RICE HUSK GASIFIER FOR PUMPING WATER: AN APPROPRIATE TECHNOLOGY DESIGNED FOR RICE FARMERS

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Rice farmers are often confronted with the high cost of fuel in operating their machines. Among the different operations, the most expensive part where farmers spend most of their resources is on the cost of fuel to pump water for crop irrigation. Per cropping season, it took the farmers to run their engine to pump water for 2 to 3 consecutive days using their single piston gasoline or diesel engine. On the average, they usually pump water for 24 hours at a rate of 10 liters per sec-hectare consuming an equivalent amount of 0.8 to 1 liters per hour of fuel. Farmers who tills 3 hectares will need to spend 64.8 liters whereas those with 6 hectares will need 129.6 liters. Translating this into cost at P45 per liter of gasoline, they roughly need to have P2,916.00 for 3- and double the cost to P5,832.00 for 6-hectare farm.

Figure 1. The Rice Husk Gasifier for Pumping Water.

Glory to God!! By simplifying the design of the conventional rice husk gasifier, a low cost and easy to build rice husk gasifier was developed. The gasifier utilizes salvage petrol drums as primary materials for the fuel reactor and gas conditioning assemblies. The design of the

Table 1. Design Specification of the Gasifier Unit.

Component	Specification
Reactor	Moving Bed - 30 cm D x 1.2 m H
Gas Conditioning	Wet scrubber, filter, and gas storage
Engine	Single piston, 17 hp, 4 stroke cycle engine
Pump	Centrifugal type 4 inches

machine was made in such as way that it can be build by the farmers themselves using locally available tools and equipment. Farmers don't need to buy new engine. They can retrofit their own existing engines to use the gas produced from the gasifier and at the same time can still utilize gasoline fuel whenever they need it. The gasifier can also be used not only for specific pumping application but can also be utilized to charge battery to energize LED bulbs, cellphones, and other home gadgets and small appliances once a DC alternator is installed. Further more, the gas produced from the gasifier can also be stored in an inflatable bag for subsequent use for clean cooking.

Table 2. Operating Performance of the Gasifier.

	Data Range
Gas Generation Time (min)	5 to 11
Fuel Consumption Rate (kg/hr)	10.5 to 10.9
Gas Flow Rate (m^3/hr)	5.5 to 7.3
Shaft Speed (rpm)	
Engine	2446 to 2634
Blower	5814 to 7238
Pump	867 to 1082
Sound (dB)	87 to 92
pH Start	7.6 to 9.0
End	7.6 to 8.4

The rice husk gasifier unit for pumping water as shown in Figure 1 above consists of three major assemblies as follows: (1) Gas Generating Assembly, (2) Gas Conditioning Assembly, and (3) Power Generating Assembly. Each assembly is built modular in such as way that they can be easily assembled and disassembled when needed. The gas generating assembly is where the gas is produced by combusting rice husk in an oxygen starved environment to produce combustible gases such as CO, H_2, and CH_4. On the other hand, the gas conditioning assembly cleans and cools the gas before it is introduced into the intake manifold of the engine. It consists of a wet scrubber, a packed-bed filter, and a gas storage cylinder. A water cooling pond is provided for the gasifier to allow circulation of water and subsequent cleaning and cooling of gas in the wet scrubber. It also provides a way to immediately quench burning char so that it wont turn into ash. The odor of the tar coming out after scrubbing is eliminated upon discharge into pond prior to disposal.

The gas generating assembly consist of the outer and inner petrol drums welded end to end to form the outer and inner cylinders. The 200-liter capacity drum serves as the outer cylinder reactor while the 50-liter as inner reactor. A locally mixed refractory cement is used as liner for the inner cylinder to minimize oxidation of metal. Beneath the inner cylinder is a 6-pieces of grate shelves to gradually remove the char during operation making it operates in a continuous mode. On top of the assembly is an outlet for gas going to the next

assembly. The unit is similarly build from salvage petrol drums that is welded end to end. At its center is a cross-flow scrubber installed to spay the gas with water and to remove the tars and particulates. The top drum is where the filter is located. Inside it are crushed stones and pebbles to mechanically filter the gas. The gas is then diverted to a gas storage cylinder to further remove liquid tars that goes with the gas. The power generating assembly is where the gas from the gas conditioning unit is converted to mechanical power. It consists of 17 Hp, single cylinder, 4 stroke engine retrofitted to consume the gas as fuel through the gas and air valves. A line shaft directly coupled to the engine with a chain coupler is provided for the assembly to drive the suction blower that pull the gas from the reactor and gas conditioning unit and forced it into the intake manifold of the engine. The gear pump that circulates the water from the water cooling pond to the scrubber is also driven from the line shaft. At the other end of the line shaft is a two groove pulley that delivers the power to a 4 in. centrifugal pump for pumping water.

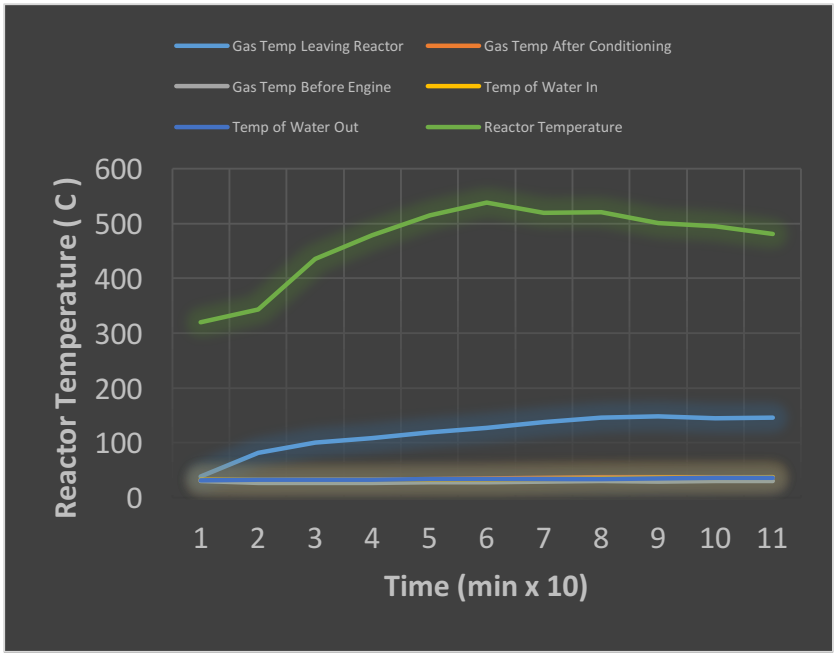

Figure 3. Temperature Profile of the Gasifier.

The gasifier was tested in a bench scale set-up that circulates pumped water from suction to discharge reservoirs. During the tests, the engine start-up using producers gas within 5 to 11 minutes from the time the fuel at the reactor is ignited. Rice husk fuel is consumed at a rate of 10.5 to 10.9 kg per hour and produces a gas at a rate of 5.5 to 7.3 m^3 per hour. The engine runs at a speed of 2446 to 2634 rpm while the blower that sucks the gas runs at 5814 to 7238 rpm. The pump that circulates the water run at 867 to 1082 rpm. The noise level during operation was measured at 87 to 92 dB. The pH

Table 3. Performance Characteristics of the Gasifier.

	Data Range
Specific Gasification Rate ($kg/hr\text{-}m^2$)	108.8 to 113.5
Fuel/Gas Ratio (kg fuel/m^3 of gas)	1.43 to 1.99
Fire Zone Rate (cm/min)	0.88 to 1.17
Superficial Gas Velocity (cm/s)	1.57 to 2.12
Water/Gas Ratio (liters/m^3 of gas)	37.04 to 58.38
Pumping Rate and Head	
Rate (m^3/hr)	15.69 to 24.77
Head (m)	1.0 to 1.2

level of water at the cooling pond ranged from 7.6 to 9.0 at the start and 7.6 to 8.4 at the end of the operation.

The maximum temperature at the reactor obtained is 540 C. Gas leaves the reactor at 150 C and enters the intake port of the engine at 35 C. The computed specific gasification rate of the gasifier reactor ranged from 108.8 to 113.5 kg/hr-m^2 whereas the fuel gas ratio ranged from 1.43 to 1.99 kg fuel per m^3 of gas. The fires zone moves upward at a rate of 0.88-1.17 cm per min while the superficial gas velocity was measured at a range of 1.57 to 2.12 cm per sec. The water to gas ratio at the wet scrubber ranged from 37.0 to 58.4 liters per m^3 of gas. For 4-hour continuous operation, the pump discharges 15.69 to 24.77 m^3/hr at a head of 1.0 to 1.2 meters.

The gasifier unit is easy to operate. Loading of rice husk is done with the use of a platform. Char is removed by swinging the lever at 45 degree turn. Only one person is required to operate and oversee the operation of the machine. Loading of rice husks and discharging of char is done once the fire zone reaches the middle portion of the reactor. The by-product of the reactor which is wet char after dropping into the water cooling pond contains high amount of carbon which turn to be a good material for carbon sequestration and at the same time helped to neutralize the acidity and eliminate the odor of the tar and particulates leaving the scrubber.

For further information, contact:

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