RICE HUSK GAS STOVE WITH IMPROVED GAS BURNER AND CHAR-DOUSING DEVICE

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Glory to God!!!

Rice husk gas stove has been developed in 2007 and research and development has been undergoing to further improve its performance as a means of a low-cost source of clean fuel for household cooking as well as source of bio-char to improve the water-holding capacity and fertility of the soil. With the growing concern on climate change as a result of increasing emission level of carbon dioxide in the atmosphere, further development on the rice husk gas stove has been recently undertaken with an aim to have greater turn-down ratio for the stove and to produce quality char in order to help sequester carbon.

Recently, Carbon Neutral Commons (CNC) undergoes series of development to improve the design of the stove particularly on the gas burner by adopting a trench-type burner to improve turn-down ratio as well as by using a water-dousing device to immediately quench burning char and prevent it from further combustion hence keeping it from turning into ash and to easily discharge char without tipping over the stove.

The stove, shown at the right, is a new version of the batch-type rice husk gas stove. The size is designed for household-use having 14cm-diameter and 70cm-high reactor. It has a grate inside that can be turned to discharge the char at the bottom. The reactor directly seats on a circular bin, which is called char bin, filled with water to collect burning char hence preventing it from turning into ash. The reactor can be easily detached from the char bin by

Figure 1. Pictorial of the Stove

Table 2. Stove Specifications.

Model	BTRHGS 14D-2
Reactor Diameter	14 cm
Reactor Height	70
Fan Size and Specs	40 mm ϕ, 12 V DC x 0.78 Amp

simply lifting it up to separate making it easier to dispose the char. The bin has four duck-type legs to make the unit stable during operation. On top of the reactor is the gas burner designed with a trench to allow complete burning of gases.

Table 2. Stove Performance.

Weight of Fuel	0.85 to 0.87 kg
Start-Up Time	0.5 to 1.0 min
Gas Generation Time	1.0 to 1.2 min
Boiling Time	6.7 to 17 min for 2 liters of water
Total Operating Time	21 to 39 min
Specific Gasification Rate	85.6 to 158.1 kg/hr-m^2
Air-Fuel Ratio	1.2 to 1.9 kg air/kg fuel
Overall Thermal Efficiency	23 to 40 %
Turn-Down Ratio	3.1
Char Produced	24 to 32%

The trench has outer and inner walls where the air is supplied naturally to improve combustion of gases. The burner is removable for ease of loading and ignition of fuel. Air is supplied into the fuel bed with the use of a 12-volt, 0.76-amp, 40mm-diameter DC fan, which can be energized through a battery equipped with 2-amp charger and a PWM switch to vary the fan speed and, at the same time, the firing intensity. The stove reactor is provided with a screen to prevent the user from accidentally touching the hot surface during cooking. Almost all of the materials used for the stove is stainless steel series 200 to have greater resistance from heat corrosion. The handle of the stove uses wood as thermal insulation.

The stove was tested following water boiling and simmering tests using 2 liters of water at 12-volt fan input with two different switch settings, i.e., low and high. The time required to attain 80% combustion upon ignition of fuel and the time required for combustible gases to be generated were recorded during the tests. The weight of rice husks used per load also the weight of char produced after burning all the fuel were measured. The temperature of water during boiling and the temperature beneath the pot were also monitored during the tests using type-K thermocouple sensor attached to a digital thermometer. Airflow rates of the fan were determined using a thermo-anemometer to measure the velocity of the fan duct multiplied by the cross-sectional area.

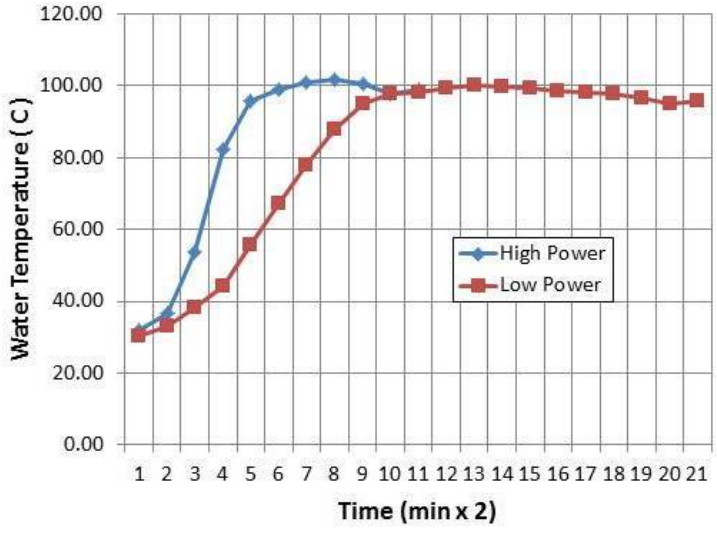

Figure 2. Temperature Profile of Boiling Water.

Results showed that the stove has 0.85 to 0.87 kg rice husk loading capacity. Spontaneous combustion of rice husks has taken place within 0.5 to 1.0 min and combustible gas was generated within 1.0 to 1.2 minutes thereafter. The stove runs for 21 and 39 min at high and low fan setting, respectively. The computed specific gasification rate of the stove ranges from 85.6 to 158.1 kg/hr-m^2; while the overall thermal efficiency based on the net energy

transmitted by the stove to the pot ranges from 23 to 40 %, which indicates high amount of char produced. The computed turn-down ratio of the stove is 3.1.

The temperature profile of boiling water and beneath the pot are shown in Figures 2 and 3, respectively. At low fan setting, 2 liters of water is hardly boiled or takes longer time to boil it in the stove. Also, the temperature monitored at the bottom of the pot is lower in low fan than in high fan setting. At low fan setting, the temperature reaches as high as nearly 450°C; whereas, at very high fan setting, the temperature reaches as high as 680°C. A dramatic increase in the temperature beneath the pot was observed at the 8th minute of the operation and gradually decreases after 20 minutes.

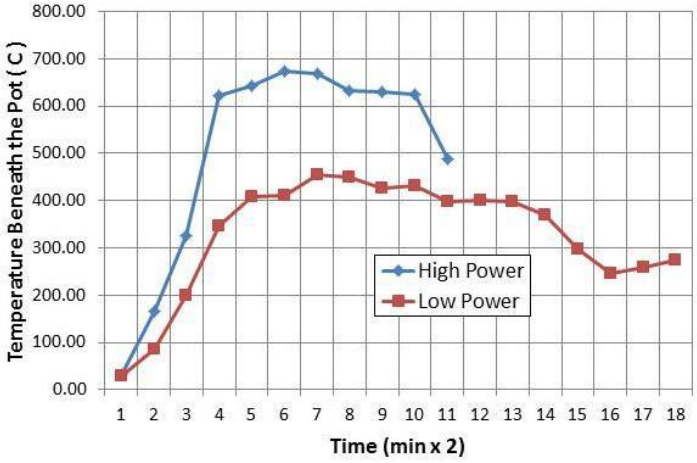

Figure 3. Temperature Profile Beneath the Pot.

Emission testing will be carried out sooner to determine other parameters, particularly in terms of the indoor pollution it contributed. The char produced from the stove will also be analysed to determine the carbon sequestration potential of the stove.

The stove can be fabricated locally. The fan including the battery, charger, and PWM switch are available from local suppliers. The stove can be further simplified to reduce materials and labor costs as well as to facilitate the fabrication by using a thinner stainless-steel sheet and TIG weld to properly weld parts. The benefits that can be derived includes: (1) energy cost savings to households; (2) added income to local shops; (3) improves quality of soil in the farm since char has high water-holding capacity; and (4) helps carbon sequestration.

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