Biochar Guidance: Considerations for Municipal Procurement & Application

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NATURE-BASED CLIMATE SOLUTIONS

SUMMARY

Biochar has increasingly gained attention as a natural climate solution for its potential to utilize organic waste streams, increase terrestrial carbon storage, and improve ecosystem health when applied to soil and water management systems. Nevertheless, a wide variance in the quality and characteristics of biochars emerging on the market has driven a need to carefully assess individual chars prior to procurement and use. This guide – prepared in consultation with experts in the science and practice of biochar – aims to outline key considerations for city officials and other first-time buyers evaluating biochars based on quality and end use.

PRIMARY CONSIDERATIONS (PROCUREMENT)

The following criteria provide foundational pillars of any biochar bid specification, independent of end use. These characteristics are fundamental to assessing the quality and composition of individual biochars, and will determine the efficacy and ecological impact of application:

PARAMETER	NOTES
DRY WEIGHT COST	Biochar can be purchased by volume or weight. Due to significant potential variability in moisture content, it is strongly recommended to base procurement contracts on a cost/dry weight basis.
PROCESS	Production records, including batch # and date of production. Slow pyrolysis between **350-1000° C** preferred for most applications.
FEEDSTOCK MATERIAL	Woody biomass, agricultural byproducts, and leafy green waste recommended. Treated lumber from C&D waste should be closely screened, as chemicals containing heavy metals or other contaminants can concentrate during pyrolysis.
ASH CONTENT	Indicates quantity of inorganic material (eg. sand, dirt). Ash content should be **below 20%, 5-10% preferable**. Increased ash content correlates negatively with specific surface area, and increases biochar pH. (Ronsse et al.. 2012)
STABLE CARBON	**$H:C_{org}$ ratio ≤ 0.7***. The molar $H:C_{org}$ ratio is an indicator of the degree of carbonization and the stability of carbon content. Values fluctuate depending on feedstock biomass and process. Values exceeding 0.7 are an indication of non-pyrolytic chars or pyrolysis deficiencies (Schimmelpfennig and Glaser, 2012).
CARBON CONTENT	**Minimum 50% of dry mass; >75% preferable.**
HEAVY METAL / TOXIN LIMITS	As 25, Hg 1, Cd 1,51, Cr 300, Cu 6002, Pb 100, Ni 100, Zn 15002 PAH < 6 mg/kg; PCB < 0.2 mg/kg, furan & dioxin < 20 ng/kg

SECONDARY CONSIDERATIONS

In addition to the above, the following are recommended as supplementary considerations for review when evaluating biochars:

- **Proximity of production / distribution centers** – as transportation will impact total carbon benefit and cost.
- **Certification from the International Biochar Initiative (IBI) or European Biochar Certificate (EBC),** or demonstration of criteria fulfillment

For applications in agriculture & vegetative growth:

- **Water holding capacity**
- **Particle size:** Smaller particle sizes will increase biochar's specific surface area and cation exchange capacity, while larger particles (>5mm) can help reduce dust and potential biochar loss via wind or water. Biochar should be sized according to soil conditions and target outcomes. Depending on soil type and interactions over time, biochar particles are likely to decrease size with aging, increasing relative surface area. This process of disintegration is more common in soil/compost mixes (vs. biofiltration systems).

For remediation applications:

- **Demonstrated efficacy in targeting specific pollutants** (tailored to end use)
- **Feedstock:** Biochar from woody feedstock should be used for stormwater applications. Manure-based biochar should not be used in water treatment, as high concentrations of nutrients would be released into the environment.
- **Production process:** Typically, **biochar produced by high temperature pyrolysis (> 700 C) is recommended to remove pathogens and organic pollutants,** where hydrophobic interaction between the pollutants and the biochar surface is the dominant removal mechanism. **Biochar produced via low temperature pyrolysis (< 500 C) is recommended for removal of metals,** given a higher cation exchange capacity resulting from incomplete combustion of biomass. In all cases ash content should be minimized (< 5%), as it inhibits removal of certain pollutants (e.g., pathogens) and increases effluent pH.

USE CASE CONSIDERATIONS

Biochar is often utilized as a tool for sequestering carbon and improving soil health by retaining nutrients and water. Yet the physical, chemical, and biological properties of biochar make it a versatile material with a variety of end uses. A growing number of biochar products are being developed for green infrastructure, water quality, and construction applications.

The following section offers best practices for two categories of end use: **vegetative growth** – such as urban forestry and agricultural applications – and **stormwater remediation**, independent of the specific biochar product utilized.

VEGETATIVE GROWTH

- **Incorporate as 10-20% of soil mix (by volume):** biochar has shown consistent efficacy at a proportion of 10-20% of total growing medium. Some adverse results have been seen at levels greater than 20%, due to heightened pH levels.
- **Apply with compost:** biochars will benefit from being pre-mixed with compost, resulting in improved consistency and ease of application. Biochar should also accelerate the composting process.
- **Incorporate in soil:** biochar should be worked into the growing media rather than top dressed, which is prone to dry out or blow away. If there is time and capability, it is ideal to inject biochar near the roots of the plant.
- **Soak the char:** dry biochar has a risk of ignition, and can generate a lot of dust. The European Biochar Certificate recommends a **minimum 25% moisture content**, for safety of handling and ensuring the char doesn't dry out or blow away. Additionally, application of dry biochar within a soil system can leach water from soil and plants.

STORMWATER REMEDIATION

- **Minimize clogging:** Biochar must be applied in the right quantity and particle size so as to not inhibit water infiltration capacity. Biochar should be used 15-30% by volume, and the grain size should not contain more than 10% fine particles (~75 μm or smaller).
- **Biological activation:** Biochar can be mixed with compost or other amendments to increase biological activity that can enhance dentification and biodegradation of organic pollutants adsorbed on biochar.

In roadside applications:

- **Stabilization:** Biochar should be mixed with sand or sandy soil and buried below a gravel layer to prevent washing off with surface runoff during overflow.
- **Increase size:** Biochar utilized in roadside stormwater infrastructure faces the additional challenge of undergoing compaction, which is often required to maintain stability of roadside soil. Larger size biochar should be used in this context, so that crushing during compaction does not reduce infiltration capacity of the filter media layer. The addition of larger biochar also prevents evaporation loss from the filter layer, and minimizes the requirement of irrigation to maintain surface vegetation.

ADDITIONAL REFERENCES

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