

Best Management Practices for Installing and Firing Outdoor Wood Boilers

Introduction

Outdoor wood boilers, known technically as hydronic heaters, can be found across much of rural America (Figure 1). They are popular among the wood burning community because they provide a way to heat with wood while keeping dirt and ash out of the home. Outdoor wood boilers also reduce the chance of a house fire since the fire is outside the home. Many users source their wood from local woodlots or process their own wood, saving energy costs and increasing their degree of energy independence compared to using expensive fossil fuels.

Air quality problems can arise with outdoor wood boilers. However, most of these problems can be

minimized or avoided if the best management practices outlined in this factsheet are followed. These practices will decrease the amount of firewood utilized thereby increasing the economic advantage of wood energy and minimizing its environmental impact.

Installation of Outdoor Wood Boilers

When purchasing an outdoor wood boiler, buy only an Environmental Protection Agency (EPA) Phase 2 unit. Due to more efficient burning, Phase 2 units use less wood to get the same amount of heat, saving you money and time. Also, Phase 2 units emit significantly less particulates than older models, reducing air quality problems in your community. Phase 2 units will have a permanently



Figure 1. Outdoor wood boiler

attached metal tag (Figure 2). Also pay attention to unit size and the water transfer system. Each of these aspects has a large impact on the efficiency of an outdoor wood boiler's performance. Outdoor wood boilers sold in Maryland must have Environmental Protection Agency Phase 2 certification (see label in Figure 2). The label will provide information on output, efficiency and particulate emissions.

Older, less efficient outdoor wood boilers are still sold in adjacent states but it is illegal to install the stoves in Maryland. The newer EPA Phase 2 boilers are much more efficient, use less wood, and have significantly lower emissions.

Emissions

The primary measure of emissions for any wood burning appliance is grams of particulate produced, expressed as grams per hour or grams per million Btu. The magnitude of the reduction in emissions that EPA Phase 2 boilers offer is significant.

According to various sources of test data compiled by the Alliance for Green Heat, older outdoor wood boilers can produce an average of 161 grams per hour of particulates. The EPA estimates the average Phase 2 stoves emit 4.8 grams of particulates per hour.

Sizing the Unit

The size or output of the boiler is expressed in British Thermal Units (Btu). The Btu is the standard unit to measure heat output and is technically the amount of heat energy needed to raise one pound of water one degree Fahrenheit. Be aware variations do exist in how Btu output is reported and advertised. Common methods include, but are not limited to, maximum hourly Btu output or Btu output per hour for an 8 hour period. The output of the unit you choose should be based on the size and insulation level of the structure to be heated. If the boiler will be used to provide domestic hot water in addition to heating, the extra demand must be factored in.

Be cautious of installing an oversized outdoor wood

boiler, a frequent mistake made by both buyer and seller. The boiler will operate most efficiently at maximum output, but as demand on the boiler is reduced the efficiency drops quickly and emissions increase. Research performed by the University of Maryland on an installed wood boiler using inline Btu meters found, over the course of a heating season, when demand on the boiler is high (cold weather) efficiency was 18% greater than when demand was low (mild weather). Purchasing a boiler capable of providing adequate heat for the coldest day of the year will result in lower efficiency of the unit over the season, because during much of the heating season. Because outside temperatures are milder during much of the heating season, the unit will be operating under low demand. This is when the unit operates least efficiently and produces more emissions.

For peak outdoor wood boiler efficiency, consider installing a unit that is slightly undersized and supplementing with other heat sources on that coldest week or two of the year. Sizing outdoor wood boilers is a balancing act and is best done with a competent dealer who understands the product they are selling and your heating needs. Have an open and frank discussion with your dealer to find the unit that is right for you. If you do not have a supplemental heat source the unit you choose needs to be large enough to meet 100% of your heat needs, even though you will experience a drop in efficiency.



crownroyalstoves.com

Figure 2. Example of EPA phase 2 tag

Reducing Heat Loss in Water Supply Lines

Outdoor wood boilers use water to transfer heat energy. Proper insulation of the water supply both to and from the home is essential to minimize heat loss (Figure 3). Even the best insulated water lines will lose some percentage of their heat to the cooler ground, but it is desirable to keep that loss at a minimum.

Research performed by the University of Maryland found a 20% loss in Btu's in a 100 foot span of well insulated pipe that extended from the boiler to the home. The 54° F ground temperature will extract a significant amount of heat energy from supply or return lines, especially if the lines are uninsulated or poorly insulated. Heat lost is energy loss no matter where it occurs in the water transfer system, and this translates into using more wood. Investing in good insulation of the water transfer system can have a significant payback due to reduced labor and wood use over the 10-15 year life of a boiler. Do your homework when sourcing underground pipe. Many insulated pipe products are available (Figure 3).



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Figure 3. Water line insulation

Also consider the distance the outdoor wood boiler is located from the structure or home it will heat. Water traveling through equally insulated lines will lose more heat through longer water lines, so locate the stove as close to the home as is workable.

Building codes and insurance policies regarding a boiler's distance from homes may vary, so be sure to use proper setbacks from property lines, structures, and meet other regulations that may apply in your area and that are pertinent to your installation.

Operating Installed Outdoor Wood Boilers

Once the outdoor wood boiler is properly sized, installed, and water supply lines are well insulated, managing wood moisture is the primary way to increase efficiency and reduce emissions. Drying wood to 20% moisture (considered air dry) is the standard recommendation for firewood. It is important to dry firewood to this level because each additional pound of water in the wood requires 1,200 Btu's to heat and vaporize. Although Btu robbing moisture is driven out of firewood during the burning process, it is not captured as heat. In a nutshell, the higher the moisture is in firewood the less heat it will provide. Theoretically burning green wood in a 100% efficient stove could require, in a 10 cord heating season, nearly one extra cord of firewood to provide the same amount of heat as firewood dried to 20% moisture. In reality, since a 100% efficient stove does not exist and because moisture lowers operating efficiency, the amount of firewood required to provide the same amount of heat as 10 air dry cords could very easily double if higher moisture wood is used. Additionally some stove models have trouble keeping a fire with high moisture wood.

Smoke is a very effective tool for judging stove efficiency. Smoke is unburned fuel. Heavily smoking boilers, or other wood burning appliances, indicate inefficiency due to stove design and/or wood with high moisture content.

The best method to dry and/or maintain firewood moisture at or below 20% is to split, cover, and protect firewood from ground moisture and rain. Splitting firewood significantly speeds the drying process allowing firewood to adequately dry in 6-9 months. When storing firewood remember it is desirable to increase airflow around firewood to speed the drying time. The best structures to dry firewood are those protecting wood from moisture in the ground and from rain while leaving the sides open to increase air flow (Figure 4). A pole building with roof and no

sides, for example, will dry firewood more quickly than a fully enclosed structure. A lower cost option is to cover only the top of a stack of firewood with a tarp while leaving the sides exposed.



worldforestindustries.com

Figure 4. Wood storage options to lower wood moisture content

Monitoring Moisture Content

To monitor the moisture of firewood consider purchasing an inexpensive (\$30-\$50) wood moisture meter (Figure 5). They can be found at home improvement stores like Lowes, Home Depot, and many online locations. Using a meter will enable you to better manage firewood moisture.



Figure 5. Wood moisture meter

Moisture readings will not accurately represent the entire piece of firewood if the wood is partially dry and the reading is taken from the end of the log. To accurately read firewood moisture split a piece of firewood and promptly

take a moisture reading, with the moisture meter, at the center of the log. To visually determine if firewood is dry observe the end of the log for “checking” (Figure 5). Checking occurs as wood contorts during the drying process. It does not guarantee the center of the log is dry, but it is an indicator the drying process is underway.



Figure 5. “Checking” of firewood

Conclusion

Outdoor wood boiler technology, efficiency, and environmental friendliness have improved significantly. EPA Phase 2 outdoor wood boilers make many of these advances available to the wood burning community. If you are replacing or installing a new stove it is critical to properly size the stove, reduce energy loss in water transfer lines, and manage your wood supply to keep moisture at or below 20%. The capital cost of replacing an older outdoor wood boiler may be prohibitive but using best practices like properly insulating water lines, drying wood, and sizing wood burning units can result in higher efficiency and less wood used.

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This publication adapted material from the following publications:

Estimates of Air Drying Times for Several Hardwoods and Softwoods by William T. Simpson and C. A. Art. USDA General Technical Report FPL-GTR-12 (<http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr121.pdf>).

Partners-Program Participation-List of Cleaner Hydronic Heaters, EPA Website (<http://www.epa.gov/burnwise/owhlist.html>).

Wood Fuel for Heating by J.P. Slusher. MU Guide G5450. University of Missouri Extension. Published March 1995, all rights reserved.

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