Modular Boilers Bring Multiple Benefits to Today's Mechanical Rooms

Christian Zapata
Product Manager, Hydronic Solutions

AERCO®
A WATTS Brand

Overview

Mechanical rooms have been evolving over the past decade. There is more emphasis than ever on improving operating efficiency to meet green (both economic and environmental) initiatives. There is also a stated goal to maximize real estate by creating as much revenue-generating square footage as possible.

Consulting specifying engineers, facility owners and managers, and other decision makers are looking at every component in a mechanical room through this modern lens. What is coming into focus is that boilers featuring a modular design offer unique benefits in certain heating applications compared to conventional models. Figure 1 provides a comparison of modular and conventional designs in five important categories.

Plant Function

A single plant with a smart controller is the best approach when a combination plant is designed to satisfy a facility's space heating (SH) and direct hot water (DHW) needs. It allows temperature and load requirements to be met without the large oversizing associated with two independent plants and dedicated controls. The key is to leverage the swing boiler concept (shown in Figure 1). Boilers are designated for SH and DHW, respectively, but can be changed to address load demand using swing valves in this design.

Figure 1

	Modular Boiler	Conventional Boiler
Heat Exchanger	Multiple	Single
Quiet Operation	✓	
Built-in Redundancy	✓	
Parts Commonality/ Simplified Inventory	✓	
Operating Costs	$	$ $

Comparison of modular and conventional boilers in five key areas

Most conventional boiler designs have a single heat exchanger and combustion control components. As a result, they are either off or fully operational. Each time the unit shuts down, the heat exchanger cools. Subsequently, it must be fully reheated before heat transfer can begin, a process that contributes to cycling losses.

Modular boilers provide multiple benefits that make them well suited for today's modern facilities. From greater operating efficiencies, fewer installation materials, and less maintenance for a greater return on investment (ROI) to having a smaller footprint that creates more revenue-generating square footage, modular boilers present economic and environmental advantages.

Benefits of Modular Boiler Design

Modular boiler systems operate differently and usually more efficiently than conventional boilers. They are typically smaller units that operate in parallel to provide varying amounts of heat to best match system load.

Each module in a boiler provides a percentage of the total heating capacity. Modular boilers feature a programmed controller that coordinates how many modules are to be fired given the load requirements. This minimizes run time and results in the units operating most efficiently.

Firing boilers and modules independently allows a heating system to efficiently satisfy the building heating load fluctuations in year-round outdoor temperatures. This is beneficial, especially when the heating demand is below the design load – which is 80% of the heating season – as the system will operate at the highest possible efficiencies.

Comparison of Boiler Types

Modular boilers incorporate a design that is distinctly different than conventional units. Multiple modules (figure 2) are contained in a single enclosure, each of which operates independently. Every module has its own heat exchanger, burner, gas valve, blower and controls within the single housing in a modular boiler.

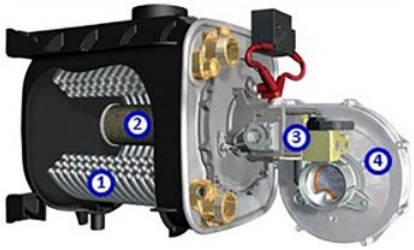


Figure 2

1. Heat Exchanger 2. Burner 3. Gas Valve 4 Blower

A modular boiler design, such as shown here on the right, allows each module to operate independently for performance advantages.

The advantage of independent modules is that if one component fails – for example, a blower – the remaining modules will continue to operate. This provides facility management with peace of mind knowing the remaining modules will continue to deliver uninterrupted heat. In addition, this allows an N+1 design to be accomplished, which is explained in more detail later in this paper.

As we noted, conventional boilers have a single heat exchanger and combustion control elements. When a component fails, the entire boiler will be non-operational. Therefore, the only way for the facility to have backup heat is to have a second boiler, which adds cost and occupies space that can be better utilized.

Modulation Explained

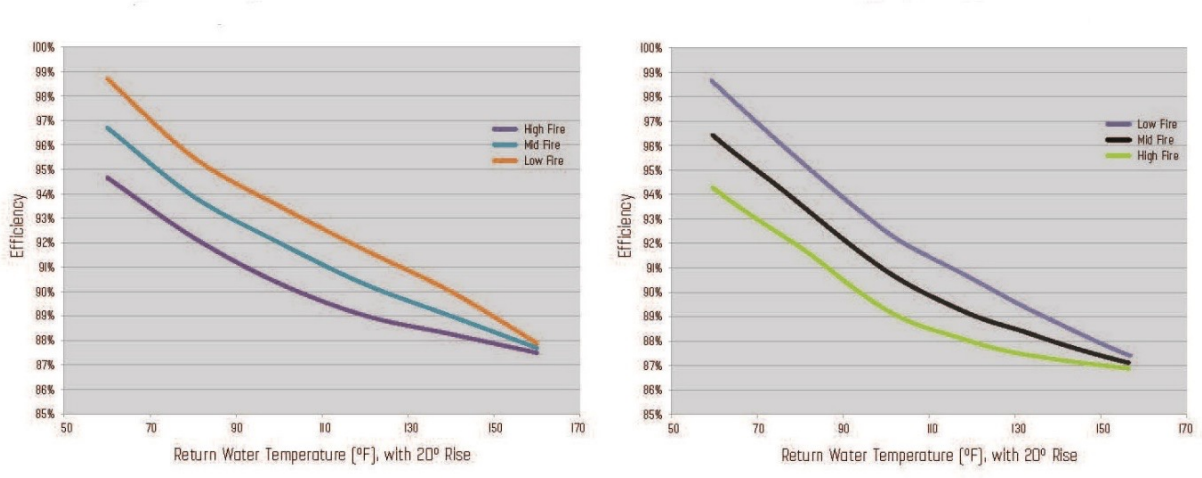
In general, modulation refers to the ability to adjust a boiler's firing rate (input) to meet the heating demand (output) of the system. Modular boilers, such as the one in figure 3, utilize a fully modulating design that precisely matches firing rate to actual building demand. With such a design, a 1100 MBH capacity modulating boiler can operate with as little as 46,000 BTU/hr., or 4.2%, input. By drawing only the necessary fuel to meet actual load changes, each unit will gradually increase its capacity – in precise 1% increments – until it reaches 100%.

Figure 3

The AERCO Modulex EXT is an example of a modular boiler that precisely matches the firing rate to actual building demand.

Less fuel burned is only one benefit of modulating input. Another advantage is that heat transfer is enhanced when the units operate at "part load." Constant operation maintains temperatures within the heat exchanger, yet the reduced input increases the time these combustion gases are in contact with the heat exchanger surface. The result is greater energy transfer and cooler exhaust gases. Such equipment features an inverse efficiency curve (figure 4), whereas the boiler performs optimally at its lowest loads.

Figure 4



Inverse efficiency curves show how modular boilers perform best at lower loads.

Five Advantages of Modular Boilers

Consulting specifying engineers, facility owners, and commercial building decision makers have a few things in common. For one, they are very budget conscious. Secondly, they want to shrink the carbon footprint. Those are two of the many benefits realized with modular boilers due to the following advantages.

Greater Efficiency – As we explained, the modular design improves turndown and allows boilers to operate at a lower firing rate for greater efficiency. Increased turndown also eliminates cycling losses for reduced wear and tear on components.

The result is a more efficient heating system with lower operating costs. In some cases, facilities that retrofitted to modular boilers from conventional units lowered operating expenses by as much as 40% annually.

Consulting engineers and facility managers do have to keep one thing in mind with modular boilers. The entire unit will need to be powered down in the event a defective module must be repaired and/or replaced.

Built-in Redundancy – Each independent module within a single boiler has the ability to maintain operation while other modules are inoperable. This helps ensure commercial facilities, such as healthcare, apartment, and schools, always have the proper heat to keep occupants comfortable in any scenario.

With condensing boilers systems, engineers usually apply an N+1 design for redundancy. N represents the number of boilers needed to meet the design load, and 1 is an additional unit. N+1 is typically accomplished by using a minimum of two boilers (1+1).

Modular boilers revolutionize the traditional N+1 design used with conventional boiler systems, and the associated costs of the extra unit by providing inherent redundancy. As an example, a 500 MBH plant can be served with a single 750 MBH modular boiler that consists of three 250 MBH modules. Two modules provide the load requirements and the third addresses redundancy.

Smaller Footprint – Built-in redundancy has another advantage. Because a modular boiler can replace multiple conventional units, facilities have more income-generating space. So, residential buildings can add another apartment, restaurants can have more tables, and hospitals can provide more beds.

Quiet Operation – With compact units come smaller burners, so modular boilers have quieter operation. A wider variety of applications and installation options are created as a result. Units do not have to be installed in a dedicated mechanical room. Rather, they can be placed in a closet or auxiliary room. The combination of size and quiet operation makes modular boilers ideal for retrofit projects.

Lower Ancillary Costs –The total cost of the boilers – and by extension the entire heating system – proves to be less with the modular option compared to conventional boilers. One modular unit can replace multiple boilers in most N+1 projects. Not only does it eliminate the need to buy a second unit, there is less venting, piping, and electrical.

Maintenance costs can also be lowered. Components are smaller and easier to access, as modular designs have greater service clearance compared to conventional boilers that are typically stacked side-by-side.

Parts inventory is simplified, as well. Sites with multiple buildings, such as colleges and universities and office parks, can utilize a model from the same series and stock only one set of parts to service an entire campus.

Ideal Applications for Modular Boilers

Modular boilers are best suited for light-commercial applications that require 2-3 boilers and 2-3 million BTU load. A case in point is a building that employs two (2) 1 million BTU boilers. With each boiler having 24:1 turndown ratio, this installation creates a system with a total turndown of 48:1. The result is the ability to precisely match the heating load in light-commercial applications.

New projects and retrofits with a limited mechanical room footprint are also ideal for modular boilers. Because of the built-in redundancy, a one-unit modular boiler will suffice in many applications and still provide an N+1 design.

Another determining factor is maintenance of multiple modules/heat exchangers. A balance between redundancy and reducing maintenance must be struck. When multiple modular boilers are used, the number of components to maintain will multiply.

Consider a facility requiring a 4000 MBH load. Installing four 1000 MBH modular boilers containing four modules each means there are 16 sets of components to maintain. In such larger load scenarios, it is worth considering a conventional boiler (one heat exchanger per boiler) and implement the appropriate N+1 design redundancy to better control maintenance costs.

Conclusion

Modular boilers are designed to meet the demands of current and future mechanical rooms. They provide higher efficiency, lower operating costs, and smaller footprints (especially when a single boiler is employed) than traditional conventional units. Consulting engineers, facility owners and managers, and other decision makers can specify modular designs to meet environmental and performance requirements in new installations and retrofit projects.

AERCO's advanced, compact commercial condensing boilers and water heaters provide safe, reliable heat and hot water to a variety of markets including education, hospitality, healthcare, government, office buildings, industrial, multifamily housing and more. Our system-design approach enables us to provide customer-specific solutions that deliver superior building performance at a lower operating cost while ensuring uptime reliability.

70 years ago, AERCO introduced an innovative design for an indirect-fired water heater – and it revolutionized the water heating industry. AERCO continued to innovate introducing the first condensing and fully modulating boiler and water heater to the commercial market. Research and innovation continue to be at the heart of everything we do. Learn more at aerco.com.

AERCO®
A **WATTS** *Brand*

Heating and Hot Water Solutions

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com