Firewood, Facts, Follies and Forest Management

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Outline

• Introduction
• What burns best and why?
  – Species
  – Density
  – Moisture
  – Burning efficiency
• Firewood volumes
• Comparing Fuels
• Cautions
Heating with firewood is likely to continue to increase in popularity as the cost of energy continues to rise.

* Prices in 2010 dollars, using PPI.
The Warmth of Wood
What Wood Burns Best?

• How much heat can you get from wood?
  – Btu’s available.
    • A Btu (British Thermal Unit)
      – basic measure of thermal (heat) energy.
    • One BTU is the amount of energy needed to 1 lb. of water 1 °F

• How many Btu’s in wood?
Combustion of Wood

Three consecutive and overlapping stages of combustion

1. **Ignition and 500°F**
   - Heat of the fire absorbed by the fuel and the wood dries
   - Greatly impacted by the amount of water in wood,
     * The wetter wood is, the less BTU’s that will be available
   - The heating value per kiln dry pound is approximately 8,000 to 9,500 Btu/oven dry pound for all species!

2. **500 to 1100 °F**
   - Wood breaks down, emitting flammable gases (volatiles) that contain more than half of the heat energy of the wood.

3. **Over 1100 °F**
   - the remaining material, charcoal, burns until it is consumed.

Ideally, well-dried wood will burn through the second stage evenly, without sparks, and with minimum smoke, and spend a long time burning in the third stage.
What Wood Burns Best?

• How many Btu’s in wood?
  – Depends:
    • Density
    • Moisture in the wood
    • Efficiency of your wood burning device
Weight per cord given a 20% moisture content and the average BTU’s produced.

<table>
<thead>
<tr>
<th>Species</th>
<th>Weight per Cord</th>
<th>Heating value per cord (Btu's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American elm</td>
<td>3,000</td>
<td>20.2</td>
</tr>
<tr>
<td>Apple</td>
<td>4,140</td>
<td>26.5</td>
</tr>
<tr>
<td>Aspen</td>
<td>2,295</td>
<td>14.7</td>
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<tr>
<td>Basswood</td>
<td>2,108</td>
<td>13.5</td>
</tr>
<tr>
<td>Beech</td>
<td>3,757</td>
<td>24</td>
</tr>
<tr>
<td>Black birch</td>
<td>3,890</td>
<td>26.8</td>
</tr>
<tr>
<td>Black locust</td>
<td>4,200</td>
<td>29.3</td>
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<tr>
<td>Black cherry</td>
<td>2,880</td>
<td>19.9</td>
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<tr>
<td>Cottonwood</td>
<td>2,108</td>
<td>13.5</td>
</tr>
<tr>
<td>Hackberry</td>
<td>3,247</td>
<td>20.8</td>
</tr>
<tr>
<td>Hard maple</td>
<td>3,757</td>
<td>24</td>
</tr>
<tr>
<td>Hemlock</td>
<td>2,482</td>
<td>15.9</td>
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<tr>
<td>Hickory</td>
<td>4,327</td>
<td>27.7</td>
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<tr>
<td>Paper birch</td>
<td>3,179</td>
<td>20.3</td>
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<tr>
<td>Red oak</td>
<td>3,757</td>
<td>24</td>
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<tr>
<td>Soft maple</td>
<td>2,924</td>
<td>18.7</td>
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<tr>
<td>Sycamore</td>
<td>2,900</td>
<td>20.2</td>
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<tr>
<td>White ash</td>
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<td>23.6</td>
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<tr>
<td>White oak</td>
<td>3,800</td>
<td>26.5</td>
</tr>
<tr>
<td>White pine</td>
<td>2,236</td>
<td>14.3</td>
</tr>
</tbody>
</table>
Wood Density or S.G.

Southern pine 0.28 versus 0.70
What Wood Burns Best?

• Moisture in Wood

• How much moisture is in wood is usually described as its moisture content (MC%)
  – MC%
    • the ratio of the weight of water in wood relative to the dry wood mass, expressed as a percentage.
Moisture Content

\[
\%MC = \left( \frac{\text{Wet Weight} - \text{Oven Dry Weight}}{\text{Oven Dry Weight}} - 1 \right) \times 100
\]
Moisture Content (oven dry basis)

\[
\%MC = \frac{\text{Wet Weight} - \text{Oven Dry Weight}}{\text{Oven Dry Weight}} \times 100
\]

\[
\%MC = \frac{0.90\, \text{kg} - 0.60\, \text{kg}}{0.60\, \text{kg}} \times 100 = 50\%MC
\]
### Green Moisture Content

<table>
<thead>
<tr>
<th>Species</th>
<th>Heartwood</th>
<th>Sapwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>30</td>
<td>112</td>
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<tr>
<td>Shortleaf pine</td>
<td>32</td>
<td>122</td>
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<tr>
<td>Eastern hemlock</td>
<td>97</td>
<td>119</td>
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<tr>
<td>Red oak</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>Yellow poplar</td>
<td>83</td>
<td>106</td>
</tr>
<tr>
<td>Hickory</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>White oak</td>
<td>64</td>
<td>78</td>
</tr>
</tbody>
</table>

- When first cut, the wood is at its highest moisture content.
- The “green” or fresh cut moisture content of wood is typically higher than 60% for most hardwoods and for some species, over 100%.
How Do I get More BTU’s?

• Dry the wood

http://nhfirewood.com
Drying Firewood

• Airdrying is most common
  – Drying times will depend on:
    • your location
    • how you pile it
    • protection from rain and snow
    • How its split
      – Splitting wood will increase drying since there will be more exposed wood surface to the air

• For most locations it takes approximately 9-12 months to dry firewood from green to 20% moisture content
How you stack it matters!

Reddit.com
Kiln Drying

• Steam, direct fired or indirect fired kilns
• Green firewood can be kiln dried from 52% to 20% in 30 hours using temperatures of 220F.
• Temperatures of 140 and 180 F require drying times of 260 and 90 hours respectively.
Firewood Measures

• Cord

• A standard cord of wood
  – the volume of stacked wood including air space occupying 128 cubic feet
  – defined as the volume of a stack of wood 4 feet high by 4 feet wide by 8 feet long
Firewood Measures

• Actual volume of wood in a 4x4x8-foot space can vary greatly depending on:
  – how tightly the wood is packed
  – the diameter of the pieces
  – the straightness of the piece

• Studies have shown that the volume of wood per standard cord can vary from 58 cubic feet to 94 cubic feet!
Firewood Measures

- Face cord, rick, pile, truckload, etc. are not standardized
  - "truck load" of firewood may vary form a 1/5 cord in a short bed light pickup to 4 cords as in a pulpwood truck
  - Firewood capacity of different sized trucks varied from less than 1/5 cord to slightly +1/2 cord
  - capacities were noticeably affected by how they were loaded
Efficiency of Wood Burning

• The efficiency of wood burning devices is related to
  – efficiency of combustion
  – efficiency of heat exchange

• EPA approved wood stoves are a minimum of 60 percent efficient with some being as high as 80% efficient.
How We Burn Wood

- Fireplace
- Stove
- Indoor boiler
- Outdoor boiler
- Masonry stove
Fireplaces

• Least efficient
  – 10-15 %
  – Must draw in as much as 300 cubic feet per minute of heated room air for combustion but then send it straight up the chimney

• Limited ability to control a fire or to temperatures for combustion
Wood Stoves

• The modern wood stove
• EPA is setting efficiency requirements
• 75 to 80 % efficient
• 30 to 40% more efficient than old stoves
Indoor Boilers

• Outputs high enough to heat an entire house through forced air or radiator systems
  – Also provides household’s hot water supply
• Highly efficient
• Meet EPA requirements
  – Reduced particulate and smoke
Outdoor Wood Boilers

- Located outdoors, heat water that is then circulated into the home through underground pipes.
- The heated water may be used directly or as a source of residential heating.
- Employ very primitive combustion technology and are designed to burn wood at lower combustion temperatures and generally have shorter stacks.
  - emit smoke closer to homes and neighborhoods.
Masonry Stoves

• Masonry stoves have a small, powerful firebox and a large masonry mass
• 18 and 20 hours of radiant heat from a single fuel load.
• 80 to 95% efficient
Comparing fuels

http://www.buildinggreen.com/calc/fuel_cost.cfm
Comparing fuels

- Or Google “fuel value calculator Forest Service”
Comparing fuels

- Don’t just look at the fuel!
- Efficiency of consumption
- Efficiency of distribution
  - Electric baseboard radiators, the heat is produced right in the room, so the distribution is 100% efficient.
  - Hot-air furnace the distribution efficiency can be quite low
    - 60% to 65% is not uncommon.
Cautions!

• Fire can be dangerous!
• Proper installation
• Proper stove maintenance
• Chimney stove pipe maintenance
• Do not move firewood
Moving Firewood

• DON’T
  – Asian longhorned beetle
  – Ash borer
  – Thousand-canker disease
  – Check with your local DOF for restrictions
Wood is the only fuel that heats twice ... first when you cut and stack it, and again when you burn it!