eTech
Heat Recovery Systems

Greengineering WhitePaper

The Charge: Achieve Maximum Efficiency *(with a minimal investment)*

The writing is on the wall. Governments at all levels — federal, state and local — are tightening their requirements on energy efficiency and emissions.

Northeastern states have formed a coalition to set minimum allowances for emissions from plants in their jurisdiction.

California has imposed stringent efficiency and emissions requirements that affect not only plants within the state's borders, but also any manufacturer or processor seeking to provide goods or services into the state.

Through several decades of energy initiatives, plant operators have taken measures to reduce costs and comply with regulations. Higher efficiency natural gas-burning boilers have become the norm. And most systems feature either integral or added heat recovery units. But legislatures are demanding more, and many operators are casting about for technologies that will allow them to eke out maximum efficiency from their plants and reap a reasonable return on their energy recovery investment.

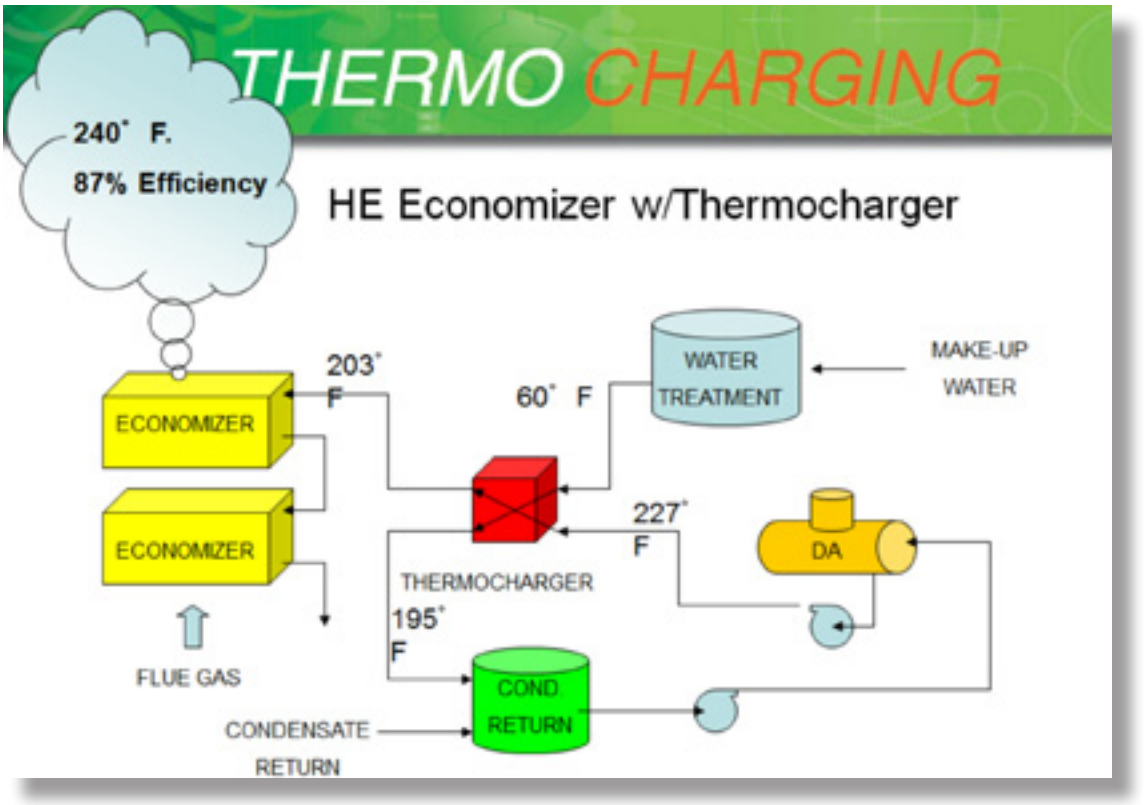
In this white paper, we will consider a new approach to energy recovery that answers several market needs: for heat recovery when square footage is scarce, when available heat sinks are limited, when investment dollars are small and when squeezing out the last few available percentage points of efficiency is imperative.

A newer option for efficiency

Most boiler room operators are well aware of the efficiency gains offered by traditional boiler economizers. Even smaller, high-pressure, firetube boilers typically attain 3–5 percent higher efficiency with the addition of an economizer.

With the addition of a condensing economizer, this figure can be further boosted by 10 percent and in some cases even more. However, this solution requires a considerable heat sink — either in makeup or cold process water — to deliver acceptable results. In most cases, this would be roughly equivalent to 50 percent of the water used.

In cases where such a large amount of cooled water cannot be cost-effectively obtained, it has been generally accepted that an existing system simply can't be made more efficient without hugely expensive upgrades. But while this may have been true in the past, there is now a one-of-a-kind solution that allows the plant operator to achieve an additional 2 percent of efficiency from an existing system using as little as 20 percent makeup water. What is more, this



solution can be added at a relatively low cost with a relatively quick payback rate.

This solution, a proprietary design by E-Tech that is currently awaiting patent approval, is called a ThermoCharger. Systems equipped with ThermoCharger technology use cold makeup water to reduce the temperature of water coming from a deaerator before it enters an economizer, thus increasing the efficiency of that unit.

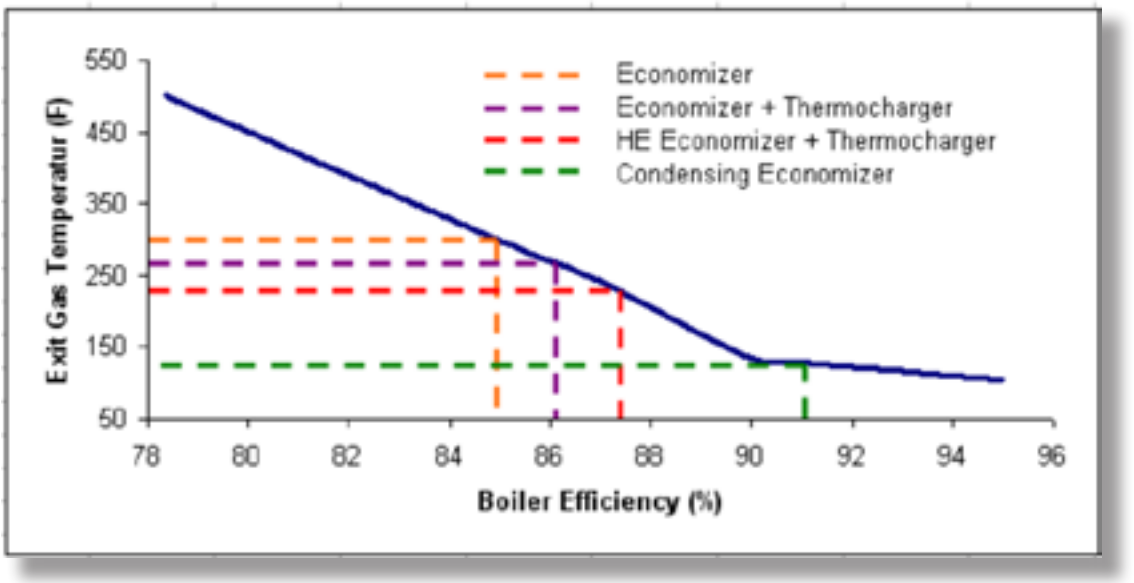
A win-win exchange

The operating principle behind the ThermoCharger is simple: The unit exchanges heat between two water streams then channels each to the part of the system where it will enhance efficiency.

ThermoCharger operation is illustrated in the diagram above. Water sources include make-up water (in this case, presumably sourced from the local water utility) and process water returned from one or more areas of the plant.

In the more straightforward of its two functions, the ThermoCharger uses cold makeup water (about 60° F) to cool deaerated water (typically about 227° F) before sending it to an economizer for further heat recovery. The ThermoCharger lowers the deaerated water temperature by 24° F, thus reducing the demand on the economizer and the amount of heat energy that is lost up the flue due to an overtaxed unit.

In the second half of the ThermoCharger process, the unit sends the makeup water (now at about 195° F) to the process water holding tank. Here it preheats the water, lowering the energy demand during the deaeration process.



Monetary benefits

With a simple energy exchange, the ThermoCharger can deliver a surprising number of economic benefits, some of them pleasantly unexpected.

The first of these, of course, is energy savings. The addition of a ThermoCharger unit can help a plant lower its energy use by up to two percent or more. The following graph indicates efficiencies that can be realized with the addition of a ThermoCharger to an existing gas-fired boiler system.

In some instances a ThermoCharger allows a company to realize energy savings when the physical limitations of their plant preclude other, traditional solutions, for instance, when flue and floor size limitations simply do not allow for the addition of a second or larger economizer.

"A ThermoCharger improves the performance of any economizer system," said Jamie Tighe, general manager and chief engineer for E-Tech Inc., a company that engineers, designs, builds and installs custom industrial waste heat recovery systems. Tighe himself came up with the concept and design of the ThermoCharger. "It can be especially useful when there's a need for enhancement but there isn't the room for a second economizer, or where you don't have the need or capacity for a condensing system. It steps into the void where you want some enhancement but don't have enough cold sink." He added though, that a ThermoCharger can even be used in conjunction with a system that was already using both a secondary economizer and a condensing economizer, further increasing the energy savings from these systems.

One of the greatest attractions of the ThermoCharger is its relatively small price. A unit can cost as little as $5,000 plus installation, which typically mirrors the cost of the unit. However, costs can range up to $90,000 for a unit in a complicated setting, for instance, in a high-pressure system, or where installation presented unusual challenges.

Still, the ThermoCharger represents a very small fraction of the total cost of a boiler and heat recovery

system. Moreover, the unit can pay for itself in as little as a year, after which any savings are "free money." And given an average life expectancy of 10 to 20 years for a ThermoCharger, energy savings could be significant. "If you're talking about a $5 or $10 million annual fuel bill, that can add up to the point where you're talking about some real money," Tighe concluded.

ROI Comparison

80,000 lb/hr boiler w/35% makeup	HE Economizer w/ ThermoCharger (87.5% efficiency)	Economizer Only (85% efficiency)
economizer	$39,400	$32,600
ThermoCharger	$6,200	$0
installation	$110,000	$78,000
installed cost	$155,600	$110,600
annual savings	$305,300	$183,300
return period	six months	six months
five-year savings	$1,370,000	$805,900

Payback can be faster yet for businesses able to take advantage of government grants and rebate programs for energy-saving equipment upgrades. One California program offers a one-time payment of $10 per dekatherm for year-over-year demonstrated savings. At current gas prices, this would represent nearly a 2:1 payback rate.

Adding a ThermoCharger can net significant savings on other equipment in the boiler system, too. By lowering the temperature of flue gases before they get to an economizer, the ThermoCharger reduces the amount of expensive heat exchanging surface that unit needs for efficient operation. "You might save $40k on a condensing economizer because it can be smaller," Tighe said.

Bob Hanson, sales manager for E-Tech, offered a black-and-white example of the savings that might be realized from the installation of a ThermoCharger and high-efficiency economizer as compared to an economizer only:

"Even with the additional costs associated with the ThermoCharger system, the payback period is the same and the annual savings are more than a $100,000 greater," Hanson noted.

Beyond the bottom line

Aside from the direct impact on operating costs at its plant, a ThermoCharger can yield other benefits that may be just as important to a company, if less immediately obvious.

The first of these is the ability to do business with customers who impose stringent energy use restrictions on vendors. "It can put you into a different tier of operating possibilities," Tighe explained. "There are some legislations both local and state that necessitate certain efficiencies in operation. In California, for instance, if you're going to sell ethanol you have to have a certain efficiency or they won't buy from you, whether you're in California or out of state. For one of our customers that made the difference."

A further benefit — one with both financial and brand image implications — is that of reduced CO2 and NOx emissions.

In recent years, much attention has been focused on their effects on both air quality and global warming. And the statistics are astonishing. Every MMBTU (or dekatherm) of natural gas conserved means at least 100 pounds less CO2 in the environment.

"These days good environmental citizenship is important," Hanson remarked. "In addition, there are environmental footprint noises being made at legislative levels now. People don't know what the requirements will be but they're getting ready for it."

For many companies doing business overseas, those requirements are already in place. For some of them, the carbon reduction provided by a condensing economizer is already making a difference, Hanson said. "We do have some customers abroad that are signed on to carbon requirements and they have been able to sell their carbon credits through the EU."

Additionally, the ability to reduce carbon output could enable increased productivity from a plant. "If people are going to be restricted on carbon output, this opens potential capacity for them," Hanson explained. "If they reduce their footprint, they can increase their output."

But above all, the incentive is savings. Said Tighe, "What it boils down to is that we're trying to reduce his fuel bill … the primary objective is to reduce costs. And we're going to use all of the tools in the tool kit to come up with the least expensive solution."

Qualities of a good application

Several design considerations must be weighed in determining whether a ThermoCharger is the right solution for a given installation. System requirements include the following:

- Products of combustion must come from a clean burning fuel such as natural gas, which contains 11–12% moisture by weight.
- The economizer must operate above the flue gas dew point and must not condense (dew point is about 135°F at 12 percent moisture). The ThermoCharger unit features a number of adjustable controls to ensure that incoming flue gas remains above the dew point.
- The boiler system must include a deaerator, and feedwater to the economizer must be properly treated.
- A minimum rate of 20 percent cold makeup water of must be available. If the rate of makeup water is 50 percent or greater, a condensing economizer should be considered instead of a ThermoCharger.
- If space and budget allow, consideration should be given to adding economizer surface area in addition to a ThermoCharger to ensure maximum efficiency. This might involve adding a secondary economizer or replacing an existing economizer with a larger one. If an economizer is not currently present, a large model should be considered for installation.
- Fan capacity must be adequate to compensate for any additional heating surfaces.