International Journal of Research in Advent Technology, Special Issue, ICIMCE 2019
E-ISSN: 2321-9637
Available online at www.ijrat.org

Performance Analysis Of Pressure Kerosene Stove With Different Commercial Burner- A Comprehensive Review

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Abstract*:* This paper discuss about the comprehensive review of thermal efficiency of pressure kerosene cooking stove. The commercial burner that are available in Indian market have been also discussed in the present paper. Venus burner have the highest thermal efficiency (58 %) as compared to roarer (55 %) and silencer burner (54 %). The emission analysis also has been done in this paper.

Index Terms - Pressure kerosene stove, commercial burner, thermal efficiency.

1. INTRODUCTION

India and other developing country facing the energy crisis and pollution, which not only affects the human also create the environment imbalance. In village areas, people are using kerosene stove and biomass for their cooking. The efficiency of biomass (5-10 %) is less than kerosene stove due to incomplete combustion [1]. Two type of kerosene stove are used, pressure kerosene stove and wick stove. The thermal efficiency of wick stove is very less as compared to pressure kerosene stove. Average thermal efficiency of pressure kerosene stove varies (40-45 %) [2-4]. However, due to the gradual shift of economy people are still using liquid petroleum gas (LPG). The combustion of LPG stove is clean as compared kerosene pressure stove. Renewable energy sources are forward step to reduce energy crisis and pollutants emission. But due to the high cost and technical management, LPG and renewable energy are not feasible for low income group people in village as well as city. Using of LPG in village areas is more complex. It is because of Cost limitation and poor distribution network of LPG. The government of India is giving huge subsidy for kerosene. Fig. 1 showing the subsidy which have been given by government of India.

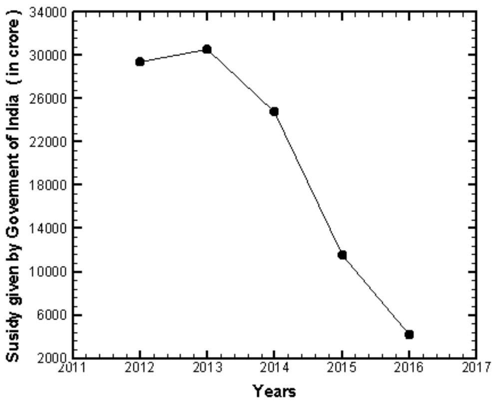

Figure 1: Year wise subsidy by Government of India on kerosene [5]

Table 1 shows the consumption of different fuel in city as well as village. So in order to reduce the huge subsidies which are given by government of India and this is possible either by reduce the kerosene consumption or utilize the maximum energy. For aforesaid purpose, a benchmark study is mandatory. A performance analysis of pressure kerosene cooking stove different commercial burner, which are available in Indian market have been done in this paper that includes thermal efficiency and thermal emissions (NO_x and CO).

Table 1: Fuel Usage, percentage of families [6]

S. No.	Main cooking fuel	Year: 2009-2010	
		Village	City
1	Wood,	76.3	17.5
2	Cow Dung cake	6.3	1.3
3	LPG	11.5	64.5
4	Kerosene	0.8	6.5
5	Others	0.8	2.3

2. CONSTRUCTION OF PRESSURE KEROSENE COOKING STOVE

There are two types of kerosene stove are used for cooking application, wick stove and pressure stove. Due to better combustion pressures kerosene stove is preferred. However, the emissions of CO and NO_x in kerosene pressure stove is higher than WHO (World Health Organization) limits [7]. Thermal efficiency of pressure kerosene stove is measured according to BIS (bureau of Indian standard) guidelines IS 10109:2002 [8]. Kerosene stove burner consists a pair of ascending and descending tube, which have been shown in Fig. 2. Both ascending and descending tube meet to the burner head. Mid of the descending tubes consists a spray nozzle. A rising tube which is connected to fuel tank consists ascending tube. Stable combustion in pressure kerosene cooking stove takes place at surface of the metallic burner, which have been shown in Fig. 3. Kerosene stove with pressure type have been designed in such a way that the combustion that occurs in kerosene stove is always fuel rich type.

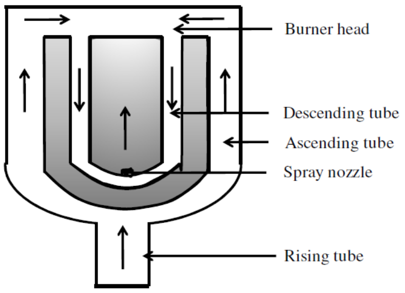

Figure 2: Schematic of the stove burner [9].

Figure 3: Illustrative interpretation of the free flame in traditional cooking kerosene stove

2.1 Types Of Commercial Burner

For measuring the performance analysis of kerosene pressure stove, a comprehensive survey was done on types of burner which are available in Indian market. There are three types of burner which are available in Indian market, venus type burner, roarer type burner and silencer type burner. Figure 4 presents types of burner. Due to the unique type of design of venus burner, it has maximum thermal efficiency [10].

3. EXPERIMENTAL METHOD

Thermal efficiency is measured according BIS guidelines, which is called water boiling test (WBT). For this purpose a small amount of kerosene is poured to spirit cup for initial ignition (as shown in Fig. 5). For the duration of burning of kerosene, burner head receives heat from the flame, which helps converts liquid kerosene to vapour. Kerosene vapour mixes with air and combustion takes place surface of burner head which have been shown in Fig. 3. Burner head continuously receives the heat

(a) (b) (c)

Figure 4: Traditional burners present in the market: (a) venus (b) silencer type (c) roarer type

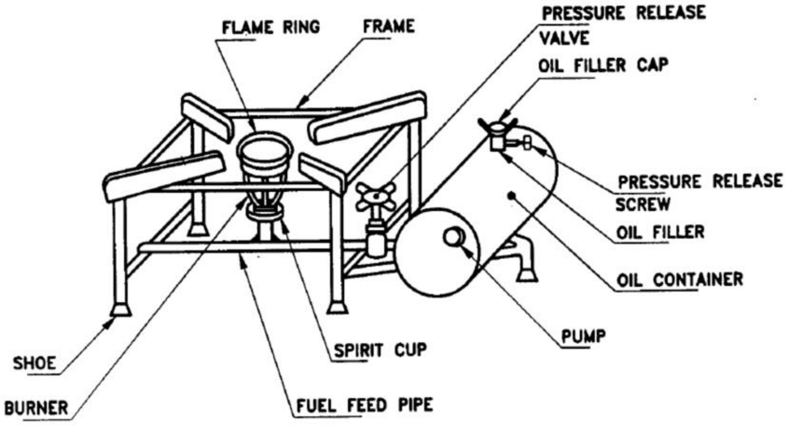

Figure 5: Schematic of a BIS specified kerosene pressure stove [8]

from the combustion flame for convert liquid kerosene to vapour and cycle continues. For measuring thermal efficiency, a known quantity of water is placed in aluminum cylindrical vessel of known diameter. Weight of the water with vessel is measured in weighing machine (least count: 1g). For initial weight of stove, burning stove is kept in platform (dimension: 400 mm × 300 mm) of weighing machine and is kept down and the same time cylindrical vessel with water is kept above the burner surface. Weight of vessel, lid, and water are measured through weighing machine. Water is heated up to 90 ˚C ± 0.5 (T_2) from room temperature (T_1). Temperature is measure by glass in mercury thermometer (accuracy ± 0.5 ˚C). An aluminum stirrer is used to maintain uniform temperature of water. After reaching the 90 ± 0.5 ˚C, stove is quenched and is measured the final weight of stove. Difference of initial and final weight of stove gives the fuel consumed. Time is also noted for heating process. Thermal efficiency is the ratio of heat consumed by water and vessel to the heat given by fuel. BIS have given standard formula for measuring thermal efficiency which is given in equation 1.

$$\eta_{th} = \frac{Heat\ Output}{Heat\ Input} = \frac{\left(m_w \cdot C_w + m_p \cdot C_p\right)\left(T_2 - T_1\right)}{m_f \cdot \mathrm{CV}} \qquad (1)$$

Where, C_p, C_w, m_w, m_p, m_f and CV are the specific heat of vessel, specific heat of water, mass of water, mass of vessel including lid and stirrer, mass of kerosene consumed and lower calorific value of kerosene, respectively. All experiment were repeated three times and average was taken as a final result. The uncertainty in thermal efficiency was found ± 1.40.

4. RESULTS AND DISCUSSION

In this section, thermal efficiency and emission (CO and NOx) have been presented. For this purpose, three burners have been selected and determined the thermal efficiency of kerosene pressure stove (as shown in Fig. 6) corresponding to different input power. From the number of experiments, it was observed that venus type of burner was the maximum thermal efficiency (58 %) than the roarer (55 %) and silencer type burner (54 %). Single tube of venus burner leads to not only maximum thermal efficiency while it helps for better environment. Maximum efficiency leads to reduction of pollutants emission. Table 2 shows maximum and minimum value of thermal efficiency. From the Fig. 6, it was observed that thermal efficiency of the burner decreases with increase input power. The reason behind of this was maximum heat loss at maximum input power.

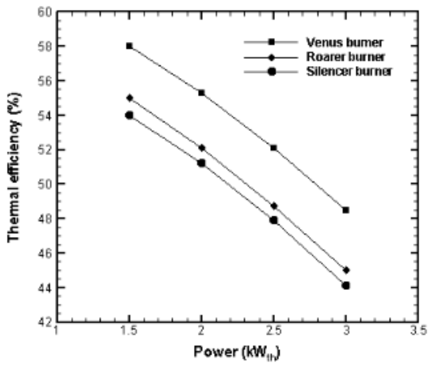

Figure 6: Thermal efficiency of different conventional burners.

Table 2: Efficiency of different types of burners.

Type of burners	Thermal Efficiency (%)	
	Maximum	Minimum
Venus	58	48.5
Roarer	55	45.0
Silencer	54	44.1

Hood method is used for measuring pollutants emission according to BIS (bureau of Indian standard) guidelines IS 10109:2002 [8]. Since venus burner have the highest thermal efficiency, so for measuring thermal emission, venus burner was selected. Fig. 7 shows the CO and NO_x for different input power. For input power (1.5 – 3kW), CO and NO_x varies in the range of (610 – 915 ppm) and (19-35 ppm), respectively. Unlike thermal efficiency, pollutants emission increase with input power. With increased input power combustion converts to fuel rich resulting more CO emission. Local temperature of flame increases with increased input power resulting more NO_x emission.

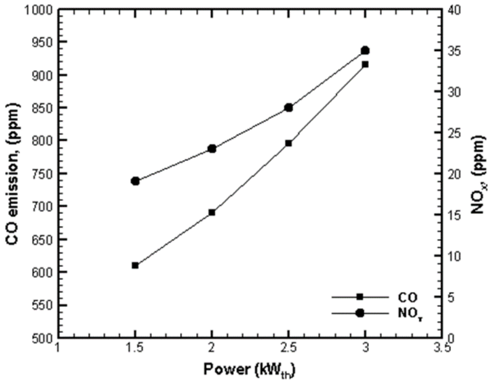

Figure7: Emission characteristics of a pressure kerosene cooking stove with venus burner.

5. CONCLUSIONS

Maximum thermal efficiency of venus type burner is 58 % at input power 1.5 kW. For the same operating condition 55 % and 54 % are maximum thermal efficiency of roarer and silencer type of burner, respectively. Through the venus type of burner, an ample amount of kerosene can be saved. However, pollutants emission of kerosene stove are very high as compared to WHO limit. So there is uttermost need of modification of existing burner so that pollutants emission can be reduced and use the energy to maximum extent.

REFERENCES

[1]Dendukuri, G. and Mittal. J. P. 1993. Some field experiences with improved chulhas in introduced in rural households of Andhra Pradesh, India, Energy Conversion and Management, 34: 457-464.

[2] Thukral, K. Bhandari, P. M. 1994. The rationale for reducing the subsidy on LPG in India, Energy Policy, 22: 81-87.

[3] Makonese, T. C. Pemberton-Pigott. Robinson, J. et al. 2012. Performance evaluation and emission characterization of three kerosene stoves using a heterogeneous stove testing protocol (HTP), Energy Sust. Dev, 16:344–351.

[4] Bhattacharya, S.C. Salam, P.A. 2002. Low greenhouse gas biomass options for cooking in the developing countries, Biomass Bioenergy, 22:305–317.

[5] Annual Report. Ministry of Petroleum and Natural Gas (2016 -17).

[6] NSSR. 2010. Implementation energy sources of Indian households for cooking and lighting, Ministry of Statistics and Programme.

[7] Kandpal, B. Maheshwari, R.C. Kandpal, T.C. 1995. Indoor air pollution from domestic cooking stoves using coal kerosene and LPG, Energy Convers. Manag, 36: 1067-1072.

[8] Indian Standard, Burners for oil pressure stoves and oil pressure heaters, specification, (Second Revision): IS 10109, 2002, Bureau of Indian Standard.

[9] Sharma, M. Mishra, S C. Mahanta, P. 2011. An experimental investigation on efficiency improvement of a conventional kerosene pressure stove, International Journal of Energy for a Clean Environment, 12: 79-93.

[10] Sinha, G S. 2017 Development and performance analysis of self-aspirated porous radiant burners for kerosene pressure stove, PhD thesis, IIT Guwahati, Guwahati, India. http://gyan.iitg.ernet.in/handle/123456789/902