Buying a Home – Natural Gas Furnaces

This article is part of a series of articles intended to help the reader better understand the construction and maintenance of a typical home in the Northeast Ohio area. It is written with current home owners and potential home buyers in mind.

This particular article discusses the heating system in use at many of the homes in the Northeast Ohio area, forced air natural gas furnaces. Natural gas furnaces can vary in efficiency, repair costs, and installation method. Three main furnace types are discussed here.

Standing Pilot - Conventional Furnace

The standing pilot type natural gas furnace is the least efficient of the three furnaces that are discussed here. These were most commonly manufactured prior to 1992. However, a few models were produced until the mid 1990's. Standing pilot furnaces have the lowest **A**nnual **F**uel **U**tilization **E**fficiency or **AFUE** rating.

Standing pilot furnaces commonly have efficiencies in the 65% range. That is, 35% of the energy consumed is not captured (65% + 35% = 100%). In some standing pilot furnaces the efficiency has been increased, as some manufacturers used larger heat exchangers to capture more heat prior to venting the combustion gases. The heating capacity of a furnace can be found on the nameplate. This is generally located just inside the burner area.

Standing pilot furnaces burn natural gas continuously. In general, the larger the pilot flame size, the greater the amount of natural gas burned by the pilot.

Some of these pilot flames are used to generate electricity in a thermal battery. This electricity is used to operate the thermostat, natural gas valve and safety controls for the furnace. This type of pilot is called a self generating pilot. It uses different types of metals sandwiched together to generate direct current. It is similar to a flashlight battery, but it generates power using heat. The advantage of this type of furnace is that it can function during a power outage, albeit with reduced capacity as the supply air blower will not operate. The supply air blower is the fan that blows the heated air through the ducts and through the floor or wall vents into the living area.

Furnaces that provide heat without a supply air blower are called gravity furnaces. That is, the heated air circulates because the warm air rises into the living quarters and the cooler air sinks and is drawn into the furnace. A gravity furnace looks a lot like a large octopus with numerous round ducts radiating out from its circular frame. This type of furnace lacks modern safety controls and is 40% to 50% efficient. It provides very warm air through the supply air registers. A single story home heated with this type of furnace can be very comfortable, until the gas bill arrives!

In general, a conventional furnace is the least expensive to repair. It does not use a printed circuit board and the components which commonly fail are relatively inexpensive. The relatively simple design of this furnace's heat exchanger makes it easier to inspect for cracks. A cracked heat exchanger will not only worsen with time, but may allow the exhaust gases of combustion, including carbon monoxide (CO), to be distributed through the home. A crack in a heat exchanger is sufficient reason to replace a conventional furnace.

If a home has a standing pilot furnace it will need to be upgraded to achieve modern efficiency levels. The next step up in furnaces is a mid-efficiency induced draft fan furnace.

Mid-Efficiency Induced Draft Fan Furnace

Induced draft furnaces eliminate the natural gas burned by the pilot light. They use electronic ignition, generally in the form of hot surface ignition to create a temperature hot enough to ignite natural gas. They generally operate in the 80% to 84% efficiency range. This type of furnace differs from the conventional natural gas discussed above in that it uses a small fan to draw combustion air into the furnace.

This type of furnace is the most common type installed in a new home or as a replacement. Mid-efficiency furnaces use a metal flue pipe to vent the exhaust gases into a masonry chimney or a metal chimney vent. If the joints of the metal flue pipe exhibits white deposits and corrosion, then there has been condensation of the exhaust gases in the pipe: the furnace is operating improperly and needs to be re-adjusted. If the metal flue pipe connects to a masonry chimney, the masonry chimney should be retrofitted with a metal chimney liner to protect the masonry. These liners are made of either aluminum or stainless steel. Stainless steel is the preferred material as it lasts longer.

A metal liner was not required with the conventional furnace so why is it required for the mid-efficiency furnace?

Since conventional furnaces are not very efficient, they generate very hot exhaust gases. The very hot exhaust gases heat the masonry chimney. Since mid-efficiency furnaces are more efficient, the exhaust gases are not as hot. Thus, the masonry chimney is not heated as much by a mid-efficiency furnace. The moisture in the exhaust gases is more likely to condense on the brick of the cooler masonry chimney. The condensation wets the brick and mortar joints and soaks into them. During a time of prolonged heating the moisture passes through the chimney walls and appears as sweating, usually on all four faces of the chimney. When the sweating is not actively occurring this phenomena is evidenced by a white powdery substance, called efflorescence, on the face of the chimney. The moisture from the exhaust gases is mildly

corrosive and it will deteriorate the mortar joints of the brick. Additionally, if the bricks in the chimney above the roof line become wet repeatedly, the faces of the bricks may spall (pop off) due to the excessive moisture being exposed to the daily freezing and thawing cycle. A metal liner is necessary in a masonry chimney to protect the chimney from the damaging condensate.

Chimney liners are not required for the high efficiency condensing furnace.

High Efficiency Condensing Furnace

A condensing furnace differs in design from the previously discussed furnace types in that it has two heat exchangers. The second heat exchanger is generally fabricated of stainless steel. Condensing furnaces generally provide a heating efficiency between 90% and 98% efficient.

Condensing furnaces are usually installed with two plastic pipes. One pipe provides a source of cold and relatively dry air from the outside for combustion and the other pipe vents the warm exhaust gases. A plastic pipe can be used to vent the exhaust gases in a high efficiency condensing furnace because the exhaust gases are relatively cool as the furnace removes nearly all the heat generated by the combustion. If a condensing furnace uses inside air for combustion, the furnace may be damaged. Damage may occur because the interior air may contain airborne contaminants from hair spray, deodorant, chlorine bleach, oil based paints, etc. The contaminants help to generate acids strong enough to damage the stainless steel secondary heat exchanger.

High efficiency furnaces can be delineated further. A single stage high efficiency furnace produces the full heating capacity whenever the thermostat calls for heat. Since this level of heating is only required during the coldest periods, the furnace must cycle on and off so as not to overheat the home.

A two stage model provides about 65% of the capacity in the first stage and adds the remainder of the capacity (up to 90% to 98%) with the second stage. These furnaces adjust between first and second stage automatically, as required, to heat your home. The two stage furnaces operate longer, but at a lower energy level. They use less natural gas and less electricity than single stage furnaces. This type of furnace provides more consistent (uniform) heating and less temperature variation.

Another optional feature available in a high efficiency furnace is modulation. A modulating furnace provides variable heat outputs by using a variable speed supply air blower and a variable heating or burner capacity. Slowing a blower fan speed by 50% drops its electrical consumption by 75%. These furnaces can not only cut your gas bill, but also cut your electric bill. These are also quieter and provide the most even temperature distribution in your home.

Safety

In closing, furnaces should be serviced prior to the heating season to minimize the risk of exposure to carbon monoxide (CO) and to be sure that the furnaces are operating efficiently. However, we note that furnaces are not the only potential source of CO in a home. Other natural gas appliances, ovens, candles, unvented fireplaces, automobiles running in a garage, cooking grills, emergency generators, and other appliances also generate CO and can put the occupants at risk. This is why every home should have at least one carbon monoxide detector. A CO detector in a home provides an additional level of safety. The life saved may be yours or that of a loved one.

Good house hunting.

Article written in January 2009 for the Prugar Consulting, Inc. Website Newsletter.