This lab is broken into two sections. Part 1 is the construction of the oven/kiln and Part 2 is running a test burn.

Part 1: Building a Top Light, Updraft (TLUD) Pyrolysis Kiln/Oven

Purpose: Creating usable biochar requires an environment where a feedstock can be heated to high temperatures, but not combusted. A pyrolysis kiln/oven does this by generating a high air flow through the gasification chamber allowing for the combustion of the syngas well above the pyrolysis layer. The construction is both cheap and easy to complete in a classroom or lab setting.

Materials:

Per Group:

- **1 (one) brand new One-Gallon paint can**
- **1 (one) Three foot section of chimney flue (This will be sold as unrolled sections that need to be assembled)**

www.efireplacestore.com

- **1 (one) 64 oz. stainless steel food service can (I got mine from the school cafeteria, just don't get ones that held tomatoes or pasta sauce as they are lined)**
- **1 (one) set of very sturdy tin snips**
- **1 (one) heavy duty can opener/church key**

- **1 (one) pair of gloves, leather or gardening gloves work best**

Procedure:

Working on a sturdy bench top or lab table, carefully follow the following directions to build and operate your TLUD Pyrolysis Kiln/Oven

Figure a: Materials for TLUD Pyrolysis Kiln/Oven

1. Make sure you have all your necessary materials and safety equipment, including gloves and safety glasses.
2. Begin by taking the 3 ft section of unrolled chimney flue and making it into a cylinder. If the locking seam gives you trouble, try viewing this video on how to do it. How to put round pipe together - via YouTube user, Robert Johnson
3. Using the heavy duty can opener/church key, make three concentric rings of holes on the **bottom** of the 1 gallon paint can. I made one additional hole right in the middle of the can. Be mindful not to make these holes bigger than the feedstock you intend to use. From this point forward this piece will now be referred to as the gasifier.

Figure b: Bottom of the paint can after punching holes

4. Next, take the 64 oz. steel food container and using the tin snips, remove the top 4 inches. This will make the crown.

Figure c: Cutting the crown

5. Using the tin snips on top 4 inch section you just removed, cut a series of triangles out of the bottom, all the way around the crown. Then, using the can opener/church key, punch a series of triangular holes along the side at the top rim. Lastly, using the tin snips cut a circular hole in the top of the crown just a little smaller than the diameter of the chimney flue from step #1. When complete your crown should look like figure d.

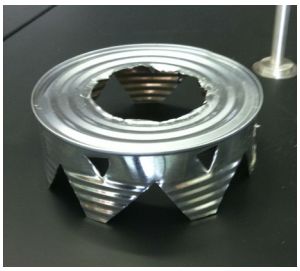

Figure d: A completed crown

6. When all three pieces (the flue, the crown, and the gasifier) are complete, they should be able to stand on top of each other as in figure e. You are now ready to pyrolysize your first sample.

Figure e: a complete TLUD

Part 2: Running a test burn

*****VERY IMPORTANT*** You must do this portion of the lab outdoors and away from overhangs and other flammable materials!!!**

Materials:

- **Your newly constructed TLUD Pyrolysis Oven/Kiln**
- **The lid that came with the paint can**
- **Feedstock (we'll use dried soybeans or any dried portion of the soybean plant) You will need enough to fill your paint can up about 75% of the way.**
- **Matches or a propane torch with igniter**
- **If using matches, a little butane lighter fluid may be necessary to initiate the burn.**
- **2 (two) bricks or other sturdy, nonflammable objects that can prop the kiln off the ground.**
- **A scale capable of measuring mass of the feedstock and can, both before and after the burn**
- **Heat resistant gloves**
- **A fire extinguisher as a safety precaution**

Procedure:

1. Mass the empty gasifier and record in your lab notebook.
2. Add enough dried soybeans to fill the gasifier approximately 75% full, it need not be exact. Mass the can now and record in your lab notebook.
3. Take your filled gasifier, your flue, and your crown outside to your burn location.
4. Place the gasifier on top of the two bricks, but do not place the crown or flue on top yet.
5.
    a. If using a torch you can go ahead and light the top layer of soybeans, but remember, your goal is simply to get it started and let the oven do what it was designed to do, separate the pyrolysis from the combustion.
    b. If using matches, put a small squirt of butane on the top layer and light it with a match.
6. Once you think your oven is sufficiently lit, place the crown on top of the paint can and the flue on top of the crown. Given a few minutes, you should notice a sufficiently raging fire that appears stationary at the junction of crown and flue. I've even seen flames shoot out the top of the flue if the combustion of syngas is particularly vigorous.
7. On a new TLUD oven/kiln you'll be able to see the pyrolysis layer migrate down the gasifier by observing the oxidation layer on the outside of the gasifier.
8. You'll know your burn is complete when smoke begins to seep out the holes in the bottom of the gasifier. This can take upwards of an hour or more. If possible, make note of how long your burn lasts in your lab notebook. When the burn is complete, remove the flue and crown from the gasifier using heat resistant gloves.

9. Place the lid of the paint can on top and remove the gasifier from the bricks and put it on the ground. This will squelch any remaining embers inside the gasifier. Keep the gasifier dry, but not inside if possible.

To be completed the following class day:

10. Bring your biochar-filled gasifier into the lab and mass the whole gasifier. Be sure to remove the lid before massing as it was not part of the original pre-burn mass. How much mass was lost as heat and combustion byproducts? What was your yield?
11. Examine a sample of the biochar. What does it look like? How does it feel? Can you crush a piece between your fingers? Place a sample underneath a stereoscope. What does it look like now? Try it with the crushed sample.
12. Summarize your observations, measurements, and calculations in a separate section in your lab notebook.
13. Save your samples as we will use them in the next lab/activity.