IBI Certified Biochar Production in California

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by
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www.syntechbioenergy.com/www.gocpc.com
SynTech Bioenergy/
Community Power Corporation

- Established in ~1998
- Specializing in
  - Efficient, small, modular, downdraft gasifier systems
  - High temperature air-blown gasification
    - 800°C to 900°C
- Producing “Zero Tar, Turn-Key Systems”
CPC’s Downdraft Gasifier

- Fresh Feed
- Final Drying
- Flaming Pyrolysis
- Char Oxidation
- Char Reduction
- Producer Gas
- Char
- Waste heat

Primary Air

Biomass

Secondary Air
BioMax® 100 GEN 2 System
BioMax® Gasifier

- Unique approach to secondary-air injection
  - 50 air lances in five levels in hot char bed
  - Maintains and controls high temperatures in long char bed
    - Char reduces CO₂ and H₂O to CO and H₂
      - Lowers temperature
    - Air oxidizes tars and char
      - Increases temperature
- Extremely low residual tars
- No gas scrubbing -- no liquid wastes
BioMax® 100 Block Diagram

Biomass

Biomass Dryer

Biomass Feeder

BioMax® Gasifier

Producer Gas Heat Exchanger

Producer Gas Filter

Clean Producer Gas to Engine genset to generate electricity

Char Fines

Coarse BioMax® Gasifier BioChar Product
BioMax® 100 Gasification

- Clean producer gas fuels two, spark-ignited engine/gensets
  - Grid quality electricity
  - Low air emissions
- IBI-Certified, BioMax® Gasifier Walnut-Shell BioChar
- Waste heat
BioMax® 100 Gasifier Systems

- Contained in three or four 20’ ISO shipping containers
- Routinely controlled remotely and autonomously w/internet
  - Computer, ipad, smart phone, etc.
- 24/7 operation in California
  - Over 50,000 hrs with BioMax® systems
  - Walnut shells as feedstock
- Two operators for five BioMax® 100 systems
  - Two BioMax® 100 Systems at Winters, CA (west of Sacramento)
  - Three BioMax® 100 Systems at Colusa, CA (north of Sacramento)
BioMax® 100 Gasifier Systems (cont.)

- 145 kW continuous net power output
- Tied into PG&E grid in CA
- Permitted by the local Air Quality Management Districts
- About 5½ tons of dry BioChar per month per system
BioMax® 100  Local Computer Control Area
Biochar - What is it?

- A black, porous material
  - Initial pore diameters about 2/3 of those in feedstock
- A poorly defined mixture of amorphous and graphitic materials
  - Amorphous Carbon
    - May contain toxic, volatile, water-soluble tarry compounds
    - High H/C and O/C atomic ratios
    - Formed at low temperatures
    - Forms and deposits in biochar pores to block them
    - Readily oxidized endothermically by CO₂, H₂O above 700°C
    - Typically present in high yield biochar production
      - e.g. more than ~10% of dry feedstock weight
Biochar - What is it? (cont.)

- Graphitic Carbon
  - Non-toxic
  - Low H/C and O/C atomic ratios
  - Forms and survives at higher temperatures
  - Resistant to H₂O and CO₂ Oxidation
    - at 800°C to 900°C
  - Remains after amorphous carbon oxidizes
  - Forms the porous structure of activated carbon
  - Typically predominant in low biochar yields
    - Less than ~10% of dry feedstock weight
Pore Size of Biochar

- Determined initially by feedstock
  - Small pores in dense nutshells
  - Medium pore diameters in hardwoods
  - Larger pore diameters in softwoods
BioMax® Gasifier Walnut-Shell BioChar

Physical Properties

- Basic (high pH of 11.55)
  - Neutralizes acidic soils
  - Counteracts acidic nitrate and phosphate fertilizers

- Particle size: minus 8 mm (~0.3 inches)
  - 2% less than 0.5 mm (~0.02 inches)
  - “air” classified to remove fine char

- Relatively high bulk density for a biochar of 15 lb/ft³ (dry basis)
  - 5-gallon bucket contains about 10 lbs of biochar (dry basis)
BioMax® Gasifier Walnut-Shell BioChar Surfaces

- High surface area of 876 m²/g
- Good adsorptive properties of micropores
  - 871 mg Iodine/g biochar
    - In lower range of commercial, activated-carbons
  - 233 mg Butane/g biochar
- Much lower adsorptive properties of mesopores
  - 65 mg Methylene Blue/g biochar
BioMax® Gasifier Walnut-Shell BioChar
Low Toxic Chemical Properties

- PAH’s (Polycyclic aromatic hydrocarbon) (Toluene Soxhlet Extraction)
  - 42 ppm Total PAH’s (up to 300 ppm Total PAH’s allowed by IBI)
  - 0 B(a)P TEQ Toxicity Equivalents (up to 3 ppm B(a)P TEQ allowed by IBI)

- Dioxins/Furans
  - None Detected
  - 0 TEQ (up to 17 ppb TEQ Dioxins/Furans allowed by IBI)

- PCB’s
  - None Detected (up to 1 ppm PCB’s allowed by IBI)
BioMax® Gasifier Walnut-Shell BioChar
Heavy Metals

- Only Trace Elemental Levels of Heavy Metals Found with IBI Protocol
  - 1.2 ppm Chromium  (up to 1200 ppm Cr allowed by IBI)
  - 57.5 ppm Copper   (up to 1500 ppm Cu allowed by IBI)
  - 0.3 ppm Lead      (up to 500 ppm Pb allowed by IBI)
  - 2.8 ppm Nickel    (up to 600 ppm Ni allowed by IBI)
  - 9.8 ppm Zinc      (up to 7000 ppm Zn allowed by IBI)
  - 66.6 ppm Boron    (declaration)
  - 253 ppm Iron      (not listed by IBI)
  - 62 ppm Manganese  (not listed by IBI)
BioMax® Gasifier Walnut-Shell BioChar
Carbon Properties

- Organic Carbon at 78.4%
- Low Oxygen at less than 1%
- Low H/C at 0.22 (suggests long life in soil)
- Graphitic structure predominates
BioMax® Gasifier Walnut-Shell BioChar

Fertilizing components (using CA fertilizer test protocols)

- N/P/K
  - 0.62% Total N / 0.43% Total P₂O₅ / 8.42 % Total K₂O
- Liming Value
  - 13% CaCO₃ Equivalent (AOAC 955.1 Protocol)
- 1.90% Calcium
- 0.26% Magnesium
- 0.95% Chloride
- 0.04% Sodium
- 0.02% Iron
- Germination
  - 111% for Corn over Control with 4 tons biochar/acre
  - About 100% for Barley, Cucumber, and Corn
    with 12 tons biochar/acre
BioMax® Gasifier Walnut-Shell BioChar
Low Toxic Trace Minerals by CA Fertilizer Protocols

- 0.51 ppm Arsenic  (100 ppm allowed by IBI)
- 0.30 ppm Molybdenum  (20 ppm allowed by IBI)
- 2.08 ppm Nickel  (600 ppm allowed by IBI)
- 0.30 ppm Lead  (500 ppm allowed by IBI)
- 65.03 ppm Barium  (not IBI specified)
- 0.75 ppm Chromium  (1200 ppm allowed by IBI)
Summary

- CPC’s BioMax® 100 Gasifier Systems
  - Automated, tightly controlled gasification
  - Separation of gasifier Biochar from producer gas and fines
    - While very hot to minimize adsorbed PAH’s
    - Fairly narrow particle size range (larger than a powder)
- Producing *IBI Certified Gasifier Biochar* from Walnut Shells
  - Low in toxic materials, e.g., PAH’s, dioxins, furans, toxic metals
  - High in K and Ca, with some nitrogen and phosphorous
  - Low H/C ratio suggests long life in the soil
  - Activated carbon properties
Thank you!

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