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Conventional and Condensing Boilers

Industry experts answer commonly asked boiler questions

By **Megan White**

The development and application of steam- and hot-water-boiler technology forever is evolving—and has been for decades. Not only is this technology responsive to the market's expectations, it looks ahead and offers innovative solutions to emerging challenges. The key is a fully informed customer who understands his or her full range of options and responsibilities. This article, in which three boiler-industry veterans respond to seven frequently asked questions, demonstrates the importance of dialogue and asking the right questions for the successful and efficient realization of a customer's goals.

What are the most important considerations when choosing between conventional and condensing boilers?
An essential question to ask when picking a conventional or condensing boiler is, "Is the system designed to take advantage of a boiler capable of operating in a condensing mode?" Terry David Crowley, vice president of Sellers Engineering Company Inc., said.

The condensation of flue products is possible in boiler systems designed to operate with return-water temperatures below 135˚F, he explained. As returnwater temperatures drop below this maximum value, condensing efficiency increases. Boiler systems designed to operate in more conventional loop-temperature ranges (140 to 180˚F) will not operate in a condensing mode or realize efficiency increases. In retrofit applications, a conventional boiler system with a higher loop temperature may require an extensive redesign instead of a boiler replacement.

"The next most important question is: If the system is designed to take advantage of condensing technology, what percent of the loading—seasonal or not—will actually provide for operating temperatures required to realize increased efficiency?" Crowley said.

There are a variety of tactics available to control building climate. These plans can change water-loop temperatures, water-loop flow rates, or both. To get a reasonable estimate of a condensing boiler's value, it is vital to be realistic when evaluating its expected efficiency. Most manufacturers' literature focus on the maximum efficiency possible with condensing technology. Few systems are designed to return water continually at the temperatures required to achieve maximum efficiency.

Further considerations include budget constraints; type of building construction and services provided; load-demand criteria; fuel flexibility; project type, such as new construction or major building rehabilitation; and application type, such as utilization in a district plant or decentralized system, Kevin J. Hoey, president and chief executive officer (CEO) of AESYS Technologies LLC, said.

What are the differences in operation-and-maintenance procedures between condensing and conventional boilers?
The condensate generated in a condensing boiler is acidic. This must be considered when evaluating how to dispose of any condensate generated, Crowley said.

"A provision for the safe discharge of collected condensate is critical," Welch Goggins, president and CEO of Cleaver-Brooks, said.

Conventional boilers do not need a stainless-steel stack, but corrosionresistant stacks must be used with condensing boilers, he explained.

Also, low return-water temperatures and their effects on mechanical joints, service valves, and transmission piping must be considered when utilizing condensing equipment, Hoey said.

What is the most common misunderstanding concerning conventional and condensing boilers?
It is a mistake to assume that a condensing boiler always will condense and provide more dramatic efficiency increases than noncondensing boilers, Crowley said.

"With a 130˚F return-water temperature, only about 15 percent of the water vapor in flue products can be condensed," he said. "With a 60˚F return-water temperature, about 92 percent of the water vapor in flue products can be condensed.

"The degree to which a condensing boiler will return maximum efficiency is related directly to the system design," he continued. "Unless return temperatures are very low (60 to 70˚F), the real difference in efficiency will be smaller. Also,
... an operation's seasonal changes caused by system design will affect real operating efficiency."

Another common misunderstanding is that conventional boilers do not have the ability to provide fuelburning equipment with turndown ratios comparable to those offered by condensing-unit manufacturers, Hoey said. Forced-draft-fuel-burner manufacturers produce equipment with turndown ratios as high as 10to-1. However, care must be taken to minimize condensing conditions in non-condensing equipment.

"The major concern is whether a unit is properly selected and adequately sized to meet minimum-and maximum-load-demand criteria," he explained.

What are some important considerations when integrating control systems with new and existing boilers?
Advanced controls must be compatible with the burner/boiler in which they are installed, Goggins said.

"Many times, advanced controls are added to a boiler, and it results in poor and sometimes unsafe operation," Goggins explained.

"Safety is always the most important consideration," Crowley said. "It is vital that any controlintegration scheme begins with the idea that nothing will be done to compromise or change the safety interlocks on the boiler."

Control compatibility should be the original burner/boiler manufacturer's responsibility, Goggins said. Controls commissioning "should be in harmony with the boiler manufacturer's trained service technician and the building-management-system supplier."

"There is no substitute for a trained operator who physically interacts with the boiler," Crowley said.

It also is critical that equipment be selected to meet minimum and maximum load-demand requirements without permitting excessive equipment cycling, Hoey said. Control strategies must be determined through a complete understanding of systems to ensure available output capacity for a given period of time with an associated load demand.

Would you consider the durability of conventional boilers to parallel environmental sustainability?
Boilers have a long useful life, Goggins said. Many large commercial and industrial boilers operate for 25 years or longer. To have environmental sustainability, the boiler fleet installed in the United States needs to be modernized.

"It is estimated that more than 65 percent of the boilers in the United States are over 25 years old," he explained. "These units are operating with high uncontrolled emissions. To support the environment, this aging fleet of equipment needs to be replaced with low-emission boilers/burners. Equipment manufacturers must be committed to offering regular service and updated retrofits to maintain top operating efficiency and low emissions."

Application requirements will continue to drive decisions regarding what boiler technology is utilized, Hoey added. Non-condensing equipment is a relevant and important component of heating and process systems. With respect to emissions and efficiency, environmental sustainability essentially is "controlled by the fuel burner, controls methodology, proper operation and sustained maintenance of equipment, and ancillary support systems," he said.

As with any equipment, the degree to which operation-and-maintenance (O&M) procedures are utilized will determine the equipment's efficiency, useful life, and economic burden on the end user, he said.

When should a boiler system be replaced, and what should a customer expect when the system is replaced with current boiler technology?
"A boiler should be replaced when it is no longer safe to operate or is grossly inefficient" and cannot be repaired at all or for a reasonable amount of money, Crowley said. "Replacement also can be required to meet stringent emission standards."

A boiler should be replaced or retrofitted when its operating efficiency is more than 5 percent below that of new equipment, Goggins said. Also, a boiler should be replaced if its emissions are more than 10 percent above regional U.S. Environmental Protection Agency standards.

Replacement should occur when a boiler cannot perform its intended service, Hoey said, adding: "As with any piece of equipment, as its useful life is approached, service interruptions caused by shutdown, elevated maintenance costs, and reduced efficiency levels will no longer meet end users' performance expectations and operational requirements."

The associated cost burden will yield to "replacement as a viable alternative to reestablish these expectations and requirements," Hoey continued.

When a new boiler system is installed, "The value to the customer must equal or exceed the cost of the replacement," Crowley said.

A customer should expect a new boiler system to be complete and professionally installed in accordance with the specifications, he said. Professional startup service, thorough personnel training, documentation, and complete O&M instructions also should be expected.

Customers should expect manufacturers to offer boiler systems with the highest efficiencies and lowest emissions, Goggins said.

"Manufacturers should provide service guidelines on how to maintain the equipment at the designed efficiency and emission performance," Goggins said.

At the same time, however, it is the end user's obligation to operate and maintain equipment and ancillary support systems in a manner consistent with the manufacturer's O&M guidelines, as well as local jurisdictional mandates, Hoey said.

What boiler-technology advancements have occurred during the last five years?
"The most important improvements in boiler technology cannot be limited to just the last five years," Crowley said. "These improvements have been ongoing in the industry for some time."

Efficiency improvements have helped offset rising energy costs and reduce carbon-dioxide, carbonmonoxide, nitrogen-oxide (NOx), and other emissions, Crowley explained, adding that improvements to combustion processes also have reduced emissions.

The further development of lowNOx fuel-burning equipment and emissions- and system-control technologies is rapidly enhancing performance capabilities, Hoey said.

Even further, advanced controls offer "computerized combustion control, high operating efficiency, building-information interconnection, and data transfer and trending," Goggins said.

A boiler's integration into other systems can allow a more optimized operation, which can result "in enhanced reliability and efficiency," Crowley said.

The Survey Respondents

The vice president of **Sellers Engineering Company Inc.**, **Terry David Crowley** has been a chairman of various ABMA technical committees, task forces, and conferences during the past 10 years. He is a member of the board of commissioners for the City of Danville, Ky., and the Bluegrass Area Development District Development Advisory Committee.

The president and chief executive officer of **Cleaver-Brooks**, **Welch Goggins** has served the

company in sales, marketing, and management capacities for more than 30 years. He is the chairman of ABMA's board of directors and executive committee. He has first-hand experience and knowledge of industry trends, market challenges, and customer issues.

The president and chief executive officer of **AESYS Technologies LLC**, **Kevin J. Hoey** is chairman of the ABMA commercial-systems group and a member of the ABMA board of directors. He also is a member of ASHRAE and ASME. He has served in both societies as a participating member of various technical and boiler- and pressure-vessel-code committees.