**INSTRUCTION MANUAL FOR KON-TIKI ‘ROLLS’ BIOCHAR KILN**

**by Permachar.net - Version 3, 22/9/2021**

EQUIPMENT

* Kon-Tiki ‘Rolls’ kiln – includes 1.2m HW350 weathering steel cone with reinforcement ring, quad galvanised heat shield, tipping frame/cradle on caster wheels, 1” drain at bottom, 304 ss mesh cover/grate on top of 2” drain hole inside the cone
* IBC with top cut off and filled to 600 litre mark with water from
	+ mains water
	+ rainwater tank
	+ water bladder
	+ dam/creek/river/lake
* Submersible pump eg. 12V/240V
* battery to run pump eg. For 12V a car/truck battery can be used or an iTECH 1000p battery, eg., which can power 12V and 240V and can be charged with 2x 120W solar PV panels
* irrigation fittings
	+ 1” drain to pump – 1” poly end connectors with BSP thread x2, 5 metres 1” rural/ag line
* PPE
	+ cotton clothes
	+ welders gloves
	+ steel capped work boots
	+ protective glasses/sunglasses
* fire lighting equipment
	+ Kerosene/firestarter
	+ newspaper/tinder
	+ matches
* additional tools
	+ Food grade Phosphoric acid
	+ shovel
	+ Laser thermometer
	+ pH meter
	+ Moisture meter
	+ wheelbarrow
	+ SS 20 litre buckets
	+ tarp

SETUP

* Roll kiln to the desired location (with quad heat shield inside cone), free from burning hazards eg 5m above and around kiln. Once in place, remove the heat shield and hook onto reinforcement ring at top of the cone. Place 2 heat shield pieces adjacent to the drain then the remaining 2 pieces opposite the drain. This will balance the cone while adding the heat shield
* move an IBC 3+ metres away from kiln
* connect the submersible pump in the bottom of the IBC to the 1” ball valve/drain on the kiln in that order
* connect the submersible pump to a charged battery (if using a 240V pump, make sure the battery can provide well above the power rating of the pump)/mains power supply
* fill the IBC with water eg. mains/pumped to say, 600 litres and add whatever you wish to inoculate/charge the biochar with during quenching eg. liquid sea kelp (sea minerals), liquid fertiliser such as NPK, additional nutrients. Live microbiology such as microbes and fungal spores can be added to the quench water at the top of the cone and stirred in after initial quenching when the water has cooled down.
* have processed/prepared feedstock eg. <20% moisture content, nearby and ready for the burn
* wear all recommended PPE

OPERATION OF KILN

* create a large pile of sticks inside of the cone eg. a tipi or layered square stack with newspaper/dry tinder (and a dash of kerosene/firestarter) in the middle.
* Light the stack from the top
* wait until the stack has burnt down and formed a layer of hot coals in the bottom
* add the first and thin eg.2” layer of feedstock covering the entire top surface of the hot coals. There may be some smoke at this stage. This is a combination of water vapour being released (white smoke) and regular smoke produced from the layer starting to pyrolyse/burn at the bottom of the feedstock layer
* When the top of the layer begins to ash, it is time to add the next layer. The layer should completely cover the bottom layer. Once again, the layer should only be thick enough eg. 3” to cover the under layer surface and still allow limited air to move through the upper/new layer. This is an art that needs to be perfected for every different feedstock type, size of processed feedstock and feedstock moisture content. If forestry waste is being used as feedstock, note that smaller feedstock pieces need to be used in the lower half of the kiln and larger pieces in the upper half of the kiln
* Once again, wait until the top layer is starting to ash under the ‘flame cap’ then add the next layer and repeat adding layers until the cone is filled with biochar right up to the top of the cone
* Add some small pieces of feedstock to the top layer to finish the burn. Once the flames have almost died down it’s time to quench! If you leave it any longer, the biochar will start to break down beneath the flame cap, ash and reduce the biochar yield.
* Quenching. If you followed the setup instructions, the under-cone drain should be connected to the pump (submersed in the IBC) and the pump connected to the battery. The ball valve lever can act like a tap – the lever, at 90 degrees, the drain is closed and parallel to the drain the drain is open which it needs to be for quenching. Turn on the pump from the battery...
* Pump until the water level is just below the upper rim of the kiln cone then turn off the pump.
* Push the biochar into the water/water mix (the back of a shovel works well) until there are are no more flames or burning biochar pieces
* Leave overnight then next morning pH adjust the quench water. Measure the pH of the quench water with a pH meter eg.Digitech. It will probably be slightly alkaline. You can customise pH for alkaline or acidic biochar which may be required for some soils/Permafert eg. for more alkaline, add ash. For more acidic, add Phosphoric acid. So, for a neutral pH, add a small amount of food grade Phosphoric acid eg. 100mL, stir biochar in the quench water with a shovel, then remeasure pH. The pH should have dropped below 7 and will gradually increase back to around 7 (over the next 6 hours).
* In 6 hours remeasure the pH of the quench water. There may be some final adjustments. When happy with the pH, disconnect the end connector from the ball valve (on the drain) then drain the kiln using a 20 litre SS bucket to transfer water back into the IBC ready for the next burn. A bucket hole can be dug with the shovel beneath the ball valve to enable larger volumes of water in the bucket, by increasing the vertical angle of the bucket, in order to speed up the process.
* The quench water now includes 'smoke water' from the biochar. If nothing was added to the IBC or only liquid kelp, the quench water can be used as a foliar spray or reused for the next burn/quench. I wouldn’t recommend using quench water for foliar spray if NPK and/or microbes and fungal spores were added.
* Remove the quad heat shield. Remove the 2 heat shield pieces opposite the drain then remove 2 pieces adjacent to the drain. Tip over the cone onto a clay/steel surface using the reinforcement ring as your lever and attach the side chain attached to the cone reinforcement ring onto the hook found on the cradle, next to one of the wheels. The chain will keep the cone tipped and steady during emptying. DO NOT use the drain as a lever as this will place undue stress on the welds attaching the drain elbow to the base of the cone.
* The biochar will partially empty from the cone
* Use a shovel to either empty the cone on site or transfer to a wheelbarrow and take to a North facing (Southern hemisphere) or South facing (Northern hemisphere) site for drying if selling biochar bags (eg. scrape the top layer of soil at a suitable site until you reach clay and place the biochar on top. Place a tarp on top of the biochar when it’s rainy or overcast and remove the tarp when it’s sunny) OR If the biochar is going into Permafert or soil directly you don’t need to dry it!!