Global Artisan C-Sink – Clarification on bulk density analysis for biochar produced in a Kon-Tiki

Preamble

As it is practically unfeasible to measure the dry weight of each biochar run produced by every C-Sink Farmer or C-Sink Cook, a decision was made to establish the standard measurement parameter for artisanal biochar as the volume of biochar relative to the type of feedstock used. To convert this biochar volume into its corresponding dry weight, it becomes essential to determine the bulk density of the biochar based on the specific feedstock utilized. However, sending raw biochar samples to laboratories, especially those located abroad, not only consumes a significant amount of time but also risks altering the biochar particles, potentially leading to inaccurate bulk density measurements. Therefore, Artisan C-Sink Managers are encouraged to acquire the necessary equipment, such as ovens and devices, for analyzing the bulk density of biochar near the production facilities, following the methods outlined in Annex 1. Alternatively, they can commission a local laboratory to measure the bulk density following the Global Artisan C-Sink method.

- Bulk density of the unground sample as delivered must be analyzed following the procedures of DIN EN ISO 17828 or ASTM D291/D291M-20.
- The sample has to be analyzed as produced and delivered.
- The sample is neither dried nor milled prior to the testing.

Please note:

Bulk density of biochar may be altered by transport, storage, or handling. Therefore, factors, such as vibrations, shocks, pressure, drying, and humidification, must be avoided when transporting the biochar from the production site to the laboratory.

Aim of the document

This document aims to provide a clear understanding of the steps involved for calculating the bulk density for Global Artisan C-Sink and is an addon to Annex 1 of the Global Artisan C-Sink Standard.

1. For biochar with a maximum particle size of 50 mm

For samples, where less than 10% of the particles present a particle size larger than 50 mm and/or present particles with a particle size < 100 mm, the following procedures must be taken.

Step	Description
1	The minimum sample volume is 30 liters.
2	90% of the sample material must present a particle size below 50 mm, and no particle must be larger than 100 mm.
3	Use a measuring box of 300 mm x 300 mm x 350 mm. The measuring box is ideally made from steel or aluminum but can also be made from wood or plastic.
4	Add an indelible marker (e.g., by paint, adhesive tape) at the insight of the measuring box at the height of 300 mm.
5	Measure the weight of the measuring box.
6	Fill the measuring box up to the 300 mm height marker. **Be exact!** Weight the measuring box with the biochar.
7	Dry the open measuring box for 24 h at 80 to 110 °C in a ventilated drying oven.
8	Measure the weight of the measuring box immediately when removing it from the drying oven.
9	Calculate the bulk density and water content using the following formula.

$$\left[Bulk\ density\ \left(\frac{g}{l}\right)\right] = \frac{[Weight\ after\ drying\ (g)] - [Weight\ of\ measuring\ box\ (g)]}{[Biochar\ volume\ (liter)]}$$

$$[Water\ content\ (\%)] = \frac{[Weight\ before\ drying\ (g)] - [Weight\ after\ drying\ (g)]}{[Weight\ before\ drying\ (g)]}$$

2. For biochar with a maximum particle size more than 50 mm

For samples, where more than 10% of the particles present a particle size larger than 50 mm and/or present particles with a particle size > 100 mm, the following procedures must be taken.

Step	Description
1	Take a sample of at least 130 liters (this includes 10 liters reserve for really getting to the 120 liters below).
2	Sun dry the sample so that when you mill the sample, no water comes out. However, keep it humid enough that it does not dust when milling. You have to find the sweet spot between too wet and too dry.
3	Measure 120 liters of the pre-dried sample (Vinit). Measure its weight (Minit).
4	Mill the 120 liters to below 3 mm (should be possible at the Artisan C-Sink Manager or lab). If you mill it smaller, there is no problem, it will not change the results, but it must be below 3 mm.
5	Put the entire milled sample (the formerly 120 liters) on one pile
6	Separate the pile into 5 piles of 24 liters. Mix each of the 5 piles thoroughly.
7	Separate each of the 5 piles into 5 piles of approximately 4.8 liters. Now you have 25 piles.
8	Take from each of the 25 piles 200 ml with measuring shovel or cup. This results in a 5 liters sample.
9	Mix the 5 liters sample thoroughly and separate the sample into two samples that are considered representative subsamples.
10	Weight the representative subsamples (the 2.5 liters) – (Msub1 & Msub2)
11	Re-measure the volume of the representative subsamples, as they may deviate from the 2.5 l.

12	Dry the representative subsamples for 36 hours at 100 to 120 °C.
13	Re-measure the volume of the representative subsamples, as they may now deviate from the 2.5 liters - (Vsub1 & Vsub2)
14	Calculate the bulk density of the fresh sample

$$[Water\ content\ (WC_{sub}, (\%)] = \frac{(M_{sub1} + M_{sub2}) - (M_{sub1dry} + M_{sub2dry})}{(M_{sub1} + M_{sub2})}$$

$$\left[Bulk\ density\ initial\ (BD_{init}, (\frac{g}{l}))\right] = \frac{M_{init} - (M_{init} * WC_{sub})}{V_{init}}$$