1979

Wood Burning Stoves

Mary Ann Sward

Larry Helwig

FS 722

wood burning stoves

Cooperative Extension Service
South Dakota State University
U.S. Department of Agriculture

wood burning stoves

By: **Mary Ann Sward,**
Extension Housing Specialist,
and **Larry Helwig**, Extension Forester

Until World War I, most American homes were heated with wood. Many parts of the country even boasted their own stove manufacturer. But most of these firms went out of business as the primary fuel for home heating switched from wood to coal, then oil, gas and electricity.

Utility costs for gas, oil and electricity have risen sharply in the past few years, and many people are exploring other ways of heating their homes. Wood-burning stoves is one alternative that has received much attention.

Before you install a wood-burning stove and expect it to heat all or part of your home, consider these following points.

Efficiency

Everyone wants to know how efficient their stove will be, and how much more efficient it is than the ever-popular fireplace. Advertising by stove manufacturers involves claims of the unit's efficiency. These claims are either absolute (certain percentage efficiency) or comparative (compares efficiency of Brand A to Brand B). When shopping for stoves, it is important for the consumer to obtain information on stove efficiency.

The term **efficiency** is frequently misunderstood. A stove may range from 20% to 65% efficiency while a fireplace may be 10% efficient at the maximum.

For our purpose, efficiency will refer to the percentage of the energy in the fuel (wood) which is converted into heat used in the home. A more efficient stove will use less wood than a less efficient stove to do the same heating job.

Efficiency, as explained above, is a measure of the stove's ability to convert wood to heat while burning. **Net efficiency** takes into account possible changes in a home's total heating needs when a stove is not in use, as well as when it is in use.

When a stove is burning, it draws some heated air from the room to provide oxygen for combustion. This same air movement occurs, but with less volume, when the stove is not in use. This movement of heated air from the interior of the home to the outside (called ventilation) is greatest on cold days. In addition, a steady wind across the chimney may cause a vacuum, resulting in a greater loss of heated air up the chimney.

Wood-burning units which require an 8-inch or larger flue (chimney liner) will have a low net efficiency, which is undesirable. This is because more room air can escape up the chimney when the unit is not in use. With a smaller flue, less volume of heated air can move up the chimney, forcing more heat into the home.

The majority of Franklin stoves, other open stoves, and all masonry or prefab fireplaces require an 8-inch or larger flue. These units can be expected to cause a net heat loss in the home when not in operation.

Maximum efficiency in the stove itself is based on two aspects: **complete combustion** and **heat transfer**. If both could be achieved, the stove would have an efficiency rating of 100%. While complete combustion is very desirable, complete heat transfer is not. If too much heat is removed (transferred) from the gases before they escape up the chimney, they would not create an adequate draft to draw fresh air into the stove for combustion and the room would become smoky. However, cooler gases escaping up the chimney produce creosote condensation, increasing the potential of an eventual chimney fire.

The conditions required for complete combustion are very simple in theory: adequate oxygen, high temperatures and a highly combustible (dry) fuel.

Design

Different structural designs in a stove will be the most important factors affecting the stove's efficiency.

Most stoves are equipped with some sort of control on the **draft** (air intake opening), which regulates the amount of air entering the stove. (See Figure 1, item 1.)

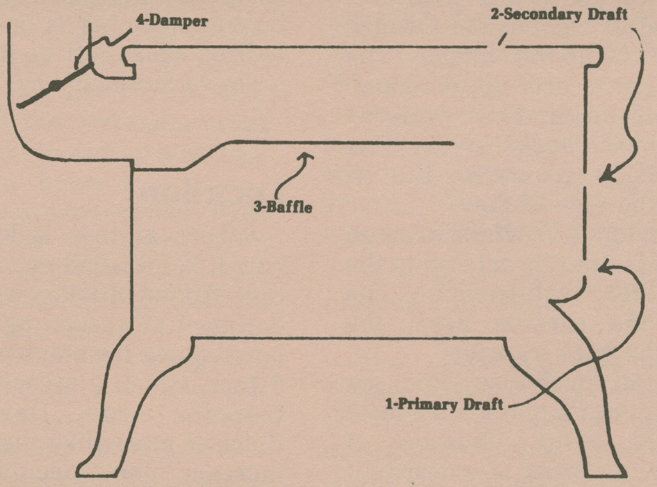


Figure 1. Basic design features of a wood burning stove.

Other design factors to consider include air-tightness, flow patterns, surface area, and color and finish.

Stoves designed to burn for long periods of time without refueling slow the combustion process by not introducing enough oxygen. This control results in a large amount of unburned gases escaping up the chimney if a secondary draft is not provided in the stove.

The **secondary draft** introduces fresh oxygen into these gases and encourages their combustion. (See Figure 1, item 2.)

An airtight stove would have no air entry other than at the drafts. Poorly constructed stoves have small cracks between pieces. Where and how much air leaks into the stove can seriously alter its efficiency.

Heat transfer can be encouraged by a number of methods, including increasing the surface area of the stove, selecting proper color, and forcing the gases to spend a longer time in the stove before entering the chimney.

Internal **baffles** can be incorporated in the stove to force the gases to circulate before leaving the stove. (See Figure 1, item 3.)

Another way to control the speed with which the gases move through the stove is by the use of **dampers.** (See Figure 1, item 4). Dampers restrict the gases from entering the chimney and force the gases to remain in the stove longer.

Flow pattern (Figure 3) is the term used to describe the movement of the gases produced during and after combustion through the stove and up the chimney. The basic patterns are: up, diagonal, across, or down. Flow patterns also affect the heat transfer. It is impossible to generalize the effects of any type of flow.

The amount of surface area on the stove is directly related to the capacity for heat transfer. The greater the surface area, the greater the heat transfer.

Color and finish also affect the efficiency. Matte black is the most desirable color because it generally radiates a consistent amount of infrared heat. How effective the particular black surface is depends on the chemical make-up of the paint. Many colors, including white, are equally good for heat emission, but discolor due to the heat.

Colors are available in a permanent form with baked enamel finishes. The major drawback is that this type of surface treatment is much more expensive than black paints commonly used on stoves.

Most stoves are of the **radiant** type—they emit most of their heat by radiation. **Circulating** stoves are essentially a radiating stove with a jacket for heating air, which connects to a forced air distribution system. Either type of stove can have high efficiency, although a circulating stove provides more all-around comfort. If you have small children, you may wish to consider a circulating stove, since its surface temperatures would be much lower than a radiating stove.

Some stove design features counteract each other. Encouraging more complete combustion in the primary chamber by introducing a secondary draft increases the speed of the gases going up the chimney; it also reduces the amount of heat transferred by the stove. The other frequent design conflict involves the use of insulating materials (Figure 2) to keep internal stove temperatures high. Metal or firebrick liners reduce the heat transferring ability of the stove, but they do even out heat transfer over time. A compromise is possible if the combustion chamber is lined, but the baffled areas left un-insulated in order to increase heat transfer.

Location

Where a stove is located and how it is installed are also important. Added efficiency on a poorly designed stove can be gained by lengthening the stove pipe by 4 or 5 feet, which increases the heat transfer area. Dark, matte-finished pipes, like the stove, can increase the amount of heat radiated into the room.

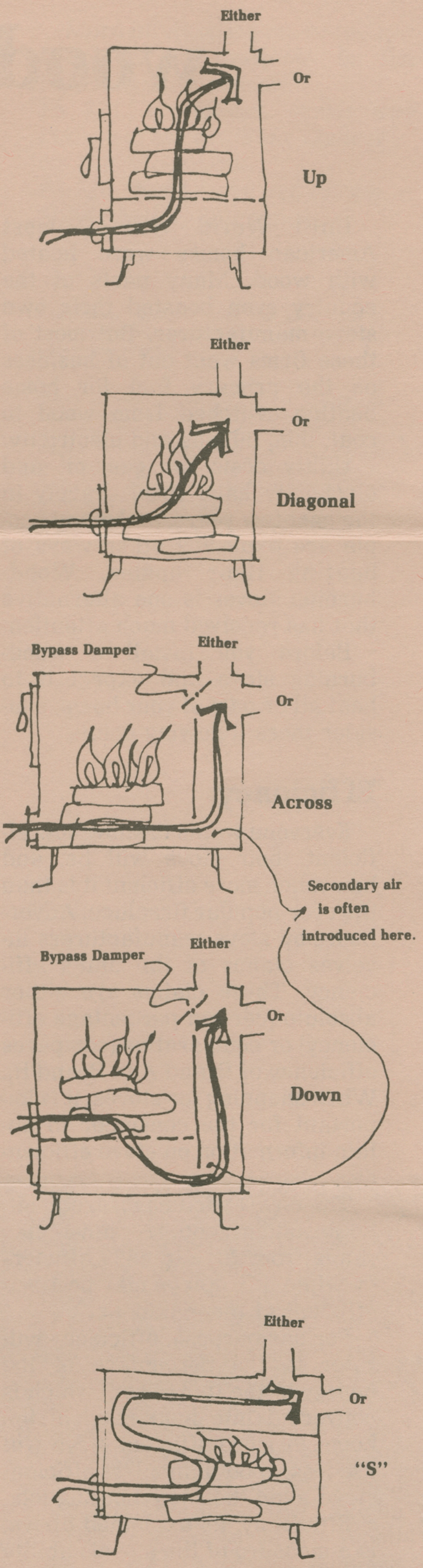


Figure 3. Flow patterns of wood burning stoves.

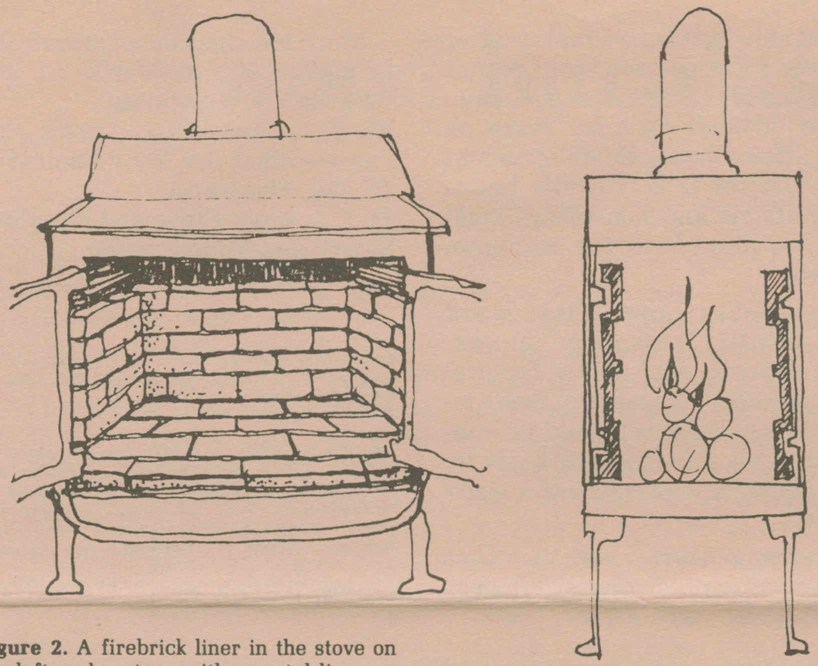


Figure 2. A firebrick liner in the stove on the left and a stove with a metal liner on the right.

Locating a stove near an outside wall leads to larger heat loss through that wall because of the increased temperature differences on the inside and outside wall. Heat loss is frequently, although not always, greater when a stove is installed in an old fireplace opening.

Wood furnaces are frequently located in basements, but they should not be located in an uninsulated basement. Such a location does not maximize the output of the stove. A stove can be converted to a furnace with a sheet-metal jacket placed around it. The air heated in this jacket is then distributed via air ducts to the rest of the house. This type of conversion is **not** a job for an amateur.

Other considerations for stove location include: 1. Place where you desire the heat. Remember that you will lose a lot of floor space and gain a permanent piece of furniture. 2. Locate where you may have an existing chimney (a stove should never be attached to a chimney flue used for a gas or oil unit). 3. Place in a central location if you wish to heat most of the home. 4. Steadiness of heat can be encouraged by locating the stove near a large mass (i.e. masonry wall), and by using an interior exposed masonry chimney. The mass will absorb heat while the fire is hottest and slowly release it—encouraging steadiness of heat. 5. The wood storage area should be close by. 6. Locate in a spot where it will be easy to maintain. 7. Be sure there is adequate structural support.

Other Factors in Stove Selection

It is difficult to compare the wood stove to a standard furnace, because the ratings are different. Stoves are generally given a rating for the number of cubic feet that can be heated. Electric systems are classified by watts, and oil or gas units by BTU's (British thermal units). The cubic foot rating of the particular stove could also be altered by how well insulated your house is.

Families who are seriously looking for a stove to serve as a primary source of home heat should limit their search to those models which have a large capacity for fuel. This lengthens the time between refueling and should encourage more steady heating. Adapting the stove to a forced air distribution system should be a prime consideration.

Controlling the rate of combustion is also important. All closed stoves can be controlled by dampers more easily than open stoves or fireplaces.

The evenness of heating provided by the stove also depends on its surroundings. If the stove is located in an area where there is a great deal of mass (large areas of brick or stone) the heat absorbed by the mass will tend to even the room temperature over time.

Some people give high priority to stoves which can retain coals overnight and keep them hot enough to burn wood put in the following morning. The fuel capacity and heat control are the keys to satisfaction with overnight fires.

Ease with which wood can be added to the stove is a very important feature. Top-loading stoves and those with large doors are generally easiest to load. Top-loading stoves are more likely to smoke during loading.

Many stoves have metal handles which can be hazardous. It is virtually impossible to eliminate handles in stove design, but various types are available.

Stoves are made either of cast iron or plate or sheet steel. Either type has advantages and disadvantages. Cast iron is stiffer and harder and is less likely to become distorted due to heat. However, cast iron is susceptible to cracking if there is a great difference in temperatures within the stove.

Steel has greater tensile strength (resistance to lengthwise stress) but may become somewhat distorted due to heat. Cylindrical and oval shapes are less likely to change shape.

Both types of metal are subject to corrosion, and thin walled stoves of either type should be avoided. Thermal stress is also reduced with thicker walls.

Burning trash, particularly plastics, can reduce the life of the stove.

How often you will need to remove ashes is largely related to the volume of ashes the stove can accumulate without imparing its operation. Different woods give different amounts of ash. More ashes can be stored when the stove does not require a grate for the wood.

Accessories

The primary accessories required with a wood stove are a poker to adjust the wood in the stove, asbestos mitt to use when in contact with hot handles, and metal container for removal of ashes. Some stoves require a grate where the wood rests during combustion; this should be purchased as a part of the stove.

Summary

With so many variables affecting satisfactory performance of wood stoves, it is no simple matter to select the precise stove to suit your needs. Decisions are even more difficult because research on various stoves by independent laboratories is still in the beginning stages and consumers must rely on data from the manufacturers.

Remember also that wood availability, storage areas, maintenance and safety factors, and possible increases of home insurance premiums should be considered on a long-range basis as you consider ownership of a wood stove.

Keeping warm with a wood stove means you always have to work at it.

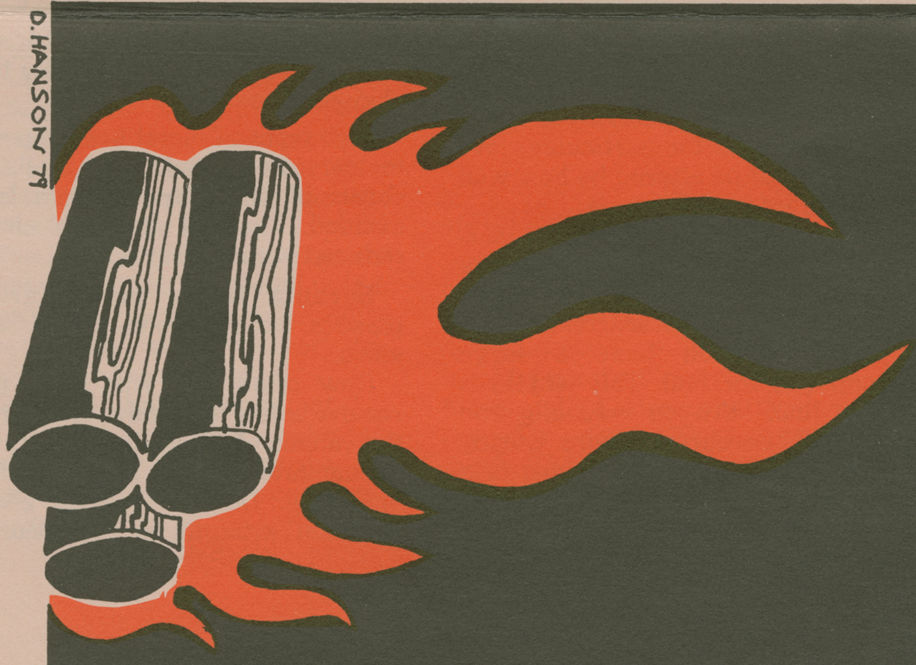
More information on stoves and fireplaces is available in the following publications.
FS 721, Fireplaces, Stoves and Fuels—What are Your Choices?
FS 723, Fireplaces
FS 724, Wood Stove and Fireplace Safety and Maintenance.

Illustrations reprinted from *The Woodburner's Encyclopedia* with permission of the Vermont Crossroads Press.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the USDA, Hollis D. Hall, Director of Cooperative Extension Service, SDSU, Brookings. Educational programs and materials offered without regard to age, race, color, religion, sex, handicap or national origin. An Equal Opportunity Employer.
File: 18.3-14—10,000 printed at an estimated 6 cents each—12-79gly—4184A

wood burning stoves

FS 722



Cooperative Extension Service
South Dakota State University
U.S. Department of Agriculture