

" Pyrolysis "

Lets begin by talking about how wood burns. You may have never heard this, but believe it or not, wood in it's solid form doesn't actually burn. Technically, it gasifies when exposed to heat... a process otherwise known as pyrolysis. During this process the wood is transformed into a combustible gas called woodgas consisting mainly of Hydrogen (H), Carbon Monoxide (CO), Methane (CH₄), Nitrogen (N), and a complex mix of particulate matter that gives us visible smoke. It's the combustion of a low percentage of these gasses and particles that we see in the form of flames when we sit and watch a campfire or a fireplace crackle. In short, anytime firewood is involved in combustion, the pyrolysis process is releasing a combustible gas, and a combustion reaction then burns some of that gas. Because the combustion of the woodgas produces heat, the entire reaction becomes self sustaining until all of what used to be solid wood has been reduced to gas and ash.

So how does this process of pyrolysis apply to wood burning appliances, specifically the wood gasification boilers? Lets talk about that campfire again. The combustion efficiency of a campfire (i.e. the total amount of energy released in the combustion reaction compared to the total amount of potential chemical energy stored in the wood) is very low at around 15%. This means that most of the gas that is being released during pyrolysis is escaping before it gets a chance to be burned. This will be visually evident by the smoke rising from the fire. So the question becomes, how much of the woodgas is able to be burned in your wood burning appliance, and how much is escaping into the atmosphere as unburned fuel?

Before efficient combustion of the woodgas can be realized, there are certain requirements that need to be met. Two factors stand out: 1) the gasses must somehow be heated to a temperature of around 2000 degrees, and 2) the gasses must be mixed with the proper amount of oxygen. If a wood burning appliance cannot meet these requirements, you basically have a campfire in a box. You can be sure the combustion efficiency is suffering if this is the case. Forced draft fans can increase combustion efficiency , but in many inefficient wood stoves and boilers, this figure can still be as low as 30%.

This issue of combustion efficiency is where the gasification boilers have the edge. All of the retained gasses from the upper chamber are forced through the coal bed and through the refractory nozzle at the base of the firebox. This effectively increases the temperature of the gasses to a point where they will combust at well over 90% efficiency when the proper amount of oxygen is added to the mix.

" Moisture Content "

One of the most widespread myths about burning firewood comes from wood burning equipment salesmen trying to convince people that their burner can burn green wood as efficiently as it can seasoned wood. This sales pitch is often geared toward customers who admit to procrastination when it comes to getting their firewood ready in time for the next season. Many people think that they can save themselves some work by purchasing one of these miracle burners... but nothing could be further from the truth. As stated on our FAQ page, just like the water that comes out of your faucets, the water that

trees store naturally in their fibers **DOES NOT BURN**. In fact, it requires the use of at least 15% of the heat energy produced by the combustion of pyrolysis gasses to vaporize the water out of the wood before the wood will release more gas. This directly translates into 15% or more increase in wood usage, and the production of large quantities of ash and creosote.. The work that people thought they would save by burning great chunks of wet and soggy wood in their miracle burner turns out will actually increase the amount of effort they have to put into acquiring their firewood simply because of the sheer increase in volume needed to generate the same heat as dry wood. Bottom line... no matter what boiler, stove, insert, or other wood burning device you are using, you are far better off to season your firewood before you burn it, than to burn it green.

So what is "seasoned" firewood and how do you get it? The industry generally accepts anything below 25% to be well seasoned enough to burn in most any wood fired appliance. Getting wood to this level of moisture will depend on several factors... species, what time of year the tree was cut down, how long after the tree was felled that the pieces were cut into lengths, the length of the individual pieces, whether or not the firewood was split, and where and how it was stacked. Lets discuss these issues one at a time.

- **Species.** Moisture content of fresh wood will vary from species to species. Ash, for instance, is the most sought after wood for burning in a green state. It's green moisture content will generally be around 35%. This is not ideal, but should still yield fairly decent heat output. Hemlock, on the other hand, can have a green moisture content as high as 65%. If you tried to burn this you will be lucky to get anything more than just a giant plume of smoke.
- **Time of year the tree was felled.** Deciduous trees have heavy sap flow during the spring and summer months. During these seasons, moisture content will be at it's highest. It is best to cut the trees down when they are dormant for the winter, when sap flow is non existent, and moisture content will be at it's lowest point.
- **How long after the tree was felled were the firewood pieces cut to length.** Wood dries fastest through the end-grain, and slowest through the bark. If you downed a tree, but left it in log form, it's likely the log is not seasoned enough to burn regardless of how long it's been down, except maybe at the very ends. It is important to at least cut your logs to length as quickly as possible to start the drying process. It will take a little longer to season your wood if you decide not to split it, but it will eventually season.
- **Length of individual firewood pieces.** Wood dries fastest through the end-grain, but if you cut your pieces extra long, it will take more time for the moisture in the center of the log to work it's way through to the ends. For relatively fast drying, it is recommended that you cut your firewood between 18" and 20" in length for most applications. The shorter the pieces, the faster they will dry.
- **Split firewood.** As stated above, the fastest route for moisture to exit a piece of wood is through the end-grain. The second fastest is through the face of a split. If you want to season your firewood as quickly as possible, you really do need to split it. The smaller the splits, the faster it will dry.
- **Stacking.** In order to speed the seasoning of your wood, it's best if it can be stacked up off of the ground, preferably in the sun, and where the wind can blow through the pile. A cover over the very top of the pile is also beneficial, and if you have space, stacking a week or two worth of wood inside during the winter will speed the drying process substantially.

If you use these simple facts regarding moisture content to plan your wood drying endeavor, you can

season most species of wood to 25% moisture content over the summer months with relative ease. There are some species, like oak, which may take a little longer to get to an optimum level of moisture, and some, like ash, which will only take a few weeks.

" Energy Content "

It is important to understand when choosing or purchasing firewood, that Btu content per unit of volume can vary drastically between species. All wood species have close to the same energy content per pound, so density will determine their Btu content per unit of volume. For our comparison chart below, we will be using the "cord" as our unit of volume. A cord is equal to 128 cu-ft of split and stacked firewood, generally measuring 4'x4'x8'. Because there is air space between the individual pieces of firewood in a stacked cord, no two cords are exactly the same, so for our comparisons, we will consider a stacked cord to be equal to 85 cu-ft of solid wood. Figures are based on 20% moisture content. Mileage may vary.

Species	Million Btu's/cord	Weight per cord (lbs)
Shagbark Hickory	28.0	4,330
Eastern Hornbeam	27.5	4,250
Ironwood	27.1	4,015
Black Birch	26.8	3,895
Black Locust	26.7	3,830
Bitternut Hickory	26.7	3,830
Apple	26.5	4,115
White Oak	25.8	4,020
Sugar Maple	24.2	3,800
Red Oak	24.0	3,685
White Ash	23.6	3,690
Yellow Birch	23.5	3,655
Red Elm	21.6	3,110
Gray Birch	20.3	3,180
Paper Birch	20.3	3,180

White Birch	20.3	3,180
Black Walnut	20.2	3,192
Cherry	20.0	3,120
Green Ash	19.9	2,880
American Elm	19.6	3,150
Black Ash	19.2	3,065
Red Maple	18.8	3,035
Hemlock	15.9	2,480
Quaking Aspen	14.5	2,290
White Pine	14.3	2,240