



Biofiltration & Odor Management Using Biochar

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~~Session E – Track F – 10:30 AM~~

October 27, 2023

Bldg 204 lower level: 11:10 – 12:15 PM (Norm Baker Sub)

Biochar in Regenerative Agriculture

The value of biochar in soil products and its application for home gardeners, small farms, and compost facilities.

Chomp manufactures Anaerobic Digestion systems that transform food waste, liquids, and other organic materials into renewable natural gas and biofertilizer.

Our systems are nearly zero waste, odor-free, compact, & uniquely suited for urban & suburban environments.



Inputs & Outputs

Food Waste



**Renewable
Natural Gas**

- Heat
- Hot Water
- Electricity
- Vehicle Fuel



Biofertilizer

- Farms
- Gardens
- Landscaping

Our Experience with Biochar

Anaerobic Digestion can use Biochar in these applications:

1. Odor Control Additive to liquid biofertilizer
2. Carbon Booster to liquid biofertilizer
3. Adsorptive Media for hydrogen sulfide removal from biogas
4. Biofilter media for ventilation odor control
5. Additive to digester feedstock to increase biogas generation
6. Methane Storage Media for pressurized biomethane RNG storage

1. Odor Control Additive to Liquid Biofertilizer

- Chomp investigated the **efficacy of powdered biochar**, sodium bicarbonate, and calcium nitrate additives in various combinations to partially deodorize fermented food waste digestate.
- In a side by side experiment with **8 treatments** we found powdered biochar to be both most effective and most cost effective.
- Biochar addition successfully **improved the Hedonic Tone** and **decreased** the Intensity of the digestate **odor**.

Test Results



Sample	digestate lb	12 mesh biochar tsp	NaHCO3 soda tsp	CaNO3 tsp	odor score 10 = best
3 biochar + soda + nitrate	0.75	1.0	1.0	1.0	10.0
7 biochar2	0.75	2.0	-	-	10.0
4 biochar2 + soda	0.75	2.0	1.0	-	10.0
8 biochar2 + soda2 + nitrate2	0.75	2.0	2.0	2.0	10.0
6 biochar + soda + nitratex2	0.75	1.0	1.0	2.0	9.0
1 biochar	0.75	1.0	-	-	3.0
2 biochar + soda	0.75	1.0	1.0	-	3.0
5 control	0.75	-	-	-	1.0

2. Carbon Booster to Liquid Biofertilizer

Biocarbon addition to fertigation directly sequesters carbon to the soil

- Increases **soil organic carbon**
- Improved **soil microbiome**
 - Biochar improves soil aeration, pH, and water and carbon content and alters the growth of soil microbiomes and plants and their interactions
 - Biochar application can increase the biomass of pine roots & maize roots by 300%
- **Sequesters carbon** for centuries or even millennia in the soil
- **Regulates nutrient release** by immobilizing free nitrogen and phosphorus in soil to improve nutrient availability annually

“Terra Preta”

- Amending Soil with biochar is modeled after a process begun thousands of years ago in the Amazon Basin, where **islands of rich, fertile soils called terra preta** (dark earth) were created by indigenous people.
- Biochar's physical and chemical nature, it has a unique ability for **attracting and holding moisture, nutrients, and agrochemicals** even retaining difficult to hold nutrients like nitrogen and phosphorous.
- Biochar's **immense surface area and complex pore structure** (a single gram can have a surface area of over 1000 square yards) provides a secure habitat for micro-organisms and fungi.

Performance in the Soil Microbiome

- Biochar plus chemical fertilizer yields **increased growth** of winter wheat and vegetables by 25-50%
- Other experiments found that biochar supplemented with fertilizer **outperformed fertilizer alone** by 60%
- The key properties of biochar are greatly affected by the type of **feed stock** being heated and the **conditions of the pyrolysis process**
- **Brunauer-Emmett-Teller analysis** (BET) can be used to assess the surface area of biochar
- The release of a substantial amount of **volatile matter** produces biochar with high porosity, diverse pore structures, and low density

Sample	BET surface area (m ² /g)
300 °C char	0.0218
500 °C char	0.0899
700 °C char	0.2720
900 °C char	0.2115

BET analysis for biochar samples

Biochar is in our All Purpose Plant Food

amazon prime Deliver to Jan Shoreline 98177 All 0195893600595

Prime Big Deal Days Medical Care Prime Video Prime Coupons Household, Health & Baby

Industrial & Scientific Janitorial & Facilities Safety Supplies Medical Supplies Food Service Diagnostic Equipment

Patio, Lawn & Garden Gardening & Lawn Care Soils, Mulches & Planting Media Fertilizers & Plant Food

Soil Magic All Purpose Plant Food 5 oz

Proudly Made from
Digested Food
Waste
At Vashon
Bioenergy Farm
Vashon Island,
Washington



These ingredients work with natural bacteria and nematodes in the soil, causing stronger overall root development. It is designed to retain soil nutrients over time and increase cell wall strength to help fend off plant stress from pests and disease. This is a slow-release plant food that has two qualities: it feeds for a longer time, and it isn't a chemical salt like commercial fertilizer, so it won't burn plants.

Biochar Can Be Added to Liquid Biofertilizer

- **Odor reducer**
- **Carbon sequestration**
- **Slow release regulation of Nitrogen & Phosphorus release to crops**

“Within just 24 hours of the biofertilizer being added, it was found that populations of **beneficial bacteria** within the plants and soil were **2-3X greater** than those in a control group of plants. Such bacteria produce compounds that not only help plants grow stronger and faster, but also **resistant to disease.**”

– UW and UC Riverside study



3. Adsorptive Media for H₂S Removal from Biogas

- Sulfide can be removed via physical methods such as **adsorption** on activated carbon and biochar.
- Removal of hydrogen sulfide from biogas was investigated in a biochar column integrated with a **continuous-stirred tank reactor** (CSTR) treating sulfate concentrations of 200–2000 mg/l.
- The **CSTR was operated** at an organic loading rate of 1.5 g chemical oxygen demand (COD)/L-day and a hydraulic retention time (HRT) of 20 days.
- The biochar was able to **remove about 98% of H₂S** for the ranges of concentrations from 105–1020 ppmv, especially at high moisture content (80–85%).

Spent media is a soil amendment

- Very high H₂S adsorption capacity (up to 273 mg H₂S/g) of biochar is expected to **enhance the H₂S oxidation** into S and sulfate.
- These findings bring a potentially novel application of **sulfur-rich biochar** as a source of sulfur, an essential but often deficient micro-nutrient in soils.

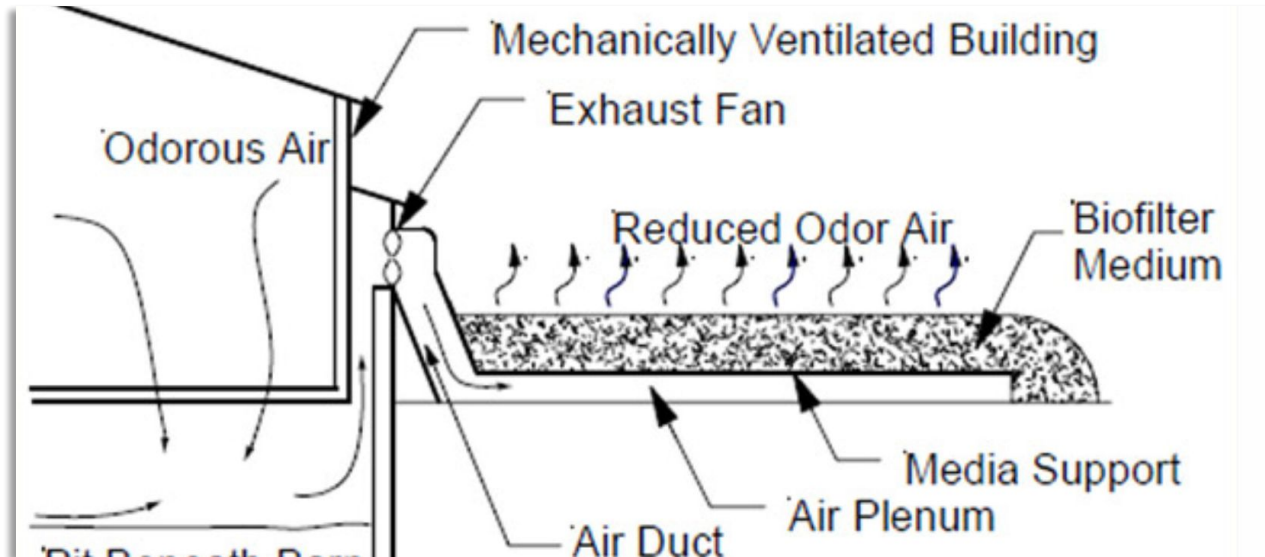


4. Biofilter Media for Ventilation Odor Control

- Chomp **ventilates** the control room, pump room, valve room, and tank headspaces of receiving, dosing, and plant food tanks to capture fugitive odors
- The **exhaust** is treated by biofiltration with a organic media biofilter
- The **biofilter media** is a mixture of bark, biochar, and compost.
- Research on **9 different biochar types** (made from manure, oak & coconut shells)
- **BET (m²/gm) values** were 9.8, 5.5, 3.6, and 3.3 for oak, pig manure, coconut shells, and chicken manure respectively at 500 C pyrolysis temperature.

Performance of biofiltration for odor control

- Biofiltration can **reduce odor and hydrogen sulfide** emissions by as much as 95% and ammonia by 65%.

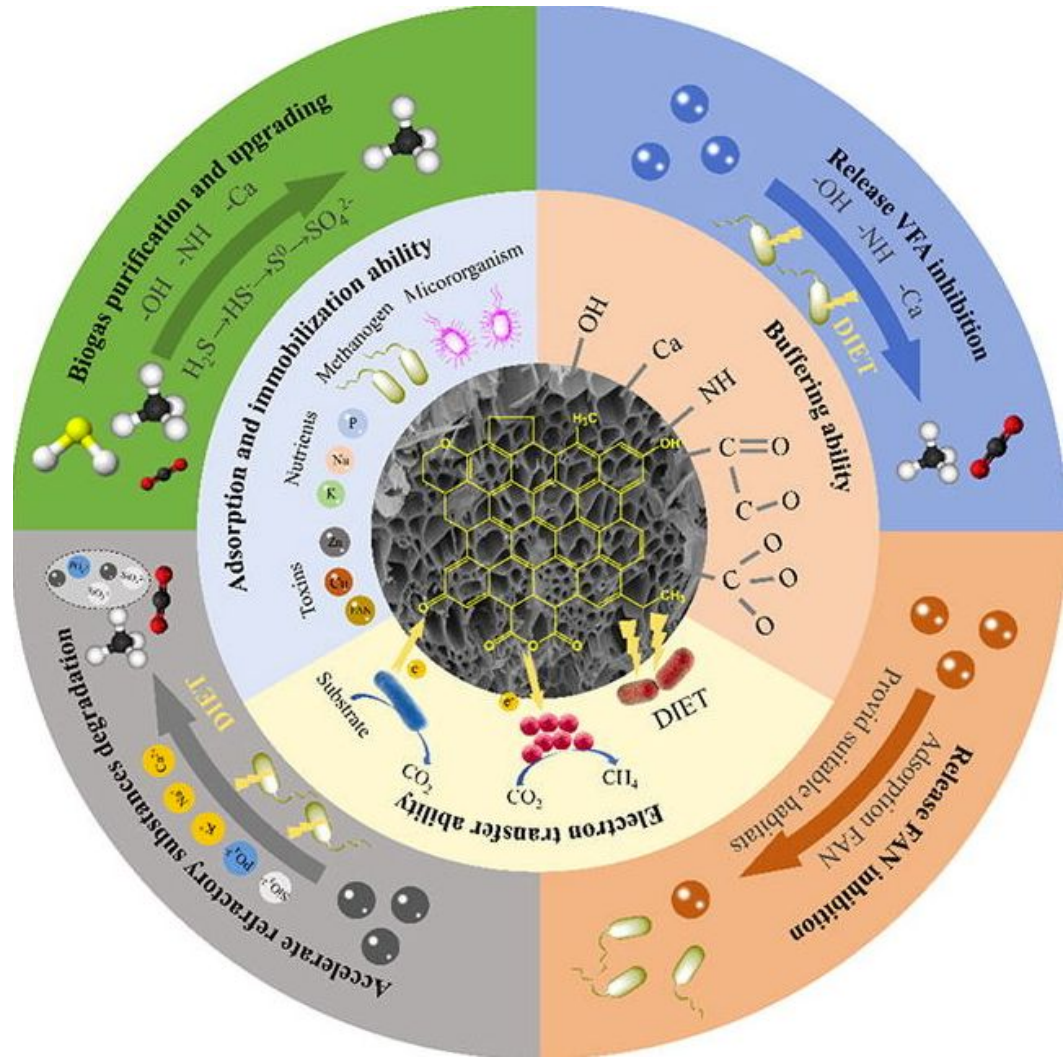


5. Additive to Digester Feedstock to Increase Biogas Generation

The anaerobic digestion process is enhanced by four different mechanisms. All these mechanisms are strictly linked to the chemical and physical properties of biochar.

- 1. Adsorption of inhibitors**
- 2. Buffering capacity of the environmental pH**
- 3. Attachment of bacterial cells within pores**
- 4. Direct interspecies electron transfer between microbial population**

Diagram of how biochar works inside the digester (the 4 mechanisms)



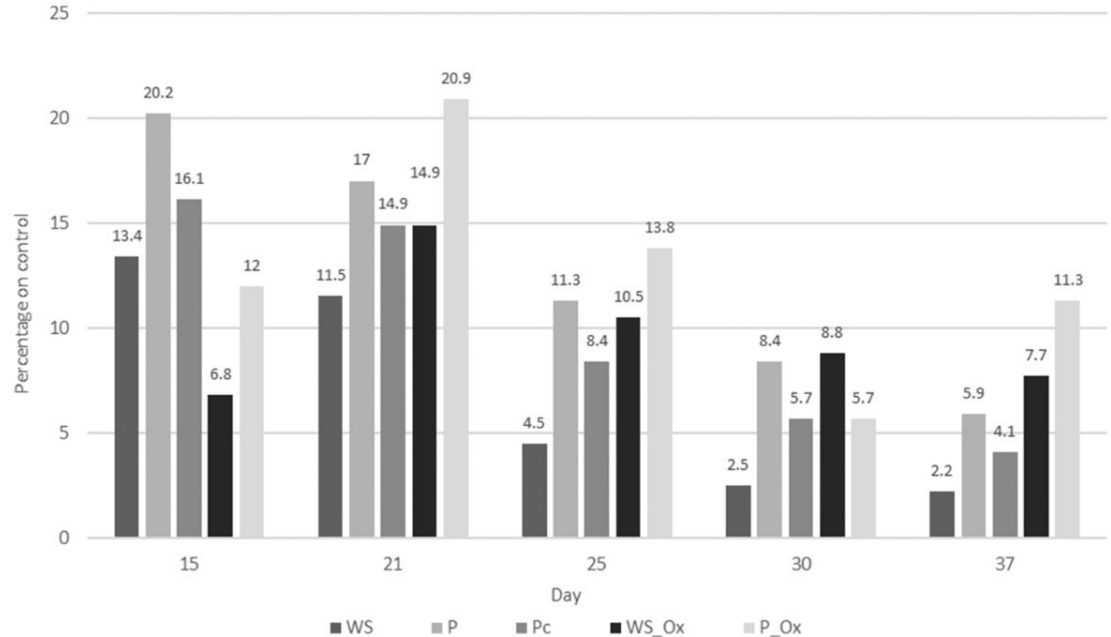
Performance of biochar addition to the AD process

- Biochar addition **reduced the lag time** (28–64%)
- Biochar **improved the biogas production** (22–40%)
- Biochar improved the relative **abundance of electro-active** microorganisms and Methanogens were enriched by 25% and 44% respectively
- Aside from the CH₄ concentration, the addition of biochar evoked a **reduction of the H₂S concentration** in the biogas by 23.3% and 37.5% for low and high concentration, respectively, compared to the control
- A positive effect of biochar on the AD process was only observed under **severe conditions** with the highest biochar dosage

Biochar increased biogas production in AD

- Increase vs. control
- wheat straw biochar (WS),
- poplar biochar (P),
- poplar biochar produced in CarbON (Pc), wheat straw oxidized biochar (WS_Ox), and
- poplar oxidized biochar (P_Ox).

From: Enhancing biogas production in anaerobic digestion by the addition of oxidized and non-oxidized biochars



Graphical representation of biogas yield increment versus control (C), for the various biochar used (WS, P, Pc, WS_Ox, and P_Ox), at different days (15, 21, 25, 30, and 37), i.e., different HRT

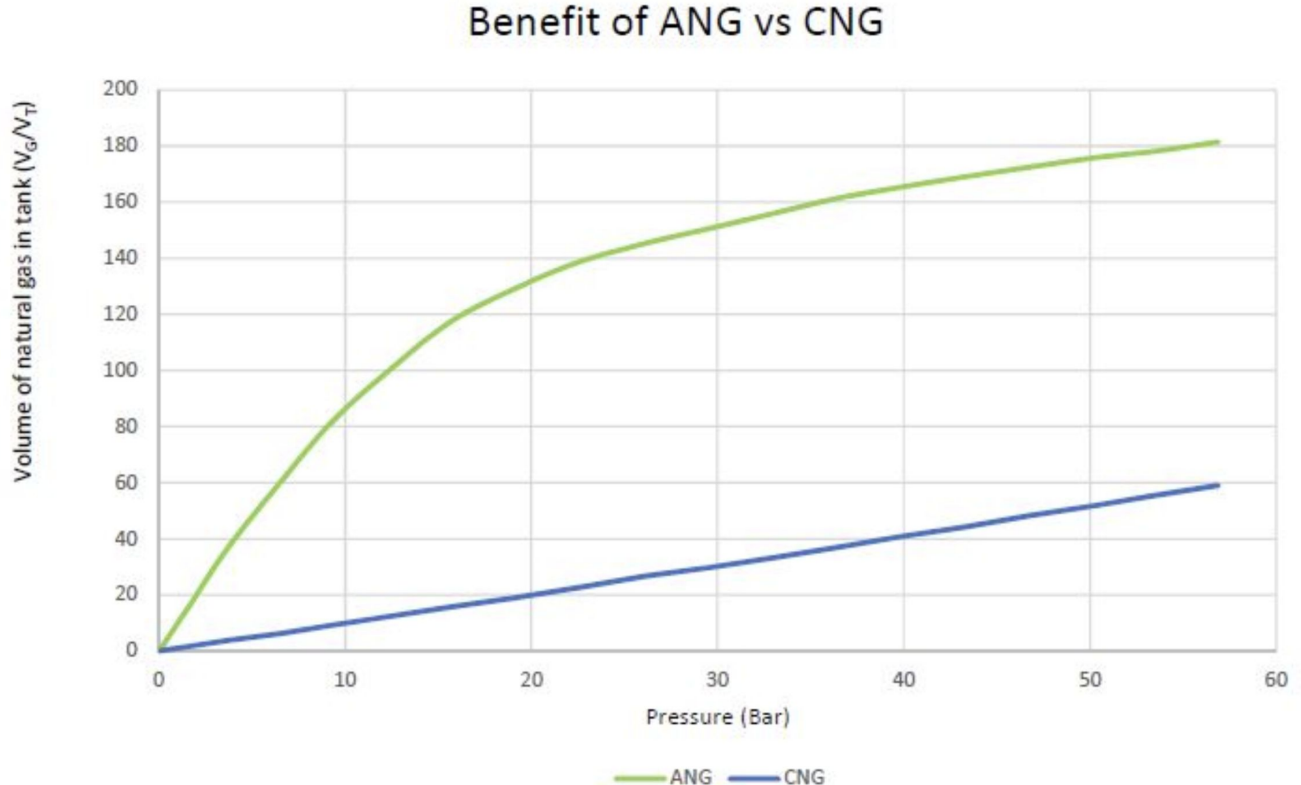
6. Methane Storage Media for Pressurized Biomethane RNG Storage

- Adsorbed natural gas (ANG) technology is a low-pressure (under 900 psi), bi-fuel solution for light-duty vehicles.
- In the ANG process, natural gas adsorbs to a porous **adsorbent** at relatively low pressure (100 to 900 psi) and ambient temperature, solving the high-pressure and low-temperature problems.



How ANG works

- 14 bar = 200 psi
 - 9.0 x more storage capacity
- 25 bar = 360 psi
 - 5.8 X more storage capacity
- 50 bar – 720 psi
 - 3.5 X more storage capacity



Thank you

Learn more about our mission at www.chomp.energy or
get in touch at info@chomp.energy