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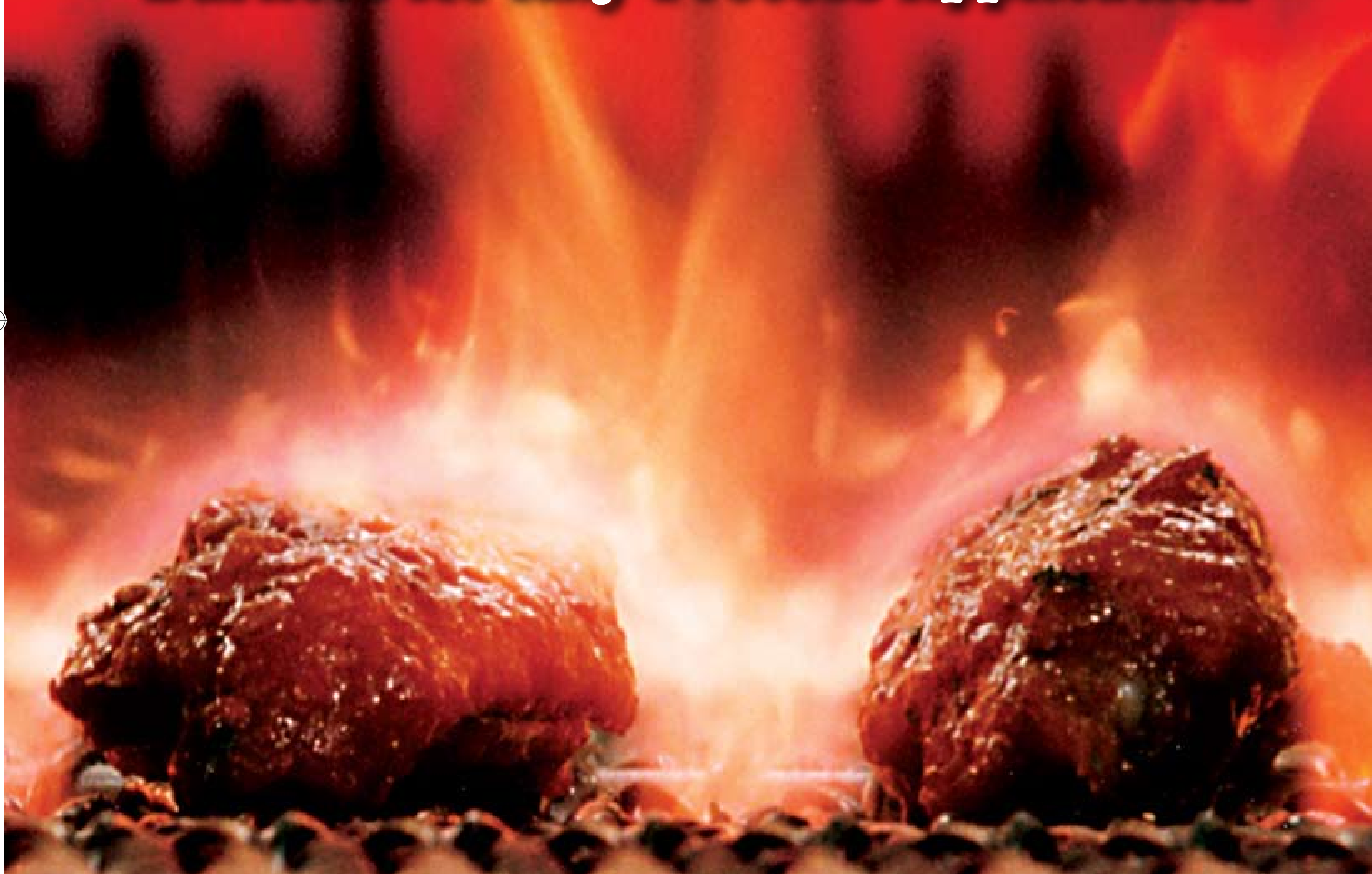

Periodical Class

Waste Not, Want Not →

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Does Waste Heat Recovery Make 'Cents'?

For industries that utilize large quantities of fuel and electricity to produce process heat — and the concomitant large amounts of exhaust heat — waste heat recovery may reduce energy consumption and yield cost savings. Is your process a candidate?

BY ERIC A. KESSLER, CLAYTON INDUSTRIES

Waste heat has been with us since the dawn of the industrial revolution. In countries where energy has always been relatively expensive, there has been an effort to reduce costs and minimize waste. In the United States, the interest in conservation has been driven primarily by periodic spikes in energy costs. Today, there is renewed interest and many opportunities for industrial processors to reduce their energy costs.

Many industries and their processes utilize large quantities of fuel and electricity that ultimately produce heat for a process — and generate large amounts of exhaust heat, much of which is wasted and simply passes out the stacks into the atmosphere or into local rivers and streams. When energy is abundant and cheap, users tend to pay little attention to this waste, but during periods of high energy costs, industrial processors need to focus on these losses and implement strategies to utilize the waste heat and reduce their energy consumption.

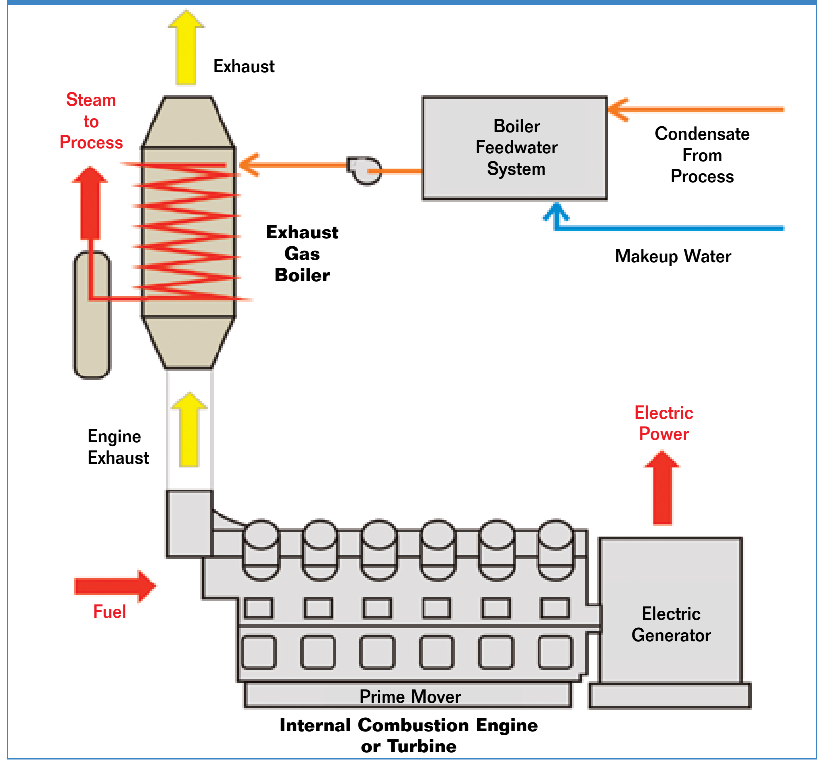
Exhaust gas boilers (the tall, white vertical equipment on the left) are heated by the waste heat stream from the process rather than from their own burner. In this installation, the metal duct in the top center of the photo is the air intake for the natural gas internal combustion engines. The intake duct connects to the blue duct on each engine.

The basic technique of waste heat recovery is to capture the waste heat streams and, utilizing a heat exchanger, transfer that heat to another medium to be put back into the process. The many advantages to the industrial processor are that waste heat recovery can reduce a facility's annual fuel bills, reduce plant emissions and improve productivity. In process heating, using waste heat will displace a portion of the fuel or electricity that would otherwise be purchased. Waste heat recovery is always a good idea when:

- The temperature of the waste heat is hotter than the input requirements of the process.
- The fuel savings achieved are greater than the capital and operational costs of the waste heat recovery equipment.

Temperature Determines Waste Value. The value of the waste heat stream is determined primarily by its temperature. It is widely held that any waste heat stream (air or liquid) of at least 500°F (260°C) is a viable source for recovery. Obviously, the higher the temperature, the higher the quality or value of the waste stream. According to a recent Department of Energy (DOE) report, with stack temperatures of 1,000°F (538°C), the heat carried away is likely to be the single biggest loss in the process. Above 1,800°F (982°C), stack losses will consume at least 50 percent of the total fuel input to the process.

PRIMARY ELEMENTS OF AN EXHAUST GAS HEAT RECOVERY SYSTEM



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In addition to heat, other considerations of the waste heat stream include pressure drop and the chemical make-up of the waste gases. The addition of waste heat recovery devices can produce pressure drops that have a negative impact on the operation of the waste heat source. Also, corrosive components and the dewpoint of the gas stream may necessitate the use of exotic metals, and the presence of materials that could foul the heat exchanger's surfaces may affect its design.

In an industrial environment, there are many possible sources of waste heat. These include ovens, furnaces, incinerators, kilns, dryers and thermal oxidizers used for pollution control. In addition, a growing source of waste heat comes from combined heat and power (CHP) installations as more and more industries choose to produce their own electricity.

The variety of equipment available for waste heat recovery includes recuperators, regenerators and waste heat and exhaust gas boilers/steam generators. The heat recovery process can be gas/gas or gas/liquid. The product of waste heat recovery can be preheated combustion air, hot water and steam. The hot water and steam can be used for plant services or as part of the original process heating. In addition, the steam can be used to run steam turbines for mechanical work or to produce electricity, run absorption chillers and regenerate desiccant dehumidifiers.

WASTE HEAT RECOVERY CHOICES

A recuperator is a gas-to-gas heat exchanger placed on the stack of the oven or exhaust of a prime mover (reciprocating engine) in a CHP installation. Recuperators transfer heat from the outgoing gas to incoming combustion air without allowing streams to mix. There are many designs for recuperators, but all rely on tubes or plates to transfer heat. They are the most widely used waste heat recovery devices.

A regenerator is basically a rechargeable storage device for waste heat. They can work with gas-to-gas, gas-to-liquid or liquid-to-liquid waste heat sources and can be installed on ovens, prime movers, chemical reactors and with steam condensate. A regenerator is an insulated container filled with material capable of absorbing and storing large amounts of thermal energy. During the first part of the cycle, the waste stream flows through the regenerator, heating the storage medium. The second part of the cycle has the un-heated stream flow through the regenerator, absorbing heat from the medium before it enters the process. The cycle then repeats itself. In continuous processes, two regenerators are required. As with recuperators, there are many designs for regenerators such as heat wheels, passive, fin-tube and shell-and-tube.

Waste heat and exhaust gas boilers/steam generators are similar to conventional boilers except they are heated by the waste heat stream from the process or prime mover rather than from their own burner. Waste heat boilers are of most value to process industries that require large amounts of steam in their process. The steam generated from a waste heat stream will not generally replace existing boilers but will supplement the steam that they produce, thereby reducing the energy cost to operate the direct-fired boilers. As the steam from a waste heat stream is available only when the process is running, waste heat boilers are generally designed to operate with existing boilers or with steam generators in a combination system.

OTHER PROSPECTS FOR WASTE HEAT RECOVERY

In addition to industrial processes, waste heat recovery systems can be used in distributed generation locations. Distributed generation (DG) is the practice of locating the power generation facility near or at the end user's location. This new concept is being driven by the high cost of building central power plants and the related transmission costs, plus the desire of many industrial and commercial users for energy independence. The justification for installing a local power plant is driven by the "spark spread," which is the cost of natural gas vs. the cost to purchase electricity.

With the increase in natural gas prices, it has become harder to justify new DG installations. By recovering the waste heat from the prime mover and generating steam and/or hot water, the user is able to reduce the amount of energy that would otherwise be purchased. This DG project then becomes a combined heat and power (CHP) project. Very few DG projects can be justified today without substantial waste heat recovery, and they are most valuable to industries that can use large amounts of steam or hot water in their process. The importance of heat recovery in a CHP project is highlighted by the impact it has on the overall efficiency of the project; for example, for a total efficiency for CHP of 85 percent, electrical production accounts for 35 percent and steam production accounts for 50 percent.

EXAMPLES DEMONSTRATE SUCCESS

Two practical examples can demonstrate the cost savings possible using industrial waste heat recovery. At one Midwest glass manufacturer, a waste heat steam generator was installed on the furnace, converting the 2,500°F (1,371°C) exhaust temperature into high pressure steam for use in process and plant services. Because the waste heat steam generator does not satisfy the plant's entire demand, it supplements a separate direct-fired steam generator. In this instance, the waste heat recovery reduces the amount of fuel that would otherwise be purchased to operate the direct-fired boiler.

In the second example, at a building products manufacturing plant on the East Coast, a newly installed CHP facility provides electricity. In order to justify the CHP project, three exhaust gas steam generators were installed on the three reciprocating engines to generate high pressure steam. This steam provides heat to the plant processes and supplements the direct-fired steam generators during the winter for plant services. For this industrial processor, waste heat recovery reduces the total energy costs while justifying the CHP project and providing energy independence for the plant.

There are many other ways for the industrial processor to save energy costs through the recovery of waste heat. Versatile types of heat exchangers — for example, simple boiler economizers to preheat feedwater or more sophisticated systems recovering heat from thermal oxidizers for high pressure process steam — exist for nearly all applications. In partnership with your heat recovery equipment supplier, savings can be substantial and the payback period short. **PH**

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