

Emerging Technologies In

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New Instruments Reduce Energy, Water Usage in Food Processes

Recent developments in continuous-process cooking provide critical reductions in energy and cost savings.

by Jim McMahon for Lyco Manufacturing, Columbus, Wis.

There are many processes in food manufacturing that can be addressed to reduce operating costs while at the same time improving sustainability. One of the most critically important objectives to achieving this is reducing process energy and water consumption. Implementing energy- and water-efficient practices and technologies should be a senior priority at system levels in food manufacturing plants. With the continual increase in energy and water costs, optimizing energy and water usage in food processing has never been a stronger issue.

Reducing energy and water usage in industrial manufacturing, including food processing, is a key focal point of the U.S. Department of Energy's sustainability initiatives. The Department's Energy Star and Industrial Technologies programs address process functions in manufacturing plants that utilize steam, compressed air, process heat, electric and other systems that could potentially be a source of wasted energy and natural resources. These programs put particular emphasis on new technologies to achieve energy sustainability.

At a glance

- Reducing energy and water usage is critical in food processes.
- Improvements in continuous-process cooking/chilling have made sustainability possible.
- Lyco's Easy-Flow quench system saves energy by reusing overflow water.
- The system maintains 100 percent uniform product cooling.

Embracing these sustainability initiatives is the continuous-process cooking and cooling method for pasta, rice and vegetables. This process has experienced continual improvements to its technology in the past four decades in the reduction of energy consumption, through improved system designs and streamlined automation. Recent technological advances in continuous-process cooking and cooling have yielded significant improvements in reaching critical energy and water efficiency levels.

Continuous-process cooking

Continuous-process cooking and cooling evolved from the batch method, which has been a standard in commercial cooking and cooling systems. But the batch method has its drawbacks. It is somewhat limited in maintaining precise temperature and time parameters of the pasta, rice or vegetable food products in the cooking and cooling process. The batch process is also limited in its agitation capability to keep these products separated during the cook and chill processes.

The first generation of continuous-process cooking/cooling systems used conveyors to move food products through the processes in series. Cookers and coolers are only as good as their ability to precisely control the product's exposure to time and temperature parameters. Conveyor-based systems, however, are prone to variable production rates, which introduces variations in product temperature, resulting in inconsistent product quality.

These conveyor-based systems have been superseded by rotary drum continuous-process cooker/coolers, which use an auger method



The Easy-Flow quench cycle uses unheated ambient temperature tap water to capture much of a product's heat before it enters the primary chill cycle.

to move food products through an enclosed, water-filled drum. Considered the industry standard for continuous-process cook and chill methods, rotary drum cooker/coolers have significantly improved the processing of pasta, rice and vegetables.

These improvements have ensured more uniform processes and allowed cookers and coolers to handle even higher throughputs. Step-blanching, for example, enables incremental temperature increases to be made

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throughout the process. Gentle mechanical agitation can be imparted to the food products as they progress through the cook and chill processes. A system called Hydro-Flow applies a combination of air and water injection, which physically and buoyantly supports heavier loads, more evenly distributing food products in cookers and coolers.

Controls automation integrated into rotary drum continuous-process cooker and cooler systems has largely made these improvements possible. Their programmable logic controllers (PLCs) provide precise automated control of process functions, including recipe management, and enable uniform cooking temperatures and control of water flow, achieving a totally consistent end process. These control systems minimize the time required to perform complex tasks and increase efficiency. They reduce operator error and process cycle times, enable improvement in product quality and consistency and increase production throughput and equipment ROI.

The benefits of these automated process tech-



A pasta run using the Easy-Flow multi-stage quench system can save a significant amount of energy and money.

nologies have also minimized energy and water consumption. Compared to batch systems and conveyor-based cooker/coolers, the latest improvements in rotary drum continuous-process cooker/coolers enables them to process the same volume of pasta, rice or vegetables in less time, using significantly less energy to heat the water required for the processes. Monitoring energy and water usage and managing process systems in these rotary drum cookers and coolers has played an important role supporting sustainability efforts in food processing plants.

Recapturing heat and water

With conventional rotary drum continuous-process cooking, the cooker is filled with ambient temperature (approximately 65 F) water and heated to 200 to 205 F. In the processing of pasta, rice or vegetables, the water needs to be continually heated to compensate for the constant addition of ambient temperature product. This requires energy.

Additionally, in the processing of pasta and rice, because water is absorbed into the products during cooking, ambient temperature makeup water needs to be continually added into the rotary drum. This adds to the heat load requirements of the cooker. And this also requires energy.

During a process run of pasta, rice or starchy vegetables, which may continue for 20 continuous hours, as much as 10 gallons of water can be overflowed per minute to reduce the buildup of starch in the water. This means an equal amount of makeup water needs to be added. The volume of overflow and makeup water varies depending on the size of the

cooker and the type and volume of pasta, rice or vegetables being run. The overflow water is discarded as wastewater—and is taking the 200 to 205 F heat energy out along with it.

For every gallon that comes out of the cooker at 200 to 205 F as overflow, a gallon of makeup tap water at approximately 65 F needs to be added. The cooker, then, has to heat that water back up to 200 to 205 F to continue the cook process. Again, this requires energy.

In essence, not only is the overflow heat energy from the cooker being wasted, new energy now has to be added to reheat the water in the cooker to 200 to 205 F.

The latest technology in continuous-process rotary drum cooking is capturing and reusing the heat from the 200 to 205 F overflow water. The overflow water, instead of being put down the drain, is moved to an adjacent storage tank where it is pumped through a heat exchanger. The heat is transferred from the hot overflow water to a reservoir of ambient temperature makeup water before it is put into the cooker.

With this process, the makeup water can reach 125 F, considerably higher than the approximately 65 F tap-originated makeup water used in all prior continuous-process cooker systems. This significantly reduces the heating load requirements of the cooker. A sizable difference in energy savings can be realized when heating water to 200 F from a starting point of 125 F.

Additionally, the starch-laden overflow water, which had previously been discarded, is then screened to remove the particulates and reused as makeup water to compensate for product absorption, providing significant water savings.

This system was developed by Lyco Manu-

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facturing. The new technology can be integrated into existing rotary drum continuous-process cooking lines. The upgrade can pay for itself, in energy savings alone, within a six-month timeframe.

Energy recuperation

In rotary drum cooking and cooling, the pasta, rice or vegetables come out of the cooker at 200 to 205 F. The product then immediately goes into a chiller where it is cooled in 35 to 40 F water. Initially, the water put into the chiller is tap water with a temperature of about 65 F. To bring the chiller's water temperature down to the 35 to 40 F range needed for cooling, energy must be expended.

As hot food products are released into the chiller, the water has to be continually cooled to take the heat out of the product and bring its temperature down to a safe 40 F range quickly in order to reduce the potential of bacterial growth.

Bacteria predominantly grow in an environment that is between 40 and 140 F. During the cooking process, raw ingredients are brought up past 140 F as quickly as possible to the final cooking temperature, thus minimizing the time that food products can be influenced by bacterial growth. The same is true on the other end of the process line with the cooling of the product—reducing its temperature as quickly as possible to below 40 F is essential.

The energy usage in this cook and cool process has been considerably improved with the addition of a mid-process quench step, adding a small reservoir between the cooker and the cooler.

Instead of moving the product directly from the 200 to 205 F water temperature of the cooker and into the 35 to 40 F chiller water, a mid-process quench cycle with unheated ambient temperature tap water (65 F) can capture much of

the product's heat before it enters the primary chill cycle. Since the quench tap water is not preheated, it requires no energy input.

Quenching reduces the temperature of the pasta, rice or vegetables down to 110 to 120 F, capturing 45 to 50 percent of the cooked product's heat energy in the quench water. The 110 to 120 F water in the quench can then be used in the cooker for makeup water to rehydrate the product, instead of bringing in the usual 65 F tap water to reach the 200 to 205 F temperature cooking range. This sizably reduces the energy draw normally needed to heat the cooker water. The quench then releases the product into the chiller, which now only has to bring the product temperature down 70 to 80 F to reach the targeted 40 F.

The quench system, called Easy-Flow, also developed by Lyco Manufacturing, maintains 100 percent uniform product cooling with less than one percent product damage. Rice, most varieties of pasta and select vegetables can be cooled in the quench to 110 to 120 F before entering the chilled water cooler.

Easy-Flow uses a patented plenum technology to achieve its high-speed cooling without damaging the product. The pasta, rice or vegetables are pulled through the cooling plenum at the bottom of the tank by Venturi effect, which increases the velocity of the fluid without pump impeller contact. The Venturi effect creates a pressure differential that pulls the water and product through at a high speed with the capability of moving 300 gallons of water and product through the plenum per minute.

Reduced consumption

Compared to conventional rotary drum continuous-process cooking, recapturing heat and water from cooker overflow and quench systems can result in considerable savings.

When recapturing heat and

water from cooker overflow, British thermal units (BTUs) can be reduced by 60 percent, kilowatt hours (kWh) can be reduced by 72 percent and water usage can be reduced by 25 percent.

With the quench system in place, for a continuous-process rotary tank cooker, BTUs and kilowatt hours can be reduced by 35 percent compared to an identical rotary tank cooker without the quench system.

For the chiller under the same conditions, with the quench

system in place, BTUs, tons of cooling required per hour and kilowatt hours can be reduced by 41 percent.

These recent technological advances have allowed food processors to significantly reduce their energy and water consumption, while achieving improved equipment and process ROI. ☐

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