PERFORMANCE OF THE MICROGASIFIER USED AS POWER SOURCE FOR RUBBER CREEPING MILL

by

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Figure 1. The (a) Fresh Rubber Latex, (b) Newly Pressed Rubber Blanket, and (c) Rubber Blanket Being Dried

Rubber in the Philippines is mainly produced in Mindanao Island which supplies 99% of the national rubber production. This is especially more so in Zamboanga Peninsula that sets the national production of 41.68 thousand metric tons of rubber annually. Producing rubber blankets from coagulated freshly harvested rubber latex is the main livelihood of the rural folks in the region. For every hectare of rubber plantation, around 20 kgs of fresh rubber latex is collected every day. Processing 20-kg fresh rubber latex which include pressing the coagulated latex from formic acid in a creeping mill and then air drying can produce 6 kgs of rubber blanket (pale creep no. 1 and 2) that is ready formarket. Fresh latex harvested during the day needs to be immediately processed into rubber

Figure 2. The Diesel Engine Operated Creping Mill to Produce Rubber Blanket.

blankets to produce quality pale creep no. 1 & 2, which are highly suitable for the production of quality rubber products. Pressing the latex to form rubber blanket is usually done on a small roller press or creeping mill that is made of two 15cm-diameter by 45cm-long cylindrical metals. One roller operates faster than the other to create pressing and stretching of materials as it passes the creeping mill. The main roller runs at a speed of around 5 to 10 rpm and the other runs two times slower than the main roller. Air drying the rubber blanket takes around 15 days before it is sold to the market. If a farmer does all the activities from tapping the latex, mixing chemical to coagulate, pressing the coagulated latex in the creeping mill, and air drying the rubber blankets, he can earn P75.00 per kg.

Of the different activities in the production of air-dried rubber latex blanket, the most tedious activity is the pressing of rubber latex which is done by pedaling the creeping machine or by using a petrol-fueled engine. In order to relieve farmers from the tedious manual labor, from high cost of petrol, and from high cost of electricity associated with the production of rubber blanket, the recently developed microgasifier that uses rice husk as fuel was installed at a rubber processing plant in Zamboanga del Sur and was used to run the roller press for rubber.

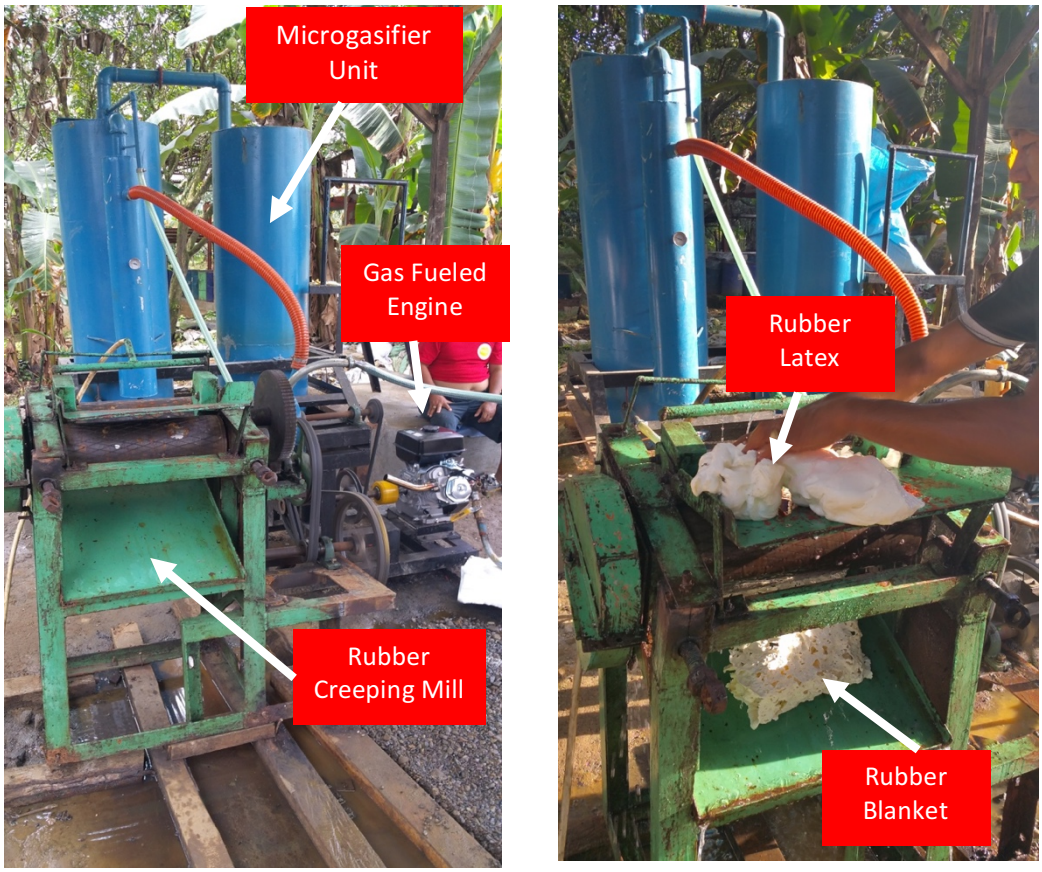

Figure 3. The Microgasifier Coupled to Rubber Creeping Mill.

As shown in Figure 3 above, the microgasifier consists of a fuel reactor where gas is generated through gasification of rice husks, a gas conditioning unit to remove particulates and to cool the gas before it is fed into the intake manifold of the engine, a power generating unit that converts the gas into mechanical power which is subsequently used to drive the creeping mill. Figure 4 show the schematic of the operation of the microgasifier as used to drive rubber creeping mill. As shown in Table 1, the fuel reactor has an inner cylinder diameter of 30 cm and a height of 120 cm and is made of 3mm-thick mild steel plate. It is shielded with an outer cylinder having a diameter of 50 cm and a height of 180 cm. Beneath the inner cylinder is a pocket-type grate that gradually discharges the char during operation. The gas conditioning unit, on the other hand, is made of the same size of steel plate with the outer cylinder of the fuel reactor. Inside it is a pipe with holes drilled along its length with 10-cm spacing to spray water to the stream of gas as the latter enters the gas conditioning cylinder.

Table 1. Design Specification of the Microgasifier.

Reactor	Downdraft 0.30m D x 1.20m H
Char Grate	8 semi-circular pockets type
Conditioning Unit	Scrubber and Filter
Engine	16hp four stroke spark ignition
Operator Required	1 person

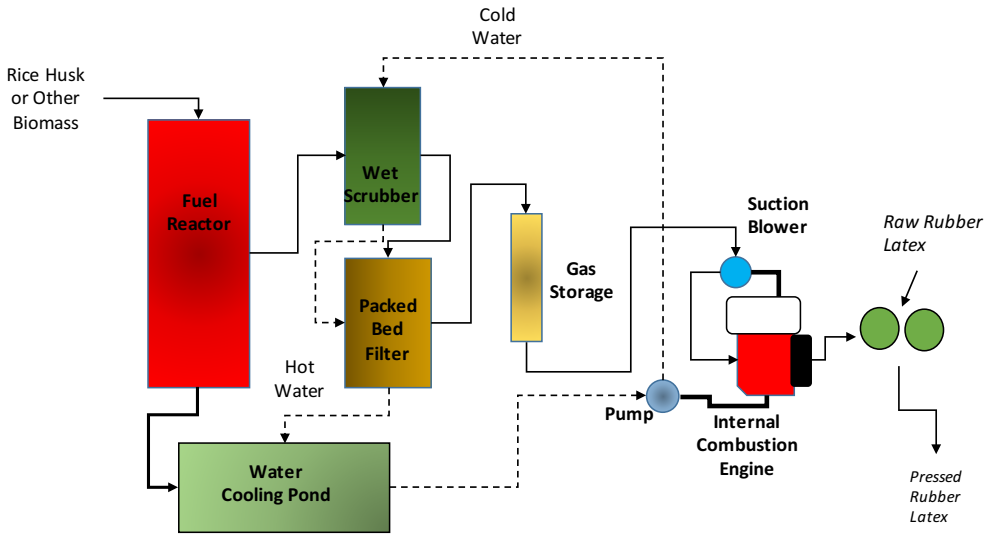

Figure 4. Schematic of the Principle of Operation of the Microgasifier.

At the upper portion of the cylinder is a perforated sheet that holds 40-cm thick layer of pebbles (with 3- to 10-mm diameter), which serve as filter for the gas. Water is sprayed into the gas with the use of a gear pump driven by the main shaft of the the power unit. Both the fuel reactor and the gas conditioning unit are seated in a rectangular concrete tank filled with water to prevent the gas from escaping during operation. The water in the tank is used to quench burning rice husks from turning into ash and, at the same time, to circulate the water for cleaning and cooling the gas. The power generating unit consists of a 16-Hp spark-ignition engine retrofitted to use either gasoline or gas as fuel. Its main shaft is directly coupled into the engine drive to transmit power to a suction blower that sucks the gas from the fuel reactor and from the gas conditioning unit. The power generating unit also consists of a pump that circulates water from the concrete reservoir to the scrubber and vice versa. The steel roller mill used to press the rubber latex is coupled to the end of the shaft with a 3in.- diameter V-pulley and belt drive.

Table 2. Performance Testing of the Microgasifier Unit.

Feedstock	Rice Husk
Moisture Content	9 - 12%
Start-Up Time	4 - 7 min
Fuel Consumption Rate	9.3 - 10.5 kg/hr
Specific Gasification Rate	132.85 - 150.00 kg/hr-m^2
Air Flow Rate	4.3 - 5.1 m^3/hr
Superficial Velocity	1.71 - 2.02 cm/sec
Air-Fuel Ratio	0.58 - 0.61 kg air/kg fuel
Engine Speed	2437 - 2531 rpm
Blower Speed	5147 - 5356 rpm
Pump Speed	1043 - 1218 rpm
Temperature	
Reactor	353 - 698°C
Gas Leaving the Reactor	51 - 165°C
Gas Entering the Engine	36 - 41°C
Water Bin	
Noise Level	92.4 - 94.7 Db

Results of performance tests for 2 hours operations shown in Table 2, reveal that the unit requires a start-up time of 4 to 7 min in order to produce the gas from rice husk (@ 9 – 12% MC). It consumes rice husk fuel at a rate of 9.3 to 10.5 kg per hour with a computed specific gasification rate of 132.85 - 150.00 kg/hr-m^2. The reactor consumes 4.3 - 5.1 m^3 of air/hr in order to gasify the fuel. The computed superficial gas velocity at the fuel bed of rice husk ranges from 1.71 - 2.02 cm/sec. The air-fuel ratio at the gasifier reactor ranges from 0.58 - 0.61 kg air per kg of fuel. The engine speed was measured using Extech Laser/Contact Tachometer Model RPM33 at the range of 2437 - 2531 rpm. The speed of the suction blower and of the gear pump used was measured using the same instrument at 5147 - 5356 rpm and 1043 - 1218 rpm, respectively.

The temperature, which was measured using Type K thermocouple-wire and Extech Multi-Channel Datalogger Model TM500 thermometer, at the gasifier reactor fuel bed was recorded at the range of 353° to 698°C from the time combustible gas is generated. The temperature of the gas leaving the reactor was measured ranging from 51° to 165°C while that of the gas

entering the engine was measured at the range of 36° to 41°C. This is because the gas was cooled before it enters the engine. The temperature of water entering and leaving the scrubber ranges 30° to 39°C and 34° to 39°C, respectively. The temperature of water in the bin was measured at the range of 27° to 30°C. The noise level of the engine was recorded ranging from 92.4 to 94.7 dB at 1.5 meter distance from the engine.

Table 3. Design Specification and Performance of the Creeping Mill.

Creeping Mill Dimension	15-cm diameter by 45-cm long solid metal
Grit Shape	Diagonal
Roller Mill Speed	
Roller 1	7 rpm
Roller 2	4 rpm
Transmission Drive	Gear, Chain & Sprocket, and Belt & pulley
Throughput Capacity	86 to 92 kg/hr
Water Dripping Rate	5 liters per hour
Manpower Requirement	1 person to feed fresh latex

Table 3 shows the design specifications of the rubber creeping mill and its performance during operation. Both rollers have 15cm-diameter and 45cm-length, however, they have differing speed in order to cause pressing and stretching of the rubber latex subsequently producing rubber blankets. The transmission drive of the machine is a combination of gears and belt & pulley. During pressing, water is allowed to drip on top of the rollers to prevent the latex from sticking into the roller surfaces. Results of the tests show that the creeping machine can produce rubber blanket at a rate of 86 to 92 kg per hour. One person is needed to operate the machine by feeding it with rubber latex.

The gasifier unit performs satisfactorily when used as drive or power source for the creeping mill. Operation of the machine can be done by one person from starting-up of the unit to loading rice husks and discharging char. Starting the operation until the gas is generated is much simpler in this model. The char disposal mechanism is not tedious to the operator because it only needs swinging the lever up to 45 degrees forward and backward to discharge the char directly into the water in order to quench burning char and prevent it from turning into ash. During operation, the bed of rice husk was observed to have an even downward movement inside the reactor every time char is discharged. However, further refinement in the design of the gasifier unit needs to be done to improve its operation and performance. Testing of the gasifier unit for other farm operations like burr milling, fluted rice milling are further recommended for future applications of the technology.

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