Replacing Your Furnace

There are usually two major reasons why you are choosing another forced-air furnace. The first is that your furnace does not function. It has just broken down, irrevocably, or it has been "red-tagged" or condemned by gas inspectors. If it is winter, and your house is getting colder quickly, you may not have the luxury of making a reasoned choice on what to buy next. The other situation is that your furnace is getting old, or your fuel bills are becoming too excessive to tolerate. In this case, you have the time to shop around and get the best furnace and fuel for your situation.

This *About Your House* is written to address both situations. If you have a dead furnace and a chilly house, you will probably take some shortcuts in your selection process.

Choice of Fuels

For many years, CMHC and others could offer sound advice on what fuel choice would be the most economical. During that period, heating systems based on electricity or propane cost the most to operate. Heating oil was somewhat more economical, and natural gas (if available in your community) was the least expensive choice.

Since 2000, the prices of these commodities have been fluctuating, and it is difficult to offer reliable advice on pricing. At one point in 2001 – 2002, heating with electricity in Manitoba was as economical as heating with natural gas. Predicting these prices over the next two decades (a common life span for a furnace) is nearly impossible. The best advice is to make a calculation based on the current prices quoted to you in your locality. See the text box entitled "Calculating fuel costs."

Calculating Fuel Costs

Here is a rough comparison of the relative costs of heating an older house in Ottawa. You can put in your own fuel prices and the efficiencies of the appliance that you are choosing to compare relative costs.

The equation is:

$$\frac{\text{Energy cost per unit}}{\text{Energy content}} \times \frac{\text{Heat load}}{\text{Efficiency}} \times 100{,}000 = \text{Cost to heat}$$

Example: For a 92-per-cent efficient gas furnace:

$$\frac{\$0.42/m^3}{37.5\ MJ/m^3} \times \frac{80\ GJ}{92} \times 100{,}000 = \$974$$

Note: It is often difficult to isolate the cost per unit of fuel, be it gas or electricity. Include all the costs that relate to the m³ of consumption for gas (for example, gas supply charge, gas delivery charges, gas surcharges). Electric utilities often also have a bewildering range of charges. Apply all the charges except fixed charges (for example, $10/month connection charge).

For oil appliances, use an energy content of 38.2 MJ/litre of oil. For electricity, use 3.6 MJ/kWh and 100-per-cent efficiency.

Note: 80 GJ (or 80 gigajoules) is the energy required for heating the example house over the winter (heat load). Your own house will likely be different. However, the relative costs calculated for alternative fuels and furnaces in the example house should help you make a selection for your house.

Furnace Sizing

You probably do not need a furnace with the output of your current furnace. Most furnaces in Canadian houses can provide far more heat than the house requires. A properly sized furnace will be running almost continuously during the coldest day of the winter. Having a furnace of a correct size will result in efficient operation during the whole heating season. A grossly oversized furnace will run only for a short period, never coming up to peak efficiency. Note, however, that sizing may not be a big issue with high-efficiency, condensing gas furnaces. Due to the design of condensing appliances, they are efficient even when oversized.

So, how do you size your furnace? You can have the contractor use a home heat loss calculation that is available from Canadian Standards Association (CAN/CSA F280) or a sizing procedure from the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI). Having a proper sizing will cost you $150 – $300 from a qualified contractor.

Those who keep their heating bills, and who are mathematically inclined, can try the calculation in the text box entitled “Calculating house heat loss from utility bills.”

Calculating House Heat Loss from Utility Bills

Here is a sample calculation, using a three-month meter reading for a typical house. You can use any period (but at least two weeks of winter weather is necessary). You can read the meter

yourself for the information, look at your furnace bills or phone your utility to see if they have appropriate records. The natural gas usage of other gas-fired appliances in the house is estimated from gas utility data and subtracted from the total for the period in question, so that the gas requirement for heating can be isolated. (Oil furnaces are harder to size using this method, but it may be possible using oil fill-up intervals and the number of litres delivered.)

The goal is to find a relationship between the gas consumed and the heating degree days (HDD). A heating degree day is essentially the number of degrees of heating required over the course of 24 hours, compared to a reference temperature of 18°C. For example, if the average daily outside temperature is 10°C, then the number of heating degree days for that day is 18°C - 10°C = 8 HDD. You can get the approximate HDD for your calculation period from the Environment Canada website. Use the data from the "Degree Days: Below 18°C" row.

Once the relationship of the HDD and gas consumption is established, then you can calculate gas consumption for the design temperature in your area. This temperature is usually available from a mechanical contractor or your local building officials. It is not the extreme minimum temperature; it can be estimated from the average temperature over 24 hours on the coldest day of the winter. To approximate the design temperature: go to the historical weather data for your community on the Environment Canada website; find the coldest January over the last several years; then pick out the lowest daily average temperature in that month; and use that as the design temperature. Being a degree or two out will not make a huge difference in the calculation.

The example below uses a design temperature of -35°C. At that temperature, the maximum HDD per day is equal to 53, which is the difference between 18°C and -35°C. Calculating the size of the furnace necessary on the coldest day of the year will mean that the furnace has the capacity to handle any expected local temperature. You can find a furnace's efficiency rating on its EnerGuide label or in the product documentation.

Example

Total gas consumption from December to March = 1,320 m^3
Estimated consumption for other gas appliances (data from utility) = 306 m^3
Therefore, gas consumption during the period for heating = 1,320 - 306 = 1,014 m^3

Heating degree days for that period (from Environment Canada data) = 2,840 HDD
Heating consumption by degree day = 1,014 m^3/ 2,840 HDD = 0.3570 m^3/HDD
Heating consumption at 53 HDD/day = (53 HDD/day)(0.3570 m^3/HDD) = 18.9 m^3/day

Where gas has an energy content of 37.5 MJ/m^3, and the existing furnace has an efficiency of 72 per cent, then:
Heat loss at 53 HDD/day = (18.9 m^3/day) (37.5 MJ/m^3)(0.72) = 510 MJ/day or 21.3 MJ/h*
According to the energy content of electricity, 3.6 MJ/h = 1 kW, then 21.3 MJ/h = 5.9 kW

This heat loss would require a furnace that produces an output of 5.9 kW or about 20,100 Btu/h (1 kW is approximately 3,412 Btu/h).

If we allow the CAN/CSA F280 permissible oversizing of 40 per cent, then the proper furnace sizing would be (1.4)(20,100 Btu/h) = approximately 28,100 Btu/h.

If you are calculating for an oil furnace, heating oil has an energy content of 38.2 MJ/litre.

* Note: This calculation is correct, although many people think the efficiency factor is in the wrong place. It is not. We are calculating the house heat loss based on fuel used and furnace efficiency. A more efficient furnace will have delivered more heat to the house, and the heat loss will be higher.

Furnace Efficiency

There is a wide range of furnace efficiencies, although only high-efficiency gas furnaces are sold in Canada as of 2010. The range of efficiency will vary by fuel.

Electric furnaces work on electric resistance. The full 100 per cent of the energy consumed goes towards the heating of the house. The inefficiencies with electric heating happen before the electricity reaches your house. If the electricity is created by burning fuels, there are inefficiencies in that process plus losses as the electricity moves through the lines.

Oil furnaces have become far more efficient since the height of their popularity in the mid-twentieth century. Efficiencies have risen from roughly 60 per cent to well over 80 per cent as a result of advanced technologies — first to flame retention head burners and then to high static pressure burners. The more efficient oil furnaces require a better chimney than their conventional counterparts, so you will probably need to upgrade the chimney with a stainless steel liner inside the old clay tile. Make sure this is included in the quote.

Failure to have a properly sized chimney will result in excessive chimney condensation and eventual destruction in the case of masonry chimneys. There are high-efficiency, condensing oil furnaces as well. Earlier versions had reliability problems. The new generation, launched in 2003, may have resolved these difficulties.

New gas furnaces in Canada are high-efficiency (89 – 96 per cent) condensing furnaces. The high-efficiency furnaces use a plastic vent and are most often vented out the side wall. Propane furnaces are usually modified natural gas equipment.

So… What Do I Buy?

Here are the most common questions about furnace replacements to CMHC staff from Canadians, and our usual answers:

Should I switch my heating fuel?

In most parts of Canada, it will be more expensive to heat with an electric furnace than one using oil or gas. An exception would be if you heat primarily with a wood stove and use the furnace

only infrequently as backup. In this case, the low cost and low maintenance requirements of an electric furnace may be a major advantage. Deciding between oil and gas furnaces is a matter of choice. Make the calculation to see if it is significantly cheaper to use one fuel or another based on current prices in your area. Oil furnaces require a tank and usually a chimney. There may be additional costs for chimney modification or oil storage tanks when purchasing an oil furnace. Some home insurance companies require periodic oil tank replacements. Check if a new gas furnace would also require relining the chimney. Consult with your contractor and make sure that these costs are included in your estimates.

Some dealers recommend a furnace of 100,000 Btu/h, and some say 80,000 Btu/h will be fine. How do I choose?

See the previous discussion on sizing. If you are buying an oil furnace, proper sizing will affect the durability and efficient operation of your appliance. Your choices are either to pay for a proper heat loss analysis, to calculate house heat loss or to accept the dealer's estimate. Sometimes government or utility programs subsidize house testing. If such a program is in effect in your vicinity, this can be an economical way to have your house heating load established.

Are there any advantages to multi-stage, multi-speed furnaces?

Multi-stage furnaces have become more popular lately, although they are more expensive than the single stage furnaces that have been sold for decades. Multi-stage furnaces have two or three levels of burner function, and an efficient, modulating circulation fan to move the heat into the house. They can provide additional heat when a quick temperature rise is required, such as in the morning when a house with a setback thermostat is being heated from 15°C to 21°C (59°F to 70°F). A traditional single speed furnace would take longer to get up to temperature. The multi-stage furnaces are no more efficient than single-stage furnaces; they offer more flexibility and perhaps more comfort.

Is Furnace "A" better than Furnace "B"? How can I find that out?

There is little or no available data to show that one manufacturer's furnace will operate longer and with less trouble than a furnace from another manufacturer. This is frustrating for consumers. We are used to being able to read ratings of one product versus another product and to make a choice based on those ratings. However, a good furnace will last 25 years. A poor one may break down prematurely at 15 years. With lifetimes of this length, and with furnace design and model changes, it is hard to predict which furnace will provide the best service.

There are two factors to help you in your choice. Pick a furnace with a long heat exchanger warranty, 20 years or more. If manufacturers are willing to back the most expensive part of their appliance for a long time, this should inspire some confidence. Also, pick a furnace manufacturer and a dealer that have been in business for a significant period of time. A furnace with a lifetime warranty offered by a company that has been in operation for only three years may not be the best deal. One would expect to pay less for this level of uncertainty. Look for contractors with memberships in trade organizations such as HRAI, which would indicate an interest in professional qualifications.

The Hot Water Heater Conundrum

There are very few high-efficiency hot water heaters available. Changing your furnace may lead to having to think about your hot water heater. Existing hot water heaters are often located vertically below the kitchen and bathrooms, where the water is used. If you are changing from an electric to a conventional gas hot water tank, and the new gas appliance has to be installed across the basement to be near the chimney, you will be waiting longer for the hot water at the tap. Consider a gas hot water tank that has side-wall venting and does not require a chimney. This way, it can stay close to the plumbing appliances that use it.

Another hot water tank issue can occur when you switch from a conventional gas furnace and hot water tank to a new, high-efficiency side-wall vented furnace. Now the hot water tank has to heat up that big chimney all by itself, and you probably will have to pay for chimney relining. It is often better, when choosing a chimneyless furnace, to switch your hot water tank to side-wall venting at the same time and seal the old chimney closed. However, side-wall vented hot water heaters are more expensive than conventional hot water heaters and can be noisier.

Instantaneous hot water heaters, which do not use a storage tank, are becoming more common. They may be more economical to operate.

Furnace Circulating Fan Choices

Most furnace circulating fans consume high amounts of electricity (300 – 700 watts). If you will be using your furnace circulating fan to move ventilation air around the house (for instance, if you have a heat recovery ventilator connected to it, or a high-efficiency air cleaner on the furnace), then look at upgrading the circulating fan to a high-efficiency DC motor. The best furnace fans now will use less than 100 W on low speed. This will result in considerable electrical savings over the life of the furnace.

Other Choices

When replacing the furnace, you may want to look at integrated systems that heat your house and your water and also provide ventilation. Devices known as “combo” units provide house and water heating. New appliances with advanced, integrated systems will provide ventilation as well as space and water heating. For some replacements, these integrated appliances will be your best choice.

Additional Resources

For further detailed information on all heating appliances, there are excellent booklets published by Natural Resources Canada in the Heating and Cooling Series.