

Original Research Article

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Development and Performance of Dual Purpose Cook Stove

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ABSTRACT

Biomass combustion provides basic energy requirements for cooking and water heating in the developing countries. Biomass is considered as the renewable energy source with the highest potential to contribute in the energy needs for both the developed and developing economics worldwide. The research work was undertaken to develop the dual purpose cook stove suitable for family size. The study revealed that the average thermal efficiency for dual purpose cook stove was found as 14.81 percent and 18.28 perusing babul sticks and neem sticks respectively and the power output ratings for dual purpose cook stove were found 1.56 kW and 1.69kW respectively with babul sticks and neem sticks. Specific fuel consumption (SFC) was found as 0.326 and 0.297 for babul sticks and neem sticks respectively because of higher calorific value of babul sticks and neem sticks respectively i.e. 3796.8 kcal/kg and 3435.2 kcal/kg. Mixture of fine and courses and was used as insulation for cook stove. In water heating, the temperature rise per unit length was 120C/m and temperature rise per unit time was 12⁰ C/min.

Keywords

Dual purpose cook stove, Biomass combustion, Babul and neem sticks

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Introduction

Energy plays a vital role in daily life. In India, most of the energy among total energy demand is used for cooking in domestic sector and it is fulfilled by using abundantly available biomass. Biomass is considered as the renewable energy source with the highest potential to contribute in the energy needs for both the developed and developing economics worldwide.

The estimates of MNRE indicate that 32 percent of the total primary energy issue in the country is derived from biomass and more than 70 percent of population is dependent on biomass for the energy needs. Traditional cook stoves or chulhas, which have efficiencies less than 10 percent and are known tube sources of large quantities of pollutants are used by most rural households in India for cooking. In such households, women and children are often exposed to high

levels of pollutants, for 3 to 7 hours daily over many years. The smoke less and energy efficient cooking stoves still remains distant dream. The improved cook stove is a combustion device through which cooking activity can be performed at country side. It has great potential to minimize emission and yield better fuel efficiency. This improved Cook stove is a dual purpose instrument i.e. It can be used for cooking as well as water heating. For being Energy efficient, the cook stove is provided with insulation of sand and small stones. For water heating purpose, a copper coil is provided in inner side of burning zone of cook stove. This water heater can be used for domestic purpose the cook stove has very less smoke formation and have high efficiency.

Materials and Methods

This cook stove is made with metal. This is developed at workshop and can be made very cheaply using local materials. This work was done by directing hot Gases from fuel wood fire up to cooking pot. A copper coil was provided inside the heating tunnel for simultaneous heating of water along with cooking.

Methodology

Design and fabrication of dual purpose cook stove

A dual purpose cook stove was developed for cooking as well as water heating with less smoke. The design specification of the dual purpose cook stove are given in Table 3.1 and Fig 3.1.

Instrument action involved for performance evaluation of dual purpose cook stove

An instrument involved for performance evaluation of dual purpose cook stove is

discussed in the following section.

Performance Evaluation of Dual Purpose Cookstove

Flame temperature

It was observed that during Water Boiling Test, the maximum flame temperature using babul sticks and neem sticks as a fuel were 680°C and 877.2°C respectively. The volatile mater is inversely proportional to the flame temperature and the flame temperature depends upon the calorific value of the fuel.

Water temperature

It was observed that time required for water boiling temperature by using Babul sticks and neem sticks in natural convection was 22-25 minutes and 20-25 Minutes respectively.

Stove Surface Temperature

The average wall surface temperature of the dual purpose cook stove was increased as duration of burning was longer in natural convection. The maximum stove surface wall temperature obtained with the babul sticks and neem sticks during Water Boiling Test in natural convection were 68.6°C and 65.3°C respectively.

Residues (Ash+Residues)

After the burning of total feed stock in a cook stove, the ash produced by different feed stocks was weighed. For babul sticks and neem sticks, the average ash produced after WBT were found as 41g and 39.66g respectively. The total ash produced from the solid biomass depended on the type of biomass used.

Unburned fuel weight

After the burning offered stocks, the unburned

fuel remained in feed stocks during the time of Water Boiling Test and Cooking Test was weighed. In Water Boiling Test for babul sticks and neem sticks, the total quantity of unburned fuel was found as 940g and 500g respectively. In Cooking Test, for babul stick and neem sticks the total quantity of unburned fuel was found as 750g and 800g, respectively.

Efficiency test

Efficiency was determined by carrying out the Standard Water Boiling Test (WBT). Thermal efficiencies obtained for babul and neem sticks were 14.81 percent and 18.28 percent respectively.

Power output rating

The power output ratings found after Water Boiling Test for babul sticks and neem sticks were 1.56 kW and 1.69 kW, resp. Typically, the minimum power requirement to cook meal for a family of 4-5 persons is about 1.5 to 2 kW with burning time about 1.0 to 1.5 hr.

Cooking Test

The actual cooking test was carried out to

analyses the performance of developed dual purpose cook stove with traditional cooking methods using selected biomass i.e. babul stick and neem sticks. The initial mass of 1kg rice was taken and babul sticks and neem sticks was used as a fuel. The amount of fuels required to cook the rice was 0.750 kg and 0.700kg for babul sticks and neem sticks. From Fig. the times pentin cooking of rice per kg of cooked food was 0.181 hr/kg and 0.163 hr/kg for babul stick and neem sticks, respectively and the specific fuel consumption (SFC) was calculated 0.326 and 0.297 for babul sticks and neem sticks, respectively. The developed cooking stove was found safe during operation and no difficulties were found at the time of cooking.

Water heating test

In water heating test, water in the tank with temperature 300C was carried In to the copper tube of length 1m. The water left the tube with temperature of 420 C i.e temperature rise is 120 C. Time taken to heat 1litre water was found to be 1 min. There fore ,the temperature rise per unit length was 120 C/min temperature rise per Unit time was 120C/min.

Results

Table.1 Technical specifications of dual purpose cook stove

S. N.	Parameter	Dimensions
1.	Height of combustion chamber, m	0.18
2.	Length of combustion chamber, m	0.18
3.	Cross-sectional area of combustion chamber, m ²	0.025
4.	Volume of combustion chamber, m ³	0.0046
5.	Height of stove walls, m	0.25
6.	Height of legs, m	0.18
7.	Outer diameter of stove	0.2
8.	Thickness of insulation, m	0.05
9.	Diameter of copper tube	0.005
10.	Length of copper tube	1

Table.1 A.Proximate composition of feedstock

S.No		content,% (w.b.) (Average)	mater,% (Average)	content,% (Average)	carbon,% (Average)
1.	Babul sticks	5.60	73.06	4.08	17.28
2.	Neem sticks	5.18	75.26	4.75	14.80

Table.2 Ultimate composition of feedstock

Sr. No	Biomass	Ultimate composition,%			
		Carbon content,% (Average)	Hydrogen content,% (Average)	Nitrogen content,% (Average)	Oxygen content,% (Average)
1.	Babul sticks	63.56	6.77	0.6388	23.95
2.	Neem sticks	64.57	6.88	0.5948	24.22

i) Performance Evaluation of Dual Purpose Cookstove

Sr. No	Particular	Formula
A 1	Proximate Analysis Moisture Content	Moisture content (%wb) = $\frac{W_2-W_3}{W_2-W_1} \times 100$
2	Volatile Mater	Volatile Mater(%)= $\frac{W_3-W_4}{W_2-W_1} \times 100$
3	Ash Content	Ash Content% = $\frac{W_5-W_1}{W_2-W_1} \times 100$
4	FixedCarbon	Fixedcarbon(%)=100-%of(M.C.+V.M.+ash)
B	UltimateAnalysis	

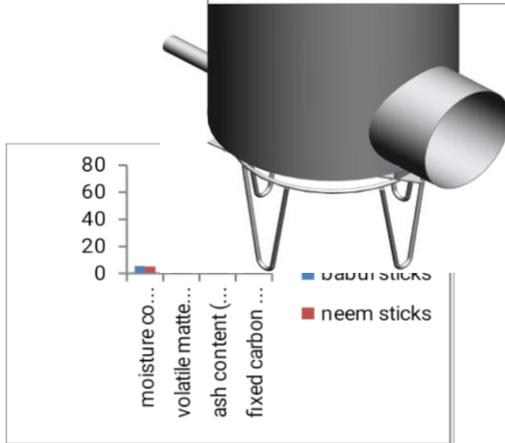
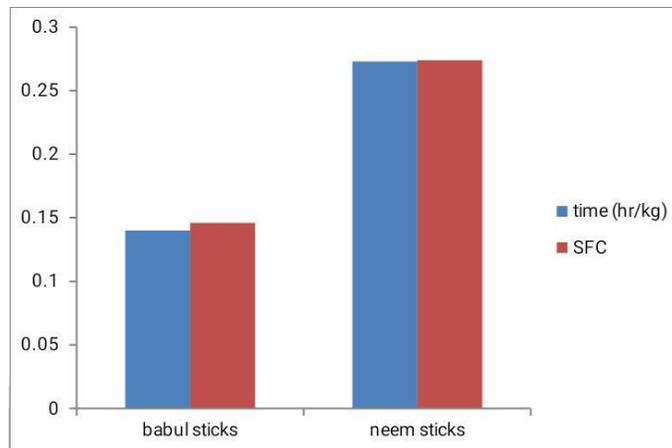
1	CarbonContent	$C=0.97FC+0.7(VM-0.1A)-M(0.6-0.01M),\%$
2	HydrogenContent	$H=0.036FC+0.086(VM-0.1A)-0.0035M^2(1-0.02M)$
3	NitrogenContent	$N_2=2.10-0.020VM,\%$
4	OxygenContent	$O_2=100-\%of(C+H+N+Ash),\%$

C	Testingof dualpurposecookstove	
1	Flametemperature	Usingthermometer
2	Watertemperature	
3	Stovesurface temp.	
4	Residues(Ash+ Residues)	Usingweighingbalance
5	Unburnedfuel weight	
6	Efficiencytest	Efficiency= $\frac{(M_w \times C_{pw} T - T) + m_{eva} \times H_1}{(F \times CV)} \times 100$
7	Poweroutput Rating	
8	Cookingtests	
9	WaterHeatingTest	

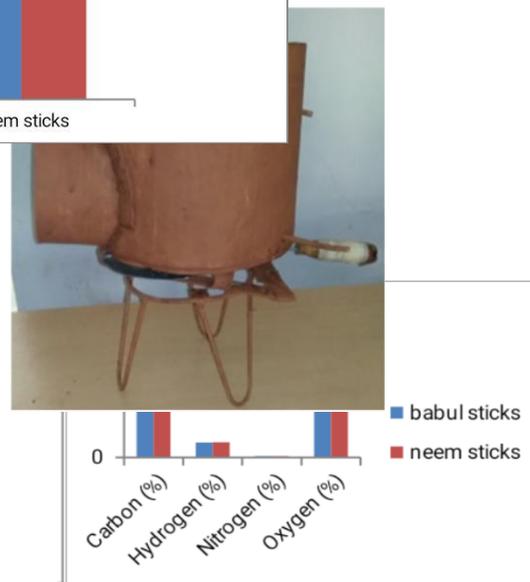
Fig.1 Dual purpose cook stove



Fig. Timespentincookingtest(hr/kg)andspecificfuelconsumptionduringCCTof developeddualpurposecookstove



Ultimate analysis of babul sticks and neem sticks



Proximate analysis of babul Sticks and neem sticks

The conclusions were drawn from the study of developed dual purpose cooks

The average thermal efficiency for developed dual purpose cook stove was found as 14.81 percent and 18.28 percent for babul and neem sticks, respectively.

The power output ratings for developed dual purpose cook stove were found 1.56 kW and 1.69 kW for babul and neem sticks.

Specific fuel consumption for developed dual purpose cook stove was found 0.326 and 0.297 for babul and neem sticks, respectively.

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