RICE HUSK GASIFIER COMBUSTOR MODEL 60D-JET BURNER

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Glory to God!!!

A rice husk gasifier combustor model 60D was recently developed. The combustor can be used to supply heat for mechanical paddy dryer, coco fiber rotary dryer, fruit/fish dehydrator, scalding vat for slaughter houses also to co-fire a steam boiler, kiln, bioethanol distiller, and many others. On top of its primary benefit of addressing the problem on high cost of energy for drying and other heating requirements, using this technology mitigates indoor pollution and carbon dioxide emission, as well as restores soil fertility. 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 husks, as source of clean fuel while, at the same, sequesters carbon and helps restore soil fertility.

Model	CNC-RHG Combustor 60D
Reactor Diameter	Moving-Bed Down-Draft Type 60 cm
Air Moving Device	Electric blower – 3 in., 220 volt, 2 Amp
Burner	Jet Type 15cm ϕ x 20 cm combustion chamber

Figure 1. Pictorial and Design Specifications of CNC RHG Combustor.

As shown in Figure 1 at the right side, the combustor consists of 60cm-diameter moving-bed downdraft-type reactor where rice husk is gasified with limited amount of air producing combustible gases rich in carbon monoxide (C0), hydrogen (H_2), and methane (CH_4). The design is an improved version of the same technology developed in 2010 in which a water-dousing device or a char bin is incorporated in the system to immediately quench burning char to discontinue combusting and prevent it from turning into ash. The reactor is provided with a 3-in. electric blower, which is essential in the gasification of rice husks. The blower is ran either by connecting to the grid or by using a 200amp-hour battery coupled to a 1000-watt DC-

AC Inverter. The hopper on top of the reactor serves as inlet for the 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 it preventing the char from turning into ash. The burner of the combustor, which is extended away from the reactor through a gas pipe, is a 15cm-diameter jet-type gas burner with 20cm-diameter combustion chamber to allow mixing of air and with 30cm-diameter hood to contain flue gases and direct them to subsequent heating application.

To start, rice husk fuel is ignited at the bottom of the reactor. The fire zone formed after the ignition of fuel moves upward of the fuel bed. Continuous operation of the combustor is obtained by maintaining the fire zone at the middle of the reactor length. This is accomplished by rotating the sweeper at quarter turn at a time. The gas produced leaves the reactor through an exit pipe passing through the particle separator to separate char particles from the gas stream before it enters the jet burner. The gas leaving the jet burner is ignited to provide the heat needed for the various applications.

Table 1. Combustor Performance.

Start-Up Time	1 to 8 min
Gas Generation Time	5 to 15 min
Fuel Consumption Rate	29.2 to 32.5 kg per hr
Specific Gasification Rate	103.4 to 114.9 kg/hr-m^2
Air/fuel Ratio	1.32 to 1.38
Equivalence Ratio	0.280 to 0.294
Superficial Gas Velocity	3 to 4 m/s
Power Input	87,692.3 to 97,500.0 kcal/hr
Power Output	50,191.6 to 52,054.7 kcal/hr
Gasifier Efficiency	52.9 to 57.2%

Table 1, above right, shows the performance of the combustor. As shown, the combustor requires a start-up time to ignite rice husk fuel within 1 to 8 minutes, depending on the operator's skill. Using rice husk with kerosene (0.5 kg/0.5 liter) as igniter, ignition time is much shorter. When the combustor is stopped for 2 hours between operations, just switch ON the blower for automatic ignition of fuel, no need of igniter. Presence of gas is observed at the jet-burner 5 to 15 minutes after complete ignition of rice husks. Before the fuel is ignited, however, the blower is set at minimum shutter opening to aid combustion of fuel and eventually reset to ¾-shutter opening once presence of gas is observed in the burner.

The amount of fuel consumed per unit time varies from 29.2 to 32.5 kg per hour, giving a 103.4 to 114.9 kg/hr-m^2 gasification rate. The airflow of the blower used for the gasification of fuel was measured at 33.7 to 35.6 m^3/hr, giving a 1.32 to 1.38 fuel-to-airflow ratio and a 0.280 to 0.294 equivalence ratio. The computed superficial velocity of gas at the reactor ranges from 3 to 4 cm/sec. Moreover, the computed power input of the combustor based on the rice husk fuel used during the tests ranges from 87,692.3 to 97,500.0 kcal/hr; while the computed power output from the heat energy from combusting gases ranges from 50,191.6 to 52,054.7 kcal/hr. Based on these data, the gasifier efficiency of the combustor obtained ranges from 52.9 to 57.2%.

Figure 2 shows the temperature profile of the fuel bed in the reactor, of the gas leaving the reactor, and of the combustion chamber at the jet-burner which were measured on the first 70 minutes of operation. Measurement was done using thermocouple-wire sensors and digital thermometers. As shown, the fuel bed temperature goes as high as 600° to 700°C; while the temperature of the gas leaving the reactor varies from 100 to 400°C. It was observed that the temperature of the gas is influenced by the location of the fire zone. At the start, where fire zone is at the lowest portion of the reactor fuel bed, the temperature was observed to be high and vice versa. Moreover, the combustion chamber temperature was measured at the 200° to 450°C range.

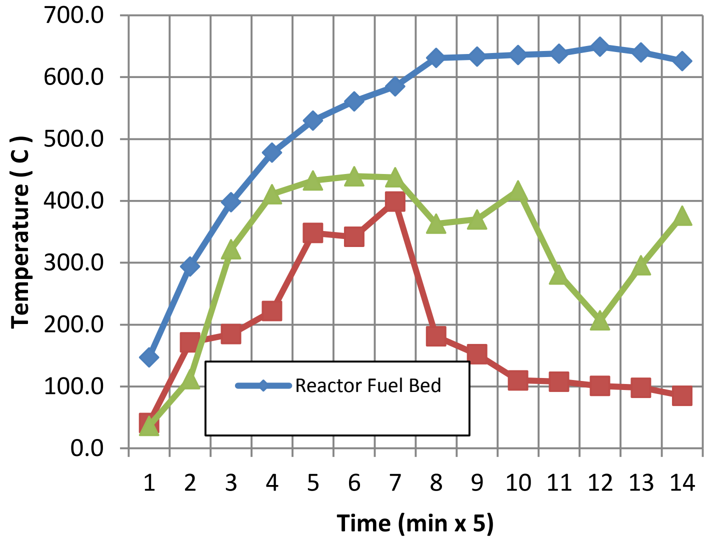

Figure 2. Temperature Profile of Combustor.

The combustor can be operated by one person who will do the manual loading of fuel into the hopper through a platform and the subsequent manual removal of char from the char bin into a plastic sack or a bucket with the use of a screen scoop. The operator needs to be trained and have thorough understanding of the operation of the combustor for him to properly operate it continuously for a longer period.

The combustor 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 it depends on the prices of materials and the cost of labor in the locality. The benefits that can be derived from using and/or producing this combustor are: (1) energy cost saving – instead of fossil fuel, biomass can be used as replacement; (2) employment generation - provides employment in the fabrication and business opportunities in selling new product plus additional revenue in the form of tax to local government units; (3) soil-quality improver production – char is produced in the combustor that can improve quality of soil in the farm; and (4) carbon sequestration medium – char helps, in one way or another, in sequestering carbon from the atmosphere and put back into the soil.

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