

Efficient Utilization of Renewable Energy for Boilers in Tea café

Meenaakumari.M, Hema.R, John Paul Praveen.A.

Abstract: Due to continuous increase in emission of Greenhouse gases and the rapidly increasing fuel price, many countries in their concerned with reduction of Liquefied Petroleum Gas (LPG) usage in teashops, which contains a mixture of Propane and Butane – both derived from distillation of crude oil. In terms of the by-products of their combustion, the gas released is CO₂, which is considered as a greenhouse gas. This project mainly focus on reducing the utilization of LPG's as much as possible by using solar energy to preheat the water before entering the boiler at Tea shops and in addition auto- ignition setup has been added. Based on the temperature of the water inside the boiler, which is monitored continuously and fed to the microcontroller, the auto- ignition is turned on and gets off. Thus reducing LPG utilization in Tea shops. Added to that, in consideration with safety MQ6 for gas leakage detection, BMP180 for monitoring pressure and boiler water level detection are monitored and maintained. With all these it is able to minimize LPG utilization by 40% – 50% during hot summer.

Keywords : Parabolic Trough Collector; Auto-Ignition; LPG Reduction; Pre-Heating.

I. INTRODUCTION

Resources in fields of agriculture, industries and domestic activities goes on increasing day by day. The main reason to switching to renewable resources is to reduce the emission of Greenhouse gases and to save money spent on purchasing hefty fuel. It is expected that solar energy utilization is going to be the emerging renewable technology in the near future. Here the main focus is on reducing the utilization of LPG's as much as possible by preheating the boiler water using solar energy. Using LPG to boil water is not ecofriendly and needs more maintenance. Zhang, G. et al. [3] energy collector and is an ecofriendly approach and here we use this model to minimize the utilization of LPG's by continuously monitoring water temperature in the boiler which has been preheated through solar energy and according to the temperature minimum or maximum auto-ignition is turned ON and OFF. Normally a busy tea café use 15 liters of water in a day for making 120 cups of tea and for boiling it they utilize around 2500 g of LPG per day. In Chennai licensed tea shop counts more than 15,000 and unlicensed one is not less in number. Approximately 2 Lakhs tea shops are there in major 10 – 15

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cities of Tamil Nadu. On an average in Tamil Nadu alone 3 to 4 Lakhs Tea shops are there where approximately Around 3,00,000 kg of LPG is used around Tamil Nadu alone. This could pollute the environment at high cost when it is considered all over the nation. Guven.H.M. et al. [10] proposed that the parabolic trough solar collectors are more suited for developing countries. Hence parabolic trough collector model will be more effective method in India to minimize the LPG utilization by pre heating the boiler water.

Since there is no ample awareness among the nation, even though Government comes forward to provide funds for installing solar energy, installation of solar energy is less in number. Government is concentrating on solar power generation and not on projects like this. If this project reach the people then LPG utilization in Tea shops is reduced by preheating the water before it reaches the boiler. Using this proposed project approximately 45% of regular LPG usage can be minimized throughout theyear.

II. METHODOLOGY

Among various types of solar collectors, in consideration with efficiency the Parabolic solar collector showed better results and this has been analyzed by Kalogirou, S.A. et al. [2]. Hence in the proposed method parabolic trough model to boil water in Tea shops is used.

Liang, H. et al. [5] has analyzed and proposed that parabolic trough model is cost effective compared to other solar collectors. Parabolic Trough is a type of solar concentrators that are curved as a parabola and Arasu, A.V. and Sornakumar, T. [6] has used new fiber reinforced plastics for the curved shape and is placed in a straight line, such that they concentrate solar radiation over a line focus. It tracks the sun in a single axis to transfer energy to water circulating through receiver pipe. The trough can thus said to be in its morning position at the start of the day. It moves to its noon position when the sun is directly overhead. By the end of the day, it moves to its evening position, following the sun all the way. This may be calculated continuously based on input to the Microcontroller from a solar radiation sensor that detects the sun's position. The other reason for using parabolic trough model is due to its compact size and this has been proposed by Fuqiang, W. et al. [4]. The motion to the parabolic trough may be electrical or hydraulic. In case of electrical, a servo or stepper is used. Bakos, G.C. [20] has proposed that the hydraulic system will used to track the position the troughs. The movement can be manual also.

The water from the tank enters the collector pipe fixed above the parabolic trough where the parabolic trough reflects the heat into the iron collector pipe absorbed from the sunlight. The boiler water level is continuously monitored using LED's. When the water level in

the boiler is minimum, which is measured using water level indicator and is indicated through LED. According to the level high, medium or low the inlet valve is opened and water is filled in the boiler.

The water which flows in the collector pipe gets heated up to 50°C and which can be noted using the temperature sensor (LM35). LM35 is a linear temperature sensor whose output voltage varies linearly with change in temperature. LM35 is three terminal linear temperature sensor. It can measure temperature from -55 degree Celsius to 110 degree Celsius. With the help of LM35 sensor in the boiler, the details about the temperature of water in the boiler is measured and it is displayed on 16x2 LCD module.

If the boiler temperature is less than 50°C auto ignition system starts and heated till necessary temperature is attained, which is monitored and displayed in the LCD display. This ignition is done using fixing the burner starter to the 10 rpm dc motor and if the water inside the boiler has attained the necessary temperature for example 95 degree Celsius then the motor rotates anticlockwise direction, so that ignition gets turned off.

In case auto ignition fails to ignite the burner and gas leaking occurs then the gas sensor MQ6 fixed near the burner detect the leakage and buzzer gives alarm.

Due to high pressure, accidents may occur. By monitoring the pressure with the help of microcontroller and using automatic pressure releasing mechanism excess pressure is released. In addition Thermal Storage Tank can be used to store excess heat generated which can be utilized next day in the morning to reduce start up time period of the system.

A.Parabolic trough collector

The Parabolic trough collector is a solar energy collector designed to capture the sun light directly and more effectively than other types of solar collectors shown in figure 1.1. The incoming sun light is reflected onto the collector pipe. So that water flows through the collector pipe gets heated. Beemkumar, N [14] has proposed different reflector material can be used. Sagade A.A., [1] proposed that parabolic trough collector with mild steel receiver with glass cover shows more efficiency than without glass cover.

Aher, S. et al. [7] also analyzed and confirmed that glass covered receivers are more efficient setup. So that more heat can be focused on the collector pipe.

Gee, R.C. and Murphy, L.M. [8] has proposed that for higher operating temperature consideration of evacuated receiver tubes will be more effective.

Heat pipe receivers in place of evacuated can be used which is easily maintained which has been analyzed by Zhan.D et al. [12] and Liang, H [13].

De Oliveira Siqueira et al. [9] performed experimental analysis of solar parabolic trough concentrating system.

Forristall, R. [11] has experimentally proved that parabolic trough with any absorber and reflector material will not show much energy loss or gain, only slight changes will be there. Accordingly, the radiative forcing model suggested by [11] reveals that solar power is absorbed by specific coating on the $Q_{a, ab}$ absorber and the $Q_{g, ab}$ glass package. The power consumed by the specific layer is partially transported to the side wall of the absorber $Q_{a, c}$, And then distributed to the working fluid by conduction of Q_{gain} . Some of the energy absorbed by the absorber is transferred to the glass package by heat transfer $Q_{c, a-g}$ and $Q_{r, a-g}$ and lost through the ends

of the receiver $Q_{l, b}$. The energy absorbed by the envelope of glass and the energy used

From the inner wall to the outer wall of the glass container, convection $Q_{c, g-e}$ and radioactivity $Q_{r, g-e}$ [11] are lost to the atmosphere. The energy balance of the solar transmitter can be written as follows [11],

$$Q_{gain} = Q_{a,c} \quad (1)$$

$$Q_{a,ab} = Q_{c,a-g} + Q_{r,a-g} + Q_{a,c} + Q_{l,b} \quad (2) \quad Q_{g,c} =$$

$$Q_{c,a-g} + Q_{r,a-g} \quad (3)$$

$$Q_{g,c} + Q_{g,ab} = Q_{c,g-e} + Q_{r,g-e} \quad (4)$$

Therefore, any error in treating solar absorption as a surface phenomenon should be relatively small.

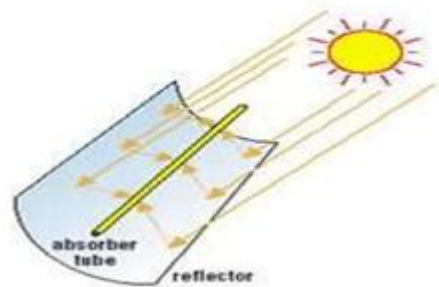


Fig 1 Parabolic Trough Collector

B. Temperature sensor LM35

Wilcher, D. [18] proposed that LM35 can measure temperature more accurately and explained displaying temperature using LCD. Its measurement value ranges of 0°C to +100°C. This LM35 is used to measure the temperature of water inside the boiler at Tea café. It is monitored continuously and is displayed in LCD. Based on the water temperature auto-ignition gets started.

C. 10 rpm DC motor

10 rpm dc motor works efficiently at 12v supply. Characteristics of DC motor has been analyzed by Liou, F.W. [16]. It is used for auto-ignition by fixing it to the ignition line of burner. When boiler water temperature is less the 50 degree Celsius it turns +90 degree. Since it is attached to the ignition system burner gets turned ON. In case if the boiler temperature is greater than 100 degree Celsius motor turns -90 degree. So that burner is turned OFF. This is controlled by PIC16f877a microcontroller.

D. Pressure sensor BMP180

BMP180 is a high precision digital pressure sensor measuring pressure ranges from 300 – 1100hpa and its supply voltage is 1.8 – 3.6V. Monisha, D.S. [17] has represented it as digital friendly sensor. The measured data is stored in E2PRROM of BMP180 and it read via I2C of the pic microcontroller. The measured pressure value is displayed in LCD. This could help in avoiding accidents due to high pressure.

E. Gas leakage detector MQ6

Apeh, S.T. [19] proposed MQ6 is high sensitive to LPG and has high response time. It is capable of detect gas leakage in less than 10 seconds. It is fixed near the burner at the same time it is placed in such a way



so that not affected by the flames. In case auto ignition fails to start and LPG starts leaking MQ6 detects the gas leakage and buzzer is interfaced to give indication.

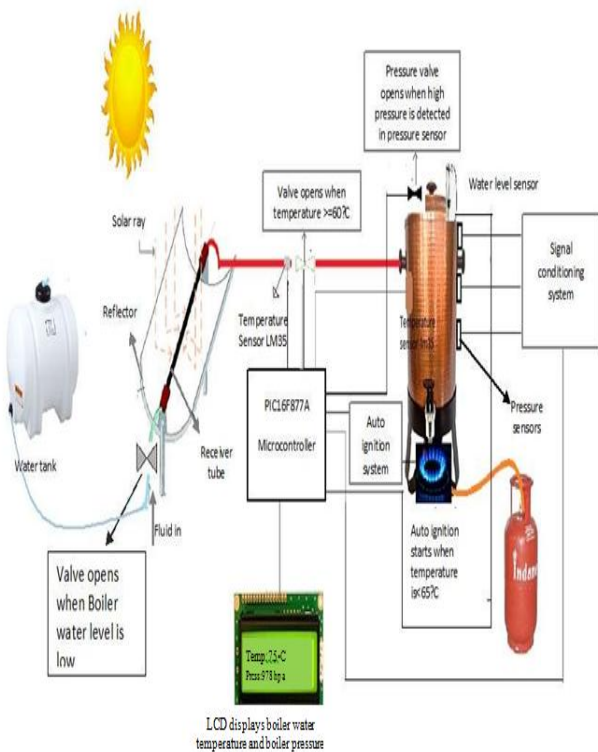
F. Level Detection

The boiler water level is monitored at three stages (high, medium, low). This is monitored by fixing copper bolts in the boiler at three points and connecting the wire in the other of the bolt shown in figure1.2. When water reaches the first level, it is indicated using LED through a wire connected in the other side of the boiler. To avoid salt deposition in the bolts it has to be removed and cleaned periodically.



Fig.2 Water level detection using copper bolts

III. BLOCK DIAGRAM:



Data	Date	Atmospheric Temperature in °C	Water Temperature in °C	Water Temperature After Preheating in °C	Avg. Tea Consumption (no. of cups)	LPG used before installing preheating setup in g	LPG used after installing preheating setup in g
D1	29.09.18	31	9	25	190	2090	1890
D2	02.10.18	30	8	22	200	2200	2020
D3	04.10.18	28	7	20	200	2200	2100
D4	11.12.18	32	11	27	190	2090	1840
D5	17.12.18	32	12	28	190	2090	1830
D6	02.01.19	29	7	20	200	2200	2070
D7	03.01.19	31	8	22	210	2310	2110
D8	05.01.19	30	9	23	200	2200	2020
D9	06.01.19	30	9	23	210	2310	2130
D10	07.01.19	31	10	25	200	2200	2000

Table 1 Observation table during winter LPG utilization without and with preheating during winter

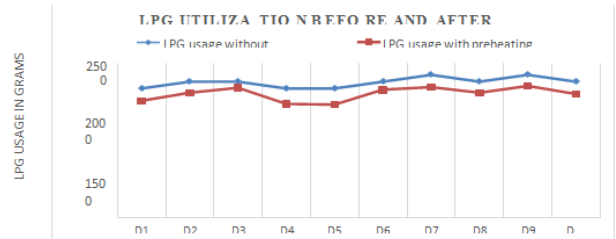


Fig.2 LPG Utilization Without and With Preheating During Winter

From the Table 4.1 and Figure 4.1 it is seen that during winter approximately it is able to reduce 15 to 20 percentage of LPG in a busy Tea café by installing Pre heating system.

Table 2. Observation Table during summer

Data	Date	Atmospheric Temperature in °C	Water Temperature in °C	Water Temperature After Preheating in °C	Avg. Tea Consumption (no. of cups)	LPG used in grams without preheating model	LPG used in grams with preheating model
D1	04.02.19	33	12	30	210	2300	2010
D2	08.02.19	35	15	36	200	2190	1820
D3	15.02.19	34	14	36	200	2190	1830
D4	20.02.19	34	13	35	190	2080	1720
D5	24.02.19	37	16	40	190	2080	1690
D6	27.02.19	35	14	37	200	2190	1820
D7	28.02.19	36	15	40	200	2190	1790
D8	03.03.19	36	16	42	210	2300	1900
D9	07.03.19	39	17	49	170	1870	1120
D10	09.03.19	37	16	47	180	1980	1450

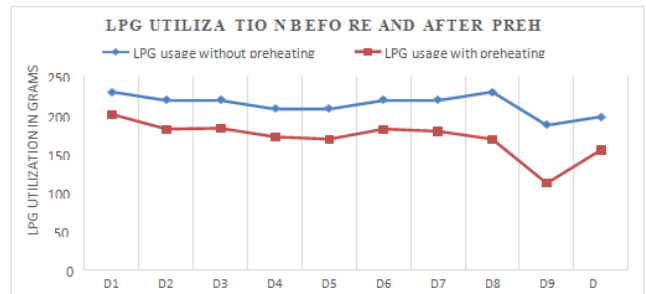


Fig.3 LPG Utilization without and with Preheating During Summer

From the Table 4.2 and Figure 4.2 it is clear that, on an average during summer it is able to reduce 40 to 50% of LPG in a busy Tea café by installing Pre heating system. By increasing the size of the parabolic trough Collector pipe size it is able to achieve greater efficiency.

IV.CONCLUSION

This development project is mainly used at Tea shops for preheating the water, before it enters the boiler and gets heated by LPG. Thus reducing the usage of LPG's at Tea shops. Parabolic trough collector setup had been used to preheat the boiler water. And further temperature sensor LM35 for monitoring the water temperature in the boiler continuously and displaying it in the LCD helps to know how much to be heated further by LPG, which minimizes LPG utilization. This ignition starts automatically when boiler water temperature is low. In case if auto ignition fails to open, MQ6 gas sensor detects the gas leakage and buzzer turns on. So that pollution caused by using LPG's at Tea shops is reduced. As this project implemented all over the nation then the usage of LPG's in large amount can be minimized. In addition to this, level sensors are used in to monitor the boiler water level and valve can opened only when the water level in the boiler is minimum. Since high pressure may leads to accidents, BMP180 is used to monitor the boiler pressure regularly. From the table 4.2 it is clear that on a hot sunny day it is able to reduce approximately 45% of LPG utilization. Hence by installing the pre heating system it is able to reduce 40% -50% of LPG during hot sunny day and it can be further increased by extending the size of parabolic trough collector and collector pipe.

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