Performance Of LPG Cooking Stove Using Different Design Of Burner Heads

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Abstract

There is tremendous demand for fossil fuels at the same these fuels are depleting at a rapid rate. So, efforts should be made to conserve it. The objective of this experimental investigation was to see the effects on using different design burner heads on the performance of LPG cooking stove. Also, burners of different material were used to study the effects of burner material on LPG stove performance. It was experimentally found out that thermal efficiency of stove using flat and flower face brass burners were higher as compared to regular cast iron burner. There was improvement of 4% when regular brass burner was used instead of regular cast iron burner. Maximum thermal efficiency of 58% was achieved when flat face brass burner head was used. While thermal of 50% was obtained when flower face burner was used.

1. Introduction

Fossil fuels reserves are depleting at a very rapid rate at the same time their usage is increasingly considerably. In order to meet the impending fuel crisis, an extensive research is being carried out in the areas of fuel conservation and alternative fuels. Liquefied Petroleum Gas (LPG) is the most commonly used conventional fuel for domestic application. In urban India, the total domestic consumption of LPG is very high. It is a known fact that LPG usage is important part of our life as 90% urban population uses LPG for cooking. With some changes in the existing LPG cooking stove, saving in its consumption can be made. Saving per family can result in enormous saving nationwide. Thus, any research work on LPG saving is need of the day.

In any combustion system, burner plays as a vital role. An improper design of burner can result to an inefficient combustion. In order to overcome this problem, it is important to choose the correct design as well as material. The aim of this work was to see the effects on using different design burner head on the performance of LPG cooking stove. Also, burners of different material were employed to study the effect of burner material on LPG stove performance. The thermal efficiency of the LPG cooking stove with regular shaped cast iron burner head was taken as reference.

2. Working of Conventional Burner

In a conventional burner, LPG and air are required to be mixed before combustion in the throat of the burner where reactions occur. There is a single flame zone. Burner work on the principle called the venturi-effect. It says that as a gas passes through a pipe that narrows or widens, the velocity and pressure of the gas vary. When pipe is narrows, the flow of gas is more rapidly. When the gas flows faster through the narrow sections the pressure decreases. The venturi-tube is a large diameter tube, gradually feeding into a smaller tube and then gradually becoming a larger tube as shown in Figure 1.

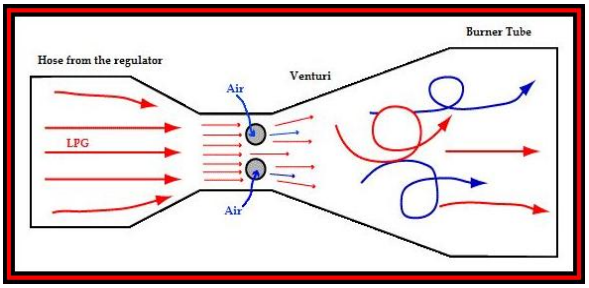

Figure 1 Mixing of LPG and Air

One of the most important parts of the burner is the orifice plug with the hole in it. This is the point where the gas escapes from the hose and enters the mixing chamber of the burner. Orifice plugs are screwed into the orifice spud. 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 suction (vacuum) available for the correct air inspiration. [1, 2]

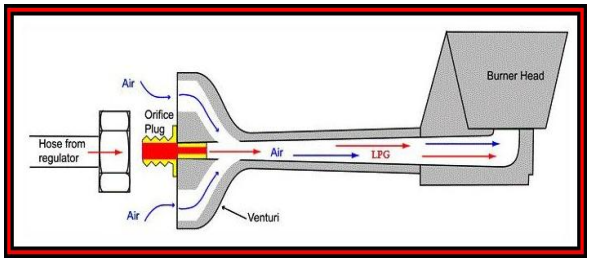

Figure 2 Working of Conventional Burner

3. Experimentations

The line diagram of experimental setup is shown in Figure 3. 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 Figure 4.

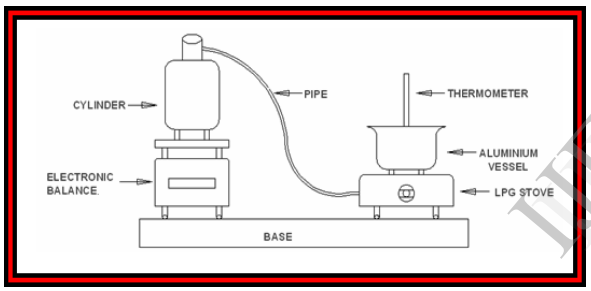

Figure 3 Line Diagram of Experimental Setup

Figure 4 Photograph of Experimental Setup

The value of thermal efficiency with regular cast iron burner was taken as reference value which was experimentally found to be 48%. Performance of LPG stove using different design burner head was evaluated.

The specifications of the LPG stove and electronic balance are shown in Table 1 and Table 2 respectively.

Table 1 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 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

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 [3]. 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 [3,4].

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:

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

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

The experiments were repeated three times and average of the three values was taken as final reading. The burner head was removed and replaced by different design. Different burner head designs used in this work are shown in Figure 5. Also, burners of different materials were employed to study the effect of burner material on LPG stove performance. The purpose of this was is to find out most efficient burner design. Usually, burner head of regular design made up of cast iron is used in LPG cooking stove shown in Figure 5 (a) is used in LPG stove. Burner head shown in Figure 5 (b) is of regular design but made up of cast iron. Figure 5(c) and 5(d) shows flat face and flower face burner respectively. Both of these burners are made up of brass. The test procedure as described above was followed for all burner designs.

5(a) Regular burner (Cast Iron)

5(b) Regular burner (Brass)

5(c) Flat face burner (Brass)

5(d) Flower face burner (Brass)

Figure 5 Different Burner Head Designs

4. Results and Discussions

Since the original burner of LPG stove was regular cast iron burner, hence the value of thermal efficiency of LPG stove using this burner was taken as reference value. Although, the design thermal efficiency of the LPG stove is 68%, which was experimentally found to be 48% due to various losses. Tests were repeated with flat and flower face brass burners respectively.

Figure 6 shows the variation of thermal efficiency of LPG stove using different burner heads. It can be seen from this bar graph that thermal efficiency improves by using flat and flower faced burners. When flower face burner was used, thermal efficiency of LPG stove was found to improve. The thermal efficiency of flat face brass burner was found to be maximum of 58%.

Figure 7 shows the variation of thermal efficiency of LPG stove using regular burner design of different materials i.e. cast iron and brass. The thermal efficiency LPG stove using regular cast iron burner was found to be 48% while that obtained with regular brass burner was found to be 52%. Thus, there was improvement of 4% when brass burner was used instead of cast iron burner.

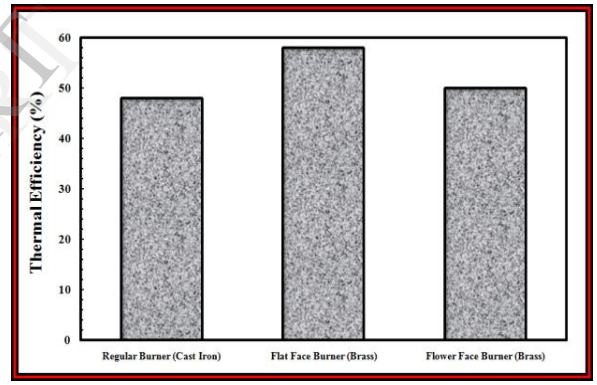

Figure 6 Variation of Thermal Efficiency (%) of LPG stove Using Different Burner Heads

Figure 7 Variation of Thermal Efficiency (%) of LPG stove Using Regular Burner Design of Different Materials

5. Conclusions

Liquefied Petroleum Gas (LPG) is the most commonly used conventional fuel for domestic application. However, their rapidly increasing consumption and consequent depletion of reserves clearly show that the end of the LPG age is not very far. Hence, efforts should be made to conserve it. Any research work on fuel saving is worthwhile. This experimental work, the effects on using different design burner heads on the performance of LPG cooking stove was studied. Further, effect of using different burner material on LPG stove performance was also studied. From this experimental work, following significant conclusions can be drawn.

The thermal efficiency of LPG stove for regular cast iron burner was found to be 48%. When flat and flower face burners were used, thermal efficiency of LPG stove improved. When flat face brass burner was used maximum thermal efficiency of 58% was achieved. While thermal efficiency of 50% was observed when flower face brass burner was used. Further, it was experimentally found out that thermal efficiency of LPG stove using regular brass burner was 4% higher as compared to regular cast iron burner.

The technique of replaced of burner head is simple and safe. It can be easily implemented in domestic LPG stove for fuel conservation.

6. Acknowledgements

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7. References

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