Kon-Tiki

Open Fire Cone Kiln

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Kon-Tiki I

1.5 m rim
0.6 m base
63.5° side
850 L volume

Production capacity:
700 l biochar in 4 to 5 hours
Yield: 25 to 30% (DM)

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Thanks to the cone form, continual vortex streaming develops assuring very clean burn with low smoke emissions.

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Building the fire

Build a stacking wood chimney in the middle of the kiln reaching up to about 25 cm under the top of the kiln.

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Enkindle the fire from the top

Light the “stacking wood chimney” from the top

creating the up-draft

let the fire burning to about 1/3 from the top of the stack creating a strong up-draft in the “stacking wood chimney” which pulls in air at the side walls of the kiln. First wood pieces fall then down the chimney lighting it at the bottom.

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Making blaze for the first charing layer

When enough air reaches the bottom of the stacking wooden chimney to make it catch fire, break down the “wooden chimney”, level the burning wood to create the blaze for the first charing layer.

Level out the blaze and put the first charing layer of wood

When the surface wood pieces start to ash at their surfaces and the blaze becomes hot enough (app. 650°C), it’s time to put the first charing layer of wood on the blaze.

Build the kiln up layer by layer every time the surface of the wood or biomass on the top layer starts to ash

Time to put the next layer

When ashes appear on the wood, put a next layer of wood.
The charring continues beneath the fire front.

Smokeless burn

Thanks to the vortex system on top of the kiln syngases, smoke, vapours and air are well mixed and burn cleanly.

Toroidal convection loops

Toroidal convection loops at the rim of the kiln create a very stable fire front above the charing layer. The convection loops pull air in the middle of the kiln and turn down the heavier smoke back into the kiln fire until completely combusted.

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time to dine

Wrap the kiln

Installing a mantel around the kiln further stabilizes the fire and reduces smoke. Here we tested a 0.6 mm steal mantle wrapped around the Kon-Tiki leaving a gap of 4 cm and overlapping the top edge by 5 cm.

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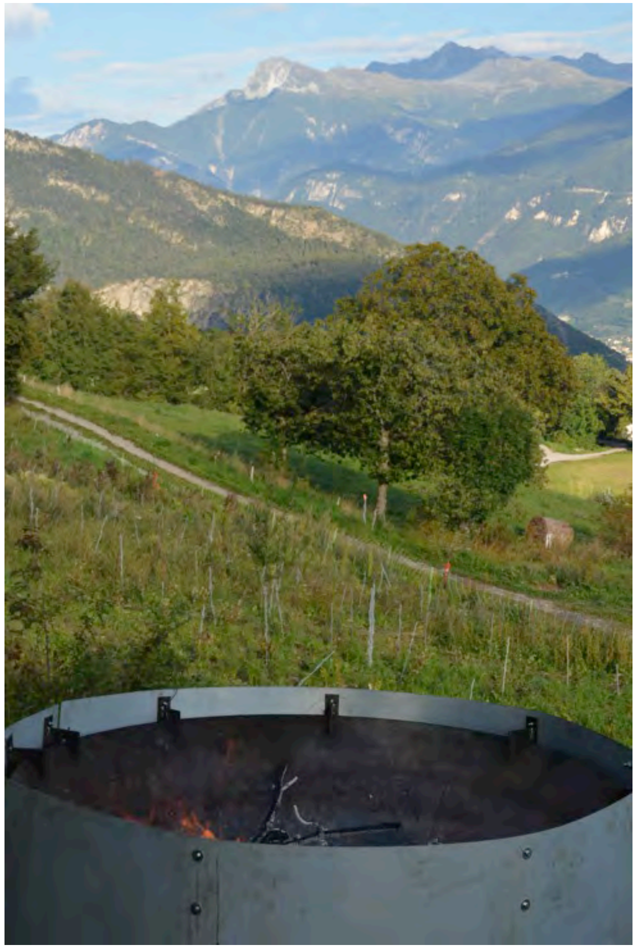
Wrap the kiln

We designed a curtain / rim shield that can be clipped to the Kon-Tiki and can be transported apart.

Wrap the kiln

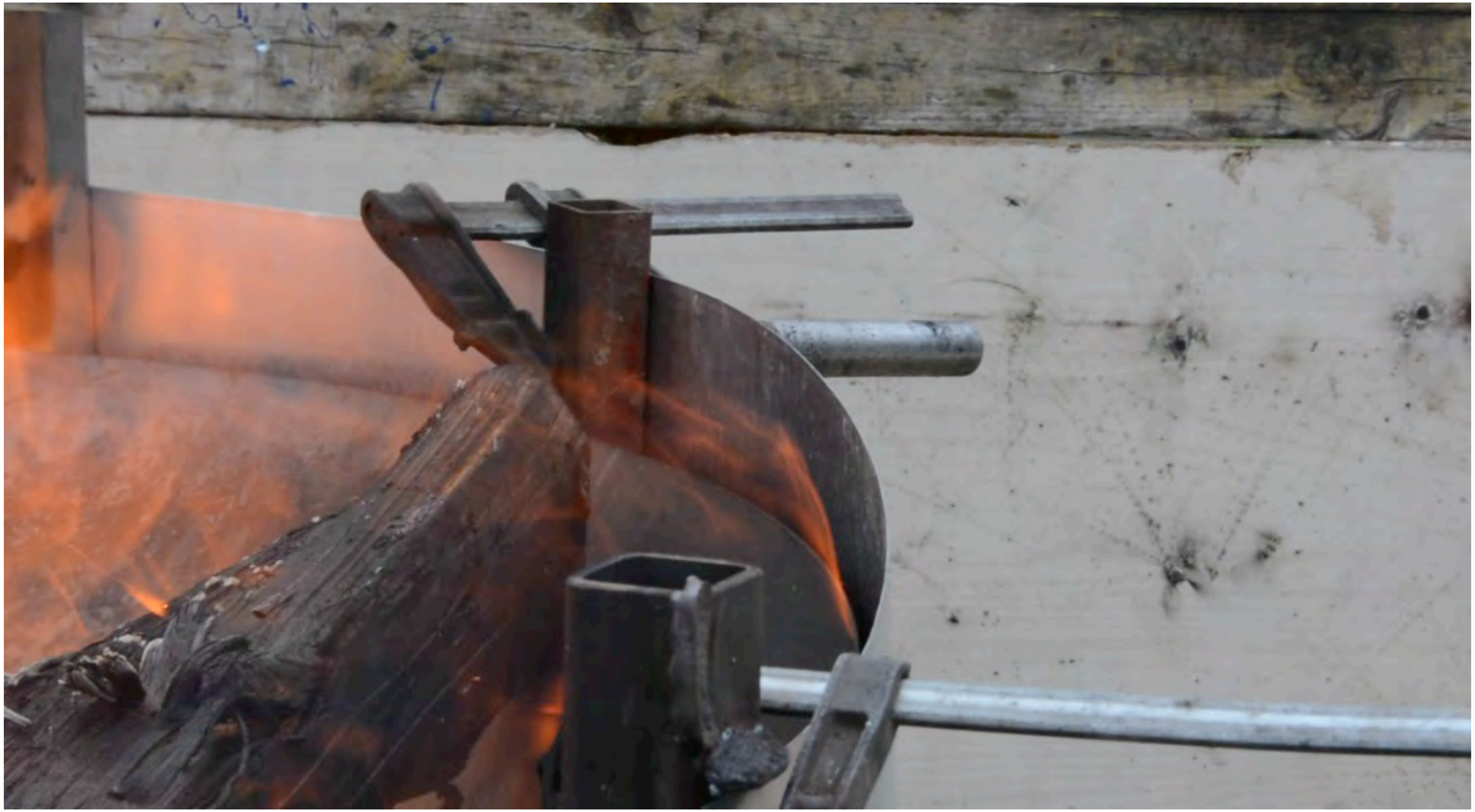


The rim shield is hooked on the rim with a distance of 6 to 8 cm and reaching equally 6 to 8 cm above the rim.

The rim shield

The rim shield insulates the kiln, it’s outside temperature rises not above 45°C which is comfortable to fire the kiln, good for working security, for keeping the heat in the kiln and avoid the influence of the side winds on the thermic.

Fire curtain



The mantle worked like fire curtain and stabilized the convection loops. There was rarely any smoke to notice.

charing temperature 650° to 750°C

The temperature at the surface of the blaze is around 620° to 660° C depending on the humidity of the feedstock. Some 30 to 50 cm into the blaze zone, temperatures reach 750° C.

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A vortex chimney was tested, but because it channels side-winds, it is no improvement

Same for a strong up-draft with a 2m chimney – Not an improvement

The elegance to work with the physics open fire deep cone kiln

No chipping, no cutting

The Kon-Tiki works as a dryer and pyrolyser. Putting a new charing layer on the blaze, the fresh wood of the layer get heated, dried and start then to outgaz. It's not the wood that burns but the wood gases.

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Pyrolyse all types of biomass

Kon-Tiki-Tas (Frank Strie)

Charing green waste

The principal of function of the Kon-Tiki makes it possible to pyrolyse all sort of biomass from wood to pomace, from straw to nut shells and even green wood.

80 – 100 KWh heat recoverable from syngas burning

Outgassing of the last top layer

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Quenching and vapour activation

Quench the kiln either from the top which needs some more water though it drives of volatiles more efficiently and partly activates the biochar …

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Quenching it from the buttom

… or you quench it from the bottom with a water hose as invented by Frank Strie from Kon-Tiki Tas. The advantage is that all type of fertilizer containing liquids can be used to charge the hot char without loosing part of it through the vapours.

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Quenching water after 10h = crystal clear

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Clean quenching water

300 l clear quenching water can be recovered, quenching thus can simultaneously be used as water filtration

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No smell, no taste, no oily touch

700 L of biochar in 5 hours

this char was sprayed before quenching with iron water to make magnetic biochar, see the brownish iron (III) coating

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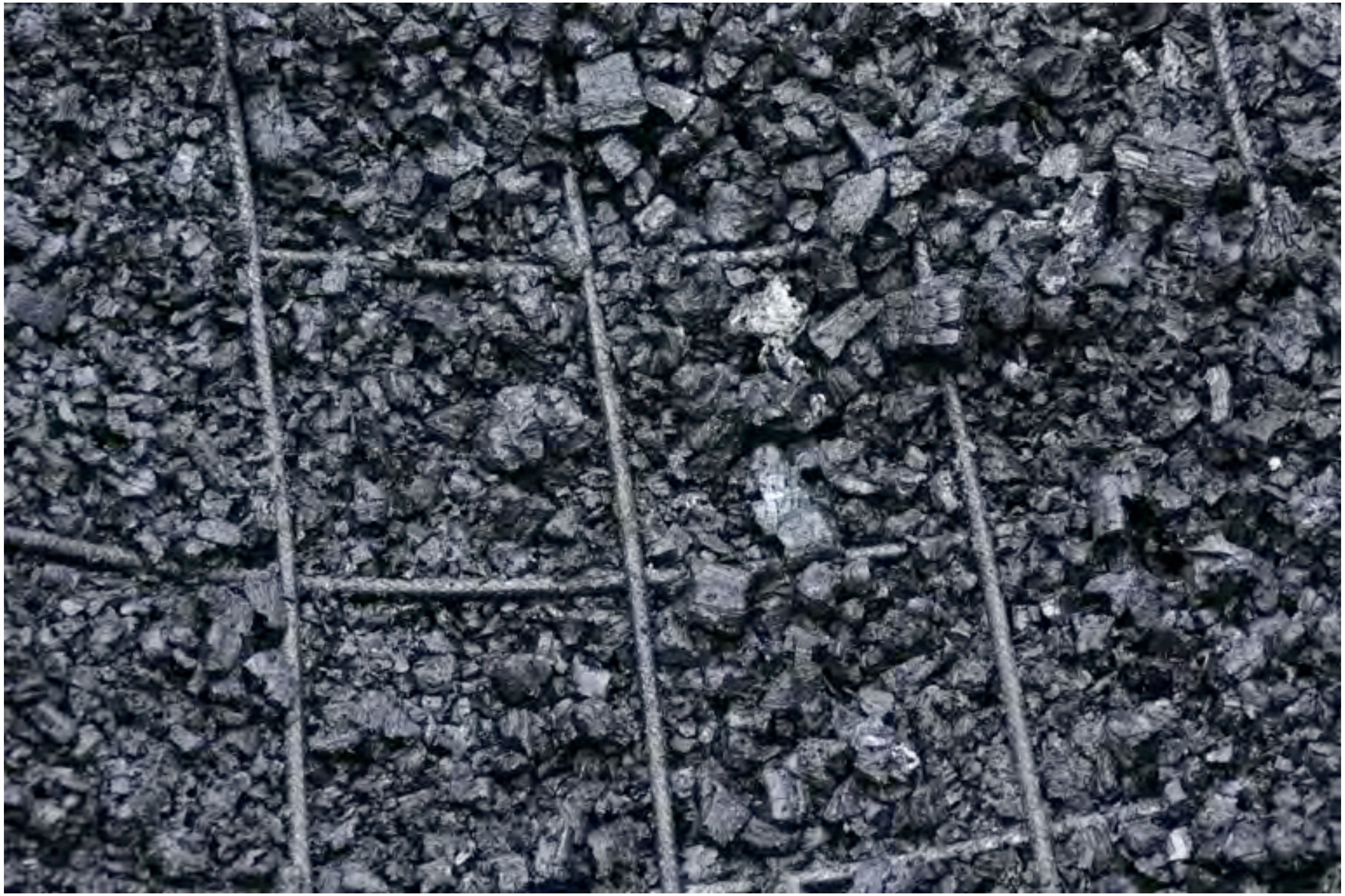
Biochar just made from bulk wood



Some Kon-Tiki kilns can be tipped to dump out the biochar

Kon-Tiki-Tas (Frank Strie)

Others make kids happy digging in the black

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Kon-Tiki Biochar fullfills all conditions for the EBC premium Certificate

Parameter	Unit	LOQ	GW 1	GW 2	Method		db
bulk density	kg/m³				DIN 51705	530	-
specific surface area (BET) (§76)	m²/g				DIN 66132/ISO 9277	-	289,9
true density (§76)	g/cm³				DIN 66137	-	1,73
total water	% w/w	0,1			DIN 51718	31,2	-
ash content at 550°C	% w/w	0,1			analogue DIN 51719	12,8	18,6
hydrogen	% w/w	0,1			DIN 51732	0,73	1,07
carbon, total	% w/w	0,2	> 50	> 50	DIN 51732	55,6	80,8
nitrogen, total	% w/w	0,05			DIN 51732	0,26	0,39
oxygen, diff.	% w/w				DIN 51733, calculated	-0,7	-1,0
carbonate as CO2	% w/w	0,4			DIN 51726	2,01	2,92
carbon, organic	% w/w				calculated	55,1	80,0
ratio H/C (molar)			< 0,6	< 0,6	calculated	0,16	0,16
ratio H/Corganic (molar)			< 0,7	< 0,7	calculated	0,16	0,16
ratio O/C (molar)			< 0,4	< 0,4	calculated	-0,01	-0,01
sulfur, total	% w/w	0,03			DIN 51724-3	0,06	0,08
pH value (CaCl2)			≤ 10	≤ 10	DIN ISO 10390	8,6	-
electrical conductivity	µS/cm	1			BGK Kapitel III. C2	575	-
salt content	g/kg				BGK Kapitel III. C2	[illegible]	[illegible]

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Kon-Tiki Biochar fullfills all conditions for the EBC premium Certificate

salt content	g/kg				BGK Kapitel III. C2	3,05	4,44
salt content calc. with bulkdensity	g/l				BGK Kapitel III. C2	1,62	2,35
thermogravimtrie					TGA 701 D4C (N)	see annex	-

Determination from the microwave digestion according to DIN 22022

lead (Pb)	g/t	2	< 150	< 120	DIN EN ISO 17294-2	-	32
cadmium (Cd)	g/t	0,2	< 1,5	< 1	DIN EN ISO 17294-2	-	< 0,2
copper (Cu)	g/t	1	< 100	< 100	DIN EN ISO 17294-2	-	130
nickel (Ni)	g/t	1	< 50	< 30	DIN EN ISO 17294-2	-	5
mercury (Hg)	g/t	0,07	< 1	< 1	DIN EN 1483	-	< 0,07
zinc (Zn)	g/t	1	< 400	< 400	DIN EN ISO 17294-2	-	180
chromium total (Cr)	g/t	1	< 90	< 80	DIN EN ISO 17294-2	-	13
boron (B)	mg/kg	1			DIN EN ISO 17294-2	-	50
manganese (Mn)	mg/kg	1			DIN EN ISO 17294-2	-	160

Determination from the melting digestion on ash 550°C according to DIN 51729-1/ -11 - referred to original substance

phosphorus	mg/kg	-9990000			DIN EN ISO 11885	-	2400
magnesium	mg/kg	-9990000			DIN EN ISO 11885	-	5900
calcium	mg/kg	-9990000			DIN EN ISO 11885	-	54000
potassium	mg/kg	-9990000			DIN EN ISO 11885	-	8200
sodium	mg/kg	-9990000			DIN EN ISO 11885	-	650
iron	mg/kg	-9990000			DIN EN ISO 11885	-	2100
silicon	mg/kg	-9990000			DIN EN ISO 11885	-	5500
sulfur	mg/kg	-9990000			DIN EN ISO 11885	-	1200

Kon-Tiki Biochar fullfills all conditions for the EBC premium Certificate

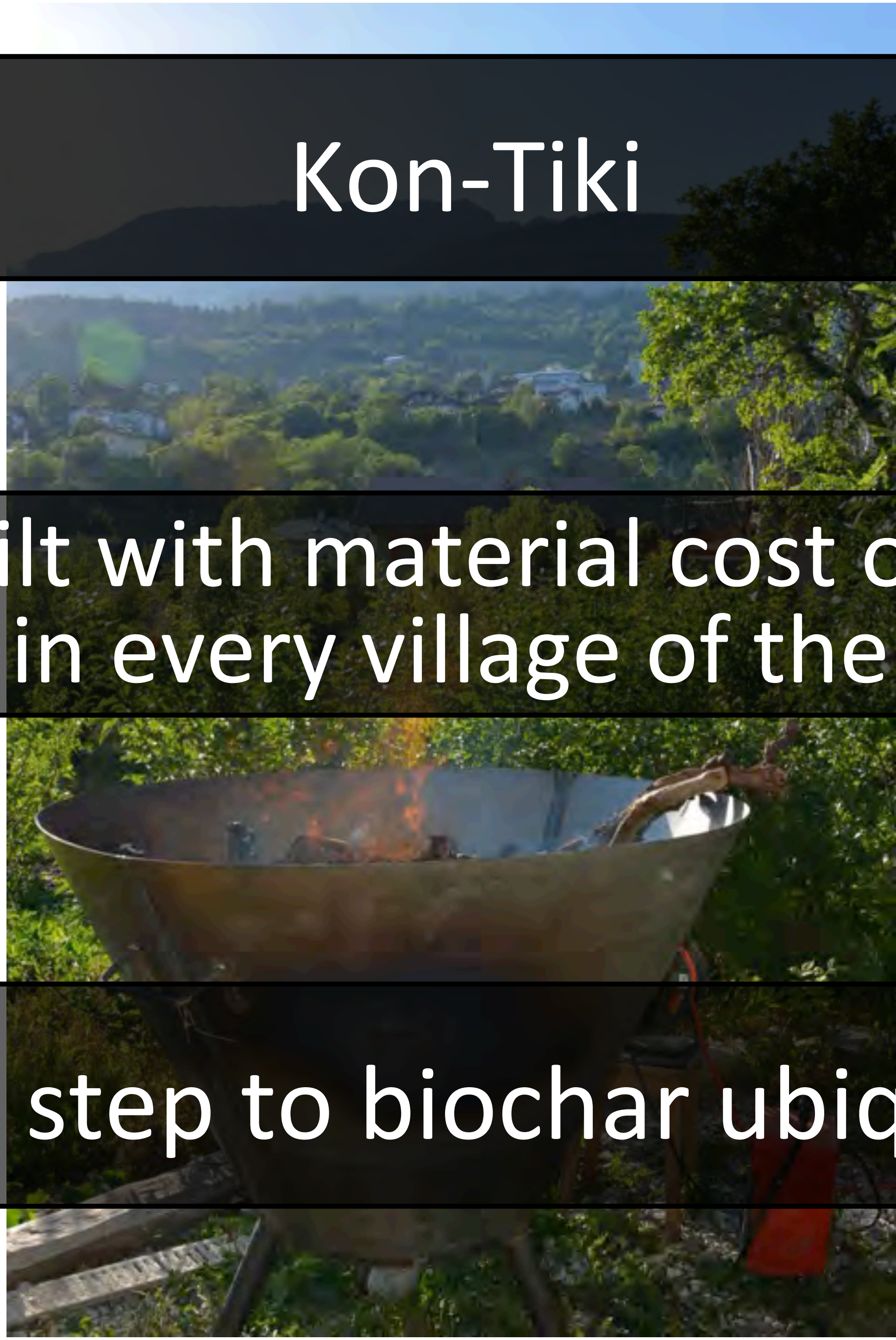
Project: Kon-Tiki II, Soil Kiln

Analysis according to European Biochar Certificate

Parameter	Unit	LOQ	GW 1	GW 2	Method		db
					Sample designation	**Kon-Tiki II**	
			limits		**Lab-ID#**	**114049997**	
Parameter	**Unit**	**LOQ**	**GW 1**	**GW 2**	**Method**		**db**
Determination from the toluene extract							
naphthalene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	3,3
acenaphthylene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
acenaphthene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
fluorene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	0,2
phenanthrene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	0,6
anthracene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	0,2
fluoranthene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	0,1
pyrene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	0,1
benz(a)anthracene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
chrysene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
benzo(b)fluoranthene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
benzo(k)fluoranthene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
benzo(a)pyrene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
indeno(1,2,3-cd)pyrene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
dibenz(a,h)anthracene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
benzo(g,h,i)perylene (toluene extr.)	mg/kg	0,1			analogue DIN EN 15527	-	< 0,1
sum PAH (EPA) (toluene extr.)	mg/kg		< 12	< 4	calculated	-	4,50

Writing a sign in the sky

Kon-Tiki



to be built with material cost of $300 to $500 in every village of the world

the step to biochar ubiquity

Mass-Energy Balance of Kon-Tiki 1

ASSUMPTIONS

1. Solid density of char = 0.4 kg/L
2. Char yield on dry basis = 25% db
3. Heating value of wood = 16 MJ/kg
4. Heating value of char = 29 MJ/kg
5. Water content of wood = 20% wb
6. Specific heat water = 4.2 kJ/kg^{o}C
7. Heat capacity of wood=2 kJ/Kg^{o}C
8. Heat capacity of char=1 kJ/Kg^{o}C
9. Water vaporization = 2260 kJ/kg

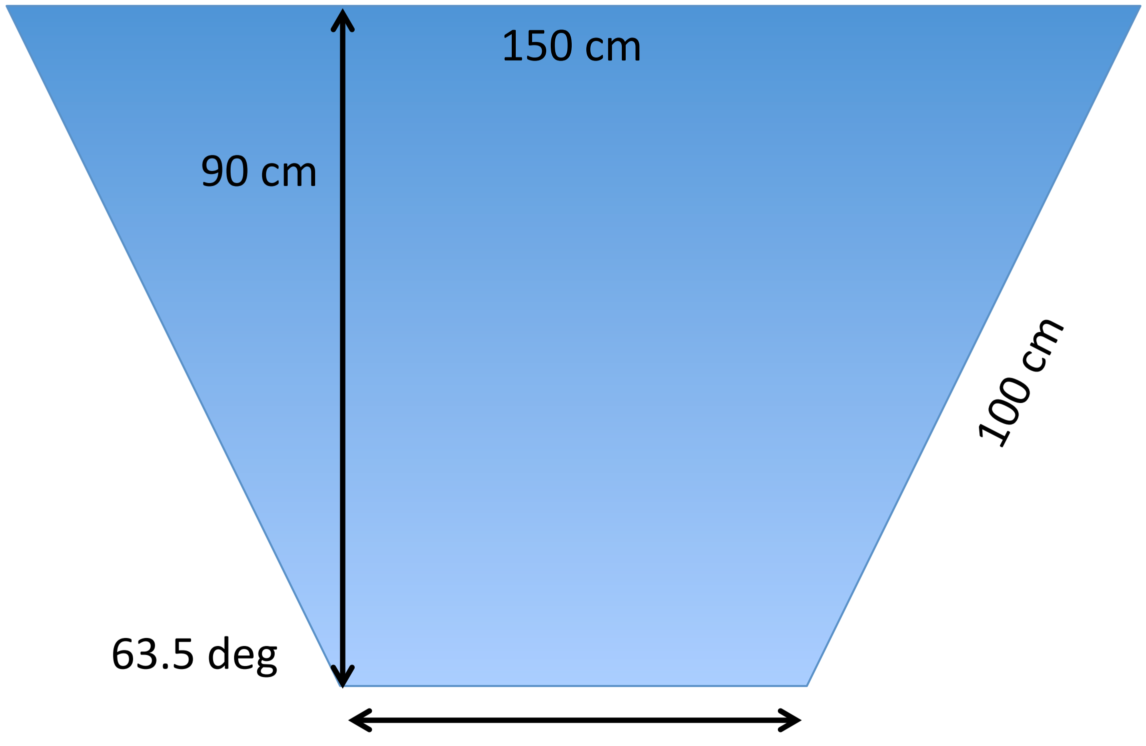
- Volume of char formed when kiln is full = 800 L
- Bulk density of char[1] = 0.25 (based on measured volumes of bulk char and water unloaded from kiln) Mass of char[2] = 200 kg
- Mass of dry feedstock = 800 kg
- Energy in original wood[3] = 12,800 MJ
- Energy in char[4] = 5,800 MJ
- Energy in syngas by difference = 7,000 MJ (55% of original wood energy)
- Power output of burning syngas over 5 hours = 1,400 MJ/h = 0.39 MW (averaged)
- Energy to dry wood and heat from 20^{o}C to 280^{o}C =519[5,6]+416[7] = 935 MJ = 13% of Syngas
- Net energy in Syngas above kiln = 5,365 MJ (assuming also 10% thermal loss in kiln)
- Heat stored in char above 70^{o}C[8] = 96 MJ (200 kg @ average temperature of 550^{o}C)

Water heating potential:

- Energy to heat water from 20^{o}C to 70^{o}C[6] = 210 kJ/kg
- Hot water output from syngas combustion = 10,000 L @ heat use efficiency of 40%
- Hot water output from char stored heat = 400 L @ heat extraction efficiency of 88%

The Kon-Tiki is open source

Please contact the Ithaka Institute for the latest design



Volume = 827 L

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The Kon-Tiki is open source

But think about a modest donation to the Ithaka Institute to cover the cost of developing and testing the Kon-Tiki, to make it known to the world and to further improve it’s design.

What is it worth to you that the Kon-Tiki exists and that the production of biochar is now at the hand of every farmer, every where in the world?

http://www.ithaka-institut.org/en/donation

The Kon-Tiki is open source

We help professional producers to develop chain production and to design a multitude of extra devices and extensions like heat recovery, nutrient loading or automatic discharge and adaptation to industrial biochar production.

Please contact the Ithaka Institute for the latest design and consulting.

What is it worth to you that the Kon-Tiki exists?

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The Kon-Tiki Crew

skipper: Hans-Peter Schmidt
navigator: Paul Taylor
1st mechanic: Markus Koller

inspired by
Kelpie Wilson, Michael Wittmann, Kamal Rashid, Moki & Albert Bates

Tasmania

Made by Frank Strie

West Australia

Made by Philipp Strie