DESIGNING AND FABRICATION OF MULTIFUEL COOKING STOVE

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*Abstract :*In this experimental study, three different design stoves , Priyagni, Harsha and the proposed Modified multi-fuel stove , have been developed based on the criteria of heat transfer improvement, heat loss reduction, burning fuel measurement, testing of output results in fuel laboratory , efficiency and emissions. The main focus is the modified stove design, which is by far a prototype. This locally produced stove consists of a combustion chamber isolated by comparative energy analysis based on experimental observations using different biomass (cow dung, babul tree and mango tree) available during the experiment.

***IndexTerms* - Thermal efficiency,combustion efficiency,safety of fuel burning,WBT.**

I. INTRODUCTION

Those who spend several hours a day on an indoor stove are a normal exercise. What these women fail to realize is that there is an invisible killer in the kitchen burning biomass fuel. 6.5 million Deaths due to air pollution annually. Of these deaths, 3.5 million are linked to energy poverty, biomass and kerosene for cooking and lighting, which affects 2.7 billion people worldwide, currently only 8% of global energy production, is free of combustion, and more than half of the rest are ineffective in technology. Place to control emissions.

The design initiative can use its design expertise to help these women continue their traditional culture and enable them to choose a cooking method that does not endanger their lives. The report describes the short process and open innovation used to create a "stove" - a low-smoke stove that prevents disease and death from indoor air pollution due to cooking activities with biomass fuels in low-income rural communities. The development included a certificate of thermal performance of the stove, fuel consumption and mono-carbon emissions. The test stove uses bio organic waste

II. LITERATURE REVIEW

Solid fuel utilization has been found to be a big source of energy for cooking and industrial heating purpose globally. Approx half of the world’s households still are using solid fuels for cooking on a daily basis (Smith et al., 2004) with a big majority of them from rural areas of developing countries. Household combustion of solid fuels vs. incomplete combustion . In 2013 ARC (Administrative Reforms Commission) has developed a system that can be constructed in country to use the IAP (Indoor air pollution) meter to capture and measure total stove emissions. The system has proved to be highly accurate for measuring relative changes needed for iterative development of stoves. The portable meter can be worn in a backpack with a sampling point near the nose and mouth of the user. The resulting carbon monoxide and particulate matter measures (with a site specific gravimetric calibration) provide an accurate assessment of personal exposure. ARC specializes in testing biomass cooking stoves. Stoves are tested to understand how they function, to compare stoves, and to improve performance. a comparative analysis of four selected wood cookers was performed using the Water in Waters Test. Selected wood stoves were Save 80, reinforced single-hole stove (S.H.I.), localized stove (L.F.M.) and traditional open fire stove .The Water Waters Test approved in this research is that of vital 1985, which is currently recognized as a standard for the performance evaluation of stoves (Ballard et al., 1996).The Water Boiling Test (WBT). The stove will be successful in your region of the world. Families will be happy cooking with the stove. The Controlled Cooking Test (CCT) is designed to answer these important questions. The test has local cooks preparing the regional foods using their fuel, their pots, and their methods of fire tending, etc. The CCT is performed with the same emissions hood used for the WBT. In this way, very accurate data on fuel use and emissions is obtained (including black carbon). ARC specializes used both tests to evolve market viable, locally appropriate stoves that meet the ISO emissions standards protecting health.

III. PARAMETERS FOR PROPOSED MODEL OF STOVE:

The following parameters, given in Table;2.1 , are selected for design and fabrication of prototype proposed model of multi-fuel stove. The stove is fabricated in workshop. Further for performance Evaluation data are generated with it.

Table 2.1: Design Criteria

Parameters	Dimensions
Height of body	**2'5"**
covered opening in the front	**4.5"**
top of the opening	**3"**
Diameter of pipe the smoke exits	**4.5"**
Height of stove	**3'**
Diameter of fire box	**4.5"**
Length of base	**1'**
Length of fuel pipe	**1'**

IV. THE PHYSICAL PARAMETERS FOR DESIGN CRITERIA:

- Combustion chamber Height is equal to internal radius of combustion chamber r_1= internal radius of insulation,
- External steel casing height of pot seat chamber, and external temperature of combustion chamber to measured internal temperature of the combustion chamber , the thermal conductivity of fibre glass k_1 =**0.037w/mk**:
- Thermal conductivity of M S= 39m/mk.

The analysis of combustion based on the ultimate analysis by mass gives, A/F=4.6107 kg air/kg fuel, for an actual air supply which is 20% in excess of Stoichiometry actual air/fuel ratio A/Factual=5.5328 kg air/kg fuel.

V. CALCULATION FOR SQUARE COMBUSTION CHAMBER THE AREA IS CALCULATED AS

A_c = L.W, (L is the length in inch and w is the width/breath in inch.)

(1) $A_c = 2'5'' \times 1'' = 29 \text{ inch}^2$

(ii) Determine the circumference of combustion chamber associated with the distance. (2)

$C_c = 2\,\pi.\, r_c$, where, r_c is combustion chamber outlet to the edge = **4.5"**

$C_c = 2\,\pi \text{ X } 2.25 = 14.13$

(iii) Determine the required gap between bottom and the edge of pot of the combustion.

Gc =A/Cc Where, Gc is the required gap

Gc=29/(14.13) =2" (approx)

(iv) Determine the optimal gap at the edge of the pot. Diameter of pot is 3",

$Cp = 2.\pi.rp$, $Cp = 2.\pi \times 3'' = 18.84$ inch .

(v) Determine needed gap at the edge of the pot.

$$Gp = \frac{A}{Cp}\ Gc = \frac{29}{18.84} = 1.5\ approx\ 2\ inch$$

VI. WATER BOILING TEST (WBT)

The usual cooking methods. These measures the fuel used for a particular class of tasks. This is used to quickly compare the performance of different ovens. Simulation involves heating the boiling water at a constant temperature of about thirty minutes

Determination of Burning Capacity Rate of Cook Stove

- The fuel quantity of 0.25 kg wood is used.
    - Fuel Consumption rate (FC) = $(M1 - M2)$ = **0.25 – 0.02 = 0.23kg**
    - Burning capacity rating (F) = $[M1 - M2] \times \frac{60}{T}$ kg/hr.
    - Heat input per hour = Burning capacity x CV kJ/hr. Where,
- M_1= initial mass of fuel taken
- M_2 = final mass of remaining fuel after burning and
- CV = calorific value of the fuel in kJ/kg

VII. DETERMINATION OF THERMAL EFFICIENCY OF COOK STOVE:

In this section the data generated by experiment has been used for calculating the thermal efficiency of proposed model of multi fuel stoves as follows

w = in kg, Mass of water in vessel,
W = in kg, Mass of vessel with lid,
$\mathbf{M_3}$ = Mass quantity of diesel used for ignition,
$\mathbf{CV_k}$ = Calorific value of diesel, in kJ/kg
$\mathbf{T_1}$ = in degree C, (initial temperature)
$\mathbf{T_2}$= in degree C (final temperature,)
$\mathbf{C_w}$ = specific heat of water (4.186 kJ/kg).
$\mathbf{C_v}$ = 90.025 kJ/KgK (specific heat of vessel material Aluminum).
$\mathbf{H_{in}}$= Heat input into the stove, in kJ,
$\mathbf{H_{out}}$= Heat output of the stove.
n = Efficiency in %.

$$H_{out} = (W \times C_V + w \times C_w) \times (T_2 - T_1)$$

$$(0.80 \times 90.025 + 0.75 \times 4.186) \times (100 - 28) = 5412 \text{ kJ/kg}$$

$$H_{in} = (FC \times C_V) + (M_3 \times CV_k) = (0.23 \times 20\text{x}10^3) + (0.3448\text{x}10^3)$$

$$= 18040 \text{ kJ/Kg}$$

$$n = 100 \times (Hout/Hin) = 100 \times (5412/18040) = 30\%$$

Power Output Rating:

$\mathbf{P_o}$= Output Power, in kW,
F = fuel consumption rate, in kg/hr
$\mathbf{C_V}$ = Calorific quantity of fuel, in kJ/kg
n = Thermal efficiency

$$Po = (F \times CV \times n)/360000 \quad KW$$

VIII. FABRICATION OF PROPOSED MODEL STOVE:

A real prototype model of proposed multi fuel stove has been fabricated in workshop laboratory .It has been used to generate the data for analysis. It is shown as Fig;8.1

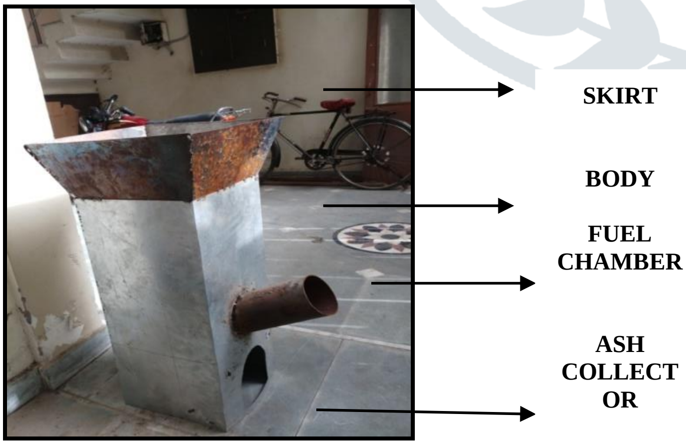

Fig. 8.1 Figure of proposed model.

IX. RESULT ANALYSIS:

In this section the performance of proposed model of muti fuel stove and two existing model of stoves are analysied and the observation of their performance is summarized into tabulating form as following.

Table 8.1: Result comparing table

S No.	Stove Parameters	Priyagni Stove	Harsha Stove	Multifuel Stove
1	**Construction material**	Metal	Metal	Metal & non metal
2	**Type of fuel**	Wood , cow dung	Wood , cow dung	Wood , cow dung , agri-residue
3	**Combustion efficiency**	Incomplete	Incomplete	complete
4	**Application of Design principles**	No	No	Yes
5	**Thermal Efficiency**	22-24%	24-26%	30-35%
6	**Cost of cooking &cook time**	More fuel& time consumed	More fuel& time consumed	Less fuel& less time consumed
7	**Safety at work**	Outer body temperature 300-350^{0}C	Outer body temperature 350-400^{0}C	Safe outer body temperature 10-20^{0}C
8	**Expected service life**	4-5 years	4-5 years	7-8 years
9	**Cleanliness of kitchen place**	Smoke & soot generation	Smoke & soot generation	Less Smoke & soot generation
10	**Heat loss to the environment**	Heat loss to the environment	Heat loss to the environment	No heat loss to the environment
11	**Portable**	Portable	Portable	Non portable

X. RESULT DISCUSSION

In this experiments work, the study has been focused on three different improved design cooking stoves, multi fuel proposed model, Harsha and Priyagni cooking stove has been tested and compared in terms of efficiency and gas emission. The main focus is on the proposed modified multi fuel this stove, which can be locally produced with local materials, It is consists of an insulated combustion chamber. As essential parameters for the stove test is the ambient temperature and quantity of water in the pot has been detected. The efficiency and other parameters of the multi fuel proposed cook stove is in the range of 30-35 % better than from the Priyagni and Harsha cook stove.

XII. CONCLUSIONS

1. The thermal efficiencies and gas emission rate of proposed multi fuel is found to be the higher than that of rest of the two models,

(2) Propsed models of multi-fuel stove, has been found much better in energetic performance than other stoves (Priyagni model and Harsha model).

(3) Modified proposed modal cooking stove was quite significant in comparison with the Priyagni and Harsha Stove of NPIC on average saved 30% of fuel wood per day. It is improvement in the combustion efficiency and expansion can be reduced by about 34 %.

XIII. FUTURE SCOPE OF OUR MODEL

This research paper is mainly based on laboratory experimental data. the important parameters are the analysis of the observed data, the heat input per hour and the heat output per hour of the stove. The analysis is part of the effect of the fuel output, the heat output of the stove, the thermal efficiency and the output of the power, that there is no specific effect on these variables.

The design principles of Dr. L. Winiarski may also apply to increasing the efficiency of the stove. At present, only 6 principles out of 10 were used to achieve better results; so, increase the efficiency of the stove, save fuel and reduce the emission level and save time.

It requires more work in the following areas; Portable cook stove design, 35-45% to increase fstove efficiency, and other types of wood to determine whether there is an emission of fuel wood independently of wood type.

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