International Journal of Research in Advanced Engineering and Technology
ISSN: 2455-0876; Impact Factor: RJIF 5.44
www.engineeringresearchjournal.com
Volume 3; Issue 1; January 2017; Page No. 92-95

Design and fabrication of low smoke multipurpose chulha

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Abstract
We know that, in the remote areas traditional chulhas are used for cooking purpose which uses wood as a fuel. Use of this kind traditional Chulhas causes indoor pollution, ineffective utilization of fuel also takes more time for cooking. But our LOW SMOKE Multipurpose Chulha overcome all these problems also increase heat utilization for the same mass of the fuel as compare to traditional chulha. In short we are trying to accelerate, Eco friendly cooking, Healthy cooking. Rural entrepreneurship, Multipurpose, fuel effective and efficient cooking

Keywords: Chulha, Lowsmoke, Rural Entrepreneur, Eco frindly

1. Introduction
India is a developing country and it needs more energy to accelerate the rate of development. India has sixth position in the total energy consumption in the world. But the energy resources are constant and energy consumption increases day by day. For the development of India requires energy efficient equipment and to save the energy consumption. There are three ways for efficient energy consumption, they are:

1. Discover new energy resources.
2. To minimize the energy losses.
3. Waste heat recovery.

Indian census of 2001, there are 638365 villages in India and about 74% population lives in villages. In villages for cooking the food they mostly used Chulha as a cooking furnace because they mostly used biomass fuel like wood, agricultural waste, etc. Which is easily available to them. They consume 10 to15% of their time of one day to cook food at Chulha. Thus they consume more time as well as more fuel as well as traditional Chulha is less Thermal Efficient. Main hazard from chulha is pollution created by smoke. This smoke also affects the health of women and children.
To make a Low Smoke Multipurpose Chulha is to increase efficiency of chulha thus to save time of people, reduce the health hazard due to traditional Chulha and to support our country in developing.

2. Literature Survey
In September 2005, Philips design global community came together in Eindhoven for a workshop entitled 'A Sustainable Design Vision" The event was all about envisioning products and services for the greater part of humanity living in developing nations under challenging living conditions. The main focus was on developing a co –creation processes to facilitate cooperation between diverse stakeholders such as end users, NGOs, local entrepreneurs and self-help groups for women.
Pune-based NGO Appropriate Rural Technology Institute (ARTI) has been a pioneer in designing low cost chulhas for rural poor. Since the early 1990s, ARTI has been working on various stove technologies such as Samuchit Sarai System, Sampada Gasifier Stove and ELFD Smokeless Stove. Among them, Bharatlaxmi Stove is the low-cost stove that has become quite popular in Maharashtra state due to its simple design and affordable price. Bharatlaxmi Stove is basically a single pot hole stove that consists of cement bricks and a cast iron fire grate and a pot holder, which are held together with a wire mesh. The setup is then fixed to the ground with a mud covering. This smokeless chulha uses firewood and has been tested for its efficiency, durability and smoke emissions. The stove can reduce fuel consumption by 50%, bringing down the cooking time by 30%. Bharatlaxmi Stove costs around INR700.The Philips Low Smoke Chulha is the result of collaboration between a multinational philanthropy initiative and a grassroots NGO. This eco-friendly stove has been enabled by Philips along with support from NGOs such as ARTI and other grassroots bodies. This low smoke stove aims to be a modular cooking device that is easy to access, reduces indoor air pollution and is available at low cost. There are two variants of this stove available: Sampoorna a complete stove with a steam cooker; and Saral, an easy-to-use stove with two cooking hotpots. The unique feature of both the stoves is that they are modular in construction, which ensures easy portability and installation.

3. Need of Low Smoke Multipurpose Chulha
1. Our main aim is to Increase the fuel efficiency.
2. To reduce the waste of heat which is wasted in traditional Chulha.
3. To reduce the pollution and increase the healthy environment in Villages.
4. To reduce the smoke which is developed in indoor of home due to traditional chulha.
5. To reduce the time required for making the food.

4. Component of LSMC
1. Water Tank
L shaped Water tank of volume 31 lit. Placed around the burning spot. It have surface area of 0.174 m^2 facing directly to burning fuel.

2. Boiling Pot

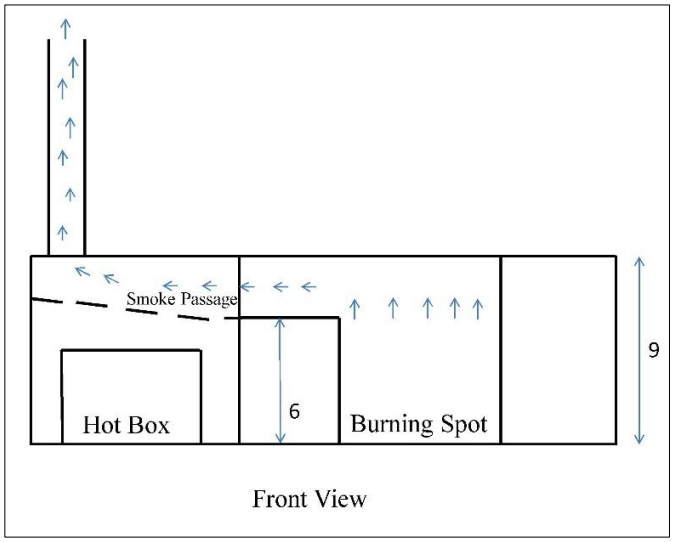

Fig 1

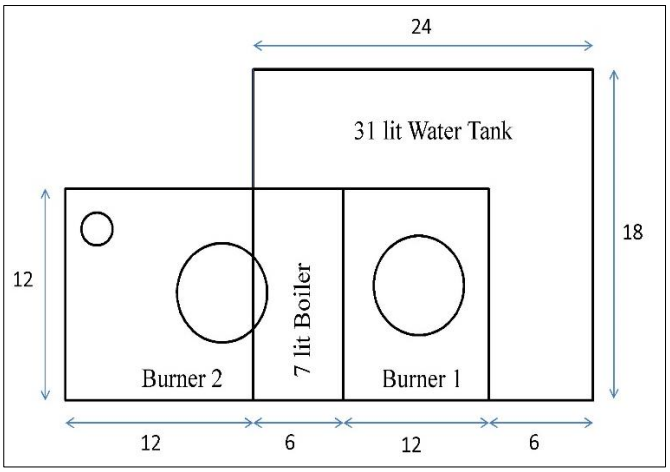

Fig 2

It is box having volume of 7 lit placed perpendiculars to largest limb of L shaped tank as shown in figure. It have surface area of 0.046 m^2 facing directly to burning fuel.

3. Cooking Spot 1 &2

Cooking Spot 1 is directly in contact with the fuel flame it can be used for cooking which require higher amount of heat while Cooking Spot 2 can be used for cooking which require less amount of heat. In cooking spot 2 the heat carried out by flue gas is used as a heating medium.

4. Hot box

It is made on the bottom side of flue gas passage. Its upper side having surface area 0.09 m^2 which transfers heat from flue gas to the box which used for keeping food hot for required time.

5. Working Process

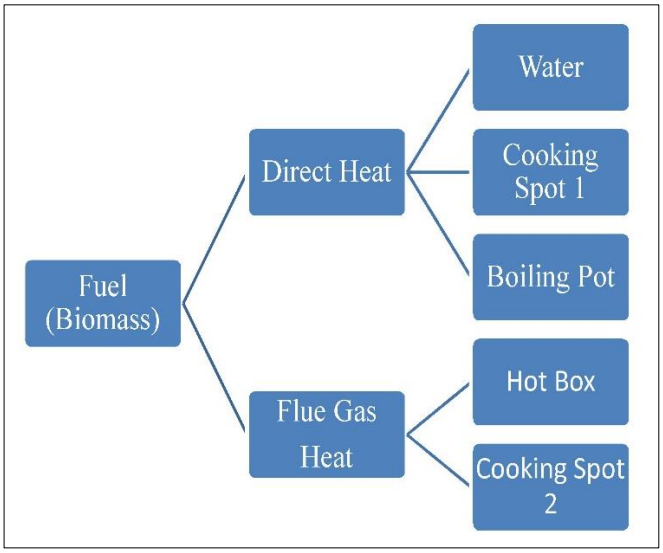

Fig 3

Biomass is used as fuel in LSMC. Fuel exerts two types of heat while burning

1. Direct heat due to burning
2. Heat carried by flue gases

1. Use of Direct heat due to burning of fuel

Fuel is burn at the burning spot. There is cooking spot 1 exactly above the burning spot which can get higher amount of heat while burning of fuel.

The inner facing surface of the water tank as well as the inner facing surface of boiling pot transfers heat from flame to the water contained in them

2. Use of Heat carried by flue gases

As shown in diagram A during passage of flue gas first it passes from passage section where it came first in contact with utensil placed at cooking spot 2 where heat is transferred between utensil and flue gas. Also there is upper facing surface of hotbox hence here again heat is transferred between air present in hot box and flue gas.

6. Observations

For checking efficiency and effective heat utilization of LSMC test was conducted as follows:

Aim: To determine percentage increase in efficiency of LSMC in comparison to traditional chulha.

Apparatus: LSMC, Traditional chulha, biomass (wood), utensils, etc.

Procedure

a. Process of heating water, cooking of rice and boiling of potato/eggs are carried out on both traditional chulha and LSMC.
b. Various observations are taken as follows.
c. Conclusion is made after calculations.

Observation

a. For traditional chulha

Table 1

Sr no.	Process	Content	Mass (m)	Initial Temp (T_1)	Final Temp (T_2)	Time Req.
1	Heating of water	Water	3 Kg	30°C	100°C	539 sec
2	Boiling of potato/egg	Potato/egg + Water	2 Kg	30°C	100°C	493 sec
3	Cooking Rice	Rice + Water	0.125 Kg + 0.5Kg	30°C	100°C	680 sec
Total time required						1712 sec

Mass of Fuel required : 0.56 Kg (1)
Total time required : 1712 sec (2)

b. For LSMC

Table 2

Sr no.	Process	Content	Mass (m)	Initial Temp (T_1)	Final Temp (T_2)	Time Req.
1	Heating of water (In tank)	Water	3 Kg	30°C	93°C	879 sec
2	Boiling of potato/egg (in boiling pot)	Potato/egg + Water	2 Kg	30°C	84°C	
3	Cooking Rice (cooking spot 1)	Rice + Water	0.125 Kg + 0.5Kg	30°C	100°C	
4	Heating water (cooking spot 2)	Water	2 Kg	30°C	39°C	
5	Hot box	-	-	37°C	39°C	

Mass of Fuel required : 0.35 Kg (3)
Total time required : 879 sec (4)

Heat Balance Sheet

a. For traditional chulha:

Table 3

No	Heat input	Calculation	Amount of Heat (KJ/Kg)	%	No.	Heat utilized	Calculations	Amount of Heat	%
1.	Biomass as fuel	$M_f \times Cv$ (0.56×17000)	9520	100	1.	Water tank (H_1)	m× Cp× (T_2-T_1) 3×4.187×(100-30)	879.27 KJ	9.24
					2.	Cooking spot (H_2)	m× Cp× (T_2-T_1) 0.5×4.187×(100-30)	146.545 KJ	1.54
					3.	Boiler pot (H_3)	m× Cp× (T_2-T_1) 2×4.187×(100-30)	586.18 KJ	6.16
					4.	Unaccounted heat	Heat exert by fuel – (H_1 + H_2 + H_3)	7908.005	83.06

Hence, efficiency of traditional chulha
$\eta_{trad.\ chulha}$ = [(Heat utilized)/(Heat exert by fuel)] × 100
= [(H_1 + H_2 + H_3)/ (M_f × Cv)] × 100
= [(879.27 +146.545+586.18)/(0.56× 17000)]× 100
= 0.1693 × 100
$\eta_{trad.\ chulha}$ = 16.93 (5)

B. For LSMC

Table 4

No	Heat input	Calculation	Amount of Heat (KJ/Kg)	%	No.	Heat utilized	Calculations	Amount of Heat	%
1.	Biomass as fuel	$M_f \times Cv$ (0.35×17000)	5950	100	1.	Water tank (H_1)	m× Cp× (T_2-T_1) 3×4.187×(93-30)	791.343 KJ	13.3
					2.	Cooking spot 1 (H_2)	m× Cp× (T_2-T_1) 0.5×4.187×(100-30)	146.545 KJ	2.46
					3.	Boiler pot (H_3)	m× Cp× (T_2-T_1) 2×4.187×(84-30)	452.196 KJ	7.6
					4.	Cooking spot 2 (H_2)	m× Cp× (T_2-T_1) 2×4.187×(39-30)	75.366 KJ	1.27
					4.	Unaccounted heat (H_4)	Heat exert by fuel – (H_1 + H_2 + H_3 + H_4)	4484.55 KJ	75.37

η_{LSMC} = [(Heat utilized)/(Heat exert by fuel)] × 100
= [(H_1 + H_2 + H_3+ H_4)/ (M_f × Cv)] × 100
= [(791.343 +146.545+452.196+75.366)/(0.35× 17000)]× 100
= 0.2462 × 100

η_{LSMC} = 24.62 %

Results

1. Change in mass of fuel required for both :
= mass of fuel required for traditional chulha – mass of fuel required for LSMC
=0.56-0.35 From (1) & (3)
= 0.21

2. Change in time required for all the processes for both
= time required for all processes carried out on traditional chulha - time required for all processes carried out on LSMC
= 1712-879 from (2) & (4)
= 833

3. Change in thermal efficiency of both
= $\eta_{LSMC} - \eta_{trad.chulha}$
= 24.62 - 16.93 from (5) & (6)
= 7.69 %

Advantages of LSMC
1. Environmental Benefits
- Lower fuel consumption.
- Increase green cover by less need to cut trees for fire wood.
- Reduce carbon emission.
- Reduce air pollution level.

2. Health Benefits
- Easy cleaning option reduce risk of injury
- Healthier life to women and young children who spend maximum time around kitchen.

3. Economic Benefits
- Any type of biomass fuel can be used for economic solution.
- Maintenance cost is negligible.
- Modular construction gives chulha a longer life.
- Less spending on medical care, so saving of money.
- Employment generation.
- Utilization of heat is more so reduce the consumption of money on fuel.

Disadvantages of LSMC
1. Environmental Hazard:-
- Less but we require cutting the trees from jungle.
- Outdoor pollution reduces but up to some extent only not completely.
- Due to LSMC temperature of surrounding is also increase.

Health Hazard
- Due to increase of surrounding temperature health problems occur.

Comparison between LSMC and Traditional Chulha

Table 4

Sr no.	Content	LSMC	Traditional Chulha
1	Fuel required	Less	More
2	Efficiency	More	Less
3	Design	Difficult	Easy
4	Maintenance	Difficult	Easy
5	Smoke creation	Less	More
6	Time required for cooking	Less	More

Conclusion
1. There is no environmental pollution occurs due to complete combustion of fuel by use of LSMC
2. There is best utilization of fuel compared to traditional chulha. The thermal efficiency of LSMC is 7.69% more thus its uses the fuel more efficiently.
3. 37.5 % less fuel required for LSMC compared to traditional chulha
4. 48% less time required for LSMC due to multiple task at one time facility provided in it.

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