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

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Glory to God!!!

A cottage-industry-size, double-burner rice husk gasifier stove has been recently developed. The stove can be used for coco-sugar processing, turmeric-tea production, mushroom bedding materials steaming, and many others. The use of this technology addresses not only the high cost of energy for cooking, but also problems on indoor pollution and excessive emission of carbon dioxide are mitigated. In addition, soil restoration is likewise addressed. This development was undertaken by Carbon Neutral Commons (CNC) to provide rural sectors in the developing world a technology that utilizes biomass wastes like rice husk as source of clean fuel while, at the same, sequesters carbon and helps restore soil fertility.

Figure 1. Pictorial and Design Specifications of CNC Double-

Model	CNC-RHGS-CI-40D-2B
Reactor Diameter	Moving-Bed Down-Draft Type 40 cm
Air Moving Device	Electric blower – 2½-in. 220 volt, 1.8 Amp
Burner	Two pieces drum-type with 6-mm ϕ holes

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 burning char to discontinue combusting preventing it from turning into ash. The reactor of the stove is provided with a 2½-in. electric blower that supplies the needed air to gasify rice husks. The blower can be ran either 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 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 preventing it from turning into ash. The two burners of the stove, which are extended through a gas pipe, are of the same size 20cm-diameter drum-type with 69 pieces 6mm-diameter holes each burner where gas exits and combusted to produce heat for cooking.

Rice husk fuel is ignited at the bottom of the reactor to start-up. The fire zone formed upon 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, which is attained by discharging the char as the fire zone goes up. The gas produced exits from the reactor through an exit pipe passing through a particle separator to separate large char particles from the gas stream before the gas enters the burner. The gas exiting from the burner is ignited to provide the heat needed for cooking.

Figure 2. The Stove During Testing.

Figure 2 on the right shows the stove during testing. The blower was set at minimum and the gas valve was made sure closed before the start of operation. Table 1 on the right below shows the performance of the stove. As shown, it takes 4 to 5 minutes to ignite rice husk fuel using rice husk mixed with kerosene (0.5 kg per 0.5 liter) as igniter. Presence of gas was observed at the burner after 13 to 17 minutes after the rice husk is fully ignited. Blower setting was then adjusted to ¾-shutter opening and the gas valve was set at full opening. Measurement was carried out using a thermocouple wire sensor and digital thermometers. As shown in Table 1, the reactor temperature goes as high as nearly 900°C while the temperature of the gas leaving the reactor measures around 400°C. The temperatures of water and that beneath the cooking vessels were measured more than 450° and 550°C. The char produced from the stove is shown in Figure 4 below.

Table 1. Stove Performance.

Start-Up Time	4 to 5 min
Gas Generation Time	13 to 17 min
Fuel Consumption Rate	18.1 to 19.4 kg per hr
Time to Boil 48 liters of Water	36.0 to 60.5 min
Power Input	65.2 to 69.8 kWt
Power Output	11.4 to 25.6 kWt
Specific Gasification Rate	144.1 to 154.4 kg/hr-m^2
Overall Thermal Efficiency	17.7 to 36.7%

Results also showed that the amount of fuel consumed per unit time varies from 18.1 to 19.4 kg per hour, giving a 144.1 to 154.4 kg/hr-m^2 gasification rate. Forty-eight (48) liters of water, initially from 30° to 31°C, in a large cooking vessel locally known as "Kawa" is brought to a boil within 36.0 to 60.5 minutes. The computed power input of the stove based on the rice husk fuel used during the test ranges from 65.2 to 69.8 kWt; while the power output from the heat energy used in boiling and in evaporating water is computed at 11.4 to 25.6 kWt. Based on these data obtained, the thermal efficiency of the stove ranges from 17.7 to 36.7%. Figure 3 shows the temperature profile of boiling two 24-liters of water in each cooking vessel used for 90-min run. The temperature profiles of the gasifier reactor bed, the gas leaving reactor, and the flame beneath the cooking vessels are also shown in this figure.

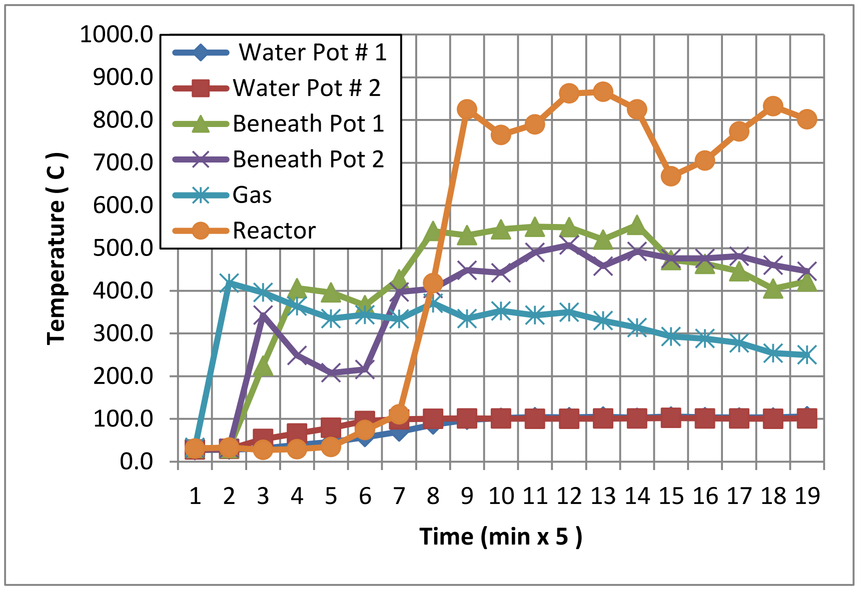

Figure 3. Temperature Profile of the Water Being Boiled, Beneath the Vessels, Fuel Bed, and Gas Leaving the Reactor.

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 into a plastic bucket by using a screen- equipped scoop. The operator needs to be trained and have 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 blower, including the inverter and the battery, are readily available locally. The cost to produce the stove depends on the prices of materials and the cost of labor in a specific locality. The stove, however, can be redesigned to further improve and reduce cost, if needed. The benefits that can be derived from using/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 quality of soil in the farm; and (4) means in sequestering carbon from the atmosphere.

Figure 4. Pictorial of the Char Produced from the Stove Immediately After Removal from the Bin.

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