Woodstoves

Increase Efficiency - Decrease Air Pollution and Creosote

Wood is abundant in many parts of the Great Land, and using a renewable resource for energy makes good sense. The U.S. Department of Energy anticipates three times as much energy will come from wood in the future.

Woodstoves seem to be the coziest, most independent way to stay warm. Unfortunately, woodstoves emit significantly more pollutants than oil-fired furnaces, and complete combustion of wood (complete efficiency) is nearly impossible.

A great deal is involved in getting the most heat possible from your wood. To accomplish this, and avoid unnecessary pollution and the risk of chimney fires, you should operate your stove properly. These pages describe some simple easy steps for all woodstove users to follow.

There are several steps to getting the fullest benefit from your stove, such as sizing and selection, installation, operation, and maintenance. The brochure, “Buying an EPA-Certified Woodstove” provides a convenient method for determining what size stove is best for your heating needs. It is available here: www.dec.state.ak.us/air/doc/epa-buy-wdstv.pdf

Heat Efficiency

Woodstove efficiency simply means heating the room instead of allowing the heat to escape up the chimney.

When wood is burned, the heat of combustion drives combustible (burnable) gases and water vapor from the log’s interior. If an insufficient amount of air exists in the firebox, these gases and other fuel particles will remain unburned as they pass up the stack to the outside. These particles and gases (except water vapor, carbon dioxide and ash) are a source of additional heat energy. If sufficient air is present and the flue gas is hot enough, burning will continue in the air space above the fire and in the lower portion of the chimney pipe. The heat of combustion is transferred to the stove surface and then to the room. At some point along the chimney pipe the flue gas temperature drops below that required to support additional burning. Hence, if all of the fuel is not burned when reaching this point it is either emitted to the outside air or deposited on the inside stack surface as creosote. In either case, a loss of energy has occurred.

Air Pollution

Complete combustion of wood to carbon dioxide and water vapor does not produce any health-related air pollutants.

Unfortunately, even when operated at optimum conditions, woodstoves do not achieve complete combustion throughout the entire burning cycle. Generally, stoves emit 30 to 250 times more solid particles and up to 1,000 times more carbon monoxide than oil-fired furnaces (on a heat-equivalent basis). These compounds do have damaging health effects and are considered to be air pollutants.

Breathable particles (smoke, creosote fumes, ash)

- Smoke and its other companions are a complex mixture of very small liquid and solid particles, many of which are inhalable. Some are suspected carcinogens.
- In periods of low wind and temperature inversions, smoke accumulation impairs visibility and may irritate the respiratory system and adversely affect the health of you and your neighbors.

Carbon monoxide (odorless, colorless gas, typical pollutant of automobiles)

- Unconsciously decreases awareness and reaction time.
- Restricts the blood's ability to carry oxygen.
- At high levels, affects the cardiovascular system and can cause death by suffocation.

Usually, for pollution to reach levels affecting the public health, two factors must occur simultaneously. First, there must be a significant quantity of pollutant and second, there is little wind to dissipate and remove the pollutant from an area. Valleys or locations surrounded by hills on three sides are especially susceptible to stagnant air conditions.

Although wood has been used almost exclusively for home heating in years past, population concentrations at that time were not high enough to create significant air pollution problems. Today, however, air pollution from wood burning is a problem in several of our communities and cities.

To Do's

- Know your stove. For each new lot of wood you burn, investigate its burning characteristics at different damper settings. Also, visually inspect the smoke coming out the stack at the different settings. The smoke will be lighter in color and more transparent as higher combustion efficiency is achieved. Heavy smoke means you're losing energy up the chimney.

- Allow proper air intake for good combustion. Over-dampering results in insufficient air, high pollution and lower heat efficiency. Too much air also results in low heat efficiency. When reloading a hot stove, open the damper for 10 to 15 minutes to allow the new wood to fully ignite.

- Place overnight loads carefully to allow good air circulation between the logs. Over-loading the stove and setting the dampers too low at night are major contributors to pollution.

- When stagnant air prevails, reduce your wood burning as much as possible.

Creosote

Creosote is a black substance composed of the unburned combustibles deposited on the inside of the chimney or stack. This material represents wasted fuel that has been gradually cooling as it travels up the chimney. Upon reaching a temperature near the condensing point of water vapor (212ºF), this wasted fuel is deposited along with water droplets on the walls of the stack as a black tar-like substance. Since creosote is a fuel, it is extremely flammable at temperatures around 100ºF and could result in a dangerous chimney fire. It is impossible to entirely prevent creosote formation from a wood burning stove, but the quantity can be greatly reduced if you minimize the conditions under which it is formed.

Wood Seasoning

Wood seasoning is the process of storing fresh-cut wood so that it may dry. Fresh cut or downed wood is usually very high in water content (45-55%), especially in southeast Alaska where high rainfall prevents in-field drying. In the interior parts of the state, where annual precipitation is quite low, downed wood may be significantly dried while lying in the woods or stored openly in a yard.

The heat efficiency from burning wood is dependent on the wood moisture content since a proportion of the fire's heat is needed to boil off the water in the wood. Thus, the more water in the wood, the greater the heat loss. Additionally, the extra steam in the firebox inhibits the complete burning of other gases liberated from the wood. If only wet wood is burned, the total wood volume used for an entire winter may be as much as 30% more than if seasoned wood were used.

Because of added water, each log you split and carry into the stove can weigh up to twice as much as a dry log.

To Do's

- Keep flue temperature high. Maintain a minimum stack temperature of 250ºF to prevent creosote condensation. An inexpensive thermometer ($10-$15) that will adhere to the stovepipe can be placed a few feet above the stove and below the insulated chimney pipe.

- If a high combustion efficiency is maintained, the quantity of unburned fuel components that form creosote will be greatly decreased. Overnight fires that are over-dampered are the worst creosote generators since the fire tends to smolder.

- Insulate stacks both inside and outside the house. This will help reduce creosote condensation by minimizing heat loss and keeping the flue gas above the 250ºF minimum temperature.

- Dry wood a minimum of 3 months; but to 12 months if possible. The length of time required to season wood depends upon how it is stored, the daily temperatures, relative humidity and whether the wood receives direct sunlight or rainfall. Using dry, seasoned wood for fuel results in a hotter firebox temperature and makes it easier to maintain the flue gas at 250ºF.

- Split, cover and stack wood to allow maximum air circulation. Cross-hatch stacking is best. If you use plastic to protect from the rain, cover only the top of the woodpile.

Stove Design

When buying a new stove you could literally spend months looking at different brands and designs. However, there are basically two distinct classes: non-airtight and airtight.

Non-airtight stoves have been used since before the colonial days. These stoves are a simple design such as the common potbellied and barrel stoves. Today, they still enjoy a high popularity due to their simplicity and the lower initial costs compared to airtight stoves. However, since the rate of intake air is not critically controlled, usually an overdraft of air occurs. Because the hot air moves quickly through the stove and out the stack, much of the heat is lost to the outside air.

Airtight stoves are devices that are literally capable of suffocating the fire by closing the dampering system. Consequently, by having a very finite control of the air supply, the heated gases stay in the stove longer and more of the fire's heat is transferred to the air inside the house. Hence, a greater overall efficiency is achievable for this class of wood burning stoves. However, to get high efficiency the wood must be dry, the air damper set correctly and the wood loaded to provide good air circulation. Many stoves incorporate design characteristics not readily visible to the eye that improve or diminish the efficiency rating. Such beneficial design characteristics as chambers for preheating intake air, internal baffles to mix air and unburned gases, and secondary combustion chambers are beneficial if the fire is maintained near optimum conditions.

Some new stoves incorporate a catalyst. These airtight stoves can achieve 15 to 20% greater heat efficiency while also reducing creosote formation and air pollution.

To Do's

- Make your home energy efficient. Reduce your heating needs by weatherizing and insulating. Ask your utility company for an energy audit. Tax credits for weatherization are available from both state and federal governments.

- Estimate your heating needs. Determine how much area a woodstove will effectively heat in your house. A good rule of thumb is 2.6 cubic feet of firebox per 1,000 square feet of heating space. Hallways can prevent the movement of heat from one room to the next. It may be impractical to assume a woodstove can heat the entire house.

- Don't buy too large a stove. Not only are you wasting money on more equipment than you need, you will have to over-damper the stove to keep the room temperature down to a comfortable level. Over-dampering will decrease efficiency.

For additional copies of this brochure or a copy of the brochures:

- ***Woodstoves: Increase Efficiency Decrease Air Pollution and Creosote***, or
- ***Catalytic Woodstoves: Installation, Operation, and Maintenance***

write or call:

Alaska Department of Environmental Conservation
Division of Air Quality
555 Cordova St.
Anchorage, AK 99501
907-265-7698
www.dec.state.ak.us/air/anpms/

For a current list of EPA-certified woodstoves or for more information about wood burning and EPA's regulations, write or call:

Wood Heater Program (EN-341W)
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460
(703) 308-8688
www.epa.gov/woodstoves/