generated from the combustion, enabling the water to fully absorb and transfer the heat directly to the intended application.

How CTE Works

Unlike older direct-contact water heaters or instantaneous gas water heaters, CTE units have a dry combustion chamber. Older direct-contact water heaters incorporate a design that sprays water directly on the flame. These "flame quenching" designs do not allow for complete combustion. They can also form acids that can cause scale buildup and result in higher levels of maintenance.

In a CTE unit, cold water is introduced at the top of the unit through a series of calibrated nozzles. The water travels down through a bed of stainless steel pall rings that allows the water droplets a surface to impinge upon the rings and to spread thinly over them, creating a huge water surface area. A gas-fired burner mounted at the top of the water heater fires downward through a flame tube. Heat from the flame works back up through the pall rings and is immediately transferred to the thin layers of cold water. Water temperatures of 185°F are reached within 15 to 20 seconds after startup, and a pump located at the bottom of the unit immediately transfers the hot water to its application or to a storage tank. Because all of the combustion takes place in this enclosed chamber, the water vapor produced during combustion is condensed, so the latent heat normally lost in a conventional steam boiler system is captured.

"The heat transfer of a CTE unit is direct, so you don't experience the heat loss that you do in a conventional boiler system," said Robert Griffin of Enbridge Gas, a leading energy utility based in Toronto.

Enbridge conducts hundreds of energy audits annually in food processing, laundry, cement and other industrial applications. According to Griffin, many of these operations use traditional boiler systems that typically operate at only 50 percent efficiency. Griffin has helped his clients evaluate CTE technology and has recommended replacing outdated boiler systems with high efficiency CTE units.

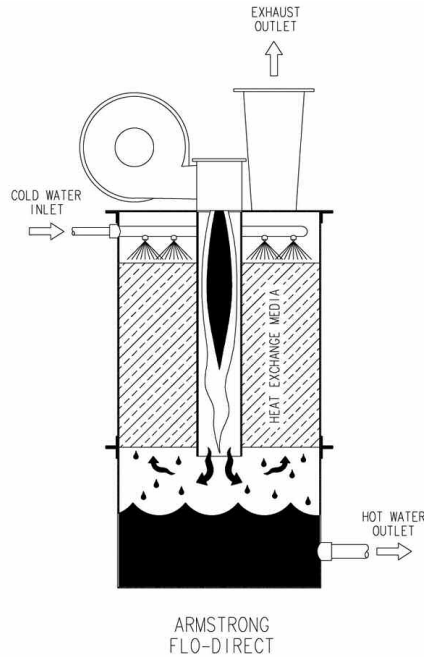
"Fuel efficiencies can approach 100 percent and can save an operation as much as 30% in energy," Griffin said.

Because the combustion takes place in an enclosed environment, CTE units have the added benefits of very low maintenance and no scale buildup. They also produce very low levels of nitrous oxide and carbon dioxide, for a more environmentally friendly effect.

Design Engineering Considerations

Some issues stemming from the older type of direct-contact systems are not found in the newer CTE direct-contact heaters. Most of these issues have to do with design limitations of 15 to 20 years ago and with improper applications, which the new CTE designs have addressed. Many of these heaters have been put into recirculation modes – recirculating hot water back through the heater. direct-contact water heaters heat water at or near atmospheric pressure; if the incoming or return water temperature is in excess of 120°F, the efficiency is reduced dramatically.

Many of these older water heater designs also involve flame quenching – spraying water directly on the flame. According to the Industrial Heating Equipment Association's (IHEA) "Combustion Technology Manual," flame quenching promotes incomplete combustion. When this occurs, alcohols, aldehydes, formic acid, higher order acids, and carbon monoxide, as well as carbon dioxide and water vapor,



Complete Thermal Exchange unit featuring a top mounted gas-fired burner and enclosed flame tube. Illustration courtesy of Armstrong International.

are present. Although these older heaters can claim very high efficiency and are widely used today, they cannot normally maintain their high efficiency throughout all levels of operation and are susceptible to higher levels of maintenance and scale buildup - problems not found in CTE direct-contact water heaters. This incomplete combustion is also the root cause of inconsistent water quality.

According to John Rivers, product specialist with Armstrong International's Hot Water Group, this is very apparent when concrete or Redi-Mix companies are pouring cement.

"The inconsistent water quality gives the final concrete different colors or tints so that when pouring cement from different batches it is difficult to match in color or tint the previous slab, which may have been poured just days or even hours earlier," Rivers said. This inconsistent water quality also comes into play when working in the food and beverage industry.

Continued on page 56

End-Users See the Benefits

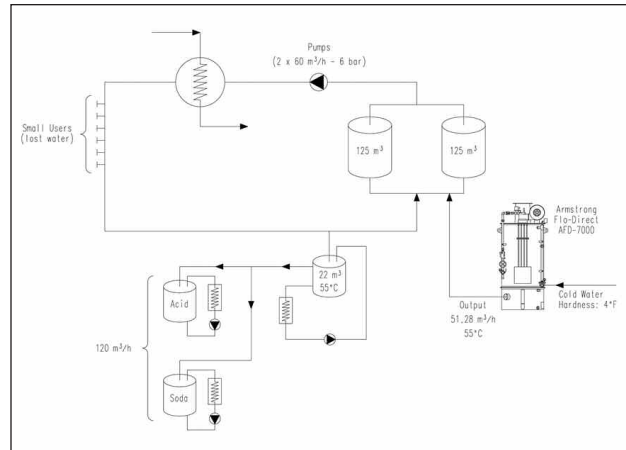
Wayne Farms LLC, the nation's sixth-largest poultry processor, processes 1.5 billion pounds of chicken annually and reported sales of \$1.16 billion in 2004. Considered an industry innovator, Wayne Farms wanted to find better ways to improve the efficiency and production of their plant operations. Ricky Culpepper, maintenance supervisor of the plant in Laurel, Miss., turned his attention to the plant's boiler system.

"Our old boiler was installed back in 1958," Culpepper said. "Not only was it costing us a considerable amount in fuel to operate, but it was no longer able to generate the large, continuous supply of hot water that we needed to process our birds."

The Laurel plant processes roughly 150,000 birds per day and needs to generate 90 gallons of 180°F water per minute. Their conventional steam boiler, which was equipped with a heat exchanger, took a long time to heat the volume of water required and sent a significant amount of waste heat up the exhaust stack. Culpepper estimated that the outdated system was eating up an inordinate amount of fuel, at a cost of up to \$40,000 annually.

It was clear that the current boiler system was inefficient and inadequate in serving the plant's production needs. Culpepper took a closer look at CTE technology.

"We were familiar with direct-contact water heater technology. The early systems were more complex, and you had



Typical recirculation installation using CTE contact heaters. Illustration courtesy of Armstrong International.

to have a good technician to install one," Culpepper said. He was intrigued by the evolution of the technology and by the advent of CTE units, which were much simpler to install and operated with fewer components. Wayne Farms installed a CTE unit in 2003.

"Our old boilers were a real headache to operate and maintain," Culpepper said. Once a year, he said, the plant had to take the system apart for inspection by the state. In addition, chemicals needed to be added on a regular basis in order to reduce scale buildup and water hardness. Culpepper's team also had to drain or "blow down" the water from the unit every day.

CTE offered several advantages over traditional steam boilers, including energy efficiencies that approach 100% and a long service life. According to Culpepper, Wayne Farms's CTE unit has performed for more than 20,000 hours with no major interruption in service.

According to Rivers of Armstrong International, CTE units do not require a boiler license to operate or an annual inspection.

EPAct 2005 Makes Adopting CTE Even More Attractive

The EPAct 2005, established in August 2005, sets forth higher standards for energy-efficient systems and provides significant incentives for companies that make the switch to higher efficiency lighting, HVAC, hot water and building envelope systems.

The act offers a one-time tax deduction for systems placed into service between Jan. 1, 2006, and Dec. 31, 2007. To qualify, a building has to increase its energy efficiency by 25 to 40 percent, compared to the ASHRAE 90 1-2001 standard. For warehouses, the eligibility is based upon increasing energy efficiency by 50%.

According to Rivers, CTE systems can easily achieve the efficiency standards called for, making the investment in the technology a "no-brainer". ■

About the Author

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