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Heating with Oil

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Heating with Oil

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EnerGuide

The Heating and Cooling series is published by Natural Resources Canada's Office of Energy Efficiency. EnerGuide is the official Government of Canada mark associated with the labelling and rating of the energy consumption or energy efficiency of household appliances, heating and ventilation equipment, air conditioners, houses and vehicles. EnerGuide also helps manufacturers and dealers promote energy-efficient equipment and provides consumers with the information they need to choose energy-efficient residential equipment.

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Natural Resources Canada's Office of Energy Efficiency promotes the international ENERGY STAR symbol in Canada and monitors its use. Major manufacturers and retailers of energy-efficient products, utilities and energy retailers, and interest groups from Australia to Europe, recognize the benefits of ENERGY STAR for consumers and have joined in promoting the symbol.

ENERGY STAR is the international symbol of premium energy efficiency. Products that display the ENERGY STAR symbol have been tested according to prescribed procedures and have been found to meet or exceed high energy efficiency levels without compromising performance.

Contents

Introduction

If your present home heating system is costing too much to operate, is in poor condition, or if you are planning to buy a new home, you are probably considering your heating options. Approximately 60 percent of the energy required to run the average home is used for space heating.

One of the most important projects you will undertake as a homeowner, along with insulating and air sealing, is choosing, changing or modifying your heating system. A wise decision about heating can significantly reduce the cost of running your home and make it more comfortable. Some impressive improvements have been made in heating systems in recent years, and there is a wide range of good equipment on the market.

You will be using your new or improved heating system for a long time, so that it's important to do your homework before you make a choice. It's worth taking the time now to ensure that you make the best choice for your situation.

You should thoroughly investigate all your options. These days, however, your options may be quite bewildering because of the wide range of equipment and energy sources available. This booklet will help you in your decision-making process. It will be useful whether you are installing a system in a new home, replacing a system in an existing home or considering upgrading your present system.

How to use this booklet

To simplify the process of choosing a heating system, we have identified five interrelated steps for making your home-heating decisions.

Step 1: Getting started

Step 2: Draft proofing and insulating

Step 3: Selecting an energy source

Step 4: Selecting or improving the heat distribution system

Step 5: Selecting the heating equipment

These steps and various options are discussed in Chapter 1. The remainder of this booklet focuses on the **oil heating** option.

Natural Resources Canada (NRCan) also produces other booklets available at oee.nrcan.gc.ca/infosource which might be of interest to you. See page 64 for more information.

How you use this booklet is determined, in part, by where you are in your decision-making process.

- If a house is being built for you, you may have all the steps and options open to you (Steps 2 through 5).
- If you already own your home but are considering replacing an existing heating system, many of the steps and options may be available if you have a variety of fuel and energy choices in your area (Steps 2 through 5).
- If your existing heat distribution system (forced-air or hydronic) is satisfactory, and you only want to upgrade it (Step 4) to reduce your heating bill, your options are switching energy sources (Step 3), selecting higher-efficiency equipment, or upgrading and adding equipment to your current furnace or boiler (Step 5). You may also decide to insulate and draft-proof (caulk and weatherstrip) your house (Step 2).
- Even if you are satisfied with your existing heat source, you should look at Steps 2, 4 and 5.

Before proceeding, you should become familiar with basic concepts that will help you understand your options.

Heating concepts

Energy efficiency

All fuel-burning systems (oil, natural gas, propane, wood) lose heat because of

- transient operation
- cold start-up
- incomplete combustion
- heat carried away in combustion gases while the furnace is running
- heat from the appliance lost up the chimney after it shuts down
- warm house air being drawn up the chimney

Heading concepts (continued)

The extent of these losses determines the efficiency of the furnace or boiler. The efficiency is measured as a percentage that indicates the amount of the original heat that warms the house.

Steady-state efficiency measures the maximum efficiency the furnace achieves after it has been running long enough to reach its peak-level operating temperature. A service person uses this important standardized test to adjust the furnace, but the measurement it gives is not the efficiency that the furnace or boiler will achieve in actual use over a heating season. The difference between the test result and actual use is much like the difference between the very low fuel consumption figures for highway driving published for cars and the actual fuel consumption of the car in day-to-day service.

Seasonal efficiency takes into consideration not only normal steady-state operating losses up the chimney but also several other losses, such as the use of heated house air for combustion and dilution processes. Seasonal efficiency also considers the fact that most furnaces rarely run long enough to reach their steady-state efficiency temperature, particularly during milder weather at the beginning and end of the heating season, as well as the loss of heat from the appliance when it is not running. The seasonal efficiency expressed as **annual fuel utilization efficiency (AFUE)** is useful to a homeowner. It is a good indication of how much the annual heating costs will be reduced by improving existing equipment or by replacing it with a higher efficiency unit (see Table 1, page 43). However, the AFUE does not consider the electricity used by the appliance to run blowers, fans, pumps, etc.

Design heat load is an important component in calculating the required size of heating equipment.

Many variables go into determining the design heat load of a house, including two temperature design conditions: the inside and outdoor design temperature. The inside design temperature is the temperature at which most occupants would be comfortable, and is typically 20°C. The outdoor design temperature represents the probable coldest outside temperature that the heating system will have to supply heat against to keep the inside temperature at the proper level – this varies by climatic region across the country.

Heating concepts (continued)

In winter, heat transfers from inside to the outside, and this transfer of heat is measured in British thermal units (Btu) or megajoules (MJ). How fast this heat is lost to the outside will depend upon the difference between the inside and outside temperatures. The greater the temperature difference, the faster the heat loss. The rate at which this heat transfers is called the heat loss and is measured in Btu per hour (Btu/h) or MJ/h. Your heating system needs to be sized to produce enough heat to maintain the interior design temperature at 20°C when the outside temperature reaches the outdoor design temperature.

The annual heating load is the number of litres, gigajoules, etc. required to heat the house over the entire heating system.

If you are heating with oil or are considering doing so, the more you understand the terminology associated with oil-heating systems, the better equipped you will be to make a wise heating system choice. See the text box "Oil heating terms" for basic terms.

Oil heating terms

Fuel oil

The petroleum industry produces several grades of fuel oil, but only one is commonly used for most home heating. This is Number 2 fuel oil, and it must meet government and industry standards for density, viscosity and heat content. In colder regions, Number 1 fuel oil, which is a slightly lighter fuel, is used.

Measuring up

The heating (bonnet) capacity of oil-heating appliances is the steady-state heat output of the furnace, commonly measured in **British thermal units per hour (Btu/h)**. One Btu is equal to the amount of energy it takes to raise the temperature of one pound of water by one degree Fahrenheit. Most oil-fired central heating appliances being sold for home use today have heating capacities of between 56 000 and 150 000 Btu/h (59 to 157 MJ/h). One litre (L) of Number 2 fuel oil contains approximately 38.2 MJ (36 500 Btu) of potential heat energy. Heating capacity is also expressed in **megajoules per hour (MJ/h)**.

Oil heating terms (continued)

The heating capacity of electric heating systems is usually expressed in kilowatts (kW). A **kilowatt hour (kWh)** is the amount of electrical energy supplied by 1 kW of power over a one-hour period.

Certification and standards

All fuel-burning furnaces, boilers and other combustion equipment sold in Canada must meet strict manufacturing and installation standards established by such organizations as the Canadian Standards Association (CSA), the Underwriters Laboratories of Canada (ULC) and the International Approval Service, Inc. (IAS). These independent bodies set standards and test for safety and performance. Before purchasing your heating equipment, be sure it carries a CSA, ULC, Canadian Gas Association, IAS or Warnock Hersey certification label.

Since 1998, Canada's Energy Efficiency Regulations have required that oil furnaces achieve at least 78 percent AFUE. Since September 2010, oil boilers must have a minimum efficiency level of 84 percent AFUE (see page 20 for more information on energy efficiency standards). Also, a new standard proposed for September 2012 will require that oil boilers be equipped with a water temperature controller that automatically adjusts the temperature of the water as the load varies. (See page 32 for more information on water temperature controllers).

Regardless of how you are heating your home currently, you can probably improve the efficiency of the heating system. Some improvements are simple enough for you to do them yourself. Others require the services of a licensed service person, a qualified heating contractor or an electrician. All improvements should be effective and pay for themselves in a reasonable period. When you consider your heating system, remember also to consider your hot water situation.

1 Making decisions about home heating

This chapter explains a five-step process that will help you make wise decisions about home heating.

Step 1: Getting started

Consider getting expert advice by having an energy retrofit evaluation done. The service includes an evaluation of your home and provides recommendations or a written report and an energy efficiency rating for your home. The evaluation will help you plan the energy upgrades that can easily be incorporated cost-efficiently into most renovation projects, resulting in a more comfortable home that uses less energy. For additional information, or to find a delivery agent in your area, visit the Office of Energy Efficiency's (OEE's) Web site at oee.nrcan.gc.ca or call NRCan toll-free at 1-800-387-2000.

Step 2: Draft proofing and insulating

Before you invest in a new or improved heating system, check the efficiency of the house envelope to determine if the house needs more insulation or has many air leaks. Determine where you can draft-proof and insulate simply and effectively **before** you have the heating system sized, installed or upgraded.

Draft-proofing and insulating have many advantages. Heating the house will cost considerably less, and you will be more comfortable because of fewer drafts and warmer surfaces, such as walls. Your house will tend to be cooler in the summer, too.

Humidity levels will improve as well. Dry air in a house during the winter is caused by too much outside air getting in. Although the relative humidity may be high for cold outside air, the absolute amount of moisture (water vapour) that cold air can hold is actually very low. When this cold, dry air is brought inside and heated to room temperature, it becomes extremely dry.

If the air inside your house feels too dry, one of the simplest solutions is to add moisture by using a humidifier or an evaporator tray. However, the best way to increase humidity levels (and lower heating costs) is to reduce air leakage. In general, most houses that have been air tightened do not need a humidifier – the moisture generated through cooking, bathing, dishwashing and other activities is sufficient.

However, with an airtight house the reverse can occur. Making your house more airtight can affect the air quality **inside**. Unwanted fumes, odours, gases and too much humidity can be trapped inside the house envelope and build up over time to unpleasant levels. One of the best ways to solve this problem is to install a fresh air intake or a mechanical ventilation system that brings in and circulates fresh air without causing drafts.

Often, the most energy-efficient way of doing this is by using a heat-recovery ventilator (HRV). An HRV consists of two air-handling systems: one collects and exhausts stale indoor air; the other draws in outdoor air and distributes it throughout the home. An HRV provides fresh air at a reduced cost while also saving energy by reducing the heating (or cooling) requirements (see page 45). Contact your service person for more information.

Insulating, caulking and weatherstripping will reduce the amount of heat needed to keep your house comfortable. If your existing home has not been thoroughly reinsulated and draft proofed, you should consider doing this **before** changing or modifying the heating system. For more information about draft proofing and insulating, write for a free copy of *Keeping the Heat In* (see page 64). Whether you plan to do the work yourself or hire a contractor, this publication explains the details and can help make the entire job easier.

To ensure that you get a heating system with the right heating capacity, be sure to draft proof and insulate **before** you and your contractor determine what size of heating system and equipment is best. In general, oversized furnaces will waste fuel because they tend to operate in frequent, short cycles. They may also decrease comfort because of the resulting excessive temperature fluctuations.

If you are building a new house, remember to find out which energy efficiency upgrades you should consider including in your building plans. Also, look for homes that have been evaluated through a program such as ENERGY STAR® for New Homes. The ENERGY STAR® for New Homes initiative helps you to identify homes that are significantly more energy-efficient than those built to minimum building code requirements. The increased energy efficiency of these homes translates into reduced energy costs for their owners.

ENERGY STAR® for New Homes is currently available in many regions across Canada and is delivered in the field by a network of regional service organizations. If you want to buy or build an ENERGY STAR qualified new home, contact an ENERGY STAR® for New Homes service organization in your area to schedule an evaluation of your building plans. Visit www.newhomes.gc.ca for more information.

Step 3: Selecting an energy source

The next step is to select the heating energy source that is right for you. Generally, your options include oil, natural gas, propane, electricity or wood. You may also choose a combination of these conventional energy sources or alternatives, such as solar energy. Your decision regarding the most appropriate energy source should be based on several considerations, the most important of which are described here.

Energy availability

Not all energy sources are available in all areas of Canada. Heating oil and electricity are generally available in most places, but natural gas, which must be delivered by pipeline, may not be available in many rural and remote areas. Propane is available in most parts of Canada and may be used in rural or cottage areas as a substitute for fuel oil or natural gas although, often, at a significantly higher operating cost. In many areas, wood is a cost-effective complement to your conventional heating system. Check with your local fuel supplier or electrical utility to find out which energy sources are available in your area.

Cost considerations

For most homeowners, a major factor in the home-heating decision is cost. This factor will have two major components – the capital cost of the installed heating system and the annual operating cost for energy. Other factors, such as maintenance costs, cleanliness and noise of operation, should also be considered.

Installation costs of various heating systems, depending on whether they are new or retrofitted, include such items as

- storage tank for oil or propane
- new or modified venting system
- connection to gas lines or electric power lines
- cost of 200-ampere service for electric heating
- heating equipment (furnace, boiler, replacement burner, baseboard heaters, heat pump, ducting system or pipes and radiators)
- thermostats and controls
- trenching or drilling for earth-energy systems (ground-source heat pumps)
- labour for installation of any of the above

The capital cost of a heating system can range from as low as $1,000 for baseboard heaters in a small house to as high as $20,000 or more for a ground-source heat pump capable of providing heating, air conditioning and hot water for a larger home. Heating contractors or utility representatives can give you an estimate of the capital cost of various systems. Always ask for a firm quote before you authorize any work.

The **operating or fuel cost** of a heating system is determined by the following three major factors.

- *Annual heating load or heating requirements of the house.* The heating requirements depend on climate, size and style of the house, insulation levels, airtightness, amount of useful solar energy gained through windows, amount of heat given off by lights and appliances, thermostat setting and other operational factors. Together, these factors determine how much heat must be supplied by the heating system over the annual heating season. This number, usually expressed as Btu, kWh or MJ (see pages 8 and 9 for a definition of these terms), can be estimated by a heating contractor, home builder or utility representative.

- *Choice of energy source and its unit price.* Each energy source is measured and priced differently. Oil and propane are priced in cents per litre (¢/L); natural gas in cents per cubic metre (¢/m3), dollars per megajoule ($/MJ) or dollars per gigajoule ($/GJ); electricity in cents per kilowatt hour (¢/kWh); and wood in dollars per (face) cord. You must consider the heat content of the various energy sources to determine the most cost-effective energy source for your area. Contact your local utility or fuel supplier for the price of energy sources. Table 2 on page 44 gives the energy content for the various energy sources in the units in which they are commonly sold.
- *Equipment efficiency.* The efficiency with which the appliance converts the energy source to useful heat in the home is also an important factor in the operating cost equation. For example, if a furnace has an AFUE (see page 7) of 80 percent, then 80 percent of the heat value in the fuel is available. The other 20 percent is lost, mostly up the chimney so that additional fuel must be consumed to make up for these losses. Improving the efficiency of the heating equipment reduces energy use and cost.

The combination of heating load, fuel choice and equipment efficiency determines the annual cost of heating. Chapter 4 has a detailed description of how you can calculate heating costs for various energy sources and technologies as well as typical seasonal efficiencies (AFUE) for a range of technologies.

In the end, a homeowner considering a new heating system must balance the capital cost against the operating cost and make the best financial decision, taking into consideration how energy prices might change in the future. Because annual operating costs (and the differences in operating costs between different technologies) are significant compared to capital costs, an investment in high-efficiency equipment is often the wise choice.

Environment

The effects of energy production and consumption play an important role in many of today's key environmental problems. Exploration and extraction of fossil fuels in fragile ecosystems, spills and leaks during transportation, urban smog, acid rain and global climate change – all can adversely affect our environment.

Each form of energy has a different impact at various points in the energy cycle. Heating your home affects the environment in various ways, from gases leaving the chimney to emissions at a coal-fired electricity generating station, to flooding at a remote hydroelectric site. While determining these impacts can be complex, it is generally true that reducing the amount of energy you consume to heat your home reduces the impact on the environment.

Step 4: Selecting or improving the heat distribution system

Most heating systems today are either forced-air systems or hydronic (hot water) systems. These consist of a heating unit (furnace or boiler), a distribution system (ducts and registers, or pipes and radiators), electric baseboards and controls (such as thermostats) that regulate the system. Some houses use space heaters and may not have distribution networks.

Forced-air systems

By far, the most common type of central heating system used in Canadian homes is the forced-air system with a furnace as the heat source. Among its advantages are its ability to provide heat quickly and the fact that it can also be used to filter and humidify household air. A forced-air system can also provide ventilation and central air conditioning. In addition, the furnace fan can be used year-round to provide continuous air circulation throughout the house while efficiently distributing heat in colder months. You should consider using a high-efficiency motor to reduce operating costs.

High-efficiency motors

Some residential furnaces have an option for a high-efficiency motor. Most motor manufacturers have an option for an electronically commutated brushless direct current (DC) motor (high-efficiency). These high-efficiency motors may be referred to as EC, ECM, BLDC or DC motors, depending on the manufacturer.

If you are purchasing a new furnace, you should consider buying one that has a high-efficiency motor. An oil-fired furnace with a high-efficiency motor is more efficient than an equivalent furnace with a standard (permanent split capacitor [PSC]) motor. In homes where the fan is run continuously or for extended periods, such a motor can significantly reduce electricity consumption while providing better air circulation. A brushless DC motor can reduce average furnace electrical consumption by more than 70 percent when used for continuous circulation. During the summer months, a brushless DC motor also saves energy by reducing the load on your air-conditioning system.

The actual electricity cost savings that you achieve will depend on how often you use the central air circulation fan in the furnace.

If you have an existing furnace fitted with a PSC motor, you can retrofit your furnace with an efficient brushless DC motor at a reasonable cost to reduce electricity consumption. Retrofit DC motors that connect to existing PSC motor connections are available from most motor manufacturers. Talk to your local installer or service person.

If your air circulation duct system has a high pressure drop of 200 pascals (0.8-inch water column) or more, a high-efficiency brushless DC motor retrofit is not recommended. Talk to your local installer or service person.

Forced-air heating systems also have some disadvantages. The temperature of the air coming from the heating registers can vary depending on the type of system. The air can sometimes feel cool (especially with certain air source heat pumps) even when it is actually warmer than the room temperature. The effect is similar to the cooling action of a fan or a summer breeze. In addition, there can be short bursts of very hot air, especially with oversized systems. Some people may find these characteristics uncomfortable at times.

The ductwork that distributes the heat may transmit the noise of the furnace and its circulating fan to every room and may circulate dust, as well as cooking and other odours, throughout the house. Consult your heating contractor for further information.

Hydronic heating systems

A hydronic heating system uses a boiler to heat water, which is then circulated through the house before returning to the boiler to be reheated.

Hot-water or steam-heating systems used to have large boilers and used wrought-iron pipes and massive cast-iron radiators; some of these still exist in older homes. For many years now, installers have been using smaller copper piping, slim baseboard heaters and smaller, more efficient boilers. CSA-approved non-metallic piping is now available as an alternative to copper piping for space heating and service hot-water distribution.

Other systems

Other home-heating systems that can be used independently or in combination with the standard systems are also available. These include **room space heaters, radiant space heaters** and **built-in radiant floor systems**. Recently, boilers and other "hot water" generators have been coupled with fan coils to provide a warm-air heating system.

Room space heaters provide heat directly to the rooms they are in and do not have a central heat distribution system. Examples are wood stoves, freestanding gas fireplaces, vented oil-fired space heaters and electric baseboard heaters.

Some space heaters can also be very effective radiant heat sources, warming solid bodies, such as people, in their line of sight without necessarily having to heat up all the air. Good examples are the new, efficient, direct-vent gas fireplaces, advanced combustion wood fireplaces, freestanding woodstoves, and portable electric infrared radiant heaters. If properly located in a major living space, a **radiant space heater** can actually act as an effective surrogate zoning system, lowering the overall heat demands of the house and the final heating bills while making the occupants feel more comfortable.

Built-in radiant floor systems are generally of two types: hot water pipes in floors and electrical cables in floors, which may also be installed in ceilings. The radiant floor type, which is becoming increasingly popular, consists of narrow hot water pipes embedded in the floor or laid in the joist space under the floor. Hot water at a temperature of around 40°C (104°F) is pumped slowly through the pipes and radiates heat into the house. Thick carpets can reduce effectiveness significantly by acting as insulation. Such a system may be more costly to install and does not appear to offer much in direct energy savings. However, some radiant floor installations may offer comfort benefits, resulting in lower thermostat settings and reduced heating bills.

Your choice of heat distribution system may be limited if you have a forced-air or hydronic system already in place. If you have an electric baseboard heater and are faced with high heating bills, you may want to change to another type of system and energy source, even though it can be an expensive undertaking.

Although a major constraint is the lack of a distribution system, many homeowners are finding that air ducts for a central forced-air system or pipes and radiators for a hydronic system can be installed at a cost that still makes the whole conversion financially attractive. Fuel-fired space heaters, wood stoves and advanced, energy-efficient wood or gas-fired fireplaces can also be effective.

Your choice will probably be based on the answers to the following questions.

- How much will the system cost compared to other systems?
- Will this type of system suit my lifestyle?
- Will I be comfortable with it?
- Do I want central ventilation, air conditioning or air circulation?
- Is there a contractor available to install the system?
- Is the system compatible with my energy choice?

Step 5: Selecting the heating equipment

After you have selected the energy source and heat distribution system, you can begin to consider the alternatives for heating equipment and efficiency levels. You will have to consider whether to upgrade your existing heating equipment or to replace it entirely. Several things can be done to improve the efficiency and general performance of an existing heating system. You also have the choice of several replacement models with various efficiency ratings and prices.

The following are some details to consider when choosing your equipment.

Equipment efficiency and suitability

See Chapters 2 and 3 for a detailed discussion of your options for oil furnaces and boilers.

Purchase, installation, operation and maintenance costs

Generally, the more efficient heating systems have a higher capital cost. You must keep this in mind when considering any changes or new equipment purchases. You want to make sure that the reduction in energy consumption and enhanced comfort will reimburse the improvement costs within a reasonable time. Most often they will.

Often, the more efficient systems require much less house air for combustion and dilution. Modifications to the existing venting system may be required because some may not need a chimney but can be vented out the side wall. This arrangement makes them safer and more compatible with airtight housing. Finally, high-efficiency heating equipment can be an additional marketing attribute if you want to sell your house.

Servicing and guarantees

It is also important to know the causes for, and frequency of, servicing your system, the price of parts, cost of servicing, and details of guarantees and warranties, such as the period covered and whether parts and labour are included. If you are uncertain about a particular model, ask the seller to give you the names of people who have had one installed.

Energy efficiency standards

The Government of Canada has implemented energy efficiency standards for nearly all heating equipment and other energy-consuming appliances and products which are imported or shipped for sale between provinces. Some provincial governments have introduced energy efficiency standards as well. Generally, these standards establish the minimum acceptable energy efficiency for specific types of heating equipment. After the standards are introduced, low-efficiency models that do not meet the standards are no longer available on the market.

Energy efficiency rating system

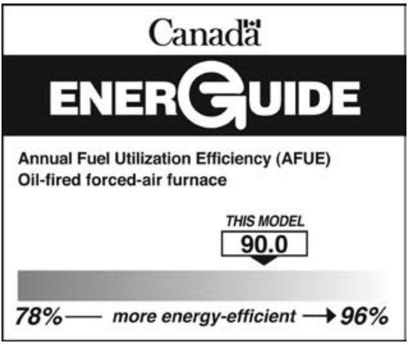
The Government of Canada and the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) have established a voluntary energy efficiency rating system for residential oil forced-air furnaces to help consumers compare the energy efficiency of different products.

The EnerGuide label with the furnace's AFUE rating (Figure 1) is shown on the back page of manufacturers' brochures. Included on the EnerGuide label is a rating scale showing the range of efficiencies for oil furnaces on the market as well as a pointer indicating where the model is positioned compared with others in terms of efficiency.

Chapter 4 shows you how to determine heating costs based on the furnace's AFUE rating.

FIGURE 1

An EnerGuide label for oil furnaces



2

Basic heating equipment for oil-fired systems

As noted in Chapter 1, most oil-fired heating systems today are either forced-air or hydronic systems. This chapter discusses the equipment that makes up these two distinct systems.

Equipment for forced-air systems

Design and operation

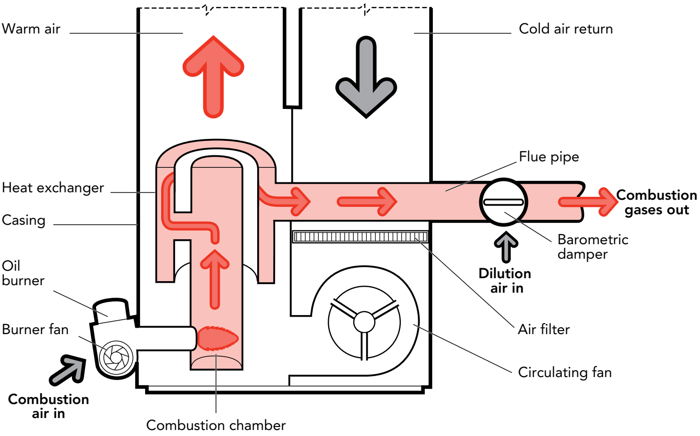
Figure 2 illustrates a basic oil-fired, forced-air heating system. This system consists of a burner fed by heating oil firing into a combustion chamber in the furnace. The oil storage tank is usually located in the house. The combustion gases pass through the furnace, where they release heat across a heat exchanger. The gases are then exhausted to the outside through a flue pipe and chimney.

For most systems, a barometric damper, acting as a valve in the flue pipe, isolates the burner from changes in pressure at the chimney exit by pulling varying quantities of heated room air into the exhaust. A circulating fan passes cool house air from the cold air return ducts over the furnace heat exchanger, where the air warms up and then passes into the hot air ducts, which distribute the heated air throughout the house.

Notice that there are two separate air movement paths. The first, the combustion path, supplies air to the burner and follows the hot combustion gases through the heat exchanger and flue pipe to the chimney and out of the house. The combustion path also includes dilution air drawn through the barometric damper. The second path circulates and heats the air within the house.

In many houses, the quantity of dilution air drawn through the barometric damper is much larger than that required for combustion and can represent from 3 percent to 15 percent of the heat loss in the house. Therefore, anything that reduces this dilution airflow without compromising the performance of the furnace will lead to increased fuel savings and efficiency.

FIGURE 2
Oil-fired forced-air furnace



Some new furnaces have an optional direct connection for using outside air for combustion (sealed combustion) instead of using indoor air. However, this method can have problems. On a cold winter day, if the air is not warmed somewhat before it reaches the burner, it can cool the fuel oil and cause start-up problems.

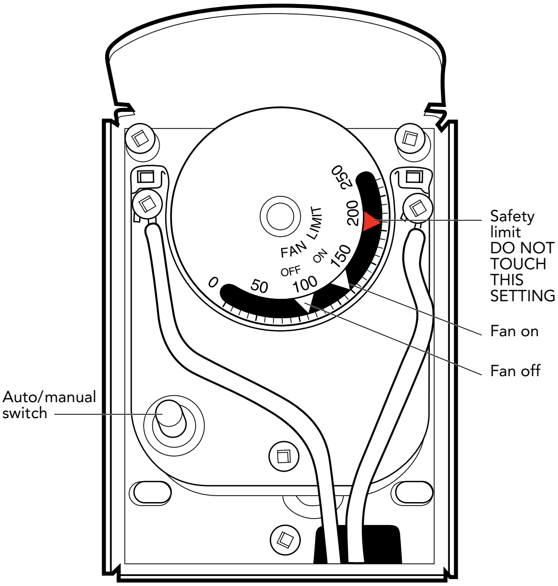
Maximizing effectiveness in forced-air heating systems

The performance of an existing forced-air heating system can be improved in several ways.

Adjusting the furnace fan

In older, oil-fired furnaces, heat output from a forced-air system can often be increased by adjusting the controls that turn the fan on and off automatically. The fan controls are usually in a metal box, on the front of the furnace, near the top. To remove the cover, you must either squeeze it or remove some screws. Inside the box is a temperature dial with three pointers (Figure 3): the lowest setting is the fan OFF pointer; the next is the fan ON setting; and the third and highest pointer is the safety limit control that shuts the burner off if the furnace gets too hot. This safety limit is normally set at the factory. Do not adjust the safety limit setting.

FIGURE 3
Circulating fan control



The ON and OFF fan control pointers are usually set for an ON temperature of 66°C (151°F) and an OFF temperature of 49°C (120°F). To increase the amount of heat taken from the furnace, most heating experts now recommend changing the ON temperature to 49°C (120°F) and the OFF temperature to 32°C (90°F). These changes make the fan come on sooner after the burner starts up and stay on longer after it shuts down, allowing the circulating air to extract more heat from the furnace and lose less heat up the chimney or through the vent.

The fan control dial is spring-mounted, so you must hold it firmly with one hand while you adjust the pointer with the other. After you replace the cover of the metal box, ensure the “auto/manual” switch is set to auto. **If you feel uncomfortable or unsure of what to do to modify these settings, ask your furnace service person to make the setting changes for you.**

These changes may result in slightly lower air temperatures from the registers at the beginning and end of the furnace cycle. If the cooler air at either end of the furnace cycle makes you feel uncomfortable, try raising the fan ON setting to 54°C (129°F) or the fan OFF setting to 38°C (100°F), or try both.

A two-speed fan will allow you to get even more heat out of the furnace while providing for continuous air circulation and more even temperatures throughout the house while the furnace is off. However, using this fan will increase your electricity bill.

As mentioned previously, some of the new high-efficiency furnaces use a more efficient, variable-speed, brushless DC (often called ECM) motor to run the circulating fan. The speed of the fan depends on the heat demand. For extended or continuous fan operation, such a unit can save a significant amount on your electricity bill while making the delivery of heat more even and comfortable.

Getting the heat where you want it

Uneven heat distribution is sometimes a problem, which results in the inability to heat some rooms in the house, such as upstairs bedrooms. This problem can be caused by warm air leaking through the joints of the heating ducts or heat loss from ductwork passing through the basement or through unheated areas such as a crawl space, an attic or a garage. When the circulating fan is running, the rate of heat loss can increase significantly if leaky ducts are in an exterior wall, an attic or a crawl space. This is one more good reason to ensure all the ducts are well sealed.

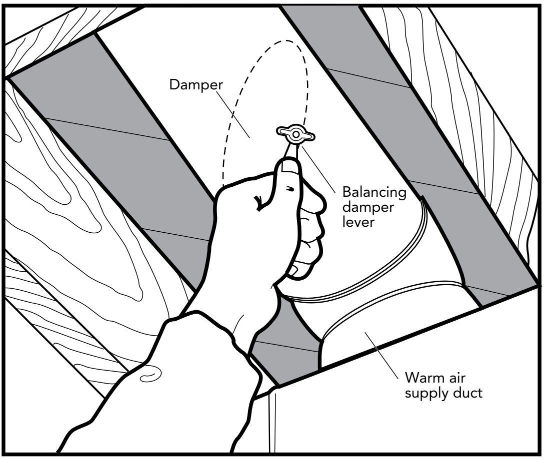
Sealing all joints in the ductwork with a water-based duct mastic (sealant) will reduce or eliminate warm air leaks. High-temperature duct tape may seal the joints but it tends to degrade or permit air leakage over time.

You should seal ducts that pass through an unheated area such as a crawl space or an attic, then wrapped them with batt or **duct insulation**. Do the same for long duct runs in the basement. It is recommended that the warm air plenum and at least the first three metres (10 feet) of warm air ducting be insulated as a minimum. A better practice is to insulate all the warm air ducts you can access. Use batt insulation with foil backing, or enclose the insulated ducts in the joist space.

If your basement is presently heated by the heat loss from the ducts, you may need to install additional registers there after you insulate the ducts. Adding the registers will ensure that the heat will be going only where you want it, when you want it, without being lost along the way.

Rooms that are on upper floors or far from the furnace are sometimes difficult to heat because of the heat losses described above and also because of pressure losses from friction and other restrictions to airflow (such as right-angle bends) in the ductwork. This problem can sometimes be corrected by slight modifications to the ductwork after the ducts have been sealed and insulated and by balancing the dampers in the supply ducts (Figure 4) to redirect the airflow from the warmer areas to cooler areas.

FIGURE 4
Balancing damper in the supply duct



In some forced-air distribution systems, balancing dampers may be located in the secondary warm air ducts, close to where they branch off from the rectangular main heating duct. Often, the balancing dampers can be identified by a small lever on the outside of the duct, as shown in Figure 4. The position of this lever (or, sometimes, a slot in the end of the damper shaft) indicates the angle of the unseen damper inside the duct. If there are no such dampers, you will have to use the ones in the floor registers.

Start by closing the dampers in the ducts that supply heat to the warmest rooms (even if completely closed, they will still supply some heat to these rooms). Wait a few days to see what effect this has on the overall heat balance, then make further adjustments as necessary. Such adjustments may reduce slightly the total airflow through the furnace, but this will be balanced to some extent by a slight increase in the temperature of the delivered air.

However, you should be careful about making adjustments yourself. It may be more practical to have a trained service technician do the adjustments. If you reduce the airflow too much, you could cause an undesirable rise in the temperature inside the furnace plenum. It is a good idea to have this furnace temperature rise checked by a furnace service person.

Most houses have inadequate cold air returns, which results in insufficient airflow through the furnace. Putting additional cold air returns in the living area, particularly in the bedrooms, can improve air circulation and heating system efficiency while also improving comfort and air quality in the house.

Dangerous and incorrect methods: An incorrect method for solving the problem of too few cold air returns has been to open the cold-air return ductwork or the plenum in the basement area near the furnace or to remove the furnace access panel near the air filter. **These methods are dangerous.** The depressurization caused by the circulating fan can disrupt the combustion and cause spillage or backdrafting of combustion products. These combustion products can then be circulated through the house instead of exhausting through the chimney. **In certain cases, this can cause carbon monoxide (CO) poisoning.**

If stubborn heat distribution problems cannot be corrected by damper adjustments and other duct modifications, have a qualified serviceperson do a complete balancing of your distribution system.

Automatic setback thermostats

The easiest way to save heating costs is to lower the temperature setting on the house thermostat when possible. An automatic setback thermostat will adjust your home's temperature automatically. These thermostats have a mechanical or electronic timer that allows you to set household temperatures for specific periods of the day and night. As a general rule, you will save 2 percent on your heating bill for every 1°C you turn down the thermostat overnight.

You could program the thermostat to reduce the temperature a short while before you go to bed and to raise it again before you get up in the morning. For very well-insulated houses, you might well extend these delays even more. You could also program it to reduce the temperature for any period during the day when the house is unoccupied and to restore the temperature shortly before you return. A good guide is to have the temperature set at 17°C (63°F) when you are sleeping or not at home and at 20°C (68°F) when you are awake and home.

Experiment with the thermostat until you find the most comfortable and economical routine for your family.

If you have a hydronic (hot water) system, you can also reduce energy use through zone control. In this system, thermostat-controlled valves on each radiator permit the control of individual room temperatures. A plumbing and heating contractor can provide more information about zone control and can install the required equipment when the heating system is installed.

Hydronic systems respond much more slowly than warm air systems. Therefore, to achieve savings with thermostat cutback, you must turn the thermostat down long before you go to bed and have it automatically turn up long before you get up in the morning.

Zone controls are also available for forced-air heating systems, usually with dampers in main duct passages driven by separate thermostats in different areas of the house, although zoning is much less common in hydronic systems.

Automatic setback thermostats (continued)

Improved thermostats

More sophisticated electronic and self-tuning thermostats are also being developed. These are very sensitive and help reduce the temperature "swing" from an average range of 1.5° to 2°C to 0.5° to 1°C, ensuring that the heating system turns on and off as close to the required temperatures as possible. Energy savings from these advanced mechanisms can vary, but comfort is usually enhanced. However, in some cases, this may make the burner cycle much more frequently, with a loss in efficiency, and may compromise the integrity of your furnace or venting system. In these cases, it may be worthwhile for you to purchase a variable-speed motor. Instead of making frequent starts and stops, it changes speeds.

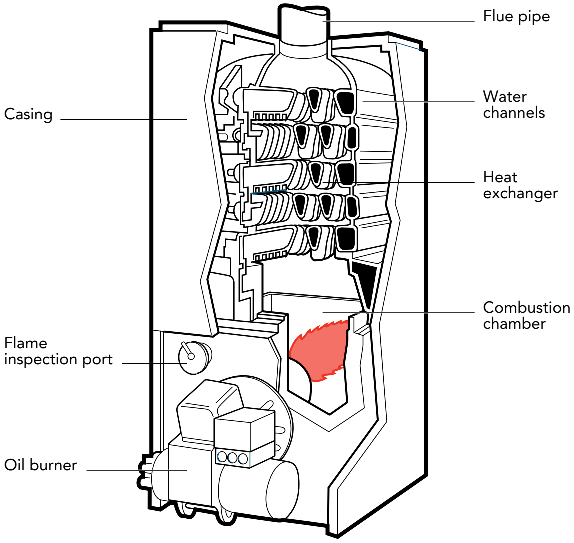
Equipment for a hydronic (hot water) heating system

Design and operation

A hydronic heating system uses hot water to distribute the heat throughout the house and has the following three basic components:

- a boiler to heat the water
- heating units in most rooms, usually baseboards or radiators, which are often located on an outside wall. Recently, radiant floors have become a desired feature for new homes, where relatively "cool" warm water at around 43°C (110°F) is circulated through an array of pipes under the floor
- a pump to circulate the water from the boiler to the radiators and back through a piping system

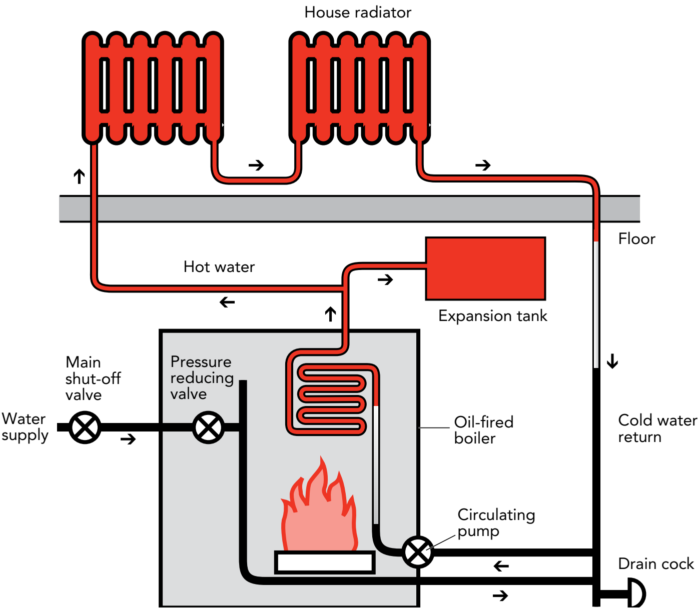
FIGURE 5
Oil-fired boiler



An oil-fired boiler (Figure 5) uses the same type of burner as an oil-fired, forced-air furnace, although a boiler is often smaller and heavier. There is no circulating fan and filter housing as there is in a forced-air system. Instead, most boilers require a circulating pump to push heat through the pipes and the radiator system, as shown in Figure 6. The seasonal efficiency of old conventional hydronic systems is similar to that of conventional forced-air systems, which is approximately 60 percent.

FIGURE 6

Hydronic heating system



Maximizing effectiveness

The performance and efficiency of a hydronic heating system can be improved in several ways.

Improving heat distribution

Old-fashioned gravity systems that circulate water or steam by natural convection are much less efficient than systems that have a circulating pump. Slow heat circulation may cause house temperatures to fluctuate noticeably between firing cycles. It can also take a long time to restore the house temperature after a nighttime thermostat setback.

Moreover, a gravity system cannot circulate hot water to radiators or baseboard heaters in basement living areas that are below the level of the boiler. These problems can be overcome by adding a circulating pump and replacing the open expansion tank with a sealed and pressurized expansion tank near the boiler. If you have a gravity system, discuss the possibility of upgrading it with your plumbing and heating contractor.

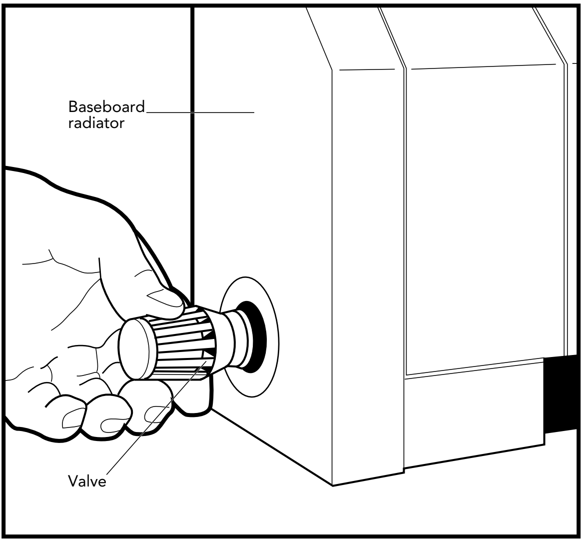
Balancing the heat

Balancing the heat delivered to different areas of the house is as important with a hydronic heating system as it is with a forced-air heating system. Radiators are often fitted with a manual valve that can control the amount of water flowing through them. Such valves can vary the heat delivered to different rooms in the same way that balancing dampers do in a forced-air heating system.

A thermostatic radiator valve (Figure 7) can be set to vary the heat output automatically in any room. In the radiator valve system, the water must pass through all the radiators, one after the other, on its way back to the boiler. Therefore, this method does not work with radiators or baseboard heaters installed in a "series loop" system.

If there is more than one loop in the system, some balancing of the heat output can be achieved by adjusting the valves that control the water flow through each loop. The heat output of baseboard units can also be controlled to some extent by regulating the built-in damper, which operates much like the damper in a warm air register.

FIGURE 7
Thermostatic radiator valve



Water temperature controllers

Conventional hydronic heating systems have the boiler water temperature set at 82°C (180°F). A controller can reduce energy consumption by adjusting the temperature of the circulating water in relation to heating load changes. Outdoor temperature is the primary variable in heat load. As it gets warmer outside, the controller reduces the boiler water temperature to a level that will maintain the design inside temperature. This is called "outdoor reset control." If the temperature is reduced too much on non-condensing boilers, corrosion can occur.

Homeowners can improve the efficiency of their heating systems by investing in one or more of the improvements described in the following section.

Upgrades and add-ons to basic oil furnaces and boilers

Downsizing heat output and improving combustion are two ways to upgrade a oil-fired heating system. Descriptions of these approaches follow.

Downsizing heat output

Most residential oil furnaces or boilers manufactured before the late 1970s have a cast-iron head burner. This kind of burner has a relatively low seasonal efficiency of approximately 60 percent. If you don't know what type of burner you have, ask your service person.

There are four main reasons for this low seasonal efficiency: an inefficient conventional burner; an inefficient furnace; air dilution; or an oversized system.

Most heating systems in older homes are greatly oversized. As well, homeowners have often added insulation, caulking, and weatherstripping, and made other improvements, to reduce heat loss and cut fuel consumption. As a result, the old systems are even more oversized.

We know that an automobile gets much better fuel economy when cruising on the highway than when continually starting, accelerating and decelerating in the city. Like an automobile, most oil furnaces perform best when running at their steady-state condition, with the maximum stable flue gas temperature. But the burner must run for between 7 and 20 minutes (min) to reach this point, and some oversized units may never run long enough to get there, even on the coldest days.

Ideally, the oil burner would run continuously when the outside temperature is at the lowest temperature expected for your area, or at what is called the “design temperature.” At that point, the furnace would be operating close to the steady-state efficiency for which it was rated. A running time of 45 to 50 min/h at your local coldest design temperature is a practical goal. Discuss this concern with your service person.

An oil heating system can be downsized just by replacing the oil burner nozzle with a smaller one. Nozzles are rated in United States gallons per hour with typical sizes of 1.1, 1.0, 0.85, 0.75, 0.65, 0.60 and 0.50. (1.0 U.S.gph = 140 000 Btu/h = 0.15 GJ/h).

With old cast-iron head burners, you should be careful not to reduce the firing rate too much because that will cause incomplete combustion and reduced furnace efficiency. If you have such a burner, you should consider reducing the nozzle only one size. In any case, with a conventional burner, the nozzle size should not be reduced below the minimum firing rate given on the manufacturer’s rating plate.

Many old oil furnaces have been retrofitted with a flame-retention head burner, which has improved their seasonal efficiency. Most oil furnaces and boilers installed in the past 15 to 20 years will have a flame retention head burner as standard equipment. With a flame-retention head burner (see Figure 8), the nozzle size can be reduced significantly, as good combustion performance can be maintained; the lower limit on the firing rate is governed by the flue gas temperature leaving the furnace. In general, you should maintain a furnace exit temperature above 204°C (400°F) if you have an outside chimney and 177°C (350°F) if you have a chimney inside the house. The proper nozzle size for your house and heating needs can be determined by your service person.

Improving combustion system performance

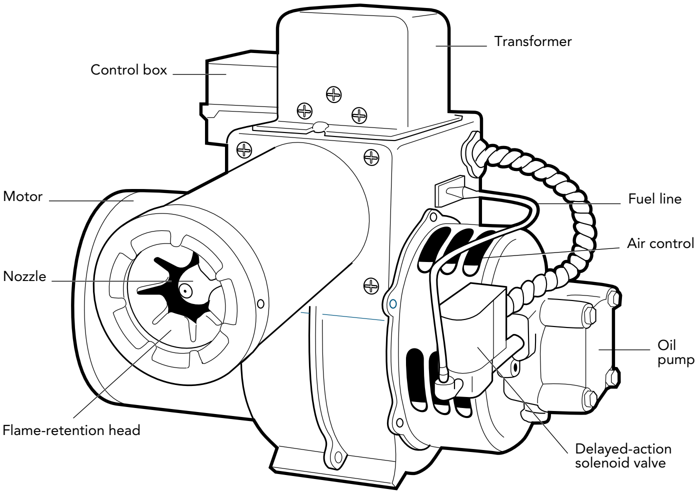
Several relatively straightforward things can be done to improve combustion performance and the efficiency of an existing oil-fired furnace or boiler.

Install a flame-retention head burner or a high-static burner

The performance of an oil-fired heating system depends, to a large extent, on how well air and fuel oil are mixed in the burner, a function performed by the atomizing spray nozzle that mixes air and fuel into a combustible mist.

FIGURE 8

Flame-retention head burner



Compared to the old cast-iron head burner, a flame-retention head burner does a much better job of mixing air and fuel. This efficiency reduces the amount of air required for good combustion. The result is a narrower, hotter flame from the same amount of fuel (see Figure 9, page 36).

Flame-retention head burners are now standard on new furnaces and can also be added to most older furnaces. Contact an oil service firm or fuel supplier to discuss a flame-retention head for your system.

High-static burners

New burners which have advanced combustion heads that operate at high-static pressure can run at even lower excess air levels than previous models. The increase in efficiency can be close to 20 percent.

As well, the high-static burner is powerful and can overcome pressure fluctuations generated at the vent termination and produce a stable flame even under adverse weather conditions. The pressure drop across the burner head also stops heated house air from flowing through the burner, combustion chamber and furnace, and out the chimney during the furnace off-cycle.

The high-static pressure makes the burner almost completely unaffected by depressurization within the house, which is a good quality to have in an airtight home. The high-static burner can also run as a sealed combustion unit.

Because of the many advantages of a high-static burner, it is recommended that any new furnace or boiler you buy be equipped with one.

Venting an increased-efficiency appliance

You should have a technician inspect your chimney if you replace the burner with a flame-retention head or a high-static burner, or replace your furnace or boiler to increase the efficiency of your existing system.

If it is a masonry chimney located on the outside wall of your house, it is probably too big for the amount of gases that will be going through it now. The flue gases can cool and condense in the chimney, causing the brick to deteriorate over time. Installing a stainless steel, double-walled flue pipe from the furnace to the chimney and/or a stainless steel liner in the chimney can prevent condensation from forming. Also, these changes can reduce the chimney draft and improve the overall performance of your heating system.

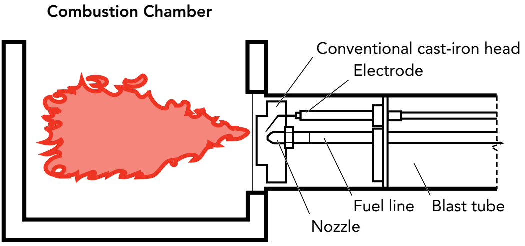
Install a delayed-action solenoid valve

An oil-fired heating system wastes heat if incomplete combustion causes a heavy layer of soot to form on the inside of the heat exchanger. Using a flame-retention head burner reduces the amount of incomplete combustion. However, a significant amount of soot can still be produced at the beginning and end of each firing cycle, which can also leave the smell of oil in the house.

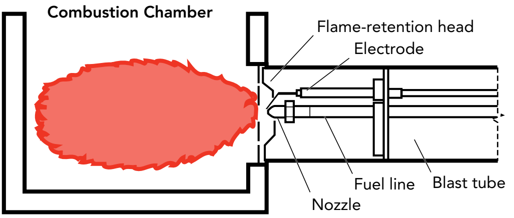
You can dramatically reduce, and even eliminate, soot formation and the associated odours by installing a delayed-action solenoid valve on the burner between the oil pump and the burner nozzle (see Figure 8, page 34).

FIGURE 9
Flame patterns with different burner heads

Flame with Conventional Cast-Iron Head Burner



Flame with Flame-Retention Head Burner



3 Furnace efficiency

Since the fuel price scare of the early 1970s, the industry has been working to improve the efficiency of furnaces and boilers. The introduction of improved burners with flame-retention heads was the first major step in boosting the efficiency of conventional oil-fired heating equipment. The high-static burner, which has recently come onto the market, has further enhanced the efficiency capability of heating systems.

Manufacturers have produced a “mid-efficiency” class of oil furnace that uses the new high-static burners. As well, they have developed a condensing furnace that cools the combustion gases enough to recover the heat that is normally lost in the form of water vapour.

New technologies are allowing appliances to integrate efficiently two functions, such as space and water heating, simultaneously.

Several oil-fired systems that are vented directly out the side wall of the house, thereby eliminating the need for a chimney, have been approved in Canada.

Mid-efficiency oil furnace

Another non-condensing, mid-efficiency furnace (Figure 10) features an improved low-mass combustion chamber (usually ceramic fibre) and passes the hot combustion gases through a heat exchanger that enables the circulating house air to extract more heat. In the most efficient designs, the barometric damper is not needed and it is not necessary to dilute exhaust gas with house air.

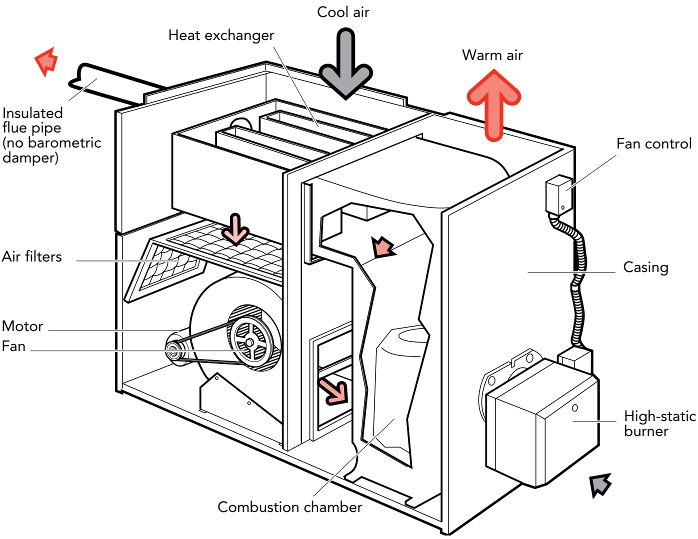
A mid-efficiency furnace must keep the exiting gases above a certain temperature to prevent water vapour in the flue gas from condensing inside the furnace or venting system, where it can cause corrosion and other serious problems. The exit temperature of the combustion gases can be as low as 150°C (302°F).

Some of the new oil-fired equipment can be vented directly though the side wall of the house without using a chimney.

One side wall-venting type uses the forced draft of a high-static burner to expel combustion gases. Others also use sealed combustion with a high-static burner.

Another side wall-venting system uses an additional induced draft fan, normally mounted downstream of the furnace on the inside wall of the house. This fan pulls the gases from the furnace out of the house through an exhaust vent. Some of these sidewall systems require dilution air from the house or have a long run time after the burner shuts off to purge the furnace system of any combustion gases. The last two types reduce efficiency.

FIGURE 10
Mid-efficiency oil furnace



The benefits of a good mid-efficiency furnace are

- much lower combustion and dilution air requirements
- more power to exhaust the combustion products (an advantage in newer, more airtight, housing)
- a safety shut-off in case of draft problems
- a more effective venting system

Mid-efficiency furnaces may have a seasonal efficiency of 83 percent to 89 percent and may use 28 percent to 33 percent less fuel than an old conventional furnace that produces the same amount of heat.

Heating industry experts believe that new technology furnaces, small enough to fit the needs of even super-insulated houses, will be the next major development in oil heating. This innovation can come about in two ways – by developing alternative technology for oil burners or by integrating the functions of various home energy requirements, such as space and water heating systems.

Condensing oil furnace

Heat is carried away not only in the high temperature of the flue gases but also in the water vapour they contain. The water vapour that is produced when fuel is burned holds a substantial amount of latent heat. For natural gas, this latent heat is approximately 11 percent of the energy in the fuel. Oil, on the other hand, produces only half the water vapour of natural gas; thus, oil has much less energy in the form of latent heat.

A condensing furnace uses a second heat exchanger that is made of stainless steel to extract more heat from the combustion gases before they leave the furnace. This practice reduces the exit temperature to between 40° and 50°C (104° and 122°F). The result is that water vapour from the flue gas condenses inside the heat exchanger and releases its latent heat to the house air that is circulating through the furnace. At this time, the combustion gases are so cool that they require only a narrow plastic vent pipe that goes out the side wall of the house instead of up the chimney. The condensate runs to a drain outlet.

The potential for efficiency improvements by condensing the flue gas is much lower for oil than for natural gas because:

- the dew point for oil is lower than for natural gas because oil contains only half as much hydrogen as natural gas. Consequently, the furnace has to work harder to condense less;
- the condensate from oil is corrosive because of its higher sulphur level, so that a condensing heat exchanger for oil must be more corrosion-resistant than one for natural gas;

- oil combustion also produces some soot, which can concentrate the acidic condensate as "acid smut" on the surface of the heat exchanger.

A new condensing oil furnace is available that addresses many of these issues. It uses a very high quality heat exchanger and a high-static burner. Plastic CPVC or ABS pipe can be used to vent the combustion products out the side wall of a house without a chimney because the flue gas temperature is very low (≈40°C). It is too soon to know if all the concerns with oil-fired condensing systems have been resolved by this furnace, but the results to date look promising.

In-house condensation problems

More efficient heating systems, combined with better draft proofing and insulation, can result in less air infiltration which, in turn, may lead to excess moisture in the house, particularly on cold winter days.

Heavy condensation on the inside of windows and dampness or mould growth on walls or ceilings are indications of too much moisture. If these are not corrected, serious structural damage will eventually occur; luckily, indoor condensation problems can be solved.

Because most of the indoor humidity is caused by regular household activities (such as showering and cooking), your first step should be to reduce the amount of moisture from these sources. You can do this, for example, by ensuring that your clothes dryer vents to the outside, using lids on pots when cooking, and keeping showers short.

The *National Building Code of Canada* requires that all new homes have some form of ventilation, although provincial or territorial regulations may not. However, you should consider installing exhaust fans in the bathroom and kitchen that vent directly to the outside.

You should also check the humidifier setting on your furnace, if it is equipped with one. It may not be necessary to have a humidifier in a more airtight house. You should also talk to a contractor about installing an HRV that will increase the ventilation in your house and decrease humidity without wasting energy.

In-chimney condensation problems

In-chimney condensation is another possible problem. The lower flue temperature achieved by the improved efficiency of today's heating equipment has created the possibility of flue gas condensation damaging the inside a masonry chimney, particularly one located on the outside wall where it is chilled by exposure to the outside air.

Look for a white, powdery efflorescence on the outside of the chimney, spalling or flaking of the bricks, crumbling mortar joints, wet patches on inside walls behind the chimney, pieces of tile at the bottom of the chimney, and water running out of the cleanout door or around the bottom of the chimney behind the furnace.

The most common cause of these problems is condensation inside a cold chimney. Water vapour is produced when oil or natural gas is burned, but humid house air drawn into the chimney also contributes to the problem.

Another cause of condensation is chimneys being larger than necessary. Furnaces that are more efficient need chimneys that are smaller than the 200 mm × 200 mm (8 in. × 8 in.) flue tile that had been standard for many years. The combustion gases, already cooled by the improved heat exchanger in the furnace, rise slowly in the cold, oversized flue, where they are sometimes cooled to the dew point of the water vapour they contain. The resulting condensation can then leak into the bricks and cause structural or water damage.

Simple remedies are available if the damage is found in time. The use of a double-walled stainless steel flue pipe from the furnace to the chimney or a stainless steel chimney liner, or both, can usually stop this damage.

Other solutions to these problems are described in Chapter 6.

4 Comparing annual heating costs

The combination of annual heating load, energy source and equipment efficiency determines the annual cost of heating.

For help determining your annual heating costs, NRCan has developed an online tool called the "Home Heating Cost Calculator," which is at oee.nrcan.gc.ca/equipment/heating/13082.

Heating costs when upgrading an existing oil heating system

If you are currently heating with oil and are considering converting to a more efficient oil heating system, you may be interested in determining the savings you could expect. Table 1 (page 43) and the following formula can provide reasonably accurate figures. You need to know your annual fuel cost and the type of heating technology you are using.

$$\text{Annual cost savings} = \frac{A - B}{A} \times C$$

Where A = seasonal efficiency of the proposed system
B = seasonal efficiency of the existing system
C = current annual fuel cost

Example: How much would you save by changing from an old oil furnace to a new oil furnace with a high-static burner at 85 percent efficiency, if your current annual fuel cost is $1,205?

The seasonal efficiency of the new furnace with a high-static burner is taken to be 85 percent, and the present oil furnace efficiency is 60 percent. Hence, A = 85 percent, B = 60 percent, (these numbers represent an average of the efficiency ranges given in Table 1) and C = $1,205.

$$\text{Annual cost savings} = \frac{85 - 60}{85} \times 1205 = \$354$$

Thus, you would save $354 per year with this new oil furnace.

TABLE 1
Typical heating system efficiencies and energy savings

Energy source	Technology	Seasonal efficiency (AFUE) (%)	Energy savings (% of Base*)
Oil	Cast-iron head burner (old furnace)	60	Base
	Flame-retention head replacement burner	70–78	14–23
	High-static replacement burner	74–82	19–27
	New standard model	78–86	23–30
	Mid-efficiency furnace	83–89	28–33
	Condensing	90+	
	Integrated space/tap water** (mid-efficiency)	60–87	0–31 space 0–41 water
Natural gas	Conventional	60	Base
	Vent damper with non-continuous pilot light	62–67	3–10
	Mid-efficiency	78–84	23–28
	High-efficiency condensing furnace	89–97	33–38
	Integrated space/tap water** (condensing)	60–95	0–37 space 0–47 water
Electricity	Electric baseboards	100	
	Electric furnace or boiler	100	
	Air-source heat pump	1.7 COP***	
	Earth-energy system (ground-source heat pump)	2.6 COP***	
Propane	Conventional	62	Base
	Vent damper with non-continuous pilot light	64–69	3–10
	Mid-efficiency	79–85	21–27
	Condensing	87–94	29–34
Wood	Central furnace	45–55	
	Conventional stove (properly located)	55–70	
	"High-tech" stove**** (properly located)	70–80	
	Advanced combustion fireplace	50–70	
	Pellet stove	55–80	

* "Base" represents the energy consumed by a standard furnace.

** Precise data will be available after the new standard is developed.

*** COP = Coefficient of performance, a measure of the heat delivered by a heat pump over the heating season per unit of electricity consumed.

**** CSA B415 or EPA Phase II tested.

Heating costs with various energy sources

You may be interested in calculating the cost of heating with oil and also comparing this amount to the costs of heating with other energy sources such as electricity, natural gas, propane or wood. To do this, you can use the following steps. You need to find out the cost of the energy sources you wish to compare and the types of heating technologies that you might want to use.

Step 1: Determine the cost of energy sources in your area

Call your local oil, gas and electricity suppliers to find out the cost of energy sources in your area. This should be the total cost delivered to your home, and it should include any basic cost that some suppliers might charge, together with necessary rentals, such as a propane tank.

Be sure to get the prices for the energy sources in the same units as shown in Table 2. Write the costs in the spaces provided. If your local natural gas price is given in gigajoules, you can convert it to cubic metres (m^3) by multiplying the price per GJ by 0.0375. For example, $5.17/GJ × 0.0375 = $0.19/$m^3$. Fuel oil is usually sold in litres.

TABLE 2
Energy content and local cost of various energy sources

Energy source	Energy content *Metric*	*Imperial*	Local price
Oil	38.2 MJ/L	140 000 Btu/gal. (U.S.)	$0. _________ /L
Electricity	3.6 MJ/kWh	3 413 Btu/kWh	$0. _________ /kWh
Natural gas	37.5 MJ/m^3	1 007 Btu/cu. ft.	$0. _________ /$m^3$
Propane	25.3 MJ/L	92 700 Btu/gal. (U.S.)	$0. _________ /L
Hardwood*	30 600 MJ/cord	28 000 000 Btu/cord	$_________ /cord
Softwood*	18 700 MJ/cord	17 000 000 Btu/cord	$_________ /cord
Wood pellets	19 800 MJ/tonne	20 000 000 Btu/ton	$_________ /tonne

Conversion 1000 MJ = 1 GJ

*The figures provided for wood are for a "full" cord, measuring 1.2 m × 1.2 m × 2.4 m (4 ft. × 4 ft. × 8 ft.). In practice, wood is usually sold as a face cord, which is typically one third of a full cord.

Step 2: Select the type of heating appliance

Choose the type of equipment you want to compare from the list of appliance types in Table 1 on page 43. Note the efficiency figures in the column titled “Seasonal efficiency.” By using these figures, you can calculate the savings you can achieve by upgrading an older system to a newer, more energy-efficient one or by choosing higher efficiency appliances with alternative energy sources.

Step 3: Determine your home’s annual heating load

If you know your heating bill and the unit cost of your energy source, you can determine your annual heating load in gigajoules using the following equation.

$$\text{Annual heating load} = \frac{\text{heating bill}}{100\ 000} \times \frac{\text{seasonal efficiency}}{\text{energy cost/unit}} \times \text{energy content}$$

For example, you have an oil bill of $ 1,700, an oil cost of $0.529/L and a conventional oil furnace and burner (seasonal efficiency of 60 percent from Table 1).

$$\text{Annual heating load} = \left(\frac{1770}{100\ 000}\right) \times \left(\frac{60}{0.529}\right) \times 38.2 = 77\text{ GJ}$$

If your bill also includes tap water heating from the same energy source, you can still calculate your annual heating load, but it will require a little more care and calculation to separate the heating portion.

If you can’t get your heating bill, you can estimate your annual heating load in gigajoules from Table 3 (page 47) by selecting the house type and location that is closest to your own.

Step 4: Use the formula

The annual heating cost is calculated as follows.

$$\frac{\text{Energy cost/unit}}{\text{energy content}} \times \frac{\text{annual heating load}}{\text{seasonal efficiency}} \times 100\,000 = \text{heating cost}$$

- Enter the cost per unit of energy and divide it by the energy content of the energy source; both numbers come from Table 2 (page 44).
- Select the annual heating load for your type of housing and location from Table 3 (page 47); divide it by the seasonal efficiency of the proposed heating system from Table 1 (page 43).
- Multiply the results of these two calculations, then multiply that result by 100 000.

The result gives you an approximate heating cost for your house. If you know your actual annual heating costs, as well as the type of heating system you have, you can modify the heating load originally taken from Table 3 to suit your specific house.

Sample calculation: You have a new semi-detached home in Fort McMurray and you want to know what the annual heating cost would be with a mid-efficiency oil furnace at 83 percent efficiency. Using the above formula, we can define the cost of oil as $0.529/L, the house heating load as 80 (Table 3) and the energy content as 38.2 (Table 2).

Annual cost of oil heating:

$$\frac{\$0.52930}{38.2} \times \frac{80}{83} \times 100\,000 = \$1330$$

If you want to compare this heating cost with those of other types of heating systems or energy sources, replace the numbers in the formula with the appropriate ones for your comparison using Tables 1 and 2 (pages 43 and 44).

TABLE 3
Typical annual heating loads for various housing types in Canadian cities

City	Old detached	New detached	New semi-detached	Town-house
Victoria	85	60	45	30
Prince George	150	150	110	60
Calgary	120	90	65	50
Edmonton	130	95	70	55
Fort McMurray/Prince Albert	140	105	80	60
Regina/Saskatoon/Winnipeg	130	90	70	50
Whitehorse	155	115	85	60
Yellowknife	195	145	110	80
Thunder Bay	130	95	70	55
Sudbury	120	90	65	50
Ottawa	110	75	55	40
Toronto	95	65	45	35
Windsor	80	55	40	30
Montreal	110	80	60	45
Québec City	115	85	65	50
Chicoutimi	125	90	70	55
Saint John	105	75	60	45
Edmundston	120	90	65	50
Charlottetown	110	80	60	45
Halifax	100	75	55	40
St. John's	120	85	60	45

Note: "New" means houses built in 2004 or later, and "old" means houses built before 2004. Due to construction practices, "weatherizing" and re-insulating can be different from house to house so that these figures are meant to be used only as general guidelines. They should not substituted for an accurate heating requirement determination, as discussed in Chapter 5.

Assumptions:
Old detached – approximately 186 m^2 (2000 sq. ft.)
New detached – approximately 186 m^2 (2000 sq. ft.)
New semi-detached – approximately 139 m^2 (1500 sq. ft.)
Townhouse – inside unit, approximately 93 m^2 (1000 sq. ft.)

5 Buying, installing or upgrading a system

You cannot shop for a furnace in the same way that you shop for a camera or a pair of shoes. There are few "furnace stores" where the different makes and models may be examined, compared and priced. To get first-hand information on the different makes and models available, you will have to contact several heating firms. Ask them for the manufacturers' illustrated sales literature for the furnaces they sell and install. You should also contact your oil supplier or a contractor for assistance and information.

If you have decided on a particular type of furnace, read the literature carefully to find out if it describes the features you are looking for – such as a high-static flame-retention head burner and a delayed-action solenoid valve. Look for its efficiency rating. You want the seasonal (AFUE) rating, not just the steady-state efficiency. Make sure you distinguish between the two types of ratings. Compare it with Table 1 on page 43.

As previously mentioned, even the best oil furnaces do not run at their maximum efficiency if they are oversized, and they can make your home uncomfortable. Do not automatically buy a new furnace that is the same size as your present one; it may be as much as three times too large.

A heating contractor cannot determine the size of furnace you need just by walking through your house. The contractor has to calculate the heating requirements of your house using one of the following methods:

- using the fuel consumption of your present furnace over a known winter period together with
  - the nozzle size
  - the steady-state efficiency
  - the degree-days between oil deliveries
  - the amount of oil consumed over that period
  - the design temperature for your region

- making a thorough measurement and examination of your house to determine
  - size
  - insulation levels
  - degree of air tightness of the house envelope

If the contractor does not use any of these factors, his or her calculation of the correct size for your new furnace will be just a guess.

To make sure proper furnace sizing is determined, the quotation and contract should include a statement such as this one: **"The furnace size will be determined by a heat loss calculation using the formulas published by: the Canadian Oil Heat Association; the Heating, Refrigerating and Air Conditioning Institute of Canada; the Canadian Standards Association; Natural Resources Canada; or other recognized organization. A copy of these calculations will be given to the homeowner."**

It is important to hire a contractor who will install your equipment properly to ensure that it will operate efficiently. Check with your local fuel dealer or provincial/territorial heating fuel regulatory office to find out how to contact a qualified, registered or licensed contractor. If your neighbours have had similar work done recently, ask them how satisfied they were with their contractors. If you are buying a relatively new type of furnace design, try to get the names of other homeowners who have had such equipment installed, and find out about the appliance's performance and the work of the installer.

Before you decide what to buy, obtain firm, written bids from several companies on the cost of

- upgrading your existing equipment
- buying and installing a completely new unit
- any other fittings and adjustments required, including changes to any ductwork or piping
- a final balancing of the heat supply to the house

With these figures and a reasonable estimate of the probable annual fuel savings determined from Table 1 on page 43, you can determine how long it will take to recover the cost. The payback period is not the only factor to consider but it is certainly one of the most important.

Remember that a building permit may be required for this type of work, and the contract should state whether the installer or the homeowner is responsible for obtaining it.

Checklist for installing an oil heating system

Get several estimates on the work to be done. When you are comparing these estimates, cost will be an important factor, but there are other elements to consider. Some contractors are better at explaining what has to be done. Some may use higher-quality components, and others may schedule the work at your convenience.

Estimates should include the following items.

- The total cost of **all** necessary work.
- An itemized list of **all** material and labour costs included in the bid:
  - – alteration or improvement of existing heat distribution ducts;
  - – installation of the furnace and oil supply piping and ductwork;
  - – installation of the water heater and vent (where applicable);
  - – installation of a chimney liner and any attendant masonry work;
  - – additional equipment such as humidifiers, air cleaners or air conditioners.
- A statement describing how much of any existing equipment will be used in the new system.
- A rough diagram showing the layout of ductwork or water pipes and the location of supply piping and heating equipment.
- A statement that clearly defines who is responsible for
  - – all permits and the payment of related fees,
  - – on-site inspections, as required,
  - – the scheduling of all other required work,

  - the removal of any existing equipment that will not be used with the new system,
  - all related costs, such as subcontracts with trades people.
- A clear estimate of when the work will be completed.
- A warranty for materials and labour.
- A schedule and method of payment.

Ensure that the technician is qualified to do the work. Ask contractors for the names of homeowners for whom they have done similar work. The Better Business Bureau will know if the contractor is a member and whether any recent complaints have been filed against him or her. Your local Chamber of Commerce or Board of Trade may also be able to help.

Some dealers will also rent heating equipment or offer lease-to-purchase plans. You may want to use these plans rather than purchase the equipment outright.

Do not hesitate to ask the contractor for a clear explanation of any aspect of the work before, during or after the installation of your heating system.

Billing

Billing for oil is handled in different ways, with two of the most common methods being equal billing and standard billing.

Equal billing: Your oil bill is paid in equal instalments, based on an estimate of your annual consumption. Periodic adjustments are made to balance your instalment amount against your actual annual consumption.

Standard billing: The bills are paid for the amount of oil consumed during that period.

Carbon monoxide detectors

Because modern houses are more airtight and have more powerful air-exhausting systems, there is a greater chance that combustion products – which contain deadly CO gas – will linger inside your house and build to potentially dangerous levels. A certified CO detector located close to fuel-fired appliances (such as furnaces, fireplaces, space heaters, wood stoves and gas or propane refrigerators) will signal the presence of CO, which must be corrected immediately.

Symptoms of low-level CO poisoning are similar to those of the flu – headaches, lethargy and nausea.

If you have a conventional wood-burning fireplace, which can leak CO, and you plan to use it often, it would be wise to install a CO detector.

6 Maintenance

Contractor maintenance

The best way to keep heating equipment operating at peak efficiency is with a regular program of expert cleaning, servicing and burner tune up. This must be done at least once a year, preferably well before the heating season arrives, and it must be done properly.

Furnace manufacturers and the instructors who train service people agree that **a proper cleaning and tune up requires at least 1.5 h, but often it takes longer. To clean and thoroughly service a boiler may take 2.5 h.**

Here are the tasks that a **service person should perform** at every annual cleaning and tune up.

- Inspect the inside and outside of the chimney.
- Clean the furnace flue pipe, barometric damper and chimney base.
- Check the condition of the furnace heat exchanger.
- Use brushes and a vacuum cleaner to remove soot buildup from the heat exchanger cavities inside the furnace. These are difficult to reach in many furnaces and it takes patience and perseverance to do a good job.
- Clean the furnace fan thoroughly (this step applies only to warm-air systems). Dirt buildup on the curved blades can reduce the amount of air that is moved, which decreases furnace efficiency. On a belt-driven fan, the motor should be oiled where possible and the belt tension checked. Every two or three years, the fan, should be removed from the furnace for a thorough examination and cleaning.
- Clean or replace the air filter (forced-air systems only).
- Open the burner and clean and lubricate the motor and blower fan, if required. If the nozzle is dirty, it should be replaced, not cleaned.

- Check the oil pressure in the burner and examine all fittings for leaks.
- Clean the oil filter bowl and replace the cartridge, if necessary.
- Check the performance of the safety features, such as the high limit control and the sensor for the cad cell flame.

The next equally important job is adjusting the furnace for maximum efficiency. This adjustment requires four measurements made through a pencil-sized hole in the flue pipe, close to the furnace. Do not worry about flue gases escaping through this hole. In a properly adjusted furnace, this will not happen.

After the furnace has been running for approximately 15 min to a steady flue temperature, a sample of the flue gases is tested for its smoke content, and the draft pressure is checked. Then the final two measurements are taken to determine the steady-state efficiency of the furnace, which are the temperature and the carbon dioxide or oxygen content of the flue gases leaving the furnace.

All four measurements are essential to the proper adjustment of an oil furnace for optimum combustion performance.

You can tell whether your furnace has ever had such attention by looking for a pencil-sized hole in the flue pipe. If there is no hole, the smoke level and draft pressure have never been tested and the steady-state efficiency has never been checked. If this is the case, talk to your fuel oil supplier or service person about it.

Service plans

You may find it helpful to buy an annual furnace service plan. This plan provides an annual inspection, cleaning and tune up, and 24-hour emergency repairs. Some plans include parts and labour; others cover labour only, which means you must pay for all parts required. Some firms offer additional insurance for complete furnace replacement, if this is ever necessary. An inspection is required before the service contract is signed.

Owner maintenance

You can do several maintenance tasks yourself to keep your system working well. But even if you do these properly and regularly, you should still have your system serviced annually by a heating contractor.

Routine chimney care

Most oil-fired furnaces and boilers require one of the following types of chimney:

- Type A chimney (a double-walled, insulated, prefabricated metal chimney with a stainless steel lining);
- masonry chimney lined with a clay flue tile;
- masonry chimney lined with a certified stainless steel liner.

Note that side wall-venting models have different venting requirements.

The flue liner should be sized in accordance with the CSA standard CAN/CSA-B139-09, *Installation Code for Oil-Burning Equipment*.

Although an oil furnace chimney rarely, if ever, needs to be cleaned, it should be checked occasionally for any sign of deterioration. You can check this by inserting a mirror in the cleanout opening at the bottom of the chimney on a bright day. Look for a broken or flaking flue liner or interior chimney damage, as well as for water running out of the cleanout door or around the bottom of the chimney behind the furnace. Then examine the outside of the chimney. Look for a white, powdery efflorescence on the outside of the chimney, spalling or flaking of the bricks, crumbling mortar joints, and wet patches on inside walls behind the chimney.

Certain types of higher-efficiency systems have special needs that may require your attention. Check your owner's manual or discuss this with your installer or service person.

Dealing with condensation in the chimney

The low temperature of the chimney itself is the major cause of condensation inside it. This problem can be overcome by installing an insulated metal liner such as a Type L, double-walled, stainless steel liner or a single-walled stainless steel liner surrounded by insulation. Check with your provincial/territorial fuel safety division to find out which method it approves.

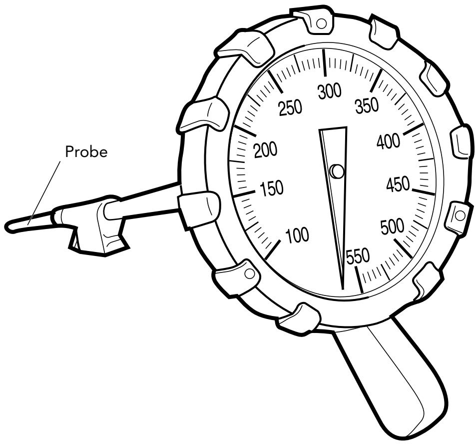
Remember, using a sealed, double-walled stainless steel flue pipe from the furnace to the chimney is a good way to keep flue gases at a temperature high enough to help prevent condensation in the chimney.

A furnace physical

There is a simple way to monitor the condition of your furnace or boiler and how efficiently it is using fuel. As we have seen, the heat that is not distributed through your house goes up the chimney, so measuring the temperature of the flue gases leaving the furnace will give a fairly accurate indication of its performance.

The maximum temperature allowed for the flue gases leaving the furnace has been 400°C (750°F) for a conventional oil-fired furnace manufactured during the last 30 years. The flue gas temperature is normally between 175°C (350°F) and 280°C (540°F). To measure this, you need a specific probe-type metal thermometer (Figure 11) that looks like a meat thermometer but reads much higher temperatures – to at least 400°C (750°F). You can get one from a heating supply company or order one through a hardware store.

FIGURE 11
Flue pipe thermometer



If the flue pipe does not have a hole, make one in the side of it, with a large nail or an electric drill, approximately 40 cm (15 in.) from the furnace exit (but not right after a large bend). Insert the flue pipe thermometer probe. The end should be near the centre of the pipe.

You can leave the thermometer in the hole permanently, if you want. If you do this, remember before you take a new reading to remove the thermometer and clean the end of the probe to remove any soot that may have built up. Turn the thermostat up to the maximum heat and let the furnace run for at least 15 min before taking a reading on the thermometer. **Remember to turn the thermostat back down after you have finished.**

Check the temperature before and after the furnace is serviced to see if it has changed. Note any steady increase through the heating season. A rise of 25°C (77°F) represents a drop of approximately 3 percent in furnace efficiency and a corresponding increase in fuel consumption. In a forced-air heating system, this may mean only that the air filter needs to be cleaned or replaced. If replacing the air filter does not reduce the flue temperature to near where it was before, call your service company.

Owner maintenance of forced-air heating systems

Cleaning or changing the air filter

IMPORTANT! Turn off the power to the furnace before opening the furnace access panel to check the filter or fan.

Few homeowners give the air filter in a furnace the attention it needs. It should be cleaned or replaced at least twice during the heating season. You can get permanent filters made of aluminum or plastic mesh that can be washed by hand, but the mesh is not as fine as glass fibre filters and does not trap as much dirt.

If you add an electrostatic air filter to your furnace, you do not need a standard filter as well. Remember that these electrostatic filters also need to be cleaned regularly. Check the owner's manual for instructions.

Fan care

The only maintenance that a homeowner can perform on a furnace fan is superficial vacuuming.

Distribution system care or maintenance

Remove obstructions from ducts, warm air registers and cold air returns so that air can move freely around the system. Use a water-based duct mastic to seal any cracks in the duct joints, as described on page 24. Also consider insulating all the warm air ducts that you can access easily.

Owner maintenance of a hydronic system

A homeowner can do the following maintenance work for a hot water heating system.

- Insulate the hot water pipes.
- Once or twice a year, bleed air bubbles out of the radiators so that they can fill with water.
- Vacuum the radiators.
- Check that the level of water in the expansion tank is below flood level.
- Oil the circulating pump (according to the manufacturer's instructions).
- Allow air to flow freely around radiators. Ensure that radiators are not covered by curtains or by ventilated wood panelling, and try to ensure that they are not directly behind furniture so that the heat generated can get into the rest of the room.

7

Domestic water heaters

Some Canadian homes that are heated with oil also use oil for their domestic hot water supply. Domestic water heaters are the second-largest individual users of energy in most Canadian houses after the space heating system. Depending upon the house type and the number and lifestyles of the inhabitants, hot water consumption may account for more than 20 percent of total annual energy consumption.

Free-standing oil-fired water heaters (see Figure 12 on page 60) now use burners that have flame retention heads and other modifications that improve efficiency. The water heaters can be connected to an existing chimney or, in some cases, can be side-wall vented, if approved for it.

Most direct heat loss from water heaters is made up of losses: by air and heat flow up the flue, both when the burner is firing and when it is not; by heat conducted through the tank walls and base; and by hot water convection losses through the hot and cold water feed pipes.

This chapter examines the options for improving the efficiency of the domestic hot water system by selecting and properly installing more efficient equipment.

Reducing energy losses

There are two basic types of oil-fired tap water heating systems:

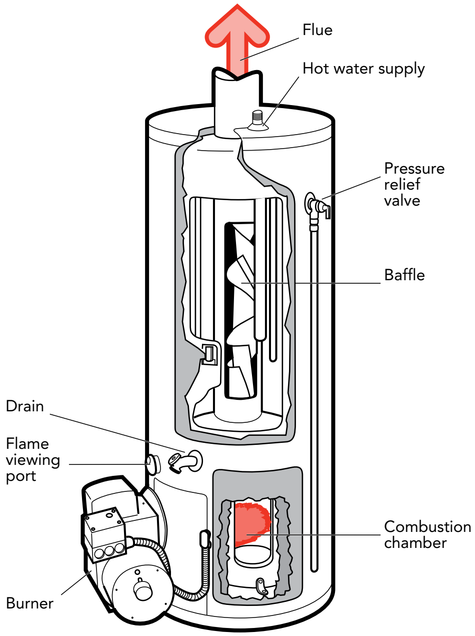
- a conventional water heater that heats the water directly in a tank;
- a system that heats the water in conjunction with another energy use, usually space heating.

For the latter, it can be in the form of a “tankless coil” inside the boiler or inside a storage tank connected to the boiler through a water-to-water heat exchanger.

The operating efficiency of a domestic hot water system can be improved by designing the system carefully and selecting equipment that generates hot water more efficiently and reduces stack and standby losses. Modifying an existing system, including piping modifications, can also reduce some of the standby losses.

Comparable to the AFUE of furnaces, the energy factor measures the seasonal performance of water heaters – the higher the number, the better the efficiency.

FIGURE 12
Oil-fired hot water heater



Reducing standby losses

The term “standby loss” refers to heat lost from the water in a domestic water heater and its distribution system to the surrounding air. The amount of loss is a function of the temperature difference between the water and the surrounding air, the surface area of the tank, and the amount of insulation encasing the tank.

Before carrying out any of the following steps, check with your local installer or oil dealer to ensure that you will not compromise the safety or operation of the appliance.

Consider the following options to reduce standby losses.

- Install heat traps above the water heater. A heat trap is a piping arrangement that prevents hot water from circulating by convection within the pipes and carrying heat from the tank to where the heat will be lost from the pipes to the surroundings.
- Insulate hot water pipes to reduce the heat loss from the pipes themselves. Pipe insulation is available in a variety of materials and thicknesses, and are easily applied to most hot water pipes. Install insulation with an RSI (insulating value) of at least 0.35 (R-2) over as much of the pipe as you can access easily and within 2 m of the water heater.

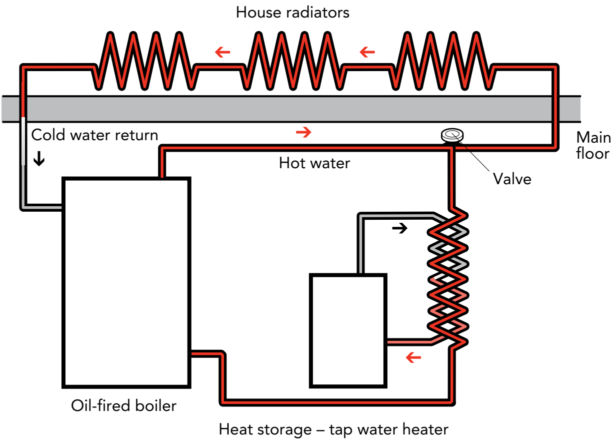
It is extremely important not to insulate over any controls or obstruct the vent connections or combustion air openings. The insulation should not come in contact with the vent connector.

Integrated space and water heating systems

Improvements to the building envelopes of homes have reduced the space heating load to the point that, in highly energy-efficient homes, it is sometimes difficult to justify the expense of a high-efficiency furnace solely to satisfy the heating load.

To take advantage of the efficiency potential of the new technologies, it may make sense to combine space heating with other functions, particularly water heating. Domestic hot water loads have increased relative to heating loads over time, making it a good idea to put more effort into improving the efficiency of the hot water generator. Therefore, it would be advantageous to combine efficient space and water heating systems.

FIGURE 13
Schematic of an efficient oil-fired integrated space-water heating system



Combining the functions of space and water heating in one unit can reduce the capital cost of the equipment and potentially increase efficiencies of operation. A schematic of such a system is shown in Figure 13.

The efficient integrated oil system couples a mid-efficiency or condensing, low-thermal mass boiler fired with a high-static burner to a well-insulated water storage tank by using an efficient water-to-water heat exchanger. When the house thermostat calls for heat, the boiler supplies heat to the house, either directly into a hydronic system or into a forced-air distribution system through a fan coil. When the house thermostat demand is satisfied, the boiler, instead of shutting off, continues to run, but releases the heat across the heat exchanger into the tap water storage tank.

There are also oil-fired boilers on the market that provide a continuous supply of domestic hot water by circulating cold water through a finned copper coil that is immersed directly in the boiler water. These systems are **tankless coil boilers**. The boiler must be kept hot even during the summer to give an adequate supply of tap water.

Most tankless coil boiler systems are very inefficient over the entire year.

Combined space-water systems that are based on an oil-fired tank water heater and fan coil tend to be quite inefficient.

Another arrangement uses a conventional oil-fired hot water heater as the basic energy generator and supplies the heated water to the house through a fan coil. Although this system has the advantage of a lower initial capital cost, its efficiency may be worse than the other systems described above.

Integrated systems are being developed which offer promise for further improvement.

If you are considering upgrading or replacing your heating system, you may want to consider installing an integrated space and water heating furnace or boiler. The energy consumption for space and water heating may be higher if these services are provided by separate units rather than by a single, integrated unit. In other words, integrated units may offer energy savings while providing the same space heat and hot water.

8 More information

Free publications from the OEE

The OEE of Natural Resources Canada offers many publications that will help you understand home heating systems and home energy use. These publications explain what you can do to reduce your energy use and maintenance costs while increasing your comfort and helping to protect the environment.

To obtain additional copies of this or other free publications on energy efficiency, contact:

Energy Publications
Office of Energy Efficiency
Natural Resources Canada
c/o St. Joseph Communications
Order Processing Unit
1165 Kenaston Street
P.O. Box 9809, Stn T
Ottawa ON K1G 6S1
Tel.: 1-800-387-2000 (toll-free)
Fax: 613-740-3114
TTY: 613-996-4397

Publications can also be ordered or viewed on-line at the OEE's Energy Publications Virtual Library at **oee.nrcan.gc.ca/infosource**.

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