Lab: How to Make Liquid Smoke

This is an advanced home project, but if you're up for the challenge, it's fun to make. It's also a great example of what chemists call *dry distillation*—separating compounds from solids under heat. (See page 360 for more about distillation.) Treat this as an experiment about process; I wouldn't use the finished product on your foods.

The smells and tastes of smoky, barbecue goodness are from chemical reactions that occur during pyrolysis (burning) of wood, not from any chemical interaction between food and smoke. Some of the desirable compounds generated by smoke are water-soluble, a lucky quirk that means we can isolate them by piping smoke through water to dissolve those compounds. Other compounds are less pleasant—at strong enough concentrations, some of them can smell rotten, like old, foul garbage.

Wood is primarily made of cellulose, hemicellulose, and lignin, all of which convert to thousands of different chemical compounds during burning. The aromatic molecules that provide smoke flavoring are generated by the lignin, which breaks down at around 750°F / 400°C. Cellulose and hemicellulose break down at lower temperatures (480–570°F / 250–300°C), but they generate compounds that both detract from the flavor and are mutagenic. Burning wood at too low a temperature can create creosote, a black oily residue generated from incomplete combustion of wood that is denser than water.

Note that wood or charcoal grills tend to heat their enclosures several hundred degrees hotter than gas-based ones.

First, grab these supplies:

Hickory or cedar wood chips (or any other wood chips suitable for smoking)
An aluminum foil disposable baking pan and tight-fitting lid (any shape pan will do; pie tins work well)
A 16–24" / 40–60 cm length of copper pipe, ½" / 1 cm diameter or smaller
A copper L-shaped elbow that fits tightly onto the copper pipe (available in your hardware store near the pipes)
2 ounces / 60 mL of heat-safe epoxy, such as J-B Weld original cold epoxy
A paper plate or piece of cardboard, for mixing epoxy
A plastic knife or popsicle stick, for mixing epoxy
A small glass bowl
Water for the glass bowl
An oven mitt or dry towel
And, obviously, a grill and fuel for the grill

Here's what to do:

We're going to smoke the wood chips in the disposable baking pan that's been sealed with epoxy (which will need to cure for several hours—plan ahead!), and then vent the smoke out through a pipe into a glass bowl filled with water. While the instructions are long, they're easy:

1. Attach the L-shaped elbow to one end of the copper pipe. It should fit snugly.
2. Check that the pipe will fit on your grill: open your grill, lay the pipe with the elbow end extending off the edge to the side and the empty end somewhere near the center of the grill. The elbow end will need to point down and vent into the small glass bowl, so adjust your setup accordingly. Two important things to check at this point: 1) make sure that you can

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close the grill lid; 2) make sure that the bottom part of the elbow will be submerged at least ¼" in the water once the glass bowl is topped off.

3. Using the empty end of the pipe, punch a hole in the side of the disposable baking pan. You can do this by pressing the pipe against the side of the pan and rotating it back and forth, almost like a drill bit; after a few seconds, it should cut through the foil.
4. Set the baking pan onto the grill (which should be off!) and feed the pipe through the hole. Line up the elbow such that it vents into the empty glass bowl.
5. Add the wood chips to the baking pan, putting a full layer in the bottom. At this point, your setup should look something like this:

6. Mix the epoxy, using the paper plate or cardboard as a palette and a plastic knife or popsicle stick to stir it.
7. Seal the hole where the pipe enters the baking pan by smearing epoxy all around the pipe at the point right inside the baking pan and pulling the pipe out a tiny bit to drag some epoxy through and plug up the hole.
8. Prepare to seal the top of the baking pan by lining the pan's top edge with epoxy. Place the lid on top of the pan, fold down the edges, and crimp and squeeze tight around all edges.
9. Wait several hours for the epoxy to cure.
10. Check that the epoxy is cured by gently pushing the pipe near where it enters the disposable baking pan. It shouldn't move.
11. Fire up the grill! After a few minutes, you should start to see steam and then smoke venting out of the pipe. Once that starts happening, add water to the bowl. You should start seeing smoke bubbles billowing through the water. Yay!

12. Let the grill run for 5–15 minutes. You should notice the water change in appearance. If you're using a gas grill, turn the heat off at this point; otherwise, use the oven mitt or towel to pick up the copper pipe and vent it outside of the water, and allow the grill to burn out.

Investigation time!

Examine the water. What do you notice? What colors do you see?

Is there stuff floating on top? What does it smell like? What do you think happens, in terms of odor, when some compounds are more concentrated than normal?

Pour off some of the top layer and look at the liquid in the middle. Dip just a tiny part of your finger into it and carefully taste a little. What does it taste like?

Remember the creosote described earlier? Do you notice anything like that? What would that mean about the temperature of your grill?