STOVE MODEL II

Stove model II was made keeping the first model as the reference. This new model has a concentrator disc of dia. 11.5 cm (0.7 dia. of the combustor) and riser of diameter 15.5 cm/ height 8.5 cm from the concentrator disc. Also for supporting a pot support or even the vessel itself a cover was made with outer chamber of the previous stove model.

Part	Diameter/ Breadth (cm)	Height (cm)	Volume
Outer Shell	23.5 x 23.5 square	32	15 litres
Combustion chamber	16.5 dia.	22	5 litres
Concentrator disc	11.5 dia. (hole)	NA	NA
Riser	15.5 dia.	8.5	NA
Cover	23 x 23 square	8.5	NA

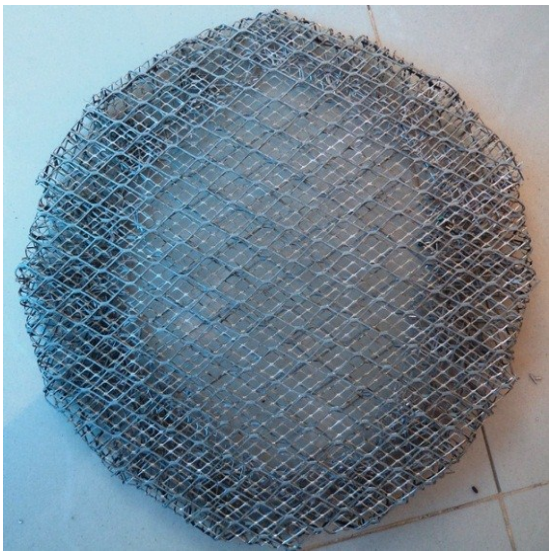
Air Inlet	Dimensions	Area
Primary air inlet area	1 cm dia. hole x 25	19.64 sq.cm
Secondary air inlet area	0.8 cm dia hole x (38+37)	37.699 sq.cm

Secondary holes are kept about 4 cm below the concentrator disc in order reduce leakage problem found in the first one.

PHOTOS:

Fig. **Combustion chamber with riser**

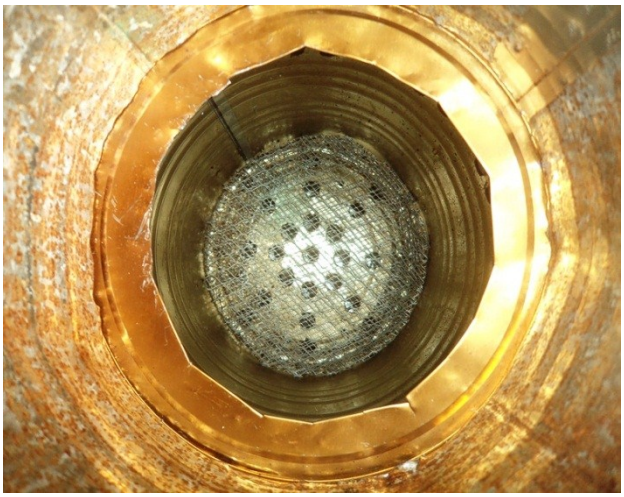
Fig. **Grate**



Grate was made from scrap of a mosquito bat.

Fig. **Stove without grate and cover**

Fig**. Inside the stove**



Concentrator disc is actually the top of the metal can (combustion chamber)

Fig. **Parts of the stove**

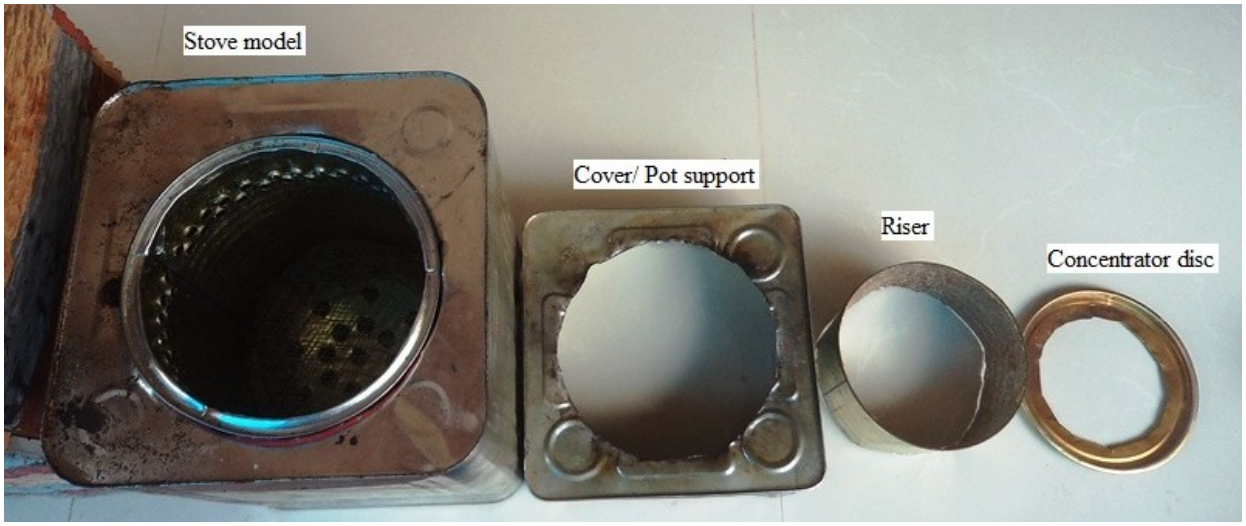


Fig. **Stove model II (different views)**

Testing on stove model II

Water Boiling Test

Method used: High Power Test –*COLD START*

Efficiency test was done on smokeless portable metallic chulha fabricated By SALOOP .T. S of Model Engineering College Trikkakkara, Ernakulam as part of his Project Work**.** Test was conducted at Integrated Rural Technology Centre (IRTC), Mundur, Palakkad under the supervision of Prof. B. M. Musthafa, Research Co-ordinator and assisted by Sri. Rangaswamy, Technical assistant.

Test Date **02.12.2014**

Procedure:

The evaluation was done by conducting a water boiling test on the chulha which was brought at the centre (IRTC). The test conducted in the following manner.

- Known mass of firewood DRY COCONUT SHELL (M_f) was taken in to lumps.
- Known mass of water (M_{w1}) was taken in a vessel (The vessel selected so that it will rest on the stand over the stove)
- Initial temperature of water was taken (T_1)
- The stove was loaded with first lot of coconut shell and the fuel was burned.
- Fuel was loaded as and when the first lot were consumed for to maintain uniform rate of burning
- Temperature of boiling water was taken (T_2)
- When the burning of firewood came to an end the vessel was removed and the mass of water remaining measured (M_{w2})

Mass of water evaporated = $M_{ev} = M_{w1} - M_{w2}$

The efficiency of stove was calculated as follows:

Input energy = Mass of fuel loaded x Calorific value of fuel.

Useful output = (Energy used to heat water from initial temperature up to stage of boiling + energy used for quantity of water evaporated)

= (Mass of water taken x Sensible heat x differences in temperature) + (Mass of water evaporated x Latent heat of water)

Percentage of efficiency = (Useful energy output/Energy input) x 100

$= [M_{w1} \mathbf{x} S_w (T_2-T_1) + M_{wev} \mathbf{x} L] / [M_f \mathbf{x} C_{vf}] \times 100$

S_w - Sensible heat of water (Specific heat) = 1 kcal/kg

L - Latest heat of vaporization of water = 540 kcal/kg

Cv_f - Calorific value of coconut shell used = 5000 kcal/kg

TEST-1

Observations:

1. Firewood details:

A mixture of size 2 cm to 3 cm

Weight = 0.75 kg

2. Vessel details:

Type : Steel

Diameter : 29 cm

Height : 14 cm

3. Temperatures:

Room temperature : 26.5 ^{0}C

Temperature of water before heating : 25.7 ^{0}C

Temperature of boiling water : 99.3 ^{0}C

4. Other details:

Test started at 12.30 pm

At 1.10 pm firewood completely burned. Remaining water measured at 1.34 pm.

Temperature of water then 80^{0}C.

5. Flame details:

Yellow

6. Smoke details:

Initial stage - Light Black

After 10 minutes - No visible smoke

After 20 minutes - No visible smoke

Efficiency calculations:

Mass of firewood loaded, M_f = 0.75 kg

Calorific value of fuel, C_f = 5000 kcal/kg

Initial temperature of water, T_1 = 25.7 ^{0}C

Mass of water taken, M_{W1} = 3 kg

Sensible heat of water (Specific heat), S_W =1 kcal/kg

Temperature of boiling water, T_2 = 99.3 ^{0}C

Mass of water remaining, M_{W2} = 1.9 kg

Mass of water evaporated, M_{W1}-M_{W2} = 3 – 1.9 = 1.1 kg

Latent heat of evaporation of water, L = 540 kcal/kg

% of efficiency = (Useful energy output / Energy input) x 100

= {3x1(99.3-25.7) + (1.1 x 540)} / (0.75x5000) x 100

= **21.73 %**

Table 6. Water temperature variation with time	
Time in minutes	Temperature (^{o}C)
0	25.7
5	84.6
10	97.2
20	98.6
30	99.3
40	80 (fuel burnt completely)

Table 7. Variation of temperature on outer metallic Stove surface		
Time in minute	Side surface-Bottom (^{o}C)	Side surface – top (^{o}C)
0	25.7	25.7
10	65	115
20	78.6	164.2
30	78	164
40	84	120

TEST-2

1. Firewood details:

A mixture of size 2 cm to 3cm”

Weight - 0.75 kg

2. Vessel details:

Type: Steel

Diameter: 29 cm

Total height: 14 cm

3. Temperatures:

Room temperature: 27.5 ^{0}C

Temperature of water before heating: 26.3 ^{0}C

Temperature of boiling water: 99.5 ^{0}C

4. Other details:

Test started at 3:19 pm. At 3:40pm firewood completely burned. Remaining water measured at 3:50pm. Temperature of water then 75^{0}C

5. Flame details:

Yellow

6. Smoke:

Initial stage - Light Black

After 10 minutes - No visible smoke

After 20 minutes - No visible smoke

Efficiency calculations:

Mass of firewood loaded, M_f = 0.75 kg

Calorific value of fuel, C_f = 5000 kcal/kg

Initial temperature of water, T_1 = 26.3 ^{0}C

Mass of water taken, M_{W1} = 3 kg

Sensible heat of water (Specific heat), S_W =1 kcal/kg

Temperature of boiling water, T_2 = 99.5 ^{0}C

Mass of water remaining, M_{W2} = 1.944 kg

Mass of water evaporated, M_{W1}-M_{W2} = 3 – 1.944 = 1.056 kg

Latent heat of evaporation of water, L = 540 kcal/kg

% of efficiency = (Useful energy output / Energy input) x 100

= {3x1(99.5-26.3) + (1.056 x 540)} / (0.75x5000) x 100

= **21.06 %**

Table 8. Water temperature variation with time	
Time in minutes	Temperature (^{o}C)
0	26.3
1	31.6
5	75.8
8	99.4
13	99.5
16	99.7 (fuel burnt completely)

Table 9. Variation of temperature on outer metallic Stove surface		
Time in minute	Side surface-Bottom (^{o}C)	Side surface – top (^{o}C)
0	25.7	25.7
1	49	63.5
4	49.7	106
5	76.5	108
13	93.4	112.5
16	99.2	108.5

Comments and suggestions:

- The efficiency of the Stove is lower when comparing with similar type of firewood stoves.
- The thermal energy loss from the metallic surface is too high (at the top surface temp. is >100 ^{o} C.
- Continuous fuel feeding is not possible in the model.
- The outer case can be replaced with cast iron or terracotta.
- The position of air hole for secondary burning can be lowered to a suitable depth.
- Easy fuel feeding position and suitable holes should be separately found out in the mould.

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