

Comparison of European Biochar Certificate Version 4. 8 and IBI Biochar Standards Version 2.0

- European Biochar Certificate first publication March 2012 <http://www.european-biochar.org/en/home>
- IBI Biochar Standards first publication May 2012 <http://www.biochar-international.org/characterizationstandard>

Parameter	European Biochar Certificate V4.8	EBC Test Method	IBI Biochar Standards V2.0	IBI Test Method
	Status (Parameter)		Status (Parameter)	
	Criteria (Units)		Criteria (Units)	
C content	Required (Total C) Biochar ≥ 50% Bio Carbon Minerals (BCM) < 50% (% of total mass, dry basis)	Total C, H, N analysis by dry combustion IR-detection (DIN 51732, ISO 29541). Inorganic C analysis by determination of carbonate-C content with HCl, as outlined in DIN 51726, ISO 925. Organic C calculated as Total C – Inorganic C.	Required (Organic C) 10% Minimum Class 1: ≥60% Class 2: ≥30% and <60% Class 3: ≥10% and <30% (% of total mass, dry basis)	Total C and H analysis by dry combustion-IR detection. Inorganic C analysis by determination of CO ₂ -C content with 1N HCl, as outlined in ASTM D4373 'Standard Test Method for Rapid Determination of Carbonate Content of Soils'. Organic C calculated as Total C – Inorganic C.
Molar H/C_{org} ratio	Required 0.7 maximum (molar ratio)	see above for H and C _{org} determination	Required 0.7 maximum (molar ratio)	see above for H and C _{org} determination
Total Ash	Required	DIN 51719, ISO 1171 or EN 14775 – ashing at 550°C, heating at 5 K/min to 106°C under nitrogen atmosphere then at 5 K/min to 550 ° C under oxygen, hold for 1h	Required	ASTM D1762-84 'Standard Test Method for Chemical Analysis of Wood Charcoal'. Ash at 750 °C for 6 hours.
	Declaration		Declaration (% of total mass, dry basis)	
Molar O/C ratio	Required	O calculated from ash content, C, H, N, S (DIN 51733, ISO 17247)	Not required	N/A
	0.4 maximum (molar ratio)		N/A	
Macro-nutrients (NPK)	Required (Total N)	Dry combustion-IR detection following the same procedure for total C and H (DIN 51732)	Required (Total N)	Dry combustion-IR detection following the same procedure for total C and H
	Declaration (% of total mass, dry basis)		Declaration (% of total mass, dry basis)	
	Required (Total P, K, Mg, Ca)	Digestion with Lithium metaborate on ash 550 °C according to DIN 51729-11 and determination with ICP-OES according to DIN EN ISO 11885 or ICP-MS according to DIN EN ISO 17294	Optional (Total P and K)	Modified dry ashing followed by ICP (Enders and Lehmann 2012). 500 °C ashing followed by HNO ₃ and H ₂ O ₂ digestion and determination by ICP-OES analysis
	Declaration (% of total mass, dry basis)		Declaration (% of total mass, dry basis)	

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	N/A	N/A	Optional (Mineral N (ammonium and nitrate))	2M KCl extraction, followed by spectrophotometry (Rayment and Higginson 1992)
			Declaration (mg kg ⁻¹)	
			Optional (Available P)	2% formic acid followed by spectrophotometry as described by Wang et al (2012)
			Declaration (mg kg ⁻¹)	
Electrical conductivity	Required	Method of the BGK (Federal quality community compost), volume 1, method III. C2 in analogy to DIN ISO 11265 Adding 1:10 H2O to the sample, shaking for 1h, followed by filtration of the solution.	Required	US Composting Council TMECC Section 04.10, modified dilution of 1:20 biochar:deionized H ₂ O (w:v) and equilibration 90 minutes on the shaker, according to Rajkovich et al (2011)
	Declaration (µS cm ⁻¹)		Declaration (dS m ⁻¹)	
Liming equivalence	Not required		Required (if pH > 7)	AOAC 955.01 potentiometric titration on “as received” (i.e., wet) samples. Use dry weight to calculate % CaCO ₃ and report “per dry sample weight”.
			Declaration (% CaCO ₃)	
pH	Required	DIN ISO 10390 with 1:5 biochar to 0.01 M CaCl ₂ -solution, 60 min shaking, measuring directly in the suspension	Required	US Composting Council TMECC Section 04.11, modified dilution of 1:20 biochar: deionized H ₂ O (w:v) and equilibration 90 minutes on the shaker, according to Rajkovich et al (2011).
	Declaration (pH) If > 10, the delivery slip must feature appropriate handling information		Declaration (pH)	
Bulk density	Required	Bulk density: DIN 51705	Not required	N/A
	Declaration		N/A	
Particle size distribution	Not required	N/A	Required	Progressive dry sieving with 50mm, 25mm, 16mm, 8mm, 4mm, 2mm, 1mm, and 0.5mm sieves.
	N/A		Declaration (% in each size class)	
Water content	Required (Water content)	DIN 51718 method A Two step: raw moisture at (40 ± 2)°C until constant mass; hygroscopic moisture in TGA crucible and nitrogen atmosphere at (106 ± 2) ° C to constant mass.	Required (Moisture content)	ASTM D1762-84 ‘Standard Test Method for Chemical Analysis of Wood Charcoal’ (specify measurement date with respect to time from production). Moisture content at 105 °C for 2 hours.
	Declaration (% of total mass, dry basis)		Declaration (% of total mass, dry basis)	

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Surface area	Required (Specific surface area)	milled < 50µm, 2h outgassing at 150°C, vacuum, N ₂ adsorption, multi-point BET method	Optional (Total surface area and external surface area)	ASTM D6556 'Standard Test Method for Carbon Black – Total and External Surface Area by Nitrogen Adsorption'
	Declaration (preferably higher than 150 m ² g ⁻¹)		Declaration (m ² g ⁻¹)	
Water holding capacity	Optional	Water holding capacity determining by soaking and drying the sample (E DIN ISO 14238). WHC calculated as mass percentage of saturated and dry mass.	Not required	N/A
			N/A	
Volatile matter	Required (Volatile Organic Compounds (VOCs))	Thermal-Gravimetric-Analysis (TGA) using Leco TGA 701 – total mass loss at 950°C	Optional (Volatile matter)	ASTM D1762-84 'Standard Test Method for Chemical Analysis of Wood Charcoal'. VM content at 950 °C for 10 minutes.
	Declaration (% of total mass, dry basis)		Declaration (% of total mass, dry basis)	
Heavy metals, metalloids and other elements	Required Metals: Pb, Cd, Cu, Ni, Hg, Zn, Cr	All metals: microwave acid digestion with HF/HNO ₃ and determination of the metals with ICP-MS (DIN EN ISO 17294-2) Hg: DIN EN 1483 Water quality - Determination of mercury - Method using atomic absorption spectrometry (H-AAS)	Required Metals: Pb, Cd, Cu, Ni, Hg, Zn, Cr, Co, Mo Metalloids: B, As, Se, Others: Cl, Na	All elements except Hg and Cl: i. Microwave-assisted HNO ₃ digestion, or ii. HNO ₃ digestion, followed by determination with iii. ICP-AES, or iv. Flame AAS (according to US Composting Council TMECC Sections 04.05 and 04.06) Hg: US EPA 7471 Mercury in Solid or Semi-Solid Waste (Manual Cold Vapor Technique) Cl: water soluble elements followed by ion chromatography or ion-selective electrode (per manufacturers instructions)
	Basic grade: Pb < 150 mg kg ⁻¹ Cd < 1,5 mg kg ⁻¹ Cu < 100 mg kg ⁻¹ Ni < 50 mg kg ⁻¹ Hg < mg kg ⁻¹ Zn < 400 mg kg ⁻¹ Cr < 90 mg kg ⁻¹ Premium grade: Pb < 120 mg kg ⁻¹ Cd < 1 mg kg ⁻¹ Cu < 100 mg kg ⁻¹ Ni < 30 mg kg ⁻¹ Hg < 1 mg kg ⁻¹ Zn < 400 mg kg ⁻¹		Maximum Allowed Thresholds: As 12 – 100 mg kg ⁻¹ Cd 1.4 – 39 mg kg ⁻¹ Cr 64 – 1200 mg kg ⁻¹ Co 40 – 150 mg kg ⁻¹ Cu 63 – 1500 mg kg ⁻¹ Pb 70 – 500 mg kg ⁻¹ Hg 1 – 17 mg kg ⁻¹ Mo 5 – 20 mg kg ⁻¹ Ni 47 – 600 mg kg ⁻¹ Se 2 – 36 mg kg ⁻¹ Zn 200 – 7000 mg kg ⁻¹ Bo Declaration Cl Declaration Na Declaration	

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	<p>Cr < 80 mg kg⁻¹</p> <p>Note1: Basic Grade following Germany's Federal Soil Protection Act (BBodSchV). Premium Grade following Switzerland's Chemical Risk Reduction Act (ChemRRV) on recycling fertilizers.</p> <p>Note2: biochars with Ni contamination < 100g mg kg⁻¹ are permitted for composting purposes only if the valid threshold are complied with in the finished compost.</p>		<p>Note: range of Maximum Allowed Thresholds reflects different soil tolerance levels for these elements in compost, biosolids, or soils established by regulatory bodies in the US, Canada, EU and Australia. See Appendix 3 of the IBI Biochar Standards for further information.</p>	
PAHs	<p>Required</p> <p>Basic grade: < 12mg kg⁻¹ Premium grade < 4mg kg⁻¹ total (sum of 16 US EPA PAHs)</p> <p>Note: Basic grade based on a value which, taking the latest research into account, only implies a minimum risk for soils and users. Premium grade corresponds to the PAH threshold defined in the Swiss Chemical Risk Reduction Act (ChemRRV)</p>	<p>DIN EN 15527 Soxhlet-extraction with toluene and determination with GC-MS or</p> <p>DIN ISO 13877 Soxhlet-extraction with toluene and determination with HPLC or</p> <p>DIN CEN/TS 16181 Soxhlet-extraction with toluene und determination with GC-MS</p>	<p>Required</p> <p>6 – 300 mg kg⁻¹ total (sum of 16 US EPA PAHs)</p> <p>AND</p> <p>3 mg kg⁻¹ B(a)P-TEQ B(a)P Toxic Equivalency (TEQ) basis</p> <p>Note: range of Maximum Allowed Thresholds reflects different soil tolerance levels for PAHs in compost, biosolids, or soils established by regulatory bodies in the US, Canada, EU and/or Australia. See Appendix 3 of the IBI Biochar Standards for further information.</p>	<p>US EPA 8270 Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) using Soxhlet extraction (US EPA 3540) and 100% toluene as the extracting solvent</p>
PCBs	Required	AIR DF 100, HRMS	Required	US EPA 8082 Polychlorinated Biphenyls

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	<p>< 0.2mg kg⁻¹</p> <p>Note: Threshold based on soil protection regulations applicable in Germany and Switzerland (BBodschV, VBBo, ChemRRV)</p> <p>Analysis only once for each producing unit. Depending on feedstock (see positive list) more regular analysis might be required.</p>	<p>or</p> <p>Soxhlet-extraction with toluene and determination with HRGC-HRMS based on US EPA 8290 (2007-02)</p>	<p>0.2 – 0.5 mg kg⁻¹</p> <p>Note: range of Maximum Allowed Thresholds reflects different soil tolerance levels for PCBs in compost, biosolids, or soils established by regulatory bodies in the US, Canada, EU and/or Australia. See Appendix 3 of the IBI Biochar Standards for further information.</p>	<p>(PCBs) Analysis by GC or</p> <p>US EPA 8275 Semivolatile Organic Compounds (PAHs and PCBs) in Soils/Sludges and Solid Wastes Using Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS)</p>
PCDD/Fs	<p>Required</p> <p><20 ng kg⁻¹ I-TEQ</p> <p>Note: Threshold based on soil protection regulations applicable in Germany and Switzerland (BBodschV, VBBo, ChemRRV)</p> <p>Analysis only once for each producing unit. Depending on feedstock (see positive list) more regular analysis might be required.</p>	<p>AIR DF 100, HRMS</p> <p>or</p> <p>Soxhlet-extraction with toluene and determination with HRGC-HRMS based on US EPA 8290 (2007-02)</p>	<p>Required</p> <p><17 ng kg⁻¹ WHO-TEQ</p> <p>Note: range of Maximum Allowed Thresholds reflects different soil tolerance levels for PCDD/Fs in compost, biosolids, or soils established by regulatory bodies in the US, Canada, EU and/or Australia. See Appendix 3 of the IBI Biochar Standards for further information.</p>	<p>US EPA 8290 Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS)</p>
Germination inhibition	<p>Not required</p> <p>N/A</p>	<p>N/A</p>	<p>Required</p> <p>Pass/Fail</p>	<p>OECD methodology (1984) using three test species, as described by Van Zwieten et al (2010)</p>