Economizers and Emissions

BY LYN CORUM

Increasing efficiency, saving energy, and reducing carbon dioxide

Among the innovative energy technologies developed this decade, condensing economizers offer the opportunity for plant owners and operators not only to reduce fuel usage, but also to reduce greenhouse gas emissions, in particular carbon dioxide (CO₂). Intended to reduce energy consumption—although they can be designed to perform additional functions, like preheating fluid or fuel—economizers can be simply defined as heat exchangers, available for boilers, power plants, and even HVAC systems.
When employed onsite at a power plant, economizers are used as part of the plant’s heat recovery steam generator (HRSG)—water passes through the economizer on its way to the boiler, thereby, preventing flooding of the boiler with water that is too cold. By preheating the boiler feedwater with energy harnessed from exhaust stack gases, economizers help reduce energy demand and save on fuel costs.

In fact, the installation of an economizer can result in a 3–10% increase in fuel efficiency. High natural gas energy prices and cap-and-trade programs (versus carbon taxes) make the economizer an attractive option for any commercial, industrial, or municipal facility that needs to reduce CO2 emissions and become more energy efficient.

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Cogeneration Partners With Economizer
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Graphic Packaging is over 100 years old, according to Andy Johnson, director of marketing and sustainability at the company. It started out as part of the Coors Company, and then spun off on its own. It owns two virgin paper mills in Louisiana and Georgia, and five paper-recycling mills in Ohio, Michigan, and Illinois, as well as the Santa Clara plant.

Graphic Packaging merged with Altivity Packaging in 2008. Johnson says Graphic Packaging is the largest folding carton paperboard packaging company in North America, with net sales in 2007 of $2.4 billion and revenues of $4.4 billion. The 50-year-old Santa Clara paperboard mill produces more than 380 tons of clay-coated paperboard daily using 100% recycled fiber, and the paperboard is used for high-end consumer packaging.
Economizer Reduces Steam Use

The mill’s cogeneration system couples a natural gas–fired LM2500 combustion turbine with a duct-fired HRSG and steam turbine. Dick Johnston, Graphic Packaging mill manager, says, “We have a huge tri-generation plant,” and he also describes it as “very efficient, a real workhorse—it’s the ultimate bang for the buck.”

The mill also sells 18 MW of power to Pacific Gas and Electric Company (PG&E). The power is wheeled through Silicon Valley Power, the local municipal electric utility. Johnston says it has one of the lowest cost standby electric rates in the state. Exhaust gases from the combustion turbine and the duct burners produce high-pressure, high-temperature steam in the HRSG. That steam is directed to and expanded in the combustion turbine and the duct burners to produce additional power. The steam is then used to dry the paper in its dryers. Until August 2008, the steam also heated process water, but no more.

Thanks to help from PG&E and its contractor, Lockheed Martin—which runs the utility’s heavy industry energy efficiency program and recommended the retrofit—the paperboard mill upgraded the HRSG stack, by installing a “condensing economizer.” In the exhaust gas stream. The heat exchanger “tube bundle,” manufactured by ConDex, is stainless steel and the housing and exhaust stack extension is fiberglass, allowing the materials to withstand the corrosive nature of the condensate.

Installation work began in November 2007 and was completed by August 2008. According to plant manager Jeff Mih, a local contractor and in-house mechanical engineer installed the condensing economizer. Johnston says the exhaust stack extension attachment draws the gases off through a 300-horsepower fan and over the economizer. Process water drawn through the economizer is heated and moves on to mix with waste paper to emulsify it. The economizer was sized so that steam is no longer expanded. While there are Btus still to be extracted, it still has to be determined if there is enough to pay for the additional investment, he adds.

Fred Yoo, senior program manager in PG&E’s customer energy efficiency group, says incentives are customized for a customer’s industrial production and based on the amount of fuel saved. In this case, Graphic Packaging was awarded an energy efficiency incentive of more than $1.1 million to offset the $3.6-million project cost.

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The ConDex condensing economizer is a relatively new product, and it created the largest energy savings in the Graphics Packaging audit, says Flanagan. Theoretically, it can be used for any boiler application—any place you want to use exhaust heat, he says. The real benefit to using waste exhaust heat is that it exhausts at 145 degrees. Because the tube bundle is stainless steel, there is no corrosion at this temperature level.

Flanagan points out that the greatest natural gas savings are seen upstream where much less fuel is needed to heat the steam for the turbine rather than during duct firing. Second, there is a significant improvement in thermal efficiency and an overall reduction in greenhouse gases.

Johnston acknowledges that with natural gas now costing six dollars per MMBtu (one thousand thousand British Thermal Units), he could not justify spending the money on the condensing economizer. However, when the go-ahead for the project was given in 2007, gas was costing $13 per MMBtu. But, it’s unlikely gas prices will stay flat.

ConDex Developed Technology

ConDex Energy, the developer and manufacturer of the condensing economizer, is a subsidiary of Combustion & Energy Systems, a Canadian company founded in 1978 with offices in Toronto and Wyoming, IL. According to Cameron Veitch, vice president of marketing and sales for ConDex, the company began designing the condensing economizer in 1998, because it saw a market opening. Few companies were entering the market at that time, because energy prices were low and the cost of equipment was high. Traditional equipment designers stayed away from the dew point of the exhaust gas for fear of condensing the water vapor out and creating an acidic residue that would corrode a standard economizer.

Veitch explains that the condensing economizer has to be effective in transferring heat, but robust enough to operate in a corrosive environment. The materials that accomplish this: stainless steel and fiberglass increase manufacturing costs. He says 19% of the energy created in the combustion process is latent heat, and the only way to retrieve it is to condense the exhaust gases and transfer the energy back out.

Veitch says that to design, install, and test the economizer took about two years. By 2000, the company had completed several heat transfer trials and laboratory analysis to arrive at an advanced metallurgy solution offering excellent heat transfer properties.

Furthermore, it was extremely resistant to the properties of the condensed water and flue gas mixture. A system of controls was also designed that would allow the ConDex system to maximize the amount of energy recovered, while remaining invisible to the boiler or other process equipment generating the heat.

Market acceptance began to catch on in 2004 and 2005, Veitch says. The driver was the growth in concern for energy efficiency on the part of both industry and consumers. By 2005, 40 to 50 companies annually were installing the economizer. Now 50 to 100 units are being sold annually, Veitch reports. Veitch says the condensing economizer installed at Graphic...
Pollutants are captured from the hot exhaust fumes that are passed through a condensing heat exchanger to produce 400-degree hot water. Carbon dioxide is then separated from the other pollutants. When cooled to 87 degrees, it turns into a compressed liquid ready for underground storage.