MODIFIED DESIGN OF THE RICE HUSK GAS STOVE FOR ENHANCED CHAR PRODUCTION

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Praise God!!

A modified design of the rice husk gas stove for enhanced char production was recently developed. The stove does not need to be tilted to discharge the char. This modified design is provided with a knob that can be rotated to turn the grate upside down letting the char fall into the bin filled with water. The char bin is enough to hold char produced for one-day cooking. The stove is also equipped with built-in battery, charger and a PWM switch as accessories so it can be used even during brown out. In this way, the stove is much applicable to women who do the cooking for the family. The stove, as shown at the right, is also provided with a sturdy frame eliminating the danger of toppling down, especially when cooking big amount of food that requires big pot or pan, and a screen casing preventing user(s) from accidentally touching the hot surface of the reactor while cooking.

Pictorial of the CNC BTRHGS Model

Model	CNC BTRHGS 20-D1
Reactor Diameter	19 cm
Reactor Height	55
Fan Size and Specs	40-mm D, 12 V x 0.78 Amp
Material	Stainless Steel No. 304

This technology is among the series of stove development carried out by Carbon Neutral Commons (CNC) aimed at improving the cooking condition in household level while, at the same time, improving carbon sequestration, supporting poverty alleviation, and enhancing soil restoration.

The stove, as shown above right, is an enlarged version of the basic design of the batch-type rice husk gas stove. Instead of the conventional 14cm-diameter by 55cm-high reactor, the stove adopts a 16cm-diameter by 55cm-high reactor for the same size of fan. The plate-type gas burner is made removable for ease of loading fuel. To simplify fabrication, the burner is provided with two layers of 6mm-diameter circumferential holes. It has a fixed enclosure to shield the flame from wind and, at the same time, to confine spilling water from the pot during boiling. The stove is supported by a frame made of 1in.-by-1in. steel tube with a rectangular-shape char bin at the bottom. The reactor is made of stainless steel 304 for longer life span. It is covered with 10mm-stainless-steel screen mesh preventing the user from touching its hot surface during cooking.

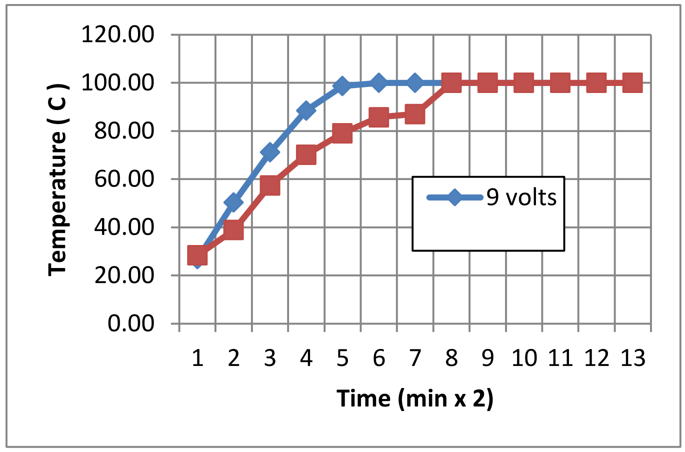
The stove was tested following a water boiling test using 2 liters of water at 7.5 and 9.0 volts fan input. The time required to attain 80% combustion of the surface of the fuel bed upon ignition of rice husks and the time required to generate combustible gas were recorded during the tests. The weight of rice husks used per load and the weight of char produced obtained from the bin, after allowing it to drip for 1 hour, were measured. The temperature of water and the temperature beneath the pot during boiling were also monitored during the tests using type-K thermocouple sensors attached to a digital thermometer to graph the temperature profile of the stove. The air flow was determined by measuring the velocity of inlet air of the fan using a digital thermo anemometer multiplied by its cross-sectional area.

Stove Performance Test Results

Fan Input (volts)	7.5 Volts	9.0 volts
Weight of Fuel (kg)	1	1
Start-Up Time (min)	2	1
Gas Generation Time (min)	1	1
Boiling Time of 2 liters of water (min)	8.33	7.33
Total Operating Time	25.33	21.33
Specific Gasification Rate (kg/hr-m^2)	118.02	140.02
Air-Fuel Ratio (m^3 of air/kg of fuel)	0.35	0.52
Superficial Gas Velocity (cm/sec)	1.14	2.02
Equivalence Ratio	0.09	0.13
Fire Zone Rate (cm/min)	2.02	2.39
Power Input (kwt)	7.01	8.32
Power Output (kWt)	1.24	1.31
Thermal Efficiency (%)	14.13	13.13
Char Produced (%)	30.5%	29.0%

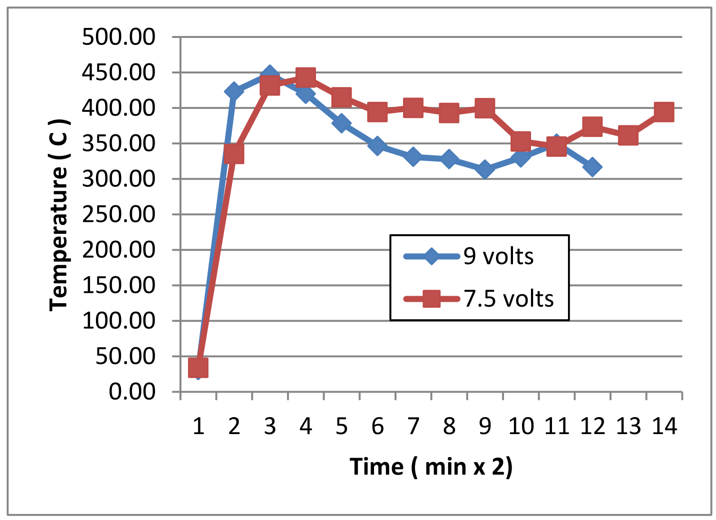
Results revealed that the stove has a rice husk loading capacity of 1 kg per load at an average moisture content of 14%. Spontaneous combustion of rice husks takes place within a minute and combustible gas is generated within 1 and 2 minutes thereafter for the voltages tested, respectively. Two (2) liters of water can be boiled in the stove within 8.33 for the 7.5 volts and 7.33 min for the 9 volts. The stove runs for 25.33 min at 7.5 volts and shorter for only 21.33 min at 9 volts fan setting. The computed specific gasification rate of the stove is 188.02 kg/hr-m^2 and 140.2 kg/hr-m^2; while the fire zone rate is 2.02 and 2.39 cm/min for 7.5 and 9.0 volts, respectively. Air-to-fuel ratio is 0.35 and 0.52 m^3 per kg of rice husk and the superficial gas velocity is 1.14 and 2.02 cm/sec, respectively. Moreover, the equivalence ratio for the 7.5-volt is 0.09 and for the 9.0-volt fan input is 0,13. The power input and power output are 7.01 kWt and 1.24 kWt for the 7.5-volt; whereas, 8.32 and 1.31 kWt for the 9-volt fan setting, respectively. Overall thermal efficiency is higher for 7.5 volts (14.13) than for 9 volts (13.13). This may be due to excessive flame for the 9-volt fan setting that overspills the bottom of the cooking pot. Moreover, the char produced is higher for the 7.5- volt than that for the 9-volt fan setting.

The temperature profile of boiling water and of beneath the pot are shown in the graphs at the right. For the boiling test, two (2) liters of water reached the boiling point (i.e., 100°C) faster at 9-volt fan setting by 3 minutes than at 7.5-volt. On the other hand, the temperature obtained beneath the pot is higher for the 7.5-volts than for the 9-volts fan setting. This is because the layer of the fire zone at a given time is thinner for the 7.5-volt than for the 9.0-volt fan setting. It can also be noticed that the temperature measured beneath the pot decreases as the fire zone moves down the reactor.



Temperature Profile of Water During Boiling Tests

The stove can be fabricated using local skills and materials at P7,500.00, including the fan and the AC-DC adopter. Accessories such as 12volt-9AH DC battery, 2-amp battery charger, and PWM switch are also available for an enhanced performance of the stove. Fabrication of the stove can be further simplified to reduce materials and labor costs. The benefits that can be derived from using and/or producing this stove are: (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 in sequestering carbon from the atmosphere back to the soil.



Temperature Profile Beneath the Pot During Tests

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