We're finding out new things about heating values and burning characteristics of different kinds of wood. This kind of information is increasingly important–America currently burns over 40 million cords of wood annually for home heating, and the figure may triple in the next decade.

NEW FINDINGS ON WOOD FUEL VALUES

by Andrew J. Baker

As HOME WOOD-FOR-FUEL trends continue to spiral upward, homeowners are asking for more and better data on burning characteristics of different types of wood, along with advice on the most efficient burning methods. The Forest Products Laboratory—a U.S. Forest Service installation in Madison, Wisconsin, that works cooperatively with the University of Wisconsin—has come up with information that will help to clarify some fuel-ish questions.

Approximately three percent of the nation's residential heating requirements is now satisfied by wood. This represents about one percent of our national energy needs. and it amounts to over 40 million cords of wood. The percentages are skewed, of course, toward the northern states. For instance, 35 percent of homes in the New England states and rural homes in the Lakes states heat with wood. (About 87 percent of this is burned as the primary. or secondary residential heating source, and most of it comes from sources that do not compete with pulpwood or lumber supplies.)

So far, wood heat has been used primarily to replace fuel oil. One reason for the high percentage of wood heat in New England is that the primary heat source there is fuel oil. In the next few years, because of the deregulation of natural-gas prices, the use of wood heat will also in-

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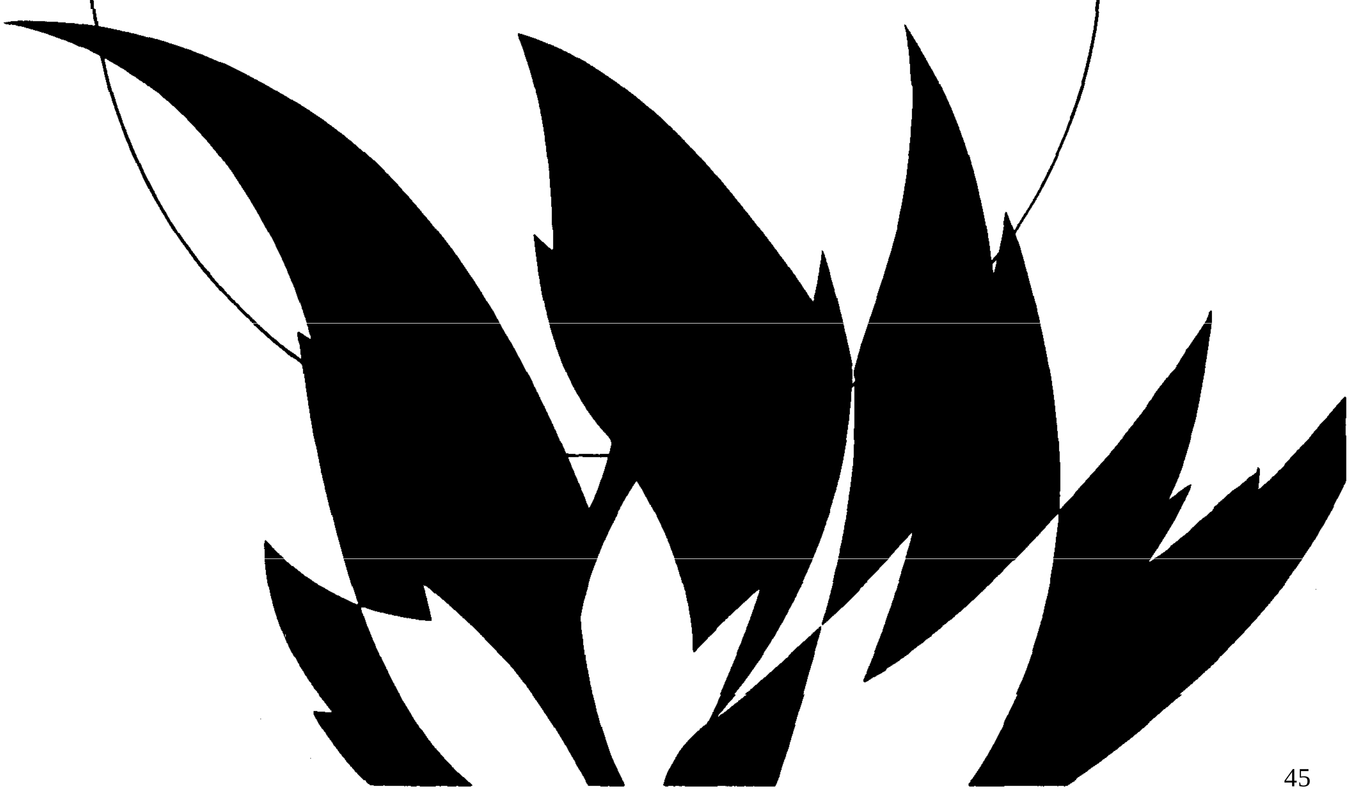


crease in rural communities where natural gas is now the primary heating fuel. Within the decade, the amount of wood used for home heating on a national basis could be three times that now used.

Just how good is wood as a fuel, and why are some species better fuels than others? The answers lie in characteristics of wood composition. Although wood species may look, feel, and smell very different, their basic elemental composition is remarkably similar.

Estimating Wood's Fuel Value

The heating value of wood depends primarily on its carbon content. All wood species contain about 50 percent carbon, 44 percent oxygen, and six percent hydrogen. In general, the carbon content of hardwood ranges from 47 to 50 percent; for softwood it's from 50 to 53 percent. This indicates that the heating value of softwoods is generally higher than that of hardwoods on a per-pound basis. The heating value for hardwoods is about 8,600 British thermal units (Btu) per dry pound, while the value for softwoods is about 9,000 Btu's per dry pound.

On a per-cord basis, however, the story is different. The weight of a cord varies greatly due to the density of the wood, and most hardwoods produce more Btu's of heat per cord than softwoods because they are denser.

Thus far, not enough data have been collected to establish an average heating value for any particular species on a per-pound basis. Some reports, however, list the per-cord heating values of different species. Although these reports are frequently intended to show the heating value of each species, they are based only on individual wood samples and probably do not represent the entire species. To measure the average heating value for a species would require sampling the species over its entire growing range, then testing to determine the heating value of each sample. Another complication is that the heating value can vary from one part of a tree to another. For example, heartwood may have a heating value different from that of sapwood or branches and twigs. Or the heating value may be different due to growing conditions of the species in one region as compared to the same species in another region.

Since wood is usually measured by the cord, it is desirable to have some reliable estimate of the heating value of a cord. The graph on page 47 is useful for estimating this value for wood that contains no moisture. It is also helpful for comparing the relative heating value (and dollar value) of various species. For instance, it can be quickly seen from the graph that a cord of hickory can have almost twice the heating value of a cord of fir, spruce, or aspen.

Drying Wood

For safe and effective burning, it is usually suggested that fuelwood be dried for three months to two years. The specific time required depends on the species, the size of the individual pieces, and the shape and location of the pile. (See AMERICAN FORESTS, November 1982, "Six Common Myths About Splitting Firewood" for another look at drying-time recommendations. Author David Tresemer stated that if wood were kept in long pieces of large diameter, the two-year drying period might be appropriate. However, for wood that had been split into stove lengths, the drying time was much shorter.)

Wood-drying recommendations for specific parts of the country are few and far between. I have seen only one such recommendation– that being in the November 1979 issue of Yankee magazine; it reported that maple, birch, and oak cut and split in Massachusetts during March were dry in August. The wood was piled in it single row and covered with plastic. In central Wisconsin, I have found that eight months is adequate to dry split firewood cut during any season and piled outside under cover. I prefer a shelter with no sides, or a covering made of shipyard lumber nailed together with cleats.

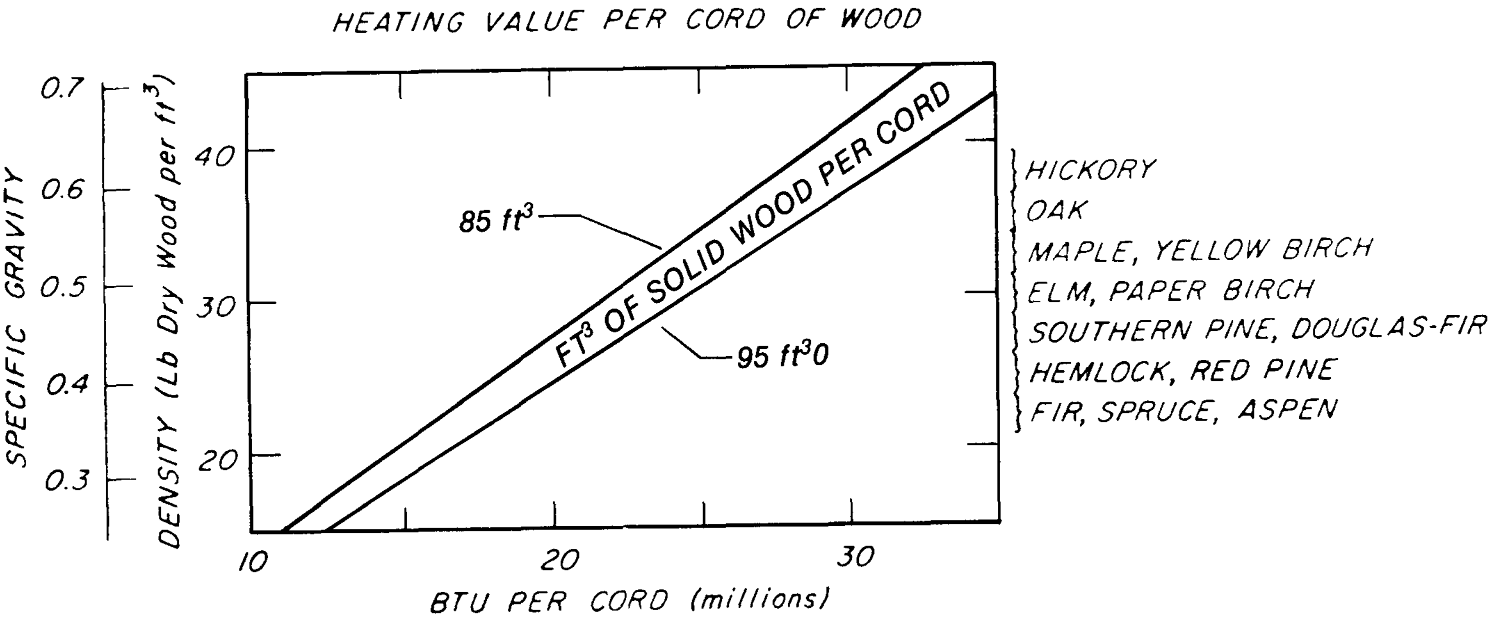
Woodburning and Creosote

Creosote is the material that collects in the chimney or stovepipe. It can be a watery material, a viscous black material, or a solid. As a solid, it can be a powder, flakes, or a hard shiny glaze. Creosote is the conden-

What the Fire is

We are burning the elm tonight
By arms' lengths, tough warty elbows
That crooked the swing, the windchimes,
The suet-balls, birdhouses; we are burning
Our memories tonight, of summertimes
Under the embrace of elm, shawled
With pinking-sheared leaves, shadows
On walls and rooftree—or dark winter limbs
Battling storms about the attic eaves
Audibly, while we warmed before a fire
Of other cordwood. We are burning
A century's seasons tonight
Of elm-speech, audible now in these
Sacrificial cracklings that talk to us
Of doughty going, our own need to keep warm,
Our need to be borne as winged seed.

-Nancy G. Westerfield



This graph was compiled using the heating values of 8,600 Btu's per pound for hardwoods and 9,000 for softwoods, density and specific-gravity information from handbooks, and the author's own measurements of the cubic feet of solid wood in a cord. Heating value is defined as the theoretical amount from one cord of wood containing no moisture.

The used estimates of solid wood in a cord are 80 to 85 cubic feet, but these values are probably appropriate for pulpwood logs. The author measured 90 to 95 cubic feet per cord for split firewood.

To use this graph if the species is known, start from the right side opposite the species name and go across to a solid-wood-per-cord line, and then down to read off the Btu-per-cord value. If the wood is split and tightly piled, usethe 95-pound-per cubic foot line. If the species is not shown, choose one that has a similar density or locate a representative density value from a handbook that gives the physical properties of wood species. If the density or specific gravity can be estimated, start at the left and go across to the appropriate solid-wood-per-cord line, and read off the Btu's per cord at the bottom.

By using the graph, it can be estimated that the heating value of maple and yellow birch, for example, which have a density of 32 to 34 pounds per cubic foot, is 23 to 26 million Btu's per cord containing85 cubic feet of dry wood. If the wood is seasoned, about 50 percent of the heating value can be recovered with a modern wood heating appliance. The brackets by the species names indicate a range of density for each.

sation of unburned vapors from the wood. It forms when the temperature of the inner surface of the chimney is below the dewpoint temperature—the temperature at which the flue gases condense.

To minimize creosote formation, one must understand the conditions that cause it. Creosote-causing conditions are those that result in a smoky fire. Most creosote is formed during startup, when wood is burned at a low heat-producing rate without sufficient air, and when wet wood is burned.

During startup, it is common to use paper to ignite small pieces of wood that will burn rapidly and ignite larger pieces of wood. At this time, the combustion air dampers are wide open, but conditions are such that not all of the gases from the paper and wood are ignited. This results in smoke that can condense on relatively cool surfaces of the chimney. These high creosote-forming conditions will persist until the larger pieces have ignited and good burning conditions are established, and until the temperature of the flue is above the dewpoint temperature of the combustion gases. Frequently, the recommendation is to burn a hot fire for 15 to 30 minutes after startup in order to evaporate or "burn out" any newly deposited creosote.

Using the heating appliance at low heating rates (when only a small amount of heat is needed) frequently causes creosote to form because the low heating rate is usually controlled by closing the combustion air supply damper. Reducing the air supply will lower the temperature in the combustion zone. Again, the results are a smoky fire and creosote formation. This explains why more creosote problems are noticed in the spring and fall when less heat is required than is needed in winter.

Low heating rates can be tolerated with minimum creosote formation if the fire is made with a smaller amount of wood than is used in the winter and if it is burned with sufficient combustion air. If these conditions are difficult to maintain over long periods of time. you can burn

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New Findings on Wood Fuel Values

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larger amounts of wood of higher moisture content and allow the moisture to help limit the burning rate. With some practice, larger amounts of higher-moisture-content wood can be burned with minimal smoke production, and that will mean that you do not have to refuel as often. The moist wood can be wood that has been partly seasoned outside. Using moisture content to help control heating rate was probably the basis for statements a generation ago that wood stored outside burned best

If green or wet wood is burned, the flame temperature may be lowered to where the gases are only partly burned. This will usually result in creosote-forming conditions. The creosote will be a nuisance and a hazard if green wood is burned for a long time.

Here are some ways to reduce creosote formation:

- Choose the proper size wood-burning appliance. Do not install one so large that it is most often used at low heating rates.
- Maintain burning conditions to minimize smoke. Smoke-formation conditions are likely during startup, when fresh wood is added, and when burning with the damper nearly closed.
- Burn a hot fire for about 30 minutes each day to heat the chimney. This helps to remove accumulated creosote.
- Protect wood from weather until it is properly seasoned and ready to use.
- Clean the chimney if it contains a creosote thickness of more than about one-eighth of an inch. With a new appliance, inspect it once or twice a month to learn how fast the creosote accumulates. Inspect the chimney at least each year.

Catalytic devices (ceramic grids that support a platinum catalyst) can speed chemical reactions to facilitate the burning of the gases, thus reducing creosote formation and increasing the stove's burning efficiency.

The Harvest

There has also been a recent realization by many woodlot owners that they can be self-sufficient in home heating by burning wood. Considering the present growth rate of hardwood woodlots, and the fact that five to 10 cords of wood are required to heat the average home each year in the upper tier of states, 10 to 20 acres of mature woodlot are required to be self-sufficient for home heating in the more northerly states. Homes in lower states may require up to five cords of fuel per year and could be self-sufficient with proportionately less land. This use of the woodlot, however, does not allow for potentially more valuable uses of wood. Those who harvest firewood should do so selectively, using forest resources wisely. ■

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