Venting & Draining Condensing Gas Furnaces

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"Make daily deposits to your box of knowledge, soon it will have many reference cards."--Randal S. Ripley

With the advent of fall, I have started to receive many calls on our technical support line of problems with 90+ high efficiency gas furnaces (condensing furnaces) that ultimately end up being a venting or draining of the condensate issue.

Many condensing gas furnaces have an aluminized steel primary and stainless steel secondary heat exchanger. The secondary heat exchanger is made of stainless steel to resist corrosion by the slightly acidic condensate produced by the combustion process.

These products are not normally harmful; but when combustion is incomplete (not enough air provided to complete combustion) the products can be harmful to both life and property. This is why we must vent these furnaces.

Venting is the process of conveying the products of combustion produced by the furnace to the outside of the building through a vent pipe or chimney, depending on the system.

A high efficiency condensing gas furnaces is a category four vented appliance. Because they operate with a vent motor that pushes the gas through the pipe creating a positive vent static pressure, the pipe must be airtight so the products of combustion will not leak out of the vent.

The manufacturer's installation instructions will specifically identify the material to be used in venting the appliance and the name plate must have the category of vent and a sticker stating "This appliance requires a special venting system. Refer to the installation instructions for parts list and method of installation."

The primary heat exchanger removes sensible heat only; that is why there is no need for draining 80+ furnaces that only have a primary heat exchanger. Metal vent pipe is necessary such as B-vent or metal liners in chimney venting applications and the vent connectors (lateral runs from the chimney to the vent) can be 26 gauge, single wall smoke pipe (24 gauge if larger than 5'') in most applications. When in doubt, whip it out; the NFPA 54 or your states code book that is.

90+ furnaces obtain such high efficiency ratings because they have both a primary and secondary heat exchanger that removes both sensible & latent heat from the flue gases causing excessive condensate production in the vent. These systems have such a low flue gas temperature, schedule 40 PVC or foam core PVC can be used.

These furnaces can **never** be vented to a chimney or chimney liner where the condensate can freeze and expand damaging the chimney or the acid in the water can break down the mortar. You can use an abandoned chimney to run your vent pipe in if it is going the entire length of the chimney and the chimney is capped.

The flue gases travel through the larger primary heat exchanger tubes transferring some of the heat to exchanger and then to the air being blown over it. The flue gases are then passed on to the much smaller but more of them secondary heat exchanger tubes. These tubes are directly over the exit to the blower motor, that just so happens to be the coolest spot in the system. The gases are now separated into smaller quantities causing the water vapor to cool to the point of condensing to water and giving up its latent heat to the exchanger and ultimately the conditioned space.

Rear view of a 90+ furnace heat exchanger. Photo courtesy of Goodman MFG.

This change of state of the water vapor not only occurs in the secondary heat exchanger but continues to take place in the vent pipe all the way until it finally exits the pipe because it is continuing to give up latent heat.

Even though the air going over the primary heat exchanger has increased in temperature since passing through the secondary heat exchanger, there is still plenty of heat transfer because the temperature of the primary exchanger is a lot hotter than the air coming from the secondary exchanger area. Remember, the greater the temperature differential, the greater the heat transfer.

Venting and ventilation (the process of supplying fresh air) must always be considered together. If venting with a one-pipe system (combustion air taken from the room the appliance is in) then combustion air rules from NFPA 54 (New Hampshire), The International Mechanical code or your states code need to be adhered to. See the March 07 Tech to Tech column on Combustion Air or NFPA 54.

If you use the direct vent method there is no further consideration of combustion air necessary. The direct venting (two-pipe) configuration is designed and constructed to provide a complete separation of the combustion system from the atmosphere of the room in which it is installed. All air for combustion is obtained from the outside atmosphere and brought in with one pipe and all flue gases are discharged to the outside atmosphere with the other.

Direct venting has many benefits such as the pipes can terminate in two separate locations or a single termination point called, a concentric vent; but the biggest benefit to this method of venting is that the termination of the vent only has to be 12” from any opening through which flue gases may enter a building (door, window or gravity air inlet).

The one-pipe method vent cannot terminate less than 4 feet below, horizontally from or 1’ above any door, window or gravity air inlet into a building. See your instruction manual for all the details on venting & draining the condensing furnace.

You can’t talk about venting a condensing gas furnace without also discussing draining. The two subjects are tied together because venting creates the need for draining and improper draining can create many problems with the operation of the system.

Because water vapor is condensing down in the vent pipe, the vent pipe must be pitched back 1/4” per linear foot of horizontal run allowing the condensate to drain back to the trap and ultimately the condensate pump. This also keeps large ice build ups from forming on the discharge pipe exit. The vent must be a minimum of 5’ with one elbow, have no dips in the piping that can fill with water and cause pressure switch issues, and must be securely hung with support every (5’) of horizontal run.

Most condensing furnaces need to have two drain connections. One that will carry the water from the vent pipe to the trap, this could be attached to a drain port in the vent elbow inside the unit or the bottom of the draft inducer; while the other would carry the water from the secondary heat exchanger to the trap. This can vary greatly from unit to unit depending on unit and Venter motor positioning. **Consult Mfg. Installation & Operating instruction manual for just about anything you need to know about getting the equipment running at its rated efficiency.**

The installation instructions will give you crystal clear instruction on where you must make your drain connections and these cannot be altered or re-engineered. Re-engineering of drains is found to be the problem of many calls for these furnaces

Most inspectors follow verbatim, NFPA 54 Table 10.4.1 which states, “Category II, III, and IV gas utilization equipment shall be vented using materials furnished or specified by the gas utilization

equipment manufacturer. The venting system shall be installed in accordance with the gas utilization equipment manufacturer's installation instructions."

I remember not so long ago inspectors were denying the use of foam core PVC because it was not listed in the manufacturer's manual. We had to provide documentation from the manufacturer before the inspector would sign off.

Troubleshooting two pipe systems is fairly straight forward. If you remove the cover to the burner compartment or the combustion air pipe and your combustion issues go away, then checking your combustion air intake pipe for blockages such as bird's, bee's or rodent nest would be your most logical next step. The same would apply if you removed the vent pipe for either a single or double piped system.

Keep in mind that the blockage doesn't have to be visible so be prepared to cut open the pipe in several places or run a snake through it if necessary.

Recirculation is another issue that can create combustion problems in two pipe systems that are not tied to a concentric vent kit. Recirculation occurs when the two pipes termination points are closer than the recommended 12 inches apart. The vent gases that are now lacking oxygen are drawn back into the combustion air intake causing combustion issues.

I can only speak for the three brands of furnaces my employer sells but none of them have a flash code that tells you the unit has been improperly drained. This can lead to chasing a ghost for those who have not experienced it and a lesson they won't soon forget once they have.

Improper draining can cause pressure switch failures by plugging the hole(s) that provide the vacuum the switches need to close them. Even a momentary blockage will cause the unit to shut down.

In the case of a partially plugged drain, the unit would shut down and possibly lockout initially but once the water had drained low enough on units that will retry after one hour or other time depending on the manufacturer, would start again and run until the water build up tripped it again.

Signs of improper or partially plugged drains are gurgling or splashing noises in the vent motor or lots of water running out when drain tubes are removed from the secondary heat exchanger drain port.

Another problem to look out for is sagging in the vent pipe on longer runs or pressure switch hoses. Water will accumulate in these areas and work basically like a trap, causing a restriction of the pipe or tubing, resulting in pressure switch failures.

Many a technician has mistaken a venting or draining problem as just a bad pressure switch. Before condemning the pressure switch, check the required vacuum the switch needs to close on the pressure switch information sticker, then pull the pressure switch tubing from the power-Venter and put your manometer tube in its place. If the vacuum is less than the required amount to pull the switch in, it is not the pressure switch.

Keep up to date on the code in your area. In New Hampshire NFPA 54 is the accepted gas code. For all the details on NH gas licensing (this is good for Mass folks also).
http://www.nh.gov/safety/divisions/firesafety/building/mechanical/gasfitters/index.html

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