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Ask the Inspector

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What is the difference in the efficiencies of different types of gas furnaces?

There are three basic levels of efficiencies of propane or natural gas fuel burning furnaces: high, mid, and conventional. The efficiency of the furnace depends on several factors, including the type of ignition system, the type and shape of the heat exchanger, the number of heat exchangers, and the type of airflow into and out of the furnace for combustion and exhaust venting.

- An ignition system is required to light the burners when the thermostat calls for heat. This can be done by having a small flame that constantly burns, (a pilot light) or by electronically lighting the flame when the burners are needed. A pilot light that is always lit wastes fuel all year, while an electronic ignition system only uses energy when the furnace is required to heat the home.

- The heat exchanger is the metal chamber where combustion occurs. The flames burn inside the heat exchanger, while air from the home flows over the outside of the heat exchanger and picks up the heat that is absorbed by the metal. In addition to transferring heat from the burner flames to the air in the home, the heat exchanger prevents exhaust fumes from entering the home.

- Any combustion appliance requires air for burning the fuel (combustion air) and in some cases, air for helping the exhaust gases travel through the chimney (draft air). In older systems, this air comes from inside the home and can enter the furnace naturally, through openings beside the burners, and where the exhaust gases exit the heat exchanger to travel through the chimney. This situation causes excess air to enter the heat exchanger and flow up the chimney when the furnace is both operating and in standby mode (not in operation). In this situation, heat is constantly being lost through the chimney and a significant amount of energy is wasted. Alternately, furnaces can be designed with fans that control the amount of air that enters or exits (or both) the heat exchanger. In some cases, the fan will push or pull the required amount of air for combustion into the heat exchangers, and the exhaust gases travel through the chimney naturally using draft air. In other cases, the fan pulls the required amount of air into the heat exchanger and also pushes the exhaust gases out of the furnace at a controlled rate, eliminating the need for natural draft air. A damper on the fan mechanism prevents air from entering the chimney when the furnace is not in operation. This type of configuration helps reduce the amount of energy that is wasted.

Conventional furnaces have a standing pilot light, very basic shaped heat exchangers, and no control over the amount of combustion or draft air that enters or exits the system. Mid- and high-efficiency furnaces have electronic ignition devices, more complicated heat exchangers (longer), and they limit the amount of combustion and draft air entering and exiting the furnace to only what is required by using a draft fan which reduces the amount of warm house air that is lost through the chimney. In addition, by controlling and limiting the rate at which the exhaust gases, are removed from the home, more heat can be extracted from the exhaust gases making the system more efficient. These combined improvements increase the efficiency significantly. The difference between a mid- and high-efficiency furnace is that a high-efficiency, or condensing furnace not only extracts heat from the flames, but also has a secondary heat exchanger that extracts a significant amount of heat from the exhaust gases immediately before they are discharged.

How is the efficiency of a furnace calculated?

The efficiency of a furnace is based on the total amount of fuel energy being used by the unit, relative to the amount of generated heat that actually stays in the home. There are two general methods of calculating efficiency: steady state efficiency and seasonal efficiency, or Annual Fuel Utilization Efficiency (AFUE). Steady state efficiency is the efficiency of the unit when it is running at its peak operating temperature. It is calculated by comparing the input heating capacity of a furnace (i.e. the amount of actual heat energy generated by the burning flames) to the output capacity, which is the heat energy that is actually harnessed to heat the home. The output capacity of a furnace is less than the input capacity and takes into consideration the amount of heat generated by the burners that is vented up the chimney with the exhaust gases, as well as the interior house air that is used for combustion of the gas. The seasonal efficiency is the efficiency of the unit determined over the course of the whole heating season, taking into consideration off-cycle losses. These off-cycle losses include the warm house air that is lost through the chimney when the furnace is not in operation and the heat that is produced from the pilot light that is continuously burning. For example, a furnace with a steady state efficiency rating of 80% indicates that for every dollar spent on fuel, 80 cents is being used to heat the home when the system has reached its peak temperature. Unfortunately this "steady state efficiency" occurs infrequently during the heating season, after the furnace has been in operating for a period of time. This same furnace may have a seasonal efficiency of 60%, due to the off-cycle losses. Therefore, for every dollar spent for gas, realistically only 60 cents is used to heat the home and 40 cents is being wasted up the chimney. High-efficiency furnaces can have a typical minimum AFUE of 90% and maximum AFUE of approximately 97%, while mid-efficiency furnaces have an AFUE of 80-82%. Conventional furnaces can have an AFUE as low as 55%.

How is the efficiency of an oil furnace different than that of a gas furnace?

Oil heating systems are classified as either conventional or mid-efficiency and operate very differently from gas furnaces. Since fuel oil is a liquid, rather than a gas, the burner has to spray the oil into the combustion chamber, where it is ignited by a spark. Increasing the efficiency of this type of burner is done by altering the spray pattern of the oil and/or optimizing the mix of fuel oil and air. The nature of the burner does not allow for much variation in the size and shape of the heat exchanger. Oil furnace heat exchangers are all round or square chambers, approximately 9 inches in width by 13 inches high. The amount of air that enters the heat exchanger is regulated by the burner. A barometric damper is present on the flue pipe of conventional oil furnaces, to allow draft air to enter the chimney, when necessary. If the damper is operating properly, there are minimal off-cycle losses through the chimney, because there are no openings into the chimney when the furnace is not in operation. Conventional oil furnaces typically have steady state efficiencies of 70-80% and seasonal efficiencies of 60-70%. Mid-efficiency oil furnaces have maximum steady state efficiencies of approximately 87%. Higher efficiencies cannot be achieved because there is less water vapour produced when fuel oil is burned compared to gas and the exhaust gases are much hotter. It is therefore much more difficult to harness the latent heat. To further improve the efficiency of the heating system, a programmable thermostat can be set to automatically adjust the temperature in the home, depending on when the occupants are typically home, away, or sleeping. A programmable thermostat that is used properly can result in significant savings. Every 1°C or 2°F the thermostat is lowered can result in a 2% savings on the heating bill.

The efficiencies of other heating systems vary:

- Electric furnaces are close to 100% efficient, however, the cost of electricity is approximately double the cost of gas for the equivalent amount of energy. This makes basic electric heating systems cost inefficient.
- Wood furnaces and stoves have become much more efficient in recent years, due to new technological advances. The efficiencies, however, also depend on the type of wood that is burned. For example, a cubic metre (slightly less than a face cord) of dried wood can produce anywhere from 35 million to 80 million BTU's, depending on the type of wood being used.
- Geothermal (ground source) systems are extremely efficient, since only a pump and fan require electrical power to run. The efficiency is expressed as the Coefficient of Performance (CoP) which is a ratio of the heat produced, and the electricity required to run the fan and pump. Most systems have a CoP of at least 3, which would be the same as a 300% efficient fuel burning furnace. That means that for every one dollar you spend on electricity for the heating system, you get three dollars worth of heat energy.