Japan Biochar Association Standard JBAS 0001

Biochar for Soil Carbon Storage

001 (2019)

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Foreword

This translation has been made based on the original Japanese Biochar Association Standard issued on 7 July, 2019.

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Introduction

Fossil fuels are concentrated carbon that has been retained under the Earth for more than 300 million years. We are exhausting such resources in less than 300 years after its discovery. If the carbon, once retained underground, is released into the atmosphere in the form of carbon dioxide, it will undoubtfully accelerate climate change. Given the evolution of living things, only green plants vegetating on land and in water biospheres are able to absorb carbon dioxide from the atmosphere.

On the other hand, the practice of utilizing biochar products, which are produced from the green plants, as a soil conditioner for agriculture and forestry has been established long before in Japan. We also have experiences with biochar products that are useful in reinforcing plant growth and increasing productivity as well as maintaining sustainable soil fertility.

We suggest a plan of atmospheric carbon dioxide reduction plan by integrating the above-mentioned two phenomena. This plan is as follows : To pyrolyze plants or plant-derived organic matters into highly stable and refractory carbon products as biochar and to confine them underground or underwater for a long period of time to mitigate the increase in carbon dioxide in the atmosphere and eventually to reduce carbon dioxide concentration in atmosphere. Specifically, we plan to storage biochars made by pyrolyzing non-hazardous unutilized organic biomass generated from agriculture, forestry, and fishery industries such as branches, leaves, and thinned timber, as well as livestock excrement, from building industry such as waste wood, and from food industry such as plant residues and food wastes, and to massively apply them in agricultural and forested lands and/or park green spaces and/or bury them under road surfaces.

This standard provides the technical framework for this plan. Its purpose is to define the parameters for evaluating biochar for soil carbon storage and to systematically develop measurement methods for the parameters.

1. Scope and Philosophy

This standard defines measurement methods for raw materials of biochar and biochar products for soil carbon storage. Self-combusting carbonization without help of fossil fuel may contribute to reduction in atmospheric carbon dioxide through carbonization of organic resources. On the other hand, biochar products vary in characteristics depending on their raw materials and pyrolysis methods. If the standard is intended to have high quantitative precision, therefore, it may become complicated. It is also highly likely to have a negative effect on the propagation of soil carbon storage technology. Therefore, its range of application is defined in accordance with the following philosophy.

The raw material shall be reasonably expected to be useful in decreasing atmospheric carbon dioxide levels and has no socioeconomically inconvenient effects. Measurement methods shall be, based on existing scientific knowledge, practical and economically feasible methods that anyone can handle.

2. Terms and Definitions

Some terms used in this standard are defined as follows.

a) Biochar

Biochar refers to pyrolyzed materials derived from biological resources, which have a one (1) or more of ratio of refractory carbon content relative to volatile matter content determined by the method specified in Section 4. Note that the biochar defined here is estimated to be pyrolyzed at temperature of 300°C or higher.

b) Bulk density

Bulk density is defined as the value obtained by dividing the mass of sample material by container volume they occupied.

c) Refractory carbon

It refers to carbon and carbon compounds which poorly decompose under natural conditions. Quantitative values of this refractory carbon shall be measured by quantitatively described in Section 4.

d) Mass conversion factor for refractory carbon

It is a factor used to determine the mass of refractory carbon contained in a given volume of biochar materials from the volume value.

$$\alpha = \frac{m_{rc}}{V}$$

where

α : mass conversion factor for refractory carbon (kg/m^3)

m_{rc} : mass of refractory carbon (kg)

V : biochar volume (m^3)

The calculation for obtaining the mass of refractory carbon shall be performed as below.

$$m_{rc} = V \times \alpha$$

The volume of biochar material is determined with the following formula.

$$V = \frac{m_{bw}}{D} \times \frac{1}{1000}$$

where

m_{bw} : biochar weight (kg)

D : bulk density (g/cm^3)

Bulk density is determined by measurement in accordance with Section 4.
Mass conversion factor for refractory carbon is determined by measurement in accordance with Section 4. Simplified mass conversion factors for refractory carbon listed in Table 1 may be applied to mass conversion factors ~~carbon provisionally~~. (Note that when using the equivalent for more than two (2) years, in principle, the coefficient determined by measurement in accordance with Section 4 shall be used.)

Table 1 Simplified mass conversion factors for refractory carbon

Raw materials for biochar	Simplified refractory carbon mass conversion factors (kg/m^3)
Woods and bamboos	100
Rice hulls	30

3. Raw Materials for Biochar

Raw materials for biochar shall meet at least one (1) of the following requirements.

a) Wood, bamboo, or their products that are free from foreign matter, paints, adhesives, antiseptics, chemicals, or any toxic substances.
b) Biologically derived organic resources that are free from foreign matter, paints, adhesives, antiseptics, chemicals, or any toxic substances.

4. Measurement Methods

JBAS 0002 Biochar for Soil Carbon Storage - Measurement Method - shall be applied for measurement.

5. Labelling

Each container of biochar products shall be labelled or attached information to indicate the following information.

(1) Standard name (“Biochar for soil carbon storage”)
(2) Name of raw materials
(3) Net mass or volume
(4) Production number or lot number
(5) Manufacturer name or its abbreviation
(6) Manufacturing date or its abbreviation
(7) Mass of refractory carbon

Annex: Biochar for Soil Carbon Storage (measurement examples)

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Categories	Raw materials	Wet weight basis*							Air-dried basis*2				
		Mass conversion factors for refractory carbon (kg/m^3)	Bulk density (g/cm^3)	Refractory carbon (%)				Carbon contents*3 (%)	Refractory carbon (%)				Carbon contents*3 (%)
				Refractory carbon content (%)	Volatile matter content (%)	Ash content (%)	Moisture content		Refractory carbon content (%)	Volatile matter content (%)	Ash content (%)	Moisture content (%)	
Biochar manufactured in a large pyrolyzer (charcoal cinder)	Moso bamboo (*Phyllostachys edulis*)	124	0.42	29.9	1.9	1.6	66.6	—	80.5	5.2	4.3	9.9	—
		127	0.43	29.8	1.8	1.4	67.0	—	81.9	5.0	3.9	9.1	—
		125	0.45	27.5	2.2	2.0	68.3	—	81.2	6.5	5.9	6.4	—
		116	0.47	24.9	2.1	1.8	71.3	—	79.0	6.7	5.7	8.7	—
		107	0.47	22.8	2.2	1.9	73.1	—	77.2	7.6	6.3	8.9	—
		123	0.36	34.2	2.3	2.2	61.3	—	81.4	5.5	5.1	8.0	—
		130	0.43	30.1	1.9	1.3	66.7	—	82.4	5.2	3.5	8.9	—
		136	0.47	28.8	2.4	1.6	67.2	—	80.3	6.7	4.5	8.4	—
		122	0.45	26.9	2.4	2.0	68.7	—	79.6	7.1	5.9	7.4	—
	Pruned pear tree branches (1) Examined in Feb, 2014	142	0.48	29.5	3.3	5.0	62.2	—	74.7	8.4	12.6	4.3	—
		144	0.50	28.6	3.4	5.1	62.9	—	73.9	8.9	13.1	4.1	—
		157	0.48	32.4	4.2	4.8	58.6	—	75.4	9.7	11.2	3.7	—
		151	0.50	30.2	3.9	5.6	60.3	—	73.3	9.4	13.5	3.8	—
		157	0.51	31.0	3.8	5.0	60.2	—	75.4	9.2	12.3	3.1	—
	Pruned pear tree branches (2)Examined in Feb, 2014	167	0.53	31.4	3.4	3.4	61.8	—	80.0	8.7	8.7	2.6	—
		—	—	26.9	3.6	4.6	64.9	—	74.6	10.0	13.0	2.4	—
		—	—	31.3	3.8	3.7	61.2	—	78.8	9.4	9.4	2.4	—
	Pruned pear tree branches (3)Examined in Feb, 2014	142	0.54	26.5	3.5	3.5	66.5	—	77.3	10.2	10.2	2.3	—
		144	0.52	27.4	3.3	3.4	65.9	—	78.2	9.3	9.6	2.9	—
		148	0.53	27.7	3.1	3.2	66.0	—	79.7	8.9	9.1	2.3	—

	Pruned grape tree branches Examined in April 2014	—	—	20.9	2.7	4.0	72.5	—	72.1	9.2	13.7	5.0	—
		—	—	24.4	2.9	4.1	68.6	—	74.7	8.9	12.6	3.8	—
		161	0.63	25.6	2.9	3.7	67.8	—	76.6	8.8	11.1	3.5	—
		—	—	23.9	2.8	2.1	71.2	—	79.8	9.4	7.0	3.8	—
	Pruned plum tree branches Examined in March 2017	132	0.57	23.2	2.7	2.4	71.7	—	79.5	9.3	8.4	2.8	—
		124	0.56	22.0	2.8	3.4	71.8	—	76.2	9.7	11.6	2.5	—
		132	0.62	21.3	2.9	4.1	71.7	—	73.4	10.0	14.0	2.6	—
Biochar manufactured in a small pyrolyzer (charcoal cinder)	Rice hulls (cultural crops)	89	0.56	15.9	4.4	22.0	57.7	—	36.2	10.0	50.1	3.7	—
		—	—	19.5	4.9	25.9	49.7	20.4	36.8	9.2	49.0	5.0	38.5
		—	—	19.8	5.0	24.4	50.8	20.9	38.5	9.7	47.4	4.4	40.6
		—	—	22.2	6.2	26.9	44.6	23.6	38.5	10.8	46.6	4.0	40.9
		—	—	15.8	2.9	23.6	57.7	17.7	35.3	6.4	52.6	5.7	39.5
		—	—	11.7	3.5	16.4	68.4	11.8	34.5	10.4	48.6	6.5	34.8
	Pinus densiflora (wood)	—	—	—	—	—	—	—	85.9	6.8	1.1	6.1	83.4
	Robinia pseudoacacia (wood)	—	—	—	—	—	—	—	84.5	5.9	2.7	6.9	80.6
	Henon bamboo	—	—	—	—	—	—	—	82.9	6.8	4.9	5.4	79.3
Commercial rice hull charcoal product	Rice hulls (cultural crops)	34	0.10	33.9	3.1	59.1	3.9	30.7	—	—	—	—	—
Commercial mangrove charcoal product	Mangrove (wood)	—	—	59.6	33.7	1.3	5.4	69.0	—	—	—	—	—
Mass-produced bark charcoal	Examined in July 2017	—	—	56.8	23.8	3.9	15.5	—	64.0	26.9	4.4	4.7	—
Black charcoal (literature value*2) Manufactured in earthen furnace	Broad-leaf trees	—	—	71.8-85.7 Mean value 82.7	5.2-19.9 Mean value 8.5	0.5-4.7 Mean value 1.8	5.5-9.9 Mean value 7.2	80.4-93.0 Mean value 89.5	—	—	—	—	—

* Measured values or weight percent based on weight of biochar samples without preliminary drying and air-drying treatments
*2 Weight percent based on weight of biochar samples after preliminary drying and air-drying treatments
*3 Reference value: The parameter is not referred to the Japan Biochar Association Standard JBAS 0001 Biochar for Soil Carbon Storage.
*4 Measured values of black charcoal from the Honshu, Shikoku, and Kyushu regions reported by Seiichi Satonaka in the Research Bulletin of the Hokkaido University Forests, 22 (2), (1963) pp. 609-814

Glossary

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The glossary gives additional descriptions of the matters prescribed in the text and related matters. It does not constitute the standard.

Biochar for soil carbon storage

The main raw materials of the biochar for soil carbon storage include trees and bamboos which consist of cellulose, hemicellulose, and lignin, as well as secondary components such as ash, oil and fat, resin, essential oil, tannin, coloring matter, and nitrogen-containing compounds. Once buried in the soil, wood and bamboo decompose and solubilize by microorganisms (decay). Atmospheric carbon dioxide is absorbed by wood and bamboo and fixed as organic matter composing them. If wood and bamboo are buried without treatment in the soil, they decay in the soil and release carbon components from organic materials in the form of carbon dioxide into the atmosphere.

Carbonization transforms some organic components of wood and bamboo through thermal decomposition and the polycondensation reaction into solid carbides (wood and bamboo charcoals). Carbides richly contain amorphous carbons, which are poorly microbiologically degradable. In other words, carbonization changes wood and bamboo into biochar (plant-derived carbides). Burying them in the soil enables long-term and stable storage of carbon in the soil.

Refractory carbon

Wood and bamboo charcoals are composed of amorphous carbons, ash, and moisture, as well as different organic components such as hydrocarbons and carboxyl, carbonyl, and ether groups. The carbons that are stable and refractory at the time of burial are the amorphous carbon. This standard defines the amorphous carbons as refractory carbons.

Refractory carbons are quantified according to the Japan Industrial Standard “Coal and coke − Methods for proximate analysis” (JIS M 8812). We define the fixed carbon that measured by JIS M 8812 standard as refractory carbons, and volatile matter by the above as organic components. Only refractory carbon contained in wood and bamboo charcoals, when buried in the soil, are ones that are retained underground as long-term and stable storage of carbon.

Mass conversion factor for refractory carbon

Refractory carbon contained in biochar must be quantified in terms of mass. However, the material is sometimes more conveniently counted and handled on volumetric basis in the distribution process. For the purpose of convenience in handling the material on volumetric basis, therefore, mass conversion

factors for refractory carbon have been developed to determine the mass of refractory carbon from a given volume of biochar.

Simplified mass conversion factor for refractory carbon

Simplified mass conversion factors for refractory carbon have been developed in reference to previous examples of mass measurement for the purpose of easier distribution and handling of biochar. The factors greatly vary depending on the raw materials and moisture content of biochar. The simplified versions, therefore, have been set out under the assumption that biochar raw materials contain carbons within the range of safety factor (20% to 50%).

If the conversion factors calculated from the measured values significantly deviate from those simplified ones as a result of biochar manufacturing refractory involved, the former factors should be applied.

References

Nobuhiko Migita, Yasumasa Yonezawa and Tamio Kondo, Wood Chemistry, Kyoritsu Publishing, Tokyo (1968) (in Japanese)

JIS M 8812:2004 Coal and coke – Methods for proximate analysis