COTTAGE-INDUSTRY-SIZE SINGLE-BURNER RICE HUSK GASIFIER STOVE

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Glory to God!!!

A cottage-industry-size, single-burner rice husk gasifier stove was recently developed. The stove can be used for coco-sugar processing, turmeric-tea production, mushroom bedding materials steaming, and many others. Aside from addressing the problem on high cost of energy for cooking, the use of this technology mitigates problems on indoor pollution as well as excessive emission of carbon dioxide. Moreover, soil restoration is also being addressed. This development was undertaken by Carbon Neutral Commons (CNC) to provide rural sectors in the developing world of a technology that can utilize biomass wastes like rice husk as source of clean fuel while, at the same time, can sequester carbon and help restore soil fertility.

Model	CNC-RHGS-CI-40D-1B
Reactor Diameter	Moving-Bed Down-Draft Type 40 cm
Air Moving Device	Electric blower – 2½-in. 220 volt, 1.8 Amp
Burner	Drum-type with 6 mm ϕ holes

Figure 1. Pictorial and Design Specifications of CNC Single-Burner RHGS for Cottage

As shown in Figure 1, the stove consists of 40cm-diameter moving-bed downdraft-type reactor where rice husk is gasified with limited amount of air to produce combustible gases rich in carbon monoxide (C0), hydrogen (H_2), and methane (CH_4). This design is an improved version of the same technology developed in 2010 wherein a water-dousing device or a char bin is incorporated in the system to immediately quench the burning char and keep it from turning into ash. The reactor of the stove is provided with a 2½-in. electric blower that supplies air necessary to gasify rice husks. The blower can be ran by tapping from the grid or by using a 100amp-hour battery coupled to a 500-watt DC-AC Inverter.

The hopper on top of the reactor serves as the feeding inlet for rice husk fuel and the rotating

sweeper beneath the char chamber gradually discharges the char by dropping it into a water-filled bin to immediately quench the burning char and keep it from
turning into ash. The burner of the stove, which is extended using a gas pipe, is a 20cm-diameter drum-type gas burner with 6mm-diameter holes on top where gas exits and is combusted to produce heat for cooking. Rice husk fuel is ignited at the bottom of the reactor to start the operation. The fire zone formed after the ignition of fuel starts to move from the bottom to the top of the reactor. Continuous operation of the stove is sustained by maintaining the fire zone at the middle of the reactor. The gas produced from the reactor leaves through an exit pipe passing through the particle separator to separate large char particles from the gas stream before the latter enters the burner. The gas leaving the burner is ignited to provide the heat needed for cooking.

Table 1. Stove Performance.

Start-Up Time	4 to 5 min
Gas Generation Time	11 to 12 min
Fuel Consumption Rate	12.58 to 13.15 kg per hr
Time to Boil 24 liters of Water	48 to 66 min
Power Input	45.29 to 47.33 kWt
Power Output	11.33 to 11.82 kWt
Specific Gasification Rate	100.16 to 104.67 kg/hr-m^2
Overall Thermal Efficiency	24.97 to 25.01%
Char Produced	50 to 62.5% by volume

Table 1 at the upper right shows the performance of the stove. The stove has 4 to 5 minutes start-up time, i.e., the time to ignite rice husk fuel, using rice husk mixed with kerosene as igniter. Presence of gas at the burner was observed after 11 to 12 minutes after rice husk fuel is fully ignited. The blower is set at minimum shutter opening and the gas valve is set at ¾-opening during the tests. Results also showed that the amount of fuel consumed at the reactor per unit time varies from 12.58 to 13.15 kg per hour, giving a 100.16 to 104.67 kg/hr-m^2 gasification rate. Twenty four (24) liters of water in a large cooking vessel, locally known as “Kawa”, with 30° to 31°C initial temperature can be brought to a boil within 48 to 66 minutes. The amount of water left in the cooking vessel after all the fuel in the reactor is completely consumed ranges from 16.2 to 18.0 liters.

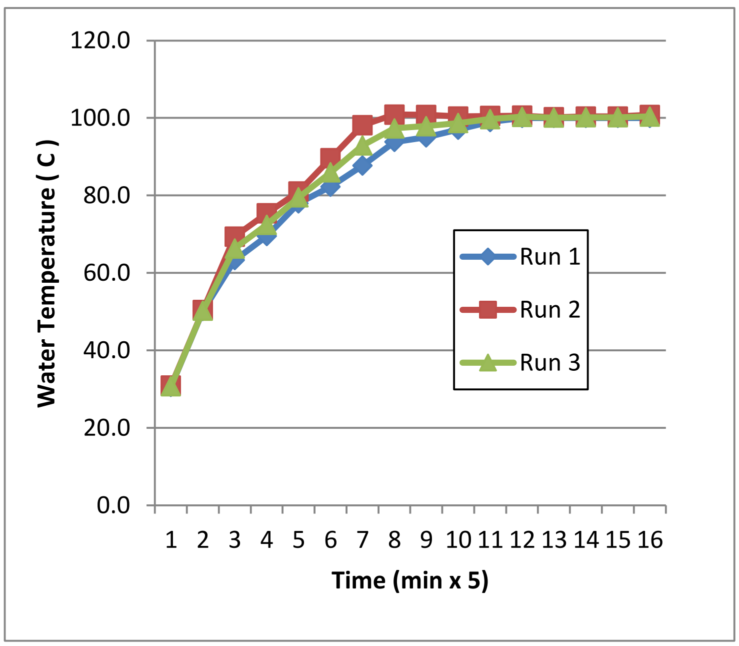

Figure 2. Temperature Profile of Boiling Water in the Stove.

The computed power input of the stove based on the rice husk fuel consumed during the test ranges from 45.29 to 47.33 kWt; while the power output from the heat energy used in boiling and evaporating water is 11.33 to 11.82 kWt. Based on these data obtained, the thermal efficiency of the stove ranges from 24.97 to 25.01%. The volume of char obtained from the bin after each operation was measured at 50.0 to 62.5% of the rice husk fuel consumed.

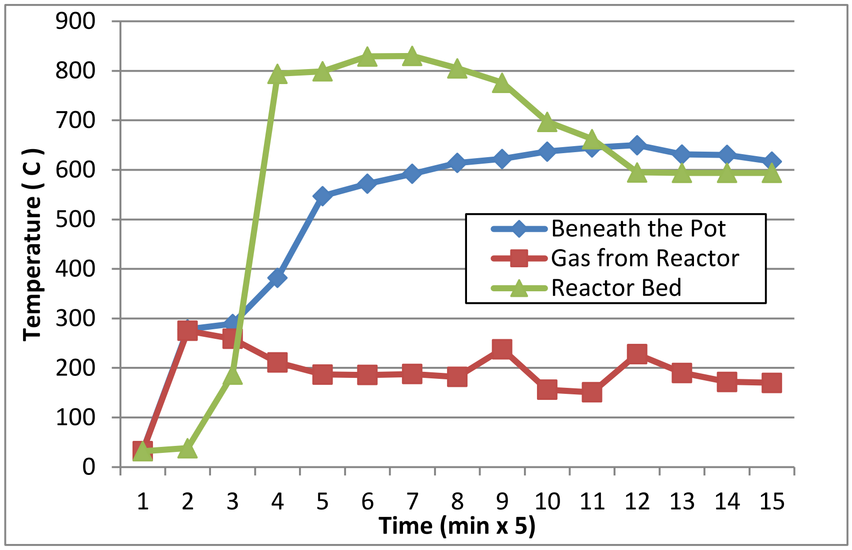

Figure 3. Temperature Profile of the of the Stove Reactor Bed, Gas Leaving, and Beneath the Pot.

Figure 2, lower right side above, shows the temperature profile of boiling 24 liters of water in a cooking vessels for three runs.
In Figure 3, the temperature profiles of the gasifier reactor bed, the gas leaving the reactor, and the flame beneath the cooking vessel is shown for one run only. Measurement was carried out using a thermocouple wire sensor and digital thermometers. As shown, the reactor temperature reaches as high as 800°C while the temperature of the gas leaving the reactor is around 150° to 250°C. The temperature beneath the cooking vessel was measured over 300° to 650°C. The char produced from the stove is shown in Figure 4 below.

The stove can be operated by one person who will do the loading of fuel into the hopper and the removal of char from the char bin. Wet char is manually discharged from the char bin and into a plastic sack or a bucket with the use of a screen-equipped scoop. The operator needs to be trained and gain thorough understanding of the operation of the stove in order that it can be properly operated continuously for more than an hour.

The stove can be fabricated using local skills and materials. The electric

Figure 4. Pictorial of the Char Produced from the Stove.

blower, including the inverter and the battery, are readily available locally. The cost to produce the stove depends on the prices of the materials and on the cost of labor in the specific locality. The stove, however, can be redesigned to further improve its design to address specific cooking practices and to further reduce cost, if needed. The benefits that can be derived from using and/or producing this stove are: (1) energy cost savings to cottage industry processors; (2) added income to local shops; (3) production of soil-amendment char that can improve soil quality in the farm; and (4) helps in sequestering carbon from the atmosphere back to the soil.

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