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Performance of LPG Burner with different Size of Ball Bearing as a Porous Medium

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Abstract—*Porous media combustion aimed at improving the performance of combustion device, as it provides a 3-d matrix mixing chamber to achieve a higher value of thermal conductivity and emissivity. The present paper compared the Thermal efficiencies of conventional LPG stove with varying size of Ball Bearing as a porous medium. As a result it gives a better prospect for the use of porous media in domestic LPG cooking stove and to achieve the maximum thermal efficiency of the stove, found to be 71% which for the conventional stove was in range of 48-52%.*

Keywords: *Porous Media, Ball bearings, Thermal Efficiency*

1. INTRODUCTION

Fossil fuels reserves are depleting day by day, and usage of the conventional fuels is increasing considerably. To meet the impending fuel crisis, therefore, an extensive research is being carried out in the area of non- conventioanl fuels like hydrogen and bio-fuels. At the same time, some design modification are also exploreds to make the existing system more and more efficient.[2] This work is to help energy to the maximum possible extent.

Liquefied Petroleum Gas (LPG) is one of the commonly used conventional fuels for domestic applications. Its consumption in domestic cooking is increasing every. The total domestic consumption of LPG in India is almost comparable with other petroleum products used in industrial application. With some improvements in the existing LPG cooking stoves, a small saving in its consumption per family will lead to an enormous saving nationwide. Thus, there is a need for research in the LPG cooking stoves. The objective of this work is to help conserve energy to the maximum possible extent and thereby extend the availability of the conventional fuels.

In any combustion system, a Burner plays as important role in combusting a fuel. An improper design of a burner often leads to an inefficient combustion, to overcome this problem it is important to choose the correct design and material for burner and burner head. The thermal efficiency of the LPG cooking stove with regular cast iron burner head available in the market showed efficiency of 47-49%.

With the objective of improving the thermal efficiency of domestic LPG stoves, in the present work, experiment were carried out by using different design and different materials of burner head instead of regular cast iron.

2. WORKING PRINCIPLE OF CONVENTIONAL COOKING BURNER

Both natural gas and propane burners work on the same principle called the "venturi effect". It says that as a gas or fluid passes through a pipe that narrows or widens, the velocity and pressure of the gas or fluid vary. As the pipe narrows, the gas flows more rapidly. When the fluid or gas flows faster through the narrow sections, the pressure actually decreases rather than increases. The venturi tube is a large diameter tube, gradually feeding into a smaller tube and then gradually becoming a larger tube.

The most important part of the burner is the orifice plug with the hole in it. This is the point where the gas escapes from the hose or a pipe and enters the mixing bell of the burner. Orifice plugs are replaceable and screwed into the orifice spud.

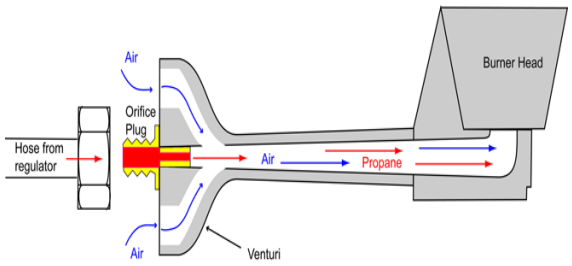

Fig. 1: Schematic diagram of a typical conventional LPG cooking stove burner

Nearly all atmospheric (venturi) burners have a gas orifice that is accurately fixed in the burner throat providing air intake. The hole in the orifice is very small to provide the correct gas flow and to provide sufficient velocity to ensure there is a suction (vacuum) available for the correct air inspiration.

3. EXPERIMENTAL METHODOLOGY

In India, the Bureau of Indian Standards (BIS) has set guidelines for testing the thermal efficiencies for all types of cooking stoves. For LPG stoves, the thermal efficiencies are determined according to specifications provided by Indian Standards. Following the guidelines, thermal efficiency of LPG stove in the present work is estimated by conducting the water-boiling test and the procedure followed is briefly described below.

The line diagram of experimental setup is shown in Fig.2. The experimental setup consists of LPG stove, a 3 kg LPG cylinder, aluminium vessel and aluminium stirrer. A thermometer (0 to 100°C) was used to measure the water temperature during experimentation. A stirrer was used for stirring the water for uniform distribution of heat. An electronic balance (of least count 1g) has been used for weight measurement of water and LPG cylinder. The photograph of experimental setup is shown in Fig.3.

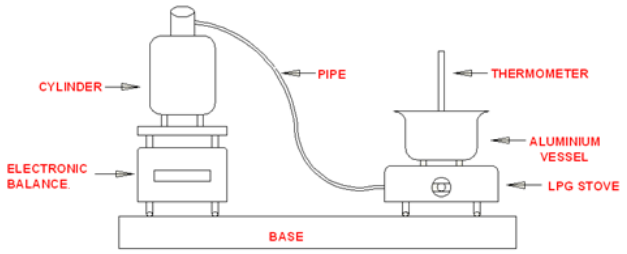

Fig. 2: Line diagram of experimental Setup

Fig. 3: Photograph of experimental Setup

Conventional LPG stove was used during entire testing. The value of thermal efficiency with conventional stove was taken as reference value. The technical specifications of the test stove and electronic balance are shown in Table 1 and Table 2 respectively.

Table 1: Technical Specifications of LPG Stove

Make of stove	Big Boss
Manufacturer	Boss Home Appliances
Type	Single burner type
Thermal efficiency (designed)	68%
Weight of burner	0.5 kg
Burner material	Brass
Design fuel	LPG
Weight of LPG cylinder	3 kg

Table 2: Technical Specifications of Electronic Balance

Make	Gold Tech
Manufacture	Precision Electronic Instrument Co., Delhi
Weighing machine type	Electronic
Range	Maximum 10 kg; minimum 20g
Least count	1g
Model	G-TET

The weight of vessel with its lid and the weight of water used in the vessel were noted. Initial temperature of water (T_1) was also noted. The weight of cylinder (W_1) was noted. The stove was lighted and water was warmed up to 80°C and stirred continuously for uniformity of temperature. When final temperature of water (T_2) has reached 80°C, the stove was put off. Again, the weight of cylinder (W_2) was recorded. The difference in the weight of cylinder (W_2-W_1) gives the mass of fuel consumed for heating water by temperature (T_2-T_1). By dividing the difference in the weight (W_1-W_2) by time taken in heating gives fuel consumption rate.

The thermal efficiency of the stove is expressed as follows:

$$\eta_{th} = \frac{(W_w \times C_w + W_{Al} \times C_{Al}) \times (T_2 - T_1)}{(W_1 - W_2) \times CV}$$

Where,

W_w is the quantity of water (in kg) in the vessel,

W_{Al} is weight of the vessel (in kg),

C_w is specific heat of water (in kJ/kg-K),

C_{Al} is specific heat of aluminum vessel (in kJ/kg-K),

CV is the calorific value of the test fuel (in kJ/kg).

4. RESULTS AND DISCUSSIONS

Fig.4 shows the variation of thermal efficiency of the LPG stove by using different size of ball bearing. The thermal efficiency conventional LPG stove was found to be 49%. This value was taken as reference value. It can be seen from bar graph that thermal efficiency improves by using ball bearings of size 3/8 inches. The thermal efficiency was obtained to be 71%.

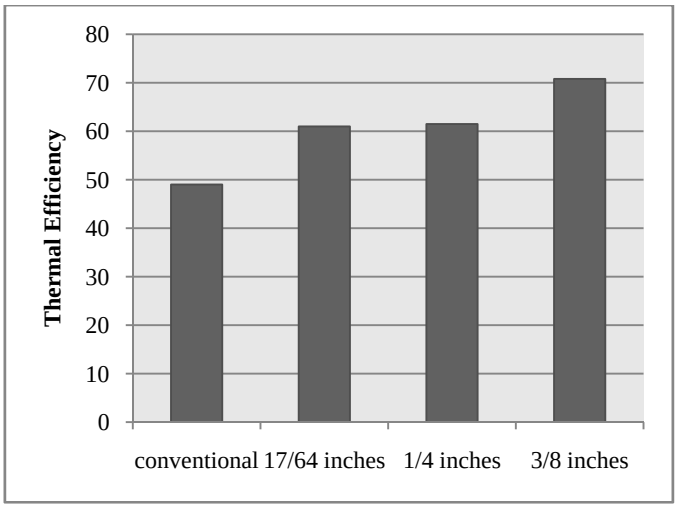

Fig. 4: Variation of thermal efficiency (%) of LPG stove by using different size of ball bearing as a porous medium

Although the Ideal thermal efficiency of the regular LPG stove is 68%, which after resistance and losses remains only 48%. But with the use of ball bearing of size 3/8 inches as a porous medium we can reach the ideal condition.

5. CONCLUSIONS

Inspite of technological development in world, our country is still facing the shortage of fossil fuel and combating with the price hike. To face such kind of problem is a difficult task but not impossible. It is duty of every citizen to show awareness in conserving the fossil fuel. After showing the positive result of our past work, we are performing this experimental work. We can see the variation of thermal efficiency of LPG Stove by using different size of ball bearing as a porous medium. As a result, We achieve maximum thermal efficiency by using 3/8" of bal bearing as a porous medium.

- We found 71% of thermal efficiency.
- Due to some losses the thermal efficiency of LPG Stove is 48% which is 65-68% in ideal condition. We can achieve ideal or more than ideal thermal efficiency and conserve fuel.

The technique is safe and secure and can be implemented in domestic LPG stove for better thermal efficiency. Also the technique requires less effort and is cost effective.

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