Design and Development of Advanced Chulha

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Abstract— For each kind of work & any prescribed task, energy is surely essential & the consumption of energy for completing work is most considerable fact which plays an important role for any equipment. On the consideration of this we are effectively trying to construct an appliance which will utilize the heat energy at its maximum extent than the conventional methods.

Key words: Advanced Chulha, Design of Chulha

I. Introduction

Depending upon the type of process, waste heat can be rejected at virtually any temperature from that of chilled cooling water to high temperature waste gases from an industrial furnace or kiln. Usually higher the temperature, higher the quality and more cost effective is the heat recovery. In any study of waste heat recovery, it is absolutely necessary that there should be some use for the recovered heat. Typical examples of use would be preheating of combustion air, space heating, or pre-heating boiler feed water or process water. With high temperature heat recovery, a cascade system of waste heat recovery may be practiced to ensure that the maximum amount of heat is recovered at the highest potential.

II. Problem Statement

Heat energy is the energy which is used in the conventional chulha for completing the required task such as cooking, boiling of water and etc. this method of using of chulha produces hazards impact on environment and the user. The following main parameters will describe the exact problem statement while using the conventional chulha.

- Fuel consumption
- Location
- Design

III. Objectives

- Fuel at its maximum extent
- House condition working
- User friendly
- Consideration of environment.

IV. Future Scope

Earlier days the fuel for cooking and the regarding works using widely which results the extreme consumption of gas cylinders, coal, electricity and etc. this provides the highly decreasing rate of such energy sources to prevent this decreasing rate of energy sourceswe are constructing an equipment with modification of conventional chulha.

- Saving of fuel and energy
- Reducing hard work
- Multi-tasking
- Food stuff prevention and oven effect
- Cost reduction
- Low maintenance

V. Construction

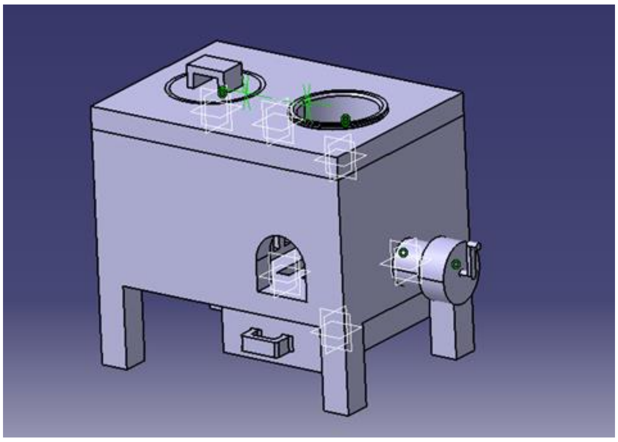

Fig. 1: Actual 3D model of chulha in CATIA

A. External Support Structure Design (Dimensions & Material)

(Outer): Galvanized Sheet (1mm)
(Inner): SS Sheet (1mm)
Outer Dimensions:
635mm x 304.8mm x 304.8mm
(25inch x 12inch x 12 inches)

B. Internal Insulation Design

Thickness of insulation (1) inch
Insulating material: Glass Wool
Density (kg/m^3): 10-80
Thermal Conductivity (k) (w/m-k): 0.04

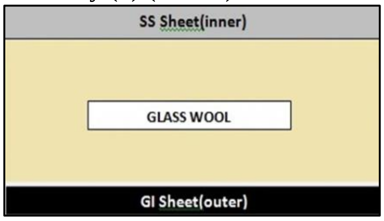

Fig. 2: Wall details of chulha

VI. Simple Calculation

A. Heat Produced By 1kg of Charcoal

= Mass * Calorific Value
Where, Mass = 1Kg of Charcoal
Calorific Value of charcoal = 6900KJ/Kg
= 1 * 6900
= 6900 KJ

B. Thermal Heat Transfer Rate of Wall

Where, X_1 = wall thickness of GLASS WOOL in mm
X_2 = wall thickness of Galvanized sheet in mm

R_1 = Thermal resistance of GLASS WOOL
R_2 = Thermal resistance of Galvanized sheet
T_o = Room temperature
T_i =Burnt Coal
Q =Heat Transfer Rate in W
K_1 = Thermal Conductivity of GLASS WOOL
K_2 = Thermal conductivity of Galvanized sheet
A = Total Area
Total Thermal Resistance,
Total $R = R_1 + R_2$
$=(X_1 / K_1*A) + (X_2 / K_2 *A)$
= (0.02/ 0.04*0.064516) + (0.001/43*0.064516)
=7.750 + 3.6046*10^-4
= 7.75037 K/W
Heat Transfer Rate,
$Q = (T_i– T_o)$/ Total R
= (2200- 301)/7.75037
= 245.02 W

C. Heat Balance of Fuel

- Calorific Value of Charcoal:- 6900 KJ/Kg (As per Indian Charcoal)
- Mass of fuel required per day per meal: 1 Kg
- Heat Energy available after burning of fuel: m × CV = 1 × 6900 = 6.9 MJ
- Heat required for cooking:- 0.9 - 2.9 MJ (Excerpt from IDEA report 'Energy from Cooking': The per capita energy consumption values for developing countries are considerably low; the values ranging from 0.9 - 2.9 MJ)
- Excess Heat Available in Chulha: 6.9 – 2.9 = 4 MJ

Assumption during calculations:-

For all heat transfer calculations, we're considering the whole system in steady state and all the materials are initially at 25^0C.

VII. Components of Advanced Chulha

A. Manual Blower

Fig. 3: Blower for Chulha

1) Product Details

- Item Weight: 132 g
- Item part number: KC127BK
- ASIN: B01C2KT7J0
- Amazon Bestsellers Rank: #20,292 in Home & Kitchen (See Top 100 in Home & Kitchen)

2) Product Description

Hand powered, blow a small amount of air to help stoke charcoal. Stops dust and sparks. A must for the amateur and the professional Perfect for use with any charcoal barbecue. Outdoor cooking hand crank BBQ air blower, green and safe Quickly heats up BBQ fires, briquettes, coal,wood etc. Compact size design, it is convenient for your carrying. This manual BBQ Fan is suitable for barbecue fire bellows. Made of plastic and stainless steel material and it is operated by a hand crank. Just simply crank the handle and the internal turbine blasts out the air, can effectively. Stop's dust and sparks Easy to operate, great for fire starting any kind especially used for barbecue fire blower or camping and family party.

3) Function

For any combustion sufficient amount of air is required. In advanced chulha total structure is enclosed within the box hence to introduce the air for combustion blower is used.

B. Metal Structure

Fig. 4: Complete structure of chulha

- Angles: We are using mild steel angles which are used as a structural frame for metal structure box. The thickness of these angles is 2 mm while these angles are rectangularly connected with each others.
- Galvanized Sheets: For creating enclosed metal structure, galvanized sheet are used which are of 1mm in thickness. These galvanized sheets are attached to the angle. The required slots are made on these galvanized sheets.

Metal structure is provided as base strength for giving support to total box. This metal structure consist of a box in which Whole GLASS WOOL has been fitted and angle are attached to the lower base which are further connected with wheel.

To collect ash from burnt fuel, ash tray is joined to the lower side of combustion chamber from outer side of metal structure. This ash tray is easily removable by which burnt coal's ash can be collected and the chulha will keep cleaned. Wheels are attached to the lower angles for easy movement of chulha. These wheels are attached with angles and freely rotate with the help of bearings.

C. Glass Wool

Fig. 5: Use of Glass Wool

Insulating material are used to resist the heat going out from the chambers. Glass Wool has very low thermal conductivity and it can stand in high temperature with high strength hence Glass Wool is used as insulating material.

In advanced chulha every wall is covered with two sheets of Glass Wool each of 12mm in thickness. These walls are attached on the top cover from inside fitted with Nut Bolt with washer.

Glass Wool is highly heat load sustainable also, it can have sufficient strength to have a mass of few material. It is widely used where the requirement of heat exchange is very low. Glass Wool is easily machinable with low efficiency machine tools.

Thermal conductivity of Glass Wool = 0.04 w/mk

D. Exhaust System

Fig. 6: Exhaust system of chulha

Flue gases will be generated due to burning of coal. To make these gases out, exhaust system is being used. This system is mounted on the heating chamber from where exhaust flue gases get entered in this system. Exhaust system consist of filters and meshing to collects oversized particles of burnt fuel.

This exhaust system initiated with the circular hole of diameter 3.5 inches and it is placed centrally on the heating chamber wall. Further this system is converted into the conical tube such as a drought of chimney. Removable filter and meshing are provided in the conical exhaust tube so that incinerator can be easily separated to keep cleanness of chulha. The height of exhaust system should be greater than 2 feet and depending upon the ventilation, we can adjust heat so that smoke problem can be avoided.

E. Copper Tubing

Fig. 7: Copper Tubing of chulha

We are using copper tube for water tubing which is efficient than that of aluminium tubing. With that result we have introduced metal tubing utilization for water tubing in our project.

We have made copper tubing in our project which is the most important advantage of our project. We have tried to save excess fuel consumption which is required to hot water, but we have introduced both applications at the same time. We are saving directly 50% of excess fuel consumption so we learnt that we save the 50% fuel for the future.

VIII. FINAL PRODUCT DESIGN

Fig. 8: Complete construction of chulha

IX. CONCLUSION

On the basis of calculation and Result table finally we conclude that, with the use of our Advanced chulha we are saving 50% of excess consumption of fuel with closed structure design. Water tubing and Heating chamber gives us required and essential heat losses recovery with high temperatures which facilitate the effective and efficient use of heat producing from combustion of fuel.

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