Winter 2006

Thermal Notes

A publication of Fluid Handling Inc.

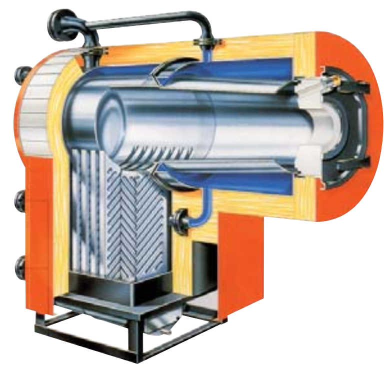
FLUID HANDLING

The Fluid Handling Condensing Boiler Lineup

1981 - 2006
25
years of excellence
FLUID HANDLING, INC.

Fluid Handling Inc. offers condensing boilers for those systems that can utilize low water temperatures to achieve high operating efficiencies. Here is our condensing boiler lineup:

- **Thermal Solutions Model EVC:** This boiler has all the features that people love in their Thermal Solutions non-condensing boilers, including stock controls, reliable no-flame burners and robust combustion air fans. Presently available in a 2,000 MBH size, models from 750 MBH to 1500 MBH are due early in 2006. Efficiency ranges from 86.5% at full load and 160º return water to 97.6 % at one-third load and 86º return water.
- **Viessmann Vertomat:** With NO minimum limits on return water temperature (32º is perfectly fine) and NO minimum flow (1/2 GPM works), these high mass boilers can operate in variable flow systems without boiler secondary pumps. Sizes range from 638 to 3361 MBH and efficiencies range from 85.5% at full load and 160º return water to 98.5% at one third load and 86º return water temperature.



The Viessmann Vertomat condensing boiler has no minimum flow and no minimum return water temperature requirements.

- **Viesmann Vitodens:** This wall-hung boiler is a true commercial-quality boiler with large heat exchanger passageways and ASME compliance. The Vitodens has an efficiency curve similar to the Vertomat. It is presently available in sizes to 230 MBH, which means that most commercial projects require multiple units.
- **Baxi Luna:** This wall-hung boiler is more competitive in price than the Vitodens, but still has many features not found on competing models. Available in sizes up to 242 MBH, efficiencies range to the mid 90's with low return water temperatures.

Whether you need a high efficiency non-condensing boiler, or a condensing boiler, Fluid Handling can help you choose the proper boiler for your system.

IN THIS ISSUE

Dresser-Rand Purchases Tuthill Energy Systems

FLUID HANDLING EXPANDS ITS STEAM TURBINE OFFERING

The Dresser-Rand Company has completed its acquisition of Tuthill Energy Systems. The acquisition marked another step in the

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Condensing Boilers: Low Water Temperatures Result In Best Efficiency

Today's emphasis on energy conservation, fueled by rapidly escalating energy prices, has created increased interest in condensing boilers. In general, condensing boilers provide higher peak efficiencies and cost more than high efficiency non-condensing boilers. It is important to understand that the peak efficiency ratings for condensing boilers occur with very low return water temperatures and low loads. If a building and its associated heating system are not compatible with low return water temperatures, condensing boilers may offer minimal fuel savings to offset their higher cost. Whether or not condensing boilers offer a return on the added investment is primarily a building and system consideration.

Background

For proper understanding of this discussion, one should understand the differences between condensing and non-condensing boilers. For a thorough discussion of this topic, please refer to the Winter 2002 Technical Notes on our website (go to www.fluidh.com, click on the "Newsletter" tab, then click on "Winter 2002").

In that article, we point out that, lacking an industry-wide standard, each boiler manufacturer has great freedom to claim high efficiency ratings. Some even test and rate their "efficiency" at temperatures outside their boilers' permitted operating range! Figure 1 of that article shows that a non-condensing boiler can actually operate more efficiently at certain conditions than a condensing boiler carrying a much higher "efficiency" rating.

Although the industry still lacks a universal rating standard, most system designers and savvy owners have come to realize that boiler efficiency is a complex issue. It is well known that the efficiency of modulating condensing boilers increases as the return water temperature drops and as load decreases. To illustrate that point, the following table compares a Thermal Solutions high-efficiency, non-condensing boiler to a Viessmann Vertomat condensing boiler, at various loads and return water temperatures (RWT's).

Table 1: Comparison of a Non-Condensing to a Condensing Boiler

% Load/RWT	Evolution[1]	Vertomat
100%/160ºF	88%	85.4%
75%/140ºF	88%	89.5%
55%/120ºF	88%	94%
100%/110ºF	88%	87.5%
100%/86ºF	88%	95.2%
30%/86ºF	88%	98.5%

Note that some Vertomat efficiencies are interpolated from published curves for the sake of illustration.

It is apparent that the designer can achieve peak efficiency by using condensing boilers coupled with true low temperature systems – that is, systems that run at low temperatures year round. However, with normal terminal equipment used in the U.S. market, designing true, low-temperature systems presents obstacles.

For example, commercial fin tube radiation delivers only about 25% as much heat with 110ºF

[1] The Evolution achieves a constant efficiency of 88%, just below the condensing range, using sophisticated electronic controls and a combustion fan VFD to increase the excess air at low loads. This keeps the products of combustion at just above the dew point temperature and assures non-condensing operation.

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Why Is My Motor Running Hot?

Many customers question why the motor on their new pump runs "too hot to touch." This article explains why some perfectly operating motors DO run too hot to touch, while others do not.

Most motors used for HVAC applications utilize either NEMA Class B or Class F insulation systems. Insulation systems consist of several components, including:

- Wire coatings to insulate the wires within coils from each other
- Polyester sheets installed in stator slots to provide phase-to-ground insulation
- Insulating varnish into which the stator is dipped to provide moisture protection and improved overall insulating performance

Per NEMA standards, motors utilizing Class B insulation may operate with stator winding temperatures as high as 130ºC (266ºF). Motors with Class F insulation may operate with stator winding temperatures as high as 155ºC (311ºF). These are maximums, and most manufacturers design for slightly lower temperatures to allow for inevitable winding "hot spots." (Hot spots occur because it is impractical to achieve uniform temperatures throughout the windings).

While the motor surface temperature will always be less than the stator temperature, it is normal for fully loaded motors to run with surface temperatures of 175-210ºF. This is literally too hot to touch.

"But," you might say, "I have touched many motors that are nowhere near 210ºF. What's up?"

This Motor Drives a Taco Horizontal Split Case Pump at the Midwest Express Center

Several factors affect the actual surface temperature of a motor. One of the biggest factors is the load demanded by the driven equipment. For a given motor, the quantity of heat generated in the windings is roughly proportional to the square of the load imposed upon the motor. For example, a 15 HP motor drawing 15 BHP will generate about four times as much heat as the same motor used in an application requiring only 7.5 BHP. So the skin temperature will be much higher with a fully loaded motor than with a lightly loaded motor of the same design. Other factors affecting surface temperature include:

- The housing design (is the motor ribbed or flat?)
- The amount of air circulated by the integral cooling fan (premium efficiency motors sometimes use smaller cooling fans to reduce power lost to the fan)
- The enclosure type
- The frequency of start/stop cycles

Therefore, the surface temperature of the motor is not a good indicator of whether the motor is running properly. Current readings from a clamp-style ammeter provide a much better check of whether an electrical problem exists. Abnormal noises indicate mechanical problems.

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water as it does with 180ºF water. Other terminal units, including reheat coils, VAV reheat boxes, and fan coil units suffer similar de-rates.

Therefore terminal equipment may require such gross over-sizing that the use of low temperature water to meet design loads is often prohibitively expensive.[2]

However, another option, nearly universally used today, is to employ hot water reset (lowering the system water temperature) during non-peak load periods. Reset provides low water return temperatures at part load, which increases the efficiency of condensing boilers during periods of low heating demand. Ideally the designer chooses either condensing or non-condensing boilers based on the building's load profile, the ability of the reset strategy satisfy the load profile at reduced water temperatures, the number of hours that reset can be employed, the efficiency curves of the various boilers, fuel cost, the cost differential between boiler types, and the project budget. It many applications, even with reset, the designer chooses non-condensing boilers because the system will not allow sufficient hours at sufficiently low water temperatures to yield a reasonable payback on the investment for condensing boilers.

A Hybrid Boiler System, A Practical Alternative

A hybrid system, using both non-condensing and condensing boilers, offers a practical alternative. The hybrid system takes advantage of the non-condensing boiler's high efficiency at elevated water temperatures and the condensing boiler's even higher efficiency at low water temperatures. **Figure 1** shows a system utilizing one condensing boiler and one non-condensing boiler piped in a series loop fashion. Boiler 1 is the condensing boiler. It operates alone during periods of light demand. An aggressive temperature reset strategy ensures that the system operates at the lowest possible return water temperature (this is subject to the ability of the terminal units to meet low load conditions at low temperatures). Both boilers operate during periods of high demand. Boiler 1 is first in line so it operates using the lowest entering water temperature. Boiler 2, the non-condensing boiler, is second in line and therefore operates at a higher entering water temperature. Depending on the load profile, the designer might choose multiple non-condensing boilers and a single condensing boiler, equal numbers of each, or a single non-condensing boiler and multiple condensing boilers.

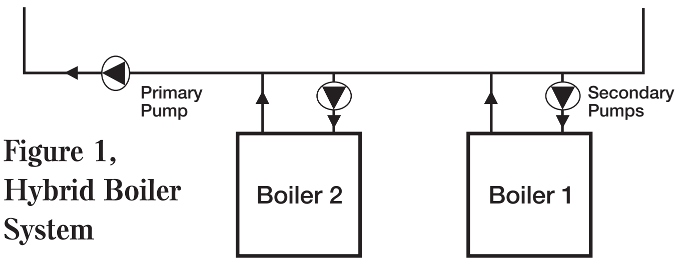

Figure 1, Hybrid Boiler System

Another way to create a hybrid system is to utilize separate boilers for separate hydronic applications. For example, a non-condensing boiler could be utilized for perimeter radiation. A condensing boiler could be used to serve outside air coils, snow melt systems, radiant loads, and any other loads that could operate year-round with low temperature water. Depending on the added cost to provide two hot water piping systems, this type of separation sometimes provides a good way to utilize condensing boilers effectively.

Hybrid Systems for Retrofit Applications

Many building owners have perfectly serviceable non-condensing boilers that are not ready for replacement. An energy-saving option for those owners is to install a "spring-summer-fall" condensing boiler in a "first on" arrangement in

[2] Notable exceptions include radiant heating systems and water source heat pump systems, for which the terminal equipment is designed for low temperature water.

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consolidation of the U.S. steam turbine industry. Prior acquisition activity had brought the Moore, Worthington, Turbodyne, and Terry steam turbine lines under the Dresser umbrella. Acquisitions by Tuthill had consolidated U.S manufacturers Coppus, Carling, and Murray under the Tuthill name. In addition, Tuthill had previously purchased Nadrowski, a German turbine manufacturer. Such manufacturing and marketing moves always result in changes in representation. So we were pleased to receive the news that Fluid Handling would be the new representative for the Dresser-Rand Company's steam turbine lines for the territories of Wisconsin, Minnesota, North and South Dakota, and the Upper Peninsula of Michigan.

With the marriage of the existing TES and D-R product lines, Fluid Handling is now capable of offering proposals for those steam turbine applications requiring:

Murray Turbines Drive Chillers at UWM's Power Plant

- Power Capabilities from 1-94,000 BHP for Mechanical Drives
- Power Capabilities from 5KW-100,000KW for Turbine Generator Sets
- Inlet Steam Pressures up to 2000 PSIG
- Inlet Steam Temperatures up to 1050ºF
- Exhaust Pressures up to 800 PSIG
- Speeds up to 17,000 RPM

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conjunction with an aggressive reset schedule to increase off-peak system efficiency. Systems employing reheat coils are particularly well suited.

Sometimes an oversized heating system provides a good candidate for replacing non condensing boilers with condensing boilers. Fluid Handling was recently involved in replacing a non-condensing boiler with four Vitodens condensing boilers. An engineering consultant, Posko Associates of Waukesha, WI, determined that the original heating system was so oversized that it would be capable of handling the actual building loads with a much lower temperature water than the original design called for. The conversion was made, and on a recent –8ºF day, the system operated perfectly at part load with a supply water temperature of 130ºF and a return of 115ºF. This set of conditions was well within condensing parameters resulting in considerable energy savings.

Conclusion

Condensing boilers demand low temperature return water to achieve high efficiency operation. Some ways of achieving high efficiencies include:

- Utilizing low temperature terminal systems with condensing boilers
- Using hybrid systems with the condensing boiler in "first on" mode
- Replacing non condensing boilers with condensing boilers in retrofit applications having oversized terminal equipment

With a good selection of condensing and non-condensing boilers, Fluid Handling can help you choose the best unit for your applications.

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To ensure proper motor life in HVAC applications:

- The equipment room should be well-ventilated and laid out with motor ambient temperature in mind. Motor manufacturers design to an ambient condition of 40ºC (104ºF). Ambient temperatures in excess of this result in higher stator temperatures, which reduce insulation life. Factors resulting in high ambient temperatures include everything from improper room ventilation to locating motors close to heat-emitting equipment such as large steam traps.
- Avoid selecting motors at their maximum nameplate ratings. Motor load affects stator temperature and stator temperature affects insulation life (it is estimated that a 10ºC rise in stator temperature can cut the motor insulation life in half). So allow a little "room" in the selection. Keep in mind that jobsite voltage imbalances result in increased winding temperatures, as do low voltage and sustained high voltage. With all factors considered, it is good practice to select motors at up to 80% or so of full power rating. Motors with a published service factor may theoretically be selected at a higher percentage of full load. This is common practice with many fractional horsepower pump selections, as many small pump motors do have service factors.

Conclusion

Checking the health of a motor by touch will generally yield little, if any, useful information. Even a properly operating motor may run hot enough to cause injury. Selecting motors a bit below their maximum power ratings and installing them in well-ventilated areas away from heat sources ensures proper motor winding life.

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FLUID HANDLING inc.
12130 W. Carmen Ave • Milwaukee, WI 53225-2135
Phone: 414-358-2646 • Fax: 414-358-8388
email: fluidh@fluidh.com