Barrel-size Micro-gasification for Combined Heat and Biochar (CHAB) in "Mini" Industries

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Introduction and Abstract

Micro-gasification devices at "mini" sizes provide thermal energy from 20 to 150 kW (70 K to 500 K BTU/hr). This is far more thermal power than needed for institutional cooking and far less than most applications of the heat for small industry and space-heating of buildings. A simple classification of gasifiers by amount of thermal output is appended at the end of this paper (extracted from the website of www.chipenergy.com)

Currently functional devices and applications presented in this document include:

1. Barrel-size biochar production (without use of the heat) by several initiatives, including:
    a. Earliest and largest, by Alex English
    b. The Re:Char project in Kenya,
    c. John Rogers in Florida,
    d. JR-Oven efforts by UB International in Mongolia and elsewhere.
    e. J-RO (the Jolly Roger Oven) in New England area,
    f. "In-field" biochar barrels.
2. TLUD heat for a dairy in Uganda;
3. TLUD drying of cacao beans in Costa Rica, with biochar production; and
4. AVUD (continuous automated operation) heat and biochar production for a municipal bio-digester and for factory space-heating in the USA.

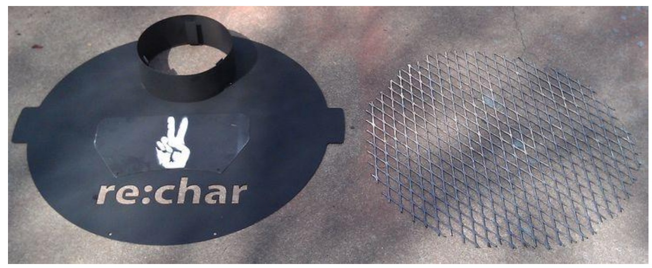
1. Barrel-size biochar production:

a. Earliest and largest, by Alex English:

For many years different people have made TLUD devices using 55-gallon (200 liter) barrels/drums as the basic size of the gasifier. The earliest known unit was made and shown by Alex English in 2000 at ARTI in India (left photo below). He also built a trial unit for heat and biochar for Burts Greenhouse in Canada, with measurements of 600 liter capacity, 42 inch diameter, and 6 ft height. This largest known TLUD included a blower for inducing the draft.

b. The Re:Char project in Kenya: One barrel-size TLUD device has been placed on the market by RE:Char for production of biochar. It is called "Climate Kiln." It has an attached grate at the bottom and a top with chimney to constrain the produced gases to be burned appropriately. The produced biochar is either dumped into extinguisher containers or the barrel is tightly capped at top and bottom to smother the charcoal (which requires numerous hours). Further information is at www.re-char.com

Climate Kiln



Prices: $140.00 lid and grate; $290.00 complete with barrel, delivery in North America, and includes sponsorship of a unit in a developing country.

c. John Rogers in Florida: Mr. John Rogers made operational a 4-barrel arrangement to produce biochar at his property in Florida, USA. His work is well represented by the YouTube video at: http://www.youtube.com/watch?v=dqkWYM7rYpU Also, a barrel-biochar-maker modeled after the John Rogers units has been made by Art Donnelly in Costa Rica. The complexity of the air-base and the combustion top are generally not needed, and are absent in the other barrel TLUDs described.

d. JR-Oven efforts by UB International (in Mongolia and elsewhere): Using the initials JR from John Rogers, the JR-Oven is promoted by UB International, headed by Dr. Karl Frogner. UBI has biochar production efforts with barrels in Mongolia, Thailand, and elsewhere. UBI information is at www.biocharinternational.org and http://biochar.bioenergylists.org/node/1749

In many ways it is similar to the RE:Char unit discussed above and the J-RO unit discussed next. The use of the word "oven" does not mean that there are any baking functions by these devices.

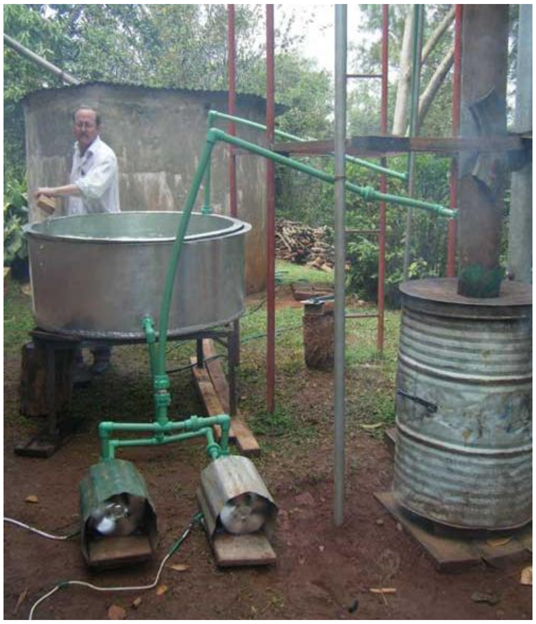
e. J-RO (the Jolly Roger Oven) in New England area: The Jolly Roger Oven, or "J-RO," is so named by Dr. Hugh McLaughlin because John Rogers said: "Carbon pirates bury black gold...so future generations will be richer." The basic design is a large barrel similar to the JR-Oven, but with an additional set of two barrels on top serving as a retort to make additional biochar and heat. Hugh McLaughlin and Douglas Clayton conduct their development work in Massachusetts and New Hampshire, USA.

http://biochar.bioenergylists.org/files/j-ros-final-jan8-2012.pdf
http://biochar.bioenergylists.org/content/JRo-video

f. "In-field" biochar barrels: The "in-field" biochar barrels by Paul Anderson are single barrels without any attached bottom, similar in concept to the TChar cookstoves. (TChar documentation is at www.drtlud.com). The barrels are set on top of loose small grates placed into shallow holes dug in fields close to the supply of fuels, where they can be conveniently loaded and ignited. After pyrolysis is completed, the barrel is raised and the char remains in the hole after the base is pulled out of the hole. The photos show a practice run in Costa Rica at APPTA with Art Donnelly.

2. TLUD heat for a dairy in Uganda

Paramount Dairies Limited (PDL) in Uganda has been using barrel-size TLUD's for heat for cheese and yoghurt production since October 2009. The thermal size is 30 kW, using papyrus reeds as the main fuel, placed vertically into the gasifier. Success is indicated by the current expansion of the cheese factory to include five of these TLUD units. The work is conducted by Engineers Charles Anglin and Patricia Senoga of Sustainable Energy in Appropriate Technology Limited (SEAT Ltd). Experimental unit in left photo. Their reports are distributed at the www.drtlud.com website.



3. TLUD drying of cacao beans in Costa Rica

Art Donnelly of SeaChar.org (Seattle) is working on biochar issues in the Talamanca area (south Caribbean coast) of Costa Rica where he is assisting APPTA, an association of small producers of cacao. Paul Anderson and Donnelly are assisting APPTA to convert its cacao processing facility from diesel and wood sources of heat to micro-gasifiers of TLUD and/or AVUD technologies. Cacao drying is extremely slow and controlled, with options for air-to-air heat exchangers (frowned upon because of possible leaks of emissions that could damage the product) or hydronic heat exchangers that use water to take the heat to large radiators that heat the air to dry to cacao beans. Photos show existing equipment.

4. AVUD micro-gasification:

AVUD micro-gasification has continuous automated operation for heat and biochar production, as described in the 2007 article in Boiling Point. http://drtlud.com/?page_id=684 . Chip Energy Inc of Goodfield Illinois produces an AVUD system with approximately 200,000 BTU/hr (60 kW) thermal output. http://chipenergy.com/Biomassfurnace.htm In addition to use for factory space-heating at the Chip Energy factory, a unit with hydronic heat ($50,000) is installed at a municipal facility for waste recycling in Rockford, Illinois to provide heat to its bio-digestor during the cold months. Simplified for minimal features and nicknamed "Dragon," the same AVUD gasifier ($15,000) yields flames that can be directed to any application as provided by the user. This unit is being considered for the APPTA cacao drying process. Automated to run 24/7 on various chunky dry biomass fuels, the Dragon's waste heat also can be used to dry the incoming fuels in the humid tropical environments such as at APPTA.

Conclusions and Projections

Using dry biomass for heat generation ranges from the sizes of small cookstoves up to giant installations. Use of gasification in the "mini" sizes is just beginning to be better understood. These are sizes that can be manually operated (especially where labor is inexpensive) but are large enough in thermal output to justify capital investments as heating equipment (especially where labor is expensive). Uses for heating moderate buildings and for institutional-size cooking will become increasingly common in the next few years. Likewise, the production of biochar in devices the size of standard 55-gallon (200 liter) barrels is also likely to become widespread.

Appendix:
A simple classification of gasifiers by amount of thermal output
(extracted from the website of www.chipenergy.com)

Sizes of gasifiers are in relative terms with rather overlapping categories. Confusion can occur because "energy" can be electrical (kWe), mechanical (HP), or thermal (kWth or BTU), or megaJoules, etc... "Power" is energy per specified unit of time. Energy should be expressed as "per hour" to show the power concentration, and kilowatts of electrical output is really kwe-hr.

NOTE:

- Large (also Super or Mega or other terms) is usually with hundreds of megawatts of electricity and thousands of megajoules or millions of BTU, etc.
- Medium seems to be seldom used as a descriptor.
- Small for the CHP gasifiers with gensets for electricity (such as 30 to 80 kilowatts of electricity.- 30 to 80 kwe) can be substantial for the thermal-only units measured in kWth, such as 500 kWth (1.7 million BTU) and larger.
- Mini is a term not used, but might cover the sizes from 100 kWth (350 k BTU up to 500 kWth (1.7 k BTU).
- Micro is a quite new term.
    - The larger sizes of micro-gasifiers are in the 15 to 100 kwth range (50 k to 350 k BTU), the sizes of the Chip Energy furnaces.
    - The middle sizes of micro-gasifiers could be with 6 to 15 kwth (20 k to 50 k BTU), like substantial outdoor grills for American homes and for the Chip Energy Biomass grills.
    - The small end of micro-gasifiers includes the cookstoves producing 1 to 6 kwth (3 k to 20 k BTU) for a one or two pot stove. TLUD (Top-Lit UpDraft) gasifiers have many advantages in this size and purpose.