A HOUSEHOLD-SIZE THREE-BURNER BATCH-TYPE RICE HUSK GASIFIER STOVE

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Figure 1. Pictorial of the Three-Burner Gasifier Stove During Testing.

Sources of alternative clean fuel for cooking is continuously sought after by households. This basically can be attributed to the erratic fluctuation in fuel prices, like LPG, which is highly dependent on the availability and supply of petrol-based fuel. With the introduction of the single-burner batch-type rice husk gas stove, most of the rural households were convinced that rice husk when gasified and used as fuel can be a good alternative low-cost and clean fuel for cooking. The single-burner batch-type gas stove, however, has limited or short operating time and it can only cook one kind at a time. Because of these limitations, households sought for a stove that can allow them to cook simultaneously in one operation with no additional task of loading and reloading of fuel to meet the entire cooking requirement. In order to address this demand, design and development of a 3-burner batch-type rice husk gasifier stove was carried at the clients' level to ensure that the technology being developed will meet exactly their need.

The stove, as shown in Figure 1, is an enlarged scale model of the batch-type rice husk gas stove with the fuel reactor entirely separated from the burners. Instead of a burner positioned on top, a cover is provided for the reactor to channel out the gas to the burners through a gas pipe. The fuel reactor, which has 25-cm diameter and 120-cm height, was designed to provide a power output of 2 kWt for a time period of 1 hour. The reactor is provided with a grate beneath to facilitate discharge of the char after operation. A water bin (36-cm H x 50-cm W x 90-cm L) is provided to immediately quench the burning char and keep it from turning into ash while, at the same time, keeping the surrounding free from fly ashes. A removable cover is provided at the top end of the reactor to facilitate loading of rice husks and to seal the reactor

from gas leakage during operation. A 2-in., 220-volt electric blower is used to provide the air required for gasification of rice husks. The combustible gas generated in the reactor is diverted to the three gas burners through a 2-in. pipe. Each burner has 12-cm diameter and 10-cm height. Thirty-six 4.5mm-ϕ holes are provided for each burner serving as gas outlet. A 10cm-diameter by 3cm-high ring is provided on top of each burner to aid in proper combustion of gases. Each burner is provided with a sub-main pipe that is equipped with a ball valve to facilitate control of the flow of gas and of the intensity of fire during cooking. The burners are supported by a table frame made of a combination of 1-in. and 2-in. square tubes.

Performance testing of the stove showed that rice husk with 10 to 14% moisture content can be successfully gasified in the fuel reactor producing a combustible gas that is subsequently used for cooking. A full load of fuel in the reactor requires 5 to 7 kg of rice husks. Ignition of rice husk requires 1 to 2 minutes using crumpled pieces of paper and gas is generated within 3 to 5 minutes thereafter. The reactor with a full load of fuel operates for 40 to 50 minutes at full shutter opening of the blower. One liter of water in each burner is brought to a boil within 7 to 8 minutes. The computed fuel consumption rate of the stove ranges from 7.5 to 8.4 kg per hour while the specific gasification rate is between 150 to 168 kg/hr-m^2. Air-fuel ratio ranges from 1.15 to 1.79 kg air per kg of fuel. The temperature of the gas leaving the reactor is at the range of 150° to 176°C and that beneath the pot ranges from 201° to 387°C for the three burners. The color of the flame is observed yellowish-to-violet in the first

Table 1. Design Specification and Performance of the the Stove.

Reactor Diameter	0.25 m
Reactor Bed Height	1.2 m
Blower Size	2-in. electric blower
Fuel	Rice Husk
Moisture	10 to 14%
Load	5 to 7 kg
Start Up	1 to 2 min
Gas Generation Time	3 to 5 min
Total Operating Time	40 to 50 min
Time to Boil 1 liters of water per burner	7 min (1^{st}), 8 min (2^{nd}), and 8 min (3^{rd})
Fuel Consumption Rate	7.5 to 8.4 kg per hr
Air Fuel Ratio	1.15 to 1.79 kg air per kg fuel
Specific Gasification Rate	150 to 168 kg/hr-m^2
Fire Zone Rate	2.4 to 3.0 cm/min
Flame Color	Yellow to blue
Gas Temperature	150° to176°C
Temp. Beneath the Pot	201° to 387°C

Figure 2. Pictorial of the Three Burners with Flame during Operation.

few minutes and then red-to-violet flame in the succeeding minutes. Char yield ranges from 27 to 32% of the gasified rice husks.

The stove can be a useful cooking device for medium- to large-size rural households. One load of fuel can cook one steamed rice and two dishes at a time. Since it operates on a batch mode, the start up time is much shorter and there is no need to attend to loading of rice husks and unloading of char during operation. What the users need to do is to maintain the right intensity of firing of the stove during cooking, i.e. the right amount of heat for a particular food being cooked.

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