

# IBI Certified Biochar Production in California



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by

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Syntech Bioenergy

[www.syntechbioenergy.com/www.gocpc.com](http://www.syntechbioenergy.com/www.gocpc.com)



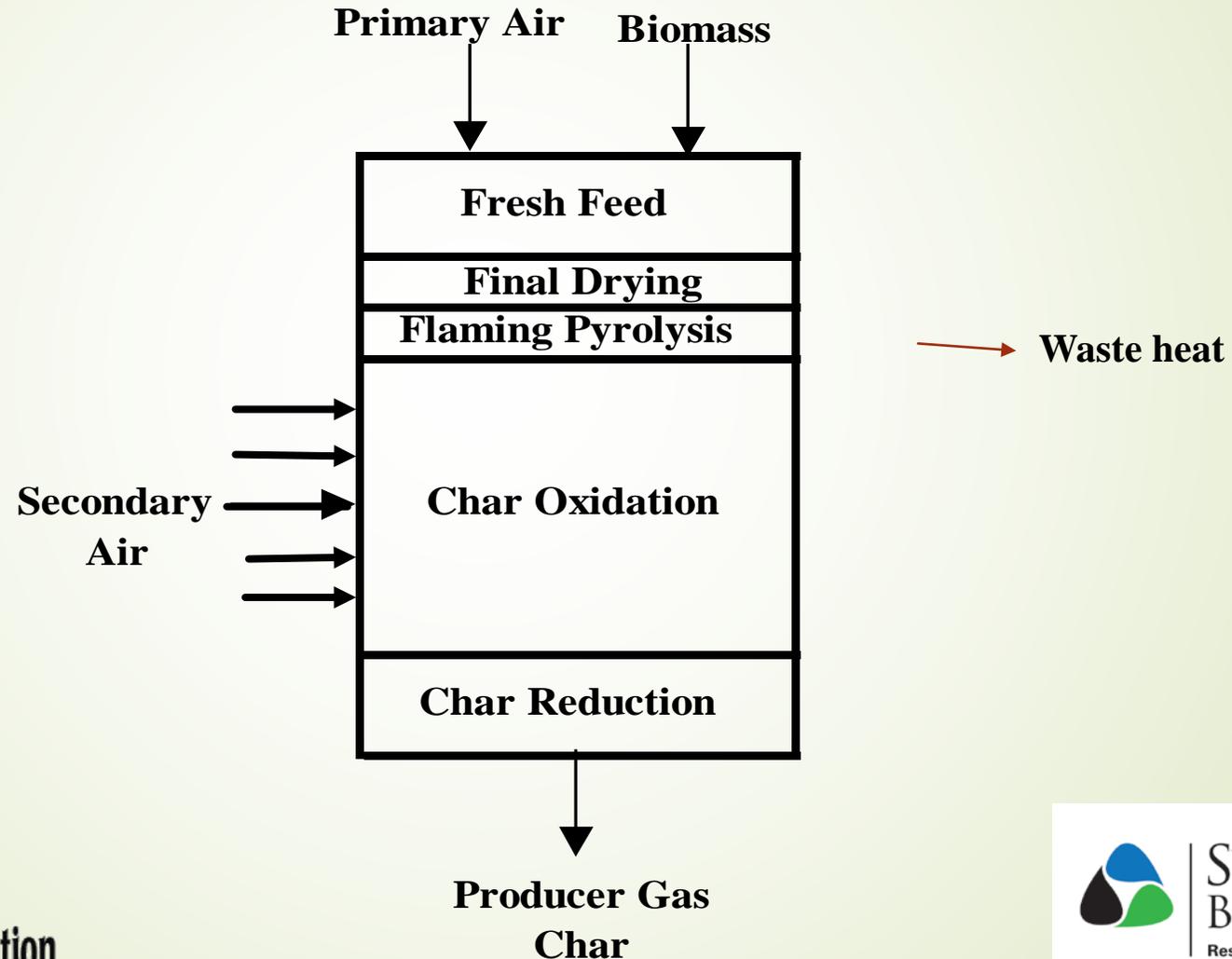
# SynTech Bioenergy/ Community Power Corporation



- 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



# BioMax<sup>®</sup> 100 GEN 2 System

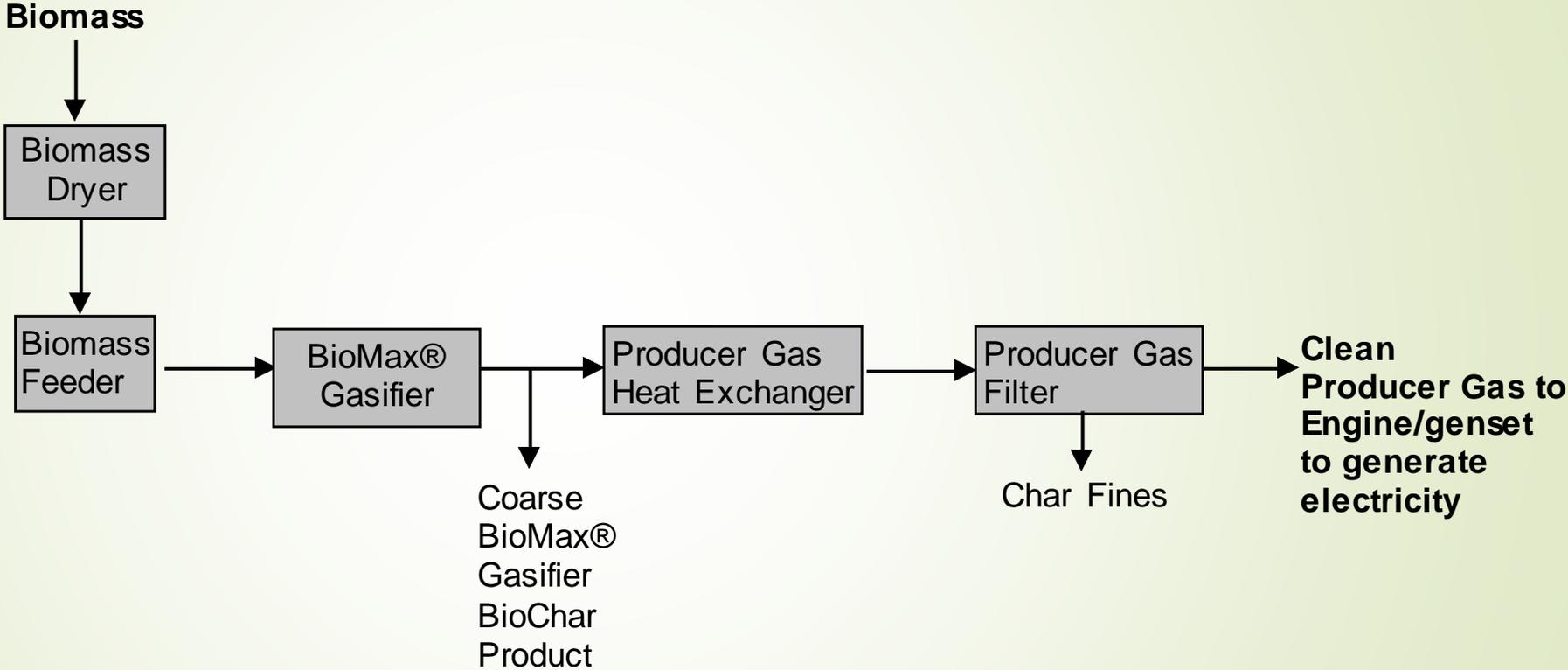


# BioMax<sup>®</sup> Gasifier



- **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 CO<sub>2</sub> and H<sub>2</sub>O to CO and H<sub>2</sub>**
      - **Lowers temperature**
      - **Air oxidizes tars and char**
        - **Increases temperature**
- **Extremely low residual tars**
- **No gas scrubbing -- no liquid wastes**

# BioMax<sup>®</sup> 100 Block Diagram



# BioMax<sup>®</sup> 100 Gasification



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



# BioMax<sup>®</sup> 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<sup>®</sup> systems
  - Walnut shells as feedstock
- Two operators for five BioMax<sup>®</sup> 100 systems
  - Two BioMax<sup>®</sup> 100 Systems at Winters, CA (west of Sacramento)
  - Three BioMax<sup>®</sup> 100 Systems at Colusa, CA (north of Sacramento)

## BioMax<sup>®</sup> 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<sup>®</sup> 100 Local Computer Control Area



# BioMax<sup>®</sup> 100 Gas Production Module





# 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 CO<sub>2</sub>, H<sub>2</sub>O 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 H<sub>2</sub>O and CO<sub>2</sub> 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<sup>®</sup> 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/ft<sup>3</sup> (dry basis)**
  - 5-gallon bucket contains about 10 lbs of biochar (dry basis)

# BioMax<sup>®</sup> Gasifier Walnut-Shell BioChar Surfaces



- High surface area of 876 m<sup>2</sup>/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<sup>®</sup> 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<sup>®</sup> 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<sup>®</sup> 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<sup>®</sup> Gasifier Walnut-Shell BioChar



## Fertilizing components (using CA fertilizer test protocols)

- **N/P/K**
  - **0.62% Total N / 0.43% Total P<sub>2</sub>O<sub>5</sub> / 8.42 % Total K<sub>2</sub>O**
- **Liming Value**
  - **13% CaCO<sub>3</sub> 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<sup>®</sup> 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<sup>®</sup> 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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