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Fireplaces, Stoves and Fuels - What are the Choices?

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fireplaces, stoves and fuels— what are the choices?

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Energy shortages, high fuel costs, emergency preparation, charm or nostalgia are some of the reasons people are looking toward stoves and fireplaces for heat sources. Whatever the reasons, there is a need to know something about available firewoods and their respective characteristics, and to thoroughly understand the equipment that burns wood and gives off energy.

Wood is a renewable, available source of energy; it has been burned in fireplaces and stoves for at least 2,000 years. However, it is doubtful that the world population could now turn back to this source for its total needs.

It is estimated that an average farm woodlot will produce only about ½ cord of wood per acre per year.

Wood can supply heating needs in cases of emergencies, be used for short heat periods (cool mornings and evenings) or satisfy our nostalgic or aesthetic needs.

The greatest need for information on wood is how it can be used most efficiently and safely, and how much it can contribute to a household's heating needs.

Wood can be secured most commonly from salvage operations, community forestry programs, old woodlots and shelterbelts. State and federal foresters will sometimes allow firewood to be collected on state and federal lands on a permit basis. Private firewood contractors often advertise material for sale. The cost will vary according to species and to the degree it has been prepared. Commonly it is bought by the cord, which has 128 cubic feet (2' x 8' x 8') of wood in it.

How Does Wood Compare With Other Heat Sources?

The efficiency of a wood burning unit has a big influence on what can be paid for a cord of wood. If wood is being burned to save money on fuel bills, the homeowner can pay more for the wood when an efficient air-tight stove is used.

Approximate figures for how much can be paid per cord of wood can be determined when certain efficiencies for different heating devices are assumed. Assume the following efficiencies: A fireplace is 15% efficient, an air-tight, woodburning stove 50%, an oil furnace 65% and electric baseboard 100%. The break-even price that can be paid for fireplace oak is \$27/cord when heating oil costs 85¢/gal or \$40/cord when electricity costs are 4¢/KWH. The amount that can be paid per cord rises dramatically when wood is burned in an air-tight stove. (See Table 1)

How Does Wood Burn?

In any wood burning device, combustion transforms wood into heat, chemicals and gases through a chemical combination of hydrogen, carbon and oxygen. Complete combustion produces water vapor (from the wood) and carbon dioxide, along with heat and noncombustible ashes. When incomplete combustion occurs, carbon monoxide, hydrocarbons and other gases are formed. The stages are simplified in Figure 1.

Obtaining High Efficiencies With Wood Fuel

Factors affecting how efficiently wood burns are the species, moisture content, degree of preparation (whether it's been split) and the design or engineering of the device in which the wood is burned.

Species makes a difference. Although they burn with different intensities, woods grown in South

TABLE 1

Species	Available Heat/ Air-Dry Cord (Million BTU's)	Price/Cord When Heating Oil is 85¢/Gal.		Price/Cord When Electricity is 4¢/KWH	
		Fireplace	Airtight Stove	Fireplace	Airtight Stove
		\$	\$	\$	\$
Oak	22.7	27	87	40	133
Ask	20.0	23	78	35	117
Elm	17.2	20	66	30	101
Pine	13.3	16	52	23	78
Poplar	12.5	14	48	22	73

1st Stage

The wood is heated to evaporate and drive off moisture.

This heat **does not** warm the stove or room.



2nd Stage

500° F - 1100° F

The wood starts to break down chemically at 500°F and **volatile matter is vaporized.**

These vapors contain between 50-60% of the heat value of the wood.

At 1100°F these vapors burn. This high temperature must be maintained for **maximum** efficiency of combustion.



3rd Stage

over 1100° F

Following the release of volatile gases, the remaining material is **charcoal**, which burns at temperatures exceeding 1100°F.



Figure 1. Stages of Combustion

Dakota produce nearly the same amount of heat pound for pound, providing the stove is able to burn the volatiles. Wood is bought by volume (the cord). The light and less dense woods (poplars), although they take up as much space, produce less heat per cord. Oak will produce about twice as much heat as a cord of poplar. Other species may have special desirable (aroma in apple wood) or undesirable (popping with pine) characteristics.

Moisture in wood requires heat to be changed into steam and driven up the chimney. With smaller amounts of water in the wood, less heat is required to drive off the moisture, and consequently, more heat will be given off by the wood. The energy used to drive off the water is not available for heating the room. (See Figure 2.)

The operator should know how to use the heating device to obtain its full efficiency by knowing how to operate dampers and how tightly to pack the wood. (The tighter the better.) Once the stove has heated an area sufficiently, closing the dampers will slow the combustion and allow the heated gases to give up most of the heat

before they pass into the venting system.

The time of the season is important. A stove with an intense fire (needed in the winter) is able to make use of the volatiles, while a cooler burning stove (needed in the fall and spring) may not reach

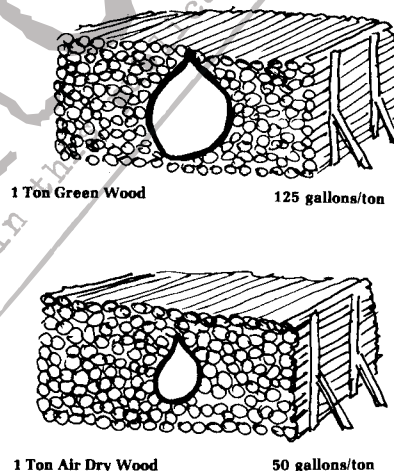


Figure 2. Burn wood that is dry. One ton of green wood will contain as much as 125 gallons of water, which needs to be heated and driven up the chimney as steam. No heat comes from this conversion process. Air-dry wood contains only about 20 percent water, which will also need to be heated and evaporated.

a high enough temperature to burn the gases. Consequently, less heat is derived from the same quantity of wood during off-season use.

A fireplace usually doesn't reach a high enough temperature at any time to burn the wood volatiles, so they escape up the chimney. An efficient stove will circulate these gases, burn them and produce more heat.

The type and design of heating device influences efficiency. A fireplace is notoriously inefficient, while a well designed, airtight stove can be highly efficient. (See the different basic designs in Figure 3, 4, 5, 6 and 7.)

Which Will It Be—Fireplace Or Stove?

The Fireplace

A fireplace, whether it be a masonry, zero clearance or other metal freestanding fireplace, will provide quick heat to a room. However, it is not considered an efficient heater.

In a properly operating fireplace, between 500 and 600 cubic feet of combustion air will be drawn up the chimney in about one minute. This occurs whether there is a roaring fire or a smoldering fire. With the flue open, no direct outside combustion air, and no glass door on the front of the fireplace, all the air from a 15' x 20' room would be drawn out in 5 minutes. If this drawn-out, warm air came from the central heating system, it further decreases the efficiency and increases the cost of operating a fireplace.

A common masonry fireplace, even when well designed, is only about 10% efficient. Consequently, a fireplace must be considered a luxury in most instances. In spite of these facts, a majority of families prefer fireplaces, and homes with them have a higher resale value. These preferences could change as energy costs increase.

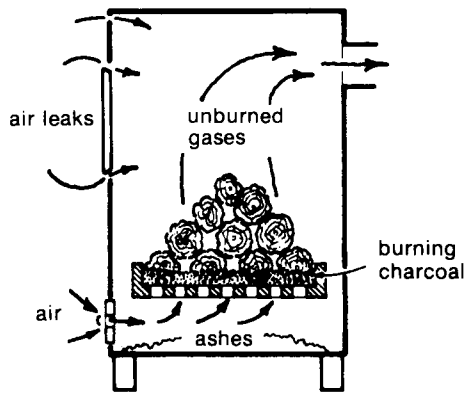


Figure 3. A simple box stove with only a primary air inlet. Most of the burnable, heat-producing volatiles are allowed to escape up the chimney. Air leaks do not give good control of the fire.

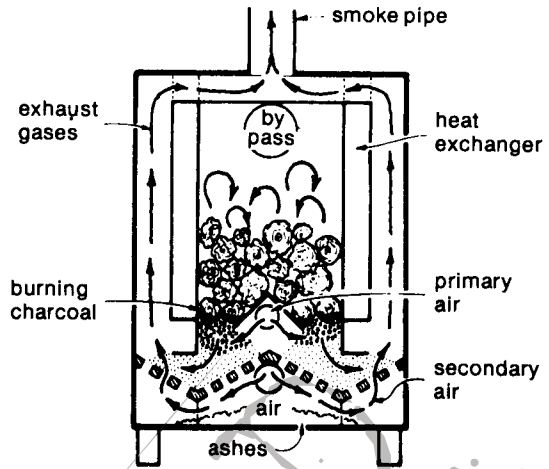


Figure 6. A type of down-draft, air-tight stove. The volatiles are brought down and through the primary combustion chamber, and then through a secondary combustion chamber, where they are mixed with secondary air supply and burned.

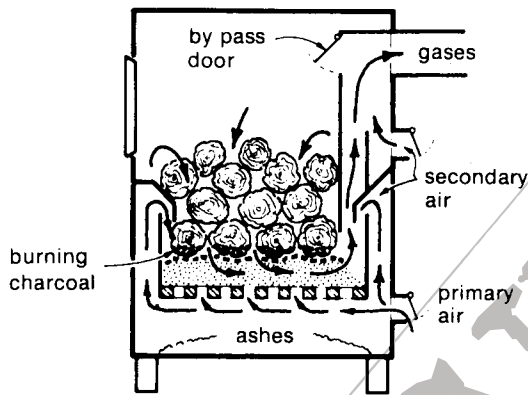


Figure 4. An Ashley air-tight stove provides primary air for combustion. During combustion, wood breaks down into volatile matter and water vapor. The volatiles have a chance to be burned, because secondary air is provided. The thermostatic damper controls the rate of combustion.

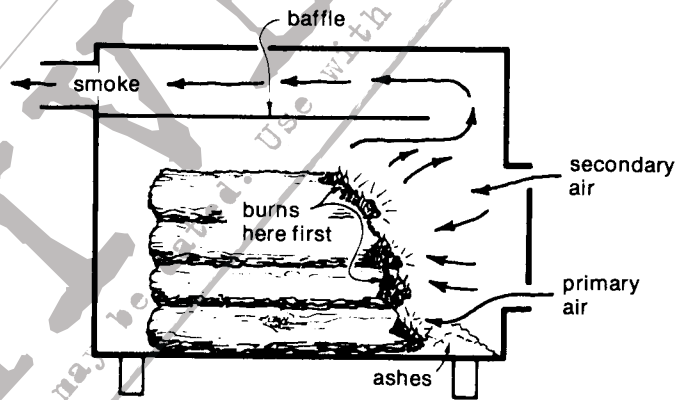


Figure 7. A front combustion, Scandinavian-type, air-tight stove. The wood pieces are ignited at the ends and burn like a lit cigar. The volatiles are brought back by the flame and around a baffle plate to burn in a secondary combustion chamber.

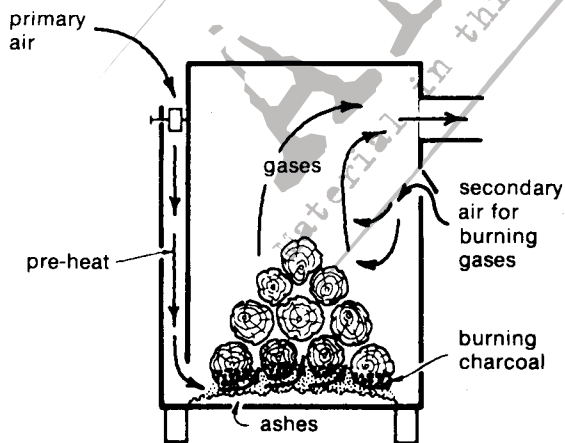


Figure 5. A base burning, air-tight stove routes the volatiles by the primary combustion chamber and then through a secondary chamber, where they have a chance to burn.

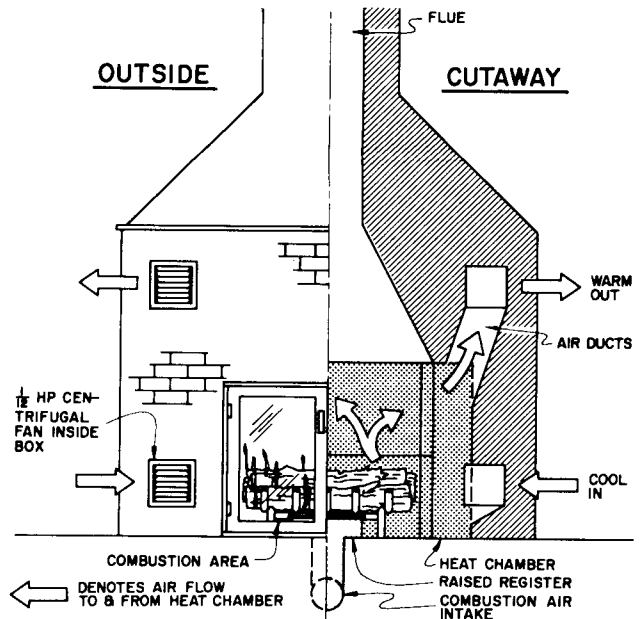


Figure 8. A basic fireplace design, which includes features to make it more heat efficient.

Ways to Improve Fireplace Efficiencies

Old Fireplaces

1. Install a damper in the chimney flue. Make it airtight so when it is closed very little warm room air escapes.
2. Install tempered glass fireplace doors. Keep them partially opened when the fire is burning at its maximum and closed when the fire is low or when the fireplace is not being used.
3. Use a hollow tube fireplace grate equipped with a blower to help distribute the heat.
4. Install a vent for obtaining outside air for the fire to use in combustion, rather than using the warm room air.
5. If possible, keep doors closed in the room where the fireplace is located.
6. Check into the feasibility of installing a metal fireplace heat exchanger.

New Fireplaces

1. Locate fireplace on an inside wall if possible. The warm walls of the fireplace exposed to the inside of the house provide usable heat and better drafting. (See Fig 9.)
2. Evaluate the free-standing fireplace and compare its efficiency with that of the built-in masonry type. (The free standing types are considered more efficient.)
3. Install a manufactured metal fireplace with a heat exchanger and a small fan to increase distribution of heated air.
4. Install tempered glass fireplace doors.
5. Install a combustion air inlet grill and vent in the hearth at the front of the fireplace to obtain combustion air from an unheated basement or the outside.
6. Do not locate the thermostat for the central heating system in the room with the fireplace.
7. Install a well-designed, "air-tight" damper system and

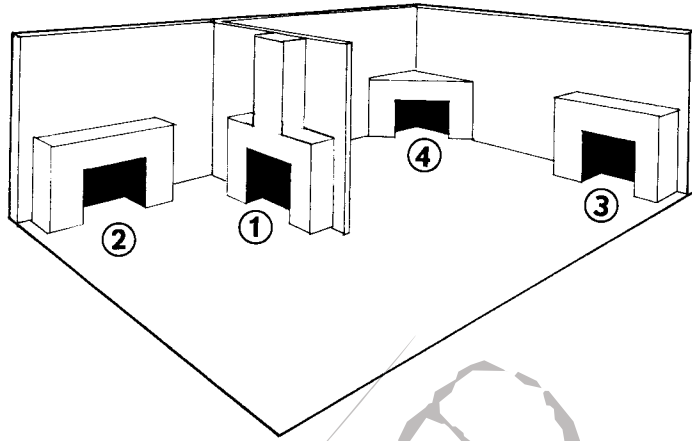


Figure 9. Locate a fireplace on an inside wall if possible (1) to use the most heat and for better drafting. The most heat will be lost by locating the fireplace on an outside wall or corner (5).

- learn its efficient settings to minimize heat losses up the chimney. If it continues to draw air from the inside of the house after being closed, it isn't functioning well.
8. If practical, the room in which the fireplace is located should have doors to close off the room from the central heating system.

Stoves

Before purchasing a stove, decide how it will be used—for emergencies, conversation or occasional use, supplemental or total heating needs. Can the money be spent better on insulating and weather tightening the house? How dependable is the wood source? What will a wood burning stove do to your insurance premiums? Does the house lend itself to the installation of a stove? There will be costs other than the purchase of the stove and the wood to burn in it.

There are many manufacturers of wood burning stoves. Appearance, style, finish, construction, materials and weight are some of the characteristics that need to be evaluated.

The Materials

The **sheet metal** stove made of relatively thin gauge is least expensive and heats a room quickly. It also cools rapidly and is usually chosen where occasional or emergency heat might be needed.

Plate steel stoves are made with 1/8 inch or thicker welded steel and are often firebrick lined to provide a more even heat.

Cast iron stoves warm up slowly but retain heat for a longer time. Cast iron has a long life, generally doesn't warp, but will crack when dropped.

What Makes A Stove An Efficient Heat Source?

The stove should be designed so it allows controlled but sufficient amounts of oxygen for complete combustion. This occurs by a two-step process. First, the primary draft allows sufficient amounts of incoming oxygen to pass readily through the burning portion of the wood to release the volatile gases. And, then the released gases travel through a sufficiently heated area within the stove where a second draft provides sufficient oxygen to burn the gases.

All stoves are designed so they allow combustion of wood, but the efficient ones also burn the volatiles before they escape up the chimney. The most efficient stoves are designed so that combustion can be controlled through the dampering system. The stove temperature needs to be hot enough (1100° F.) to ignite and burn volatile gases. Internal baffle plates in the stove can create a secondary chamber for extra efficiency.

The Designs

The **simple box stove** is the most basic stove design available. It has only a primary air intake that supports initial combustion. No provision is made to burn volatile gases. A stove with this basic design will be 10 to 15% more efficient than a fireplace. (See Figure 3.)

Airtight stoves usually come with well-located air intakes and baffle plates or secondary chambers. Some have thermostatic dampers regulating the intensity of combustion. Often they have an outside jacket with a fan to help distribute the heat. At best, expect from 45 to 60% efficiency in these kinds of air-tight stoves. (See Figure 4.)

A few new or revived airtight designs have appeared on the market since wood burning has increased. They all have a high (45-60%) efficiency rating.

The **base-burning** design has been modified by some designers to secure more complete combus-

tion. The outlet from the firebox chamber is located at the base of the firebox, forcing the volatiles to pass over the hot charcoals before leaving the stove. Base burners tend to smoke when refueled and should be equipped with a by-pass door. The design works best with a fairly high thermostatic setting and frequent refueling with smaller amounts of wood. (See Figure 5.)

The **down-draft** design drives the volatiles *through* the charcoal bed rather than close to it. Smoking during refueling is a problem, but can be avoided by getting the chimney hot by opening the draft a few minutes before refueling and by providing a by-pass door. (See Figure 6.)

The **front-combustion** design brings the draft from the end rather than from below and burns the wood evenly from one end to the other like a cigar. The addition of a baffle plate in the upper part of the firebox forces the volatiles into a S-shaped pattern,

where they mix with secondary air and are burned. The design, in theory, gives uniform heat throughout the cycle once the draft has been properly set. (See Figure 7.)

Most of the stoves of Scandinavian design are imported and rate quite highly in material and workmanship. They are usually compact, will fit on a hearth or will install in most fireplace openings.

The following list of fact sheets completes the information on fireplaces and wood burning stoves.

FS 722, Wood Burning Stoves

FS 723, Fireplaces

FS 724, Wood Stove and

Fireplace Safety and Maintenance

All of the material in this series should be read before making decisions concerning fireplaces and stoves.

Use of a product name or design does not imply endorsement of one product over another.

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