A BIOCHAR PRODUCING FURNACE FOR 6-TON CAPACITY FLATBED PADDY DRYER

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Biochar is basically a product of pyrolysis, gasification, or direct combustion. What matter during the process is the quality of biochar is dependent highly on the amount of air used, temperature during combustion, and the time the biomass material is expose into the heat during the process. In order that quality biochar can be produced, the process of treating biomass need to be considered. Biochar that is designed to be used for agriculture to inhibit microbial activity needs to undergo pyrolysis process to produce organic biochar and at the same time pyrolysis oil. However, if biochar need to be recalcitrant in nature, the biomass need to be process on a direct combustion process to produce highly thermally degraded material with almost no unburned cellulose or fiber left. Making it to produce higher percentage amount of carbon through direct combustion can be done by shorten the exposure time of biomass in the combustor. The design of furnace to produce biochar rather than ash is another alternative technology development of Carbon Neutral Commons in coming up to utilize biomass of any form that can

Figure 1. The Char Producing Biomass Furnace.

Table 1. Design Specification of the Furnace.

Type	Double Inclined Grate
Overall Dimension of Combustion Chamber	0.9 m x 0.9 m x 1.2 m H
Feeder	20 cm D Screw P=D/2
Drive	Pulley/Belt, Gear Box (1:60), and Chain/Sprocket
Air Supply	Force Draft Blower 3 in.
Wall	10 mm Inside and 3 mm Outside Plates
Heat Exchanger	21 pc 3 in. D x 1.5 m H BI Pipes Sch 40

Table 2. Design and Performance Specification of the Furnace.

Combustion Chamber	1 m3
Wall Thickness	10 mm MS Plate
Heat Exchanger Pipes	21 pcs, 3 in. BI pipe sch 40
Fuel Feeder	20 cm Screw
Blower Size	3-in. electric blower
Fuel	Rice Husk
Moisture	10 to 16 %
Fuel Load	9 to 16 kg
Start Up	4 to 7 min
Fuel Consumption Rate	7.5 to 8.4 kg per hr
Airflow Rate at the Combustion Chamber	81 to 208 m^3 per hour
Fuel Residence Time	10 to 17 min
Combustion chamber Temperature	515 to 680 C
Temperature of Air Entering the Furnace	28 to 31 °C
Temperature of Air Leaving the Furnace	95 to 127 °C
Char Yield	0.31 to 0.40 kg char per kg of rice husks

produce highly recalcitrant char through the use of a furnace.

The design of the biochar producing furnace is shown in Figure 1 in the right. This furnace aimed to provide heat to a 6-ton capacity paddy dryer while at the same time producing biochar instead of ash as the by-product. The furnace has a combustion chamber of 1 m3 made of 10 mm thick mild steel plate. At the lower portion of the combustion chamber are two inclined grates with plurality of 6 mm diameter holes facing each other where air necessary for combustion in introduced into the fuel by means of 3 in. electric blower delivering an air of 81 to 208 m^3 per hr . On top of it is a heat exchanger pipes vertically positioned directly unto it for the flue gases to pass through to heat incoming air to be used for drying. Rice husk or any granular materials can be fed to the furnace by means of a screw feeder with feed hopper on one end and the furnace combustion chamber on the other end. The screw is drive by means

of a 2hp, 220 volt electric motor and a gear drive operating at 1:60 reduction speed. As the fuel is feed into the furnace combustion chamber, it moves gradually along the length of the grate by means of screw pushing the fuel. Heat energy is transferred from the fuel to the combustion chamber wall as well as on the pipe walls. Lateral fins are provided outside the wall surfaces of the combustion chamber to absorb the heat accumulating the wall thereby improving the heat transfer while at the same time disallowing temperature increase on the wall furnace.

Performance test using rice husk and mixture of other biomass fuel like straw showed that the time to set the fuel on fire is within 4 to 7 min from the start of ignition. Shorter time of ignition if the furnace start-up ignition is made strong enough using newspaper or with coconut leaves as material with kerosene sprinkled on the fuel. The temperature of the combustion chamber reached at the ranged of 515 to 680 C at the optimum firing using type K thermocouple wire with ceramic shield as sensor and digital thermometer to measure the temperature. The temperature of air entering the drying bin which is a mixture of ambient air and the heated air from the furnace ranged of 59 to 80 C using a type K thermocouple wire sensor and digital thermometer for measurements. Air entering the heat exchanger as a result of suction of the dryer fan is at a rate of 1.15 to 1.78 m^3/s. The temperature of the air entering the heat exchanger is at 28 to 31 C and leaves the furnace air duct at 95 to 127 C. Biomass fuel stay inside the furnace for almost 10 to 17 minutes once it enters the furnace combustion chamber and before it is discharged to the other end by the screw. The furnace consumes 3 to 4 sacks (12 kg per sack) of rice husk per hour. For every kilogram of biomass, a kg rice husks 0.31 to 0.40 kg of char is obtained. Corn cobs is also used as fuel for the furnace to obtain high start-up. However, less char is obtained from the use of corn cob as fuel for the furnace. Drying operation in the Municipality of Basista, Pangasinan using 6 tons of freshly harvested paddy showed that at the initial moisture of 20 to 23%, the furnace can sustain the supply of heat to dry the paddy down to 13 to 14% within 10 to 12 hours depending on the ambient condition during drying. Drying was successful using the furnace because the unit can supply the amount of heat and temperature required during drying. Minimal mixing of paddy was made during test operation since the fan that pushes the hot air into the bed of paddy has enough pressure draft required in pushing the hot air into the drying bin. Paddy dried in the bed after drying was observed to be uniform all throughout the bin. The miller where the furnace is installed were satisfied in the performance of the furnace together with the dryer.

It can be concluded that a biomass furnace can also be used to produce higher amount biochar during operation by shorten the residence time of the fuel inside the combustion chamber. By increasing the feed rate of fuel, exposure time of biomass is shorten hence producing more carbon retained in the fuel.

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