

Homework 13 Solar Power for Africa 2023 Due Monday November 20

We heard from Mingming Lu from the Environmental Engineering Department at UC who is an expert at biochar. Biochar, charcoal, and activated carbon can be almost the same thing in some cases. Charcoal is the original material dating back through the entirety of the 200,000-year human history. “Biochar” was coined in 2005. Activated charcoal was used by Egyptians 6,000 years ago. Biochar and charcoal derive from biosources like agricultural waste, sewage sludge, wood. Generally, biochar is from agricultural waste and charcoal from wood. Activated carbon can derive from biosources but also from coal and tar and other fossil sources. Activated carbon is made porous either with phosphoric acid or with high pressure dry steam that either erodes or pops the carbon to create very high surface area for adsorption of chemicals such as absorbing amines from water in a fish tank, or drugs and pesticides from drinking water in Cincinnati. High surface area biochar is now becoming fashionable for agricultural use, confusing things more.

(Other carbons that you may run into are carbon black (tires), coal (we already discussed), coke (for reduction of iron ore), graphite (for Li^+ battery anodes), , petroleum coke (used to make synthetic graphite), graphene, fullerenes (C_{20} etc.), carbon nanotubes, buckeyball (Buckminsterfullerene), diamond (cutting tools/abrasives).)

- a) List the five stages of charcoal production.
- b) How does traditional charcoal production in a pit differ from charcoal production in a retort kiln. Sketch a retort kiln and explain how it works.
- c) Explain how wood gas is produced. Is wood gas for electricity a renewable energy source? Do a complete life cycle analysis including all input to make your assessment. (You may want to just google this question and find several answers. For instance, <https://www.science.org/content/article/wood-green-source-energy-scientists-are-divided>)
- d) Solar furnaces for biochar <https://www.solarpaces.org/designing-solar-furnaces-to-make-biochars-without-air-pollution/>
Green garbage disposal https://www.youtube.com/watch?v=iys379_2CTg
Solar toilet for biochar (Gates Foundation Project) <https://www.youtube.com/watch?v=sDehxJBknFg>
Review paper by Ndukwu et al. <https://reader.elsevier.com/reader/sd/pii/S1018363920302440?token=8DAFAAFB0103DA13170165F3D22951C55AAB229C859EB1E46A5C8221D82165CEF5550C7578C44820A1CF2F267A38B789&originRegion=us-east-1&originCreation=20221108210645>
Consider the above schemes for production of biochar using solar energy. Comment on the feasibility of each scheme in the context of 1) complete use of the energy associated with the feed biomass (wood gas); 2) economic or realistic usefulness; 3) comment on a scheme that could lead to a viable (energy balance, economic, realistic) use of solar power to generate charcoal, biochar, activated carbon.
- e) Explain the different forms of carbon listed above, how they are produced, and their uses/importance.

