THERMAL® SOLUTIONS

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The Perils of Firetube Condensing Boilers

Let's give credit to those who were here first. Firetube condensing boilers pushed efficiency from "near" condensing and two-piece copper designs to full condensing units largely made of stainless steel today, with a little detour to cast aluminum along the way. The features and operating characteristics of these 1st vertical models are still the standard that condensing boilers in North America must meet today…but should they be?

The Good, the Bad, and the Solution

Copper was KING 20+ years ago, aggressively taking sales from traditional cast iron products. High efficiency ranged from a low to mid 80% with cast iron to 87-88% range with copper. A small footprint and large BTU's that fit through doorways lead to multiple copper unit installs vs large sectional cast iron boilers. In the transition to copper the need for increased pump flow arose. You gained in efficiency, put smaller boilers in, and no one seemed to care that you needed bigger pumps to achieve this.

History has a way of repeating itself… And as copper took from cast iron, condensing took from copper to become the preferred high-end play in the market. Focusing on efficiency gains, moving from 87-88% to low-mid 90%, and didn't need all at that flow so critical to copper. Here's where lower flows and pressure drops of firetube platforms began to drive change. It makes sense, right? Less pressure drop leads to smaller pump selection. Smaller pumps lead to greater electrical conservations…dare we say the beginnings of the green initiative?

Most copper boilers were also piped primary secondary (just like cast iron boilers), to ensure proper flow through the boilers and adding some protection to lower return temperatures. So what else did firetubes push to overthrow copper, the reigning KING of the time? You guessed it…variable or full flow piping layouts and systems. You could eliminate a pump, you needed less near-boiler piping and field install costs were cheaper. You didn't have to worry about return temperatures, the colder the better. Hence, you have reasons for change vs the main stream establishment, copper boilers. Copper replaced cast iron, and condensing firetubes have replaced copper. What is next?

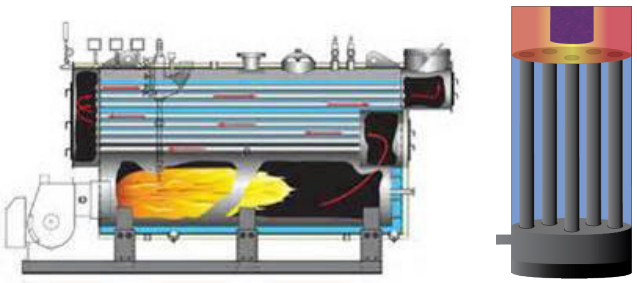

Figure 1. "Original" firetube design (left) vs. "new" firetube design (right).

As the firetube platform gained momentum most manufacturers moved the burner from the front of the firetube designs to the top. In doing so, units could be made smaller to fit through a door and coordinate direction of products of combustion and condensate. These designs are called vertical condensing firetubes and have become the standard for condensing boilers operating traits and characteristics. Looking back, this was a major shift away from what was reliable for so many years. It used the same items (tube sheets, welds, and tubes) but in an entirely different environment. Compare the older designs and the location of the burner vs the 1st tube sheet and tubes to today's vertical

designs. Instead of gradually absorbing heat as flue gas passes through tubes, today's vertical firetube burner sits inches away, BLASTING all that heat directly on the tube sheet, welds, and the tops of the tubes. MOVING THAT BURNER CHANGED EVERYTHING and this "simple change" now fuels movement away from vertical condensing firetubes.

All objects expand and contract as they are heated and cooled. Where does this natural movement "go" in today's vertical design? It "goes" into the material in the form of stress. By design, there is no "room" for this natural occurrence and boy have they turned up the heat on this critical component. Ohh, and it's not made of carbon steel anymore, and the welds are different than the boiler that lasted forever. Notice vertical firetube manufacturers jumping from grade to grade of stainless steel over the years: 316, 316l, 409, 404, each with different qualities trying to combat the environment they had previously placed old reliable in. Are they asking too much of this material in their design?

A welded fortress…made to keep you out?

A traditional cornerstone of non-condensing boilers is serviceability. They can easily be opened up to clean and service them, if a component wears out, you put another one in and get back to heating. It has always been this way, but not a vertical firetube condensing boiler… A typical 2000mbh vertical firetube has over 100 feet of welds. Yes, over 100 feet, with most of it on top, trying to hold the tubes and tube sheet in place so water doesn't come out everywhere. By the way, what happens if your vertical firetube leaks at the tube sheet, welds, or tubes? It goes to the scrap yard and you wait for a whole new heat exchanger, often costing 60% of the original install cost. That's right, labor to tear down, and then reinstall. YOU CAN'T REPAIR any vertical firetube condensing boilers heat exchanger. Whoops…did they forget? Maybe they didn't care. Is this the throw-away mentality inherent from the behemoth water heater manufacturers, dabbling in the boiler market, dominating press and copy? Have they convinced everyone there are no other options and that you, your customer or installing contractor don't have a say in the matter? How do you get in here to clean these things anyway? Yes, gas burns clean, but products of combustion do form and need to be cleaned in order to maintain that specified, high efficiency mark year after year. Most vertical firetubes contain baffles or inserts, many are not removable and those that are better have 8-10 feet of clearance overhead to pull them, or it probably won't get done. How about that burner way up on top? Many metal mesh burners require annual cleanings. How much does that thing weigh? Do you really need a ladder to get up there to disconnect blower and gas? Putting it mildly, these manufacturers didn't think about service. They didn't think maintenance, and they didn't care about what you, as an engineer or building owner, are left with after installation.

Say it ain't "flow"…

The market certainly loves the lower flows associated with vertical firetubes, right? However, with low flow rates come other problems, namely eliminating air and sediment entrapment. Unfortunately for the vertical firetubes, where do those air bubbles collect and form? How about right under the tube sheet with that burner firing inches away? If the heat doesn't transfer evenly through the tube sheet, you get warping, a leak, and a trip to the local junkyard. Recently some manufacturers have tried to mask this issue with a concave shaped tube sheet to help with air bubbles. Is this like the little finger that so many cast iron people told us that collected air bubbles in their products? This may or may not help with air bubbles, but it certainly does not deal with natural expansion and contraction of material exposed to heat and stress put upon the core of vertical firetube designs.

Many of us have been marketed into believing firetubes hold up better in less than ideal water conditions. Most would agree that the harshest water conditions are

caused by the addition of fresh water. By adding new water, you acquire additional impurities which come out into the system and collect at the point of lowest flow and highest heat…PSSST that's in the vertical firetubes vessel. Water heaters are exposed to addition of fresh water all the time, yet the biggest manufacturers that own the entire market do not offer a firetube water heater? Hmm, interesting.

Me too, me too, me too…

If you haven't noticed, all the vertical firetubes look the same and have the same basic characteristics. There is a burner sitting on top, firing inches away from tube sheet, which is held together by welds that, by design, are not allowed to move. There are variations in material to cope with environment: numbers of tubes, shapes of tube sheets and baffles…but really, these are band-aids masking a flaw in the design. Vertical firetube condensing boilers are all the same; copies of each other mimicking 1st designs. Where's the innovation? It's been 20+ years…

When you really look at it, every vertical firetube is chasing the same thing - the one trait that continues to define our condensing market. The "desire" for this one trait has given us unserviceable and unrepairable condensing boilers with huge questions surrounding longevity. It was the key in taking down King copper… lower flow rates with pumping/piping "advantages". When you strip this away, what are we really left with? A design that was flawed from the very beginning and repeated in every "me too" vertical firetube condensing product that hit the market afterward.

Figure 2: Arctic by Thermal Solutions.

The Solution

A condensing boiler designed to move naturally with exposure to heat, not trying to hold it back. A condensing boiler built around service after the sale with unprecedented access to burner and heat exchanger.

A condensing boiler that is field repairable…just like all the non-condensing boilers are…and with the same waterside traits you want from those original condensing designs. Mr. Engineer, if you're having issues with your condensing boilers' heat exchanger or reliability in answering the call for heat, you don't need another vertical firetube! You need an Arctic from Thermal Solutions, a Burnham Holdings Company.

Burner location tells it all

This is not another "me too". It looks different, because it is different. We hear what the marketplace is saying about waterside requirements, longevity, and service. The Arctic delivers on all three. From 1000-6000 mbh, natural, LP and dual fuel with a unique feature set based on common sense, not following the common crowd. The burner is up front, right where you can see it, hear it, look at it and service it. Removable panels around the boiler provide access to the burner chamber and entire heat exchanger. You don't need to disconnect any blowers or gas piping. Burner set-up and maintenance is simple, as it ought to be.

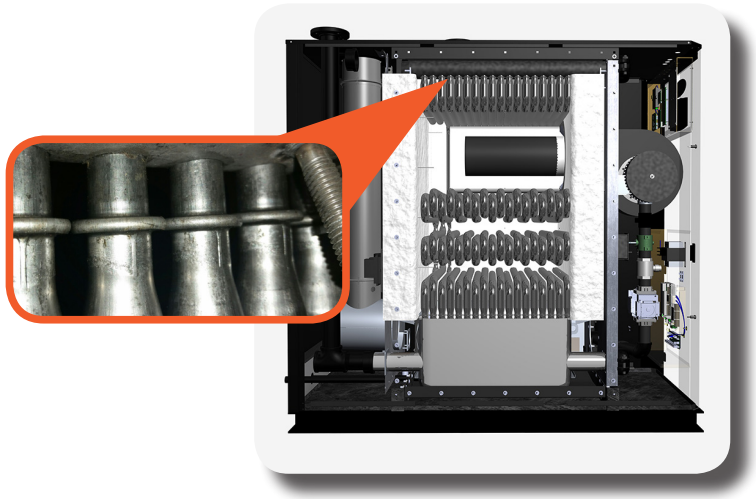

Figure 3: Arctic's weld-free tube design allows simple tube change-outs in the field along with complete access to the heat exchanger.

Free to move

Arctic tubes naturally flex & move as they are exposed to heating cycles. Instead of trying to contain Mother Nature with a weld and prevent this natural movement, we welcome it, relieving the stress that vertical firetubes are continually under.

Lifetime seal vs a 10 year weld

This really says it all about longevity, doesn't it? A weld-free seal from tube to upper header works and has worked for over a century, based on sister company Bryan Boilers flexible tube design. It's your choice, move with the expansion and contraction from heating cycles, or try to hold it, harness it, prevent it at all costs…and hope that weld and material hold up to the ruthless stress brought on by the very nature of the vertical firetube design

Made to service

We touched on the burner, but how about cleanings and reparability, like boilers of yesterday? Talk about unique, removable panels providing complete access to entire heat exchanger. Products of combustion can be easily removed with a nylon brush, ensuring that 95% rating is attainable year after year. Everything you see is a component and can be replaced, making the Arctic the only field serviceable condensing boiler in the industry. Yes, you can change the tubes in the field! No waiting on the factory. With a properly valved-off unit, you can be up and running in hours instead of weeks with a vertical firetube heat exchanger. It's never good to have a problem, but it's comforting to know that it's not complicated to get up and working again, and at a fraction of what the other guys make you go through.

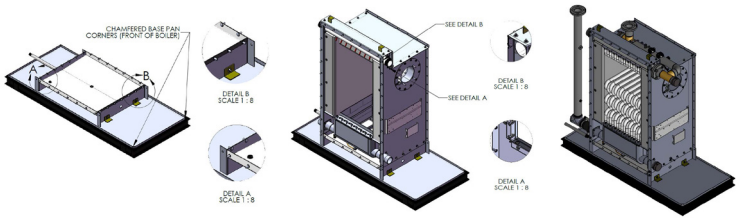

Figure 4: Arctic knockdown construction allows high efficiency commercial condensing to go where no other boiler can.

Knockdown & reverse construction

Because the Arctic uses no welds in securing tube to header, Thermal Solutions has the only knock-down condensing boiler. It can come in pieces, similar to old cast iron sections, or partially assembled based on space requirements. Weight constraints on elevators? No problem. Take it up in pieces. Need to fit 6000btus through a door? No problem. You can now put condensing boilers where no others can go. Need to maximize boiler room space? We offer reverse construction models to utilize clearance space in between units or place side by side and service from outside.

Tru-O2 High Turndown changes everything you think you know about turndown…

Tru O2 High Turndown

Up to 20:1 on 3500-6000 mbh, Tru-O2 deserves its own article based on the public's prior knowledge of high turndown. No more wasteful and performance robbing amounts of excess air at low fire. No more multiple burner systems. No more trim systems reliant on automotive sensors. Tru-O2 maintains a constant O2 setting across the entire firing range and maintains a consistent dew point maximizing condensing efficiency. Other models dilute efficiency by increasing excess air at low fire. One of the biggest culprits has more than 50% excess air, lowering dew point temperature by 15 or more degrees. These systems must return 115 degree or lower water temperature in order to condense instead of the sweet spot maintained by Tru-O2 at 130°F.

Did someone say O2 trim? The other guys need to do this so their boiler will lite? Choosing a system with high excess air and light-off tied to the lowest input rating, is a recipe for disaster. You will hear about ambient air and how change in temperature is an issue. Odd, we don't hear about ambient air conditions on 5:1 turndown systems. And you won't hear about it with Tru-O2. Thermal Solutions' system, a Siemens system, has the same O2 setting across the entire firing range. Meaning, it's set up just like a 5:1 system with the same O2 settings at low and high fire. Why would you complicate things with a sensor they can get to last? The answer is: because they have to. A poor choice of systems…makes

them have to reset combustion in order to lite off. Notice the sensors do not operate 24/7, 1st versions did, but the sensors don't hold up. In fact there aren't even on 7 hours. It's another band-aid, not a feature. Tru-O2 features an independent ignition position not tied to the lowest input setting, reliability answered.

Look what the me-too's have given us, or marketed us into accepting what high efficiency condensing boilers are:

- Unserviceable: can't clean them, can't service them, no thought of maintenance at all
- Throw-aways: you can't repair them…you know where they end up
- STRESSFUL design: what have they done to old reliable?
  - Put him in a tight box under extreme heat and told him not to move
  - Change materials change number of tubes….band-aides
- High Turndown: it's a joke what they are marketing to us

Is this the picture we want of high efficiency boilers? is this what we want from our premium products? We get it on waterside; yes, great traits, but man, what about everything else? Copper was king once and then replaced by vertical firetubes for efficiency, pumping & piping. Vertical firetubes are now being replaced for lack of service, longevity and reliability. The Arctic will give you the flows you want in a better design.

To find out more about the end of vertical firetube condensing boilers and the complete lineup of condensing and non-condensing products from Thermal solutions, visit www.ThermalSolutions.com.