# Blowin' Smoke

James Fischer

## Really, don't let the smoke get in your eyes, it's nasty stuff.

No, let's not compare different smoker fuels. It just doesn't matter. Macbeth worried about Birnam wood coming to Dunsinane, but he was the only person with a valid reason to care about one fuel versus another.

Heresy? Not at all. In fact, there really is very little difference between smoker fuels. No matter if you use pine needles, tree bark, dried grasses, dried leaves, pine cones, cotton waste, or burlap, you are burning much the same thing. To get technical, cellulose, hemicellulose, and lignin make up the bulk of plants that grow on Earth. Under identical conditions, they should burn nearly identically.

But what goes on in a smoker?

What makes smoke?

Just what IS smoke, anyway?

Burning wood is familiar to just about everyone, so let's burn some wood, and watch what happens.

We were all told in school that wood, if burned efficiently by complete combustion, breaks down into its basic chemical structure of Carbon, Hydrogen and Oxygen, just as decaying trees do in a forest. But "efficient, complete combustion" is very difficult to achieve, and absolutely impossible in a bee smoker.

Wood, like any plant, contains a number of things:

Water - Freshly cut wood is about half water, by weight. "Seasoned" wood that has been left to sit for a year or two contains a lot less water. Kiln-dried wood contains about 15% moisture.

Volatile Organic Compounds - When plants are alive, they contain sap and a wide variety of volatile hydrocarbons in their cells. Cellulose, the chief component of plants, is a carbohydrate, meaning it is made of glucose.

A compound is "volatile" if it evaporates when heated. These compounds are all combustible.

Ash - Ash is the non-combustible minerals in the tree's cells, including calcium, potassium and magnesium. We don't call it "ash" until after burning, but anything that won't burn will be left as "ash".

Efficient burning happens only at temperatures well above 1200°F. The usual fire in a fireplace or woodstove never gets that hot (they typically reach about 900°F at the hottest), thus burning some volatiles, but releasing most of them into the air as pollution and smoke. Bee smokers burn at much lower temperatures than fireplaces, and the lack of oxygen in a smoker assures "smoldering" rather than burning. So, a smoker uses a multi-stage, low-temperature process to break down smoker fuel.

### First, Let's Blow Off Some Steam

All plant material contains water. The water must be evaporated out of the wood before the remaining fibers will be heated any further. The temperature of the wood will not rise above 212°F until the water is gone. The steam is also 212°F to start. Steam can scald your bees to death, and it is not going to cool off very much in the mere inches between your smoker and the bees. Even though "green stuff" appears to make great smoke when added to a burning fire, much of the "smoke" you see may be steam. The point here is that you don't want to use green stuff in your smoker.

### News Flash - Wood Does Not Burn!

Let's assume you are using well-dried materials, or have waited long enough for the moisture to boil out of your fuel. The temperature rises to about 450°F, as we all remember from Ray Bradbury's book *Fahrenheit 451*.

But even then, wood still does not burn! Here's a secret - wood never really burns. Next time you set a fire in the fireplace or make a campfire, watch what goes on. If you look closely, you will see that the flames never actually touch the wood. What is burning is a small fraction of the volatile gasses evaporated out of the wood. If you look closer still, you can see fingers of smoke arising from the wood well away from any flames. These are gasses evaporating at temperatures below that of combustion. On a scale of inches, the phrase "where there's smoke, there's fire" is very untrue.

When heat is applied, wood undergoes a process of thermal degradation called "Pyrolysis" in which the wood breaks down into volatile

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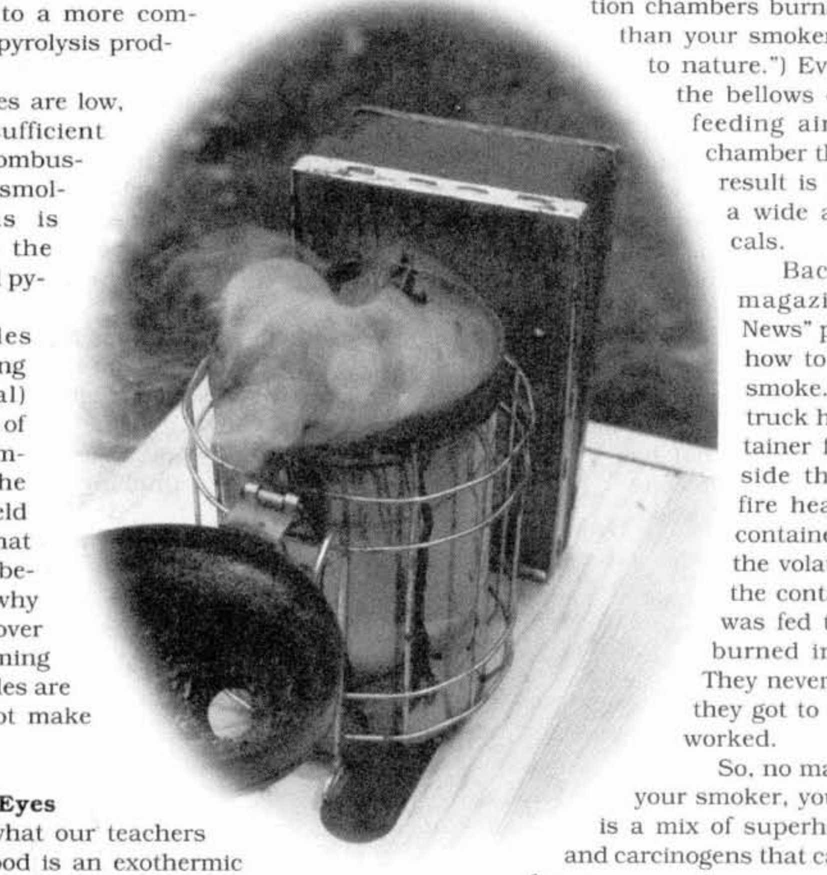
gasses and solid carbonaceous char (charcoal). The cellulose and hemicellulose form the volatiles, and the lignin becomes the char.

**Up In Smoke**

The substances created by pyrolysis are very complex. They consist of a gas fraction (carbon monoxide and carbon dioxide, hydrocarbons, and free elemental hydrogen), a condensed fraction (water, aldehydes, acids, ketones, and alcohols), a tar fraction (sugar residues from the breakdown of cellulose, furan derivatives, phenolic compounds), and some charred material.

This chemistry set of compounds is what we call "smoke". The mix is different depending upon temperature, amount of oxygen available, and so on. The same material, burned in your smoker on two different days, is sure to produce a slightly different mix of chemicals.

If enough oxygen is present and the temperature is sufficiently high, the volatiles can burn. This only happens to a small fraction of the volatiles in a smoker, more are burned in a fireplace or woodstove. The result is less smoke from a fireplace than a smoker, due to a more complete oxidation of the pyrolysis products in the fireplace.



When temperatures are low, or when there is insufficient oxygen for complete combustion of the volatiles, smoldering occurs. This is "smoking," which is the emission of unoxidized pyrolysis products.

After the volatiles are gone, the remaining lignin char (charcoal) burns in the presence of oxygen in glowing combustion. These are the beloved coals that yield the thin blue smoke that makes for a great barbecue, and the reason why you want to cook food over coals rather than flaming wood - the nasty volatiles are long gone, and will not make your steak taste bad.

**Smoke Gets In Your Eyes**

Let's go back to what our teachers told us – "Burning wood is an exothermic chemical reaction of oxygen (O) with cellulose ($C_6H_{10}O5$), the major component of wood, to produce carbon dioxide ($CO_2$), steam ($H_2O$) and heat. The chemical reaction describing the process is: $C_6H_{10}O_5 + 6O_2 = 6CO_2 + 5H_2O + \triangle$."

Lies! All lies! It is never that simple. In fact, a fire is a small-scale petroleum refinery and charcoal factory. We are dealing with hydrocarbons, and the more Carbons and Hydrogens we link together by letting the fire smolder, the more complex the chemicals we get.

Here's a list of the hydrocarbons, starting with the simplest. Your smoker can make all of these, and burn a small percentage of each.

| Name | Carbon Atoms | Molecular Formula |
|---|---|---|
| methane | 1 | $CH_4$ |
| ethane | 2 | $C_2H_6$ |
| propane | 3 | $C_3H_8$ |
| butane | 4 | $C_4H_{10}$ |
| pentane | 5 | $C_5H_{12}$ |
| hexane | 6 | $C_6H_{14}$ |
| heptane | 7 | $C_7H_{16}$ |
| octane | 8 | $C_8H_{18}$ |

Propane? Yes, just like the gas company delivers. Butane? Yes, same as in a disposable lighter. Octane? Yes, octane. You are making and burning gasoline in your smoker. Your super-high-efficiency wood stove with dual-stage combustion chambers burns much more gasoline than your smoker. (So much for "back to nature.") Every time you squeeze the bellows of a smoker, you are feeding air into a combustion chamber that lacked air, and the result is partial combustion of a wide assortment of chemicals.

Back in the 1970s, the magazine "Mother Earth News" published an article on how to run a car with wood smoke. The bed of a pickup truck held a sealed steel container full of wood, and outside the container, a wood fire heated the wood in the container. The heat drove off the volatiles from the wood in the container, and this smoke was fed to the carburetor and burned in the truck's engine. They never said how many miles they got to a cord of wood, but it worked.

So, no matter what you burn in your smoker, your "clean, cool smoke" is a mix of superheated toxic chemicals and carcinogens that cannot possibly be good for you, your bees, or your honey if used in excessive amounts.

Bottom line, easy on the smoke. It's nasty stuff. BC

*James Fischer made his money in computers, so he has significant experience with smoke and mirrors.*