

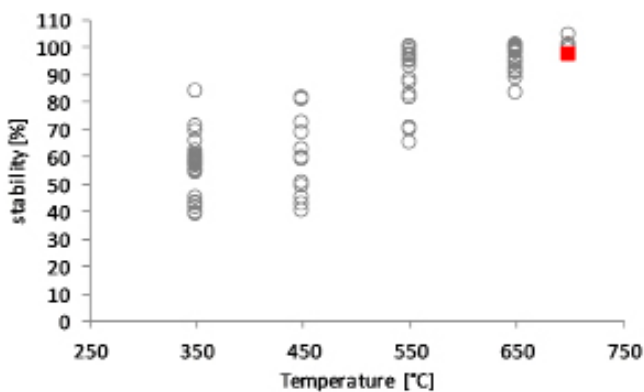


Feedstock: Sewage sludge | **Production:** Pilot-scale rotary kiln pyrolysis unit, nominal peak temperature 700°C

Key features: • Reproducible • Extensively characterised • Readily available



Biochar C stability compared to a set of 92 biochar



Basic Utility Properties		Mean	Run-to-Run Variation, SD(n)
Moisture ^(a)	wt.% (a.r.)	1.69	0.29 (2)
C _{tot}	wt.% (db.)	29.55	0.34 (2)
H	wt.% (db.)	0.83	0.05 (2)
O (by difference)	wt.% (db.)	2.75	0.39 (2)
H:C _{tot}	Molar ratio	0.34	0.02 (2)
O:C _{tot}	Molar ratio	0.07	0.01 (2)
C _{org}	wt.% (db.)	tbd	tbd
H:C _{org}	Molar ratio	tbd	tbd
Total ash ^(a)	wt.% (db.)	63.91	0.41 (2)
Total N	wt.% (db.)	3.79	0.05 (2)
pH	[-]	9.60	0.33 (2)
Electric conductivity	dS/m	133.40	7.80 (2)
Liming (if pH above 7)	% CaCO ₃	tbd	tbd
Biochar C stability ^(b)	% C-basis	96.44	0.07 (2)

Production parameters		Mean	Run-to-Run Variation, SD(n)
Nominal HTT	°C	700	0 (2)
Reactor wall temp.	°C	700	0 (2)
Max. char HTT	°C	650	- (2)
Heating rate	°C/min	89	- (2)
Kiln residence time	min	~13	- (2)
Mean time at HTT	min	~5	- (2)
Biochar yield	wt.% (db.)	26.02	3.87 (2)
Pyrolysis liquid yield	wt.% (db.)	tbd	- (2)
Pyrolysis gas yield	wt.% (db.)	tbd	- (2)
Pyrolysis liquid HHV	MJ/kg	tbd	- (2)
Pyrolysis gas HHV	MJ/kg	tbd	- (2)

Advanced Analysis & Soil Enhancement Properties		Mean	Run-to-Run Variation, SD(n)
Mineral N (ammonium & nitrate)	mg/kg	tbd	- (2)
Total P ^(c)	wt.% (db.)	2.50	0.04 (2)
Total K ^(c)	wt.% (db.)	0.42	0.00 (2)
Available P	mg/kg	9.2	0.5 (2)
Volatile Matter ^(a)	wt.% (db.)	16.41	1.11 (2)
Total Surface Area	m ² /g	tbd	tbd
External Surface Area	m ² /g	tbd	tbd

Toxicant Reporting - Total Content		Mean	Run-to-Run Variation, SD(n)	comparison vs. recommended standard thresholds	IBI	EBC	BQM
Germination Inhibition Assay	pass/fail	tbd	tbd		6-20	4	20
Polycyclic Aromatic Hydrocarbons (EPA16) ^(d)	mg/kg dry wt.	1.40	0.45 (2)		9	20	20
Dioxin/ Furan (PCDD/ Fs) ^(e)	ng/kg I-TEQ	0.36	- (2)		0.2-0.5	0.2	0.50
Polychlorinated Biphenyls (PCBs) ^(f)	ng/kg dry wt.	0.051	- (2)		12-100	n/a	10
As	mg/kg dry wt.	<0.72	- (2)		1.4-39	1	3
Cd	mg/kg dry wt.	12.36	0.37 (2)		64-1200	80	15
Cr	mg/kg dry wt.	292.72	7.44 (2)		40-150	n/a	n/a
Cu	mg/kg dry wt.	296.63	5.01 (2)		63-1500	100	40
Pb	mg/kg dry wt.	195.93	3.23 (2)		70-500	120	60
Hg	mg/kg dry wt.	<0.23	- (2)	1-17	1	1	
Mo	mg/kg dry wt.	4.67	0.12 (2)	5-20	n/a	10	
Ni	mg/kg dry wt.	66.25	1.29 (2)	47-600	30	10	
Se	mg/kg dry wt.	<1.40	- (2)	1-36	n/a	5	
Zn	mg/kg dry wt.	896.21	25.63 (2)	200-7000	400	150	

Notes: HTT=highest treatment temperature, n.d. = not detected, SD = standard deviation (refers to run-to-run consistency, not analytical error) + available standards related to biochar (IBI = International Biochar Initiative, EBC = European Biochar Standard, BQM = Biochar Quality Mandate).

(a) TGA, (b) Cross A, Sohi SP (2013), (c) Aqua Regia digestion followed by ICP, (d) Soxhlet extraction (toluene, 6h) determination by GCMS, (e) US EPA 1613, (f) AES O84 (based on US EPA 1668)