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# EFFECT OF AUTOMATED BURNER KNOB FOR DIFFERENT MEDIUM ON GAS CONSUMPTION BY LOCAL STOVE FOR HOUSEHOLD AND INDUSTRIAL SAFETY

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**Key words:** Traditional stove, LPG detector, Electronic components

**ABSTRACT**

This article presents a framework of house hold and industrial automation, safety and fuel conservation through a very basic approach. The ever increasing demand and usage of LPG in India poses a major concern regarding the availability of safe and efficient stoves at households as well as the industries. The ideas presented show comparison between the gas consumption with and without the use of an automated system implemented on the traditional stove. The comparison has been defined by means of graphs with traceability capabilities depending upon the experiments carried out. The experimental setup used, is made from readily available components hence providing a feasible solution to the stated problems.

## INTRODUCTION

The The usage of LPG gas cylinders in India is very common. The rapidly developing nation is yet to adopt safer and better practice for usage of LPG for domestic and industrial purposes. The demand has led to a rise in price of LPG that makes it inaccessible to the lower income groups (Pedro, *et al.*, 2011, Pohekar, *et al.*, 2005; Pachauri and Jiang, 2008; Sharma, *et al.*, 2009; Rao, 2012; Thukral and Bhandari, 1994; Makonese, *et al.*, 2012; Bhattacharya and Salam, 2002) The available gas stoves provide an efficiency of about 40-45% (Pohekar, *et al.*, 2005; Zhang, *et al.*, 1999; Parikh, *et al.*, 2001; Mishra, *et al.*, 2015; Pantangi, *et al.*, 2007; Pantangi, *et al.*, 2011; Muthukumar, *et al.*, 2011). These stoves do not hold much ground when it comes to the consumption of LPG, and with the increasing demands of LPG and minimal availability of resources, a solution needs to be provided. Being the second largest consumer of LPG in the world, better and safer practices need to be put to use to conserve as much LPG as possible. The currently available products in the market are either not easily affordable to the common man, or do not deliver the desired results. Above that the onset of automation has opened up many opportunities. One such field is Home Automation under which the current project would fall. The aim of an HA (Home Automation) system is to provide homes with a certain degree of 'intelligence' and to improve the quality of life of its inhabitants (Mishra, *et al.*, 2015). The AutoKnob, focuses on doing the same to the LPG stove. The methods and components used in this project are aimed to make the product cheap and readily available to the common people. This would also allow easy installation and maintenance. The simple idea here is to automate the gas stove available in Indian household using basic electrical components to obtain feedback and perform desired operations. The AutoKnob would be easy to fit on any gas stove eliminating the necessity of purchasing a new stove altogether (Muthukumar, *et al.*, 2013; Mujeebu, *et al.*,

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2011; Jugjai, *et al*., 2001; Jugjai and Rungsimuntuchart, 2002; Trimis and Durst, 1996; Barra, *et al*., 2003; Gao, *et al*., 2014). The major control unit and the components like the timer and IR sensor will be integrated into the main body to allow easy access to the stove. The knob will be controlled by a servo motor, obtaining pulses from an Arduino board based on the feedbacks of the sensors. The sensors being used are temperature sensor to assist in cooking and IR sensor to identify if there is a vessel on the stove while the flame is on. A timer is provided to time the heating and avoid rushing to the stove again and again. The LPG detector is another sensor that will be fixed near the cylinder to detect any leaks and warn the user through an alarm. Side by side the detection of a leakage would also immediately shut off the knobs ensuring that there is no flame to ignite the leaking gas. This product if put to use can reduce the wastage of gas by optimizing the burner flame to some extent. This would also help in preventing accidents due to gas leakages. Since this product deals with knobs, it can be used at any place that requires regulating the flow of LPG through a knob. The industrial and domestic usage of this product will help in aid in safe handling of LPG gas preventing damage to both humans and property. The product has several advantages. It can regulate the knob of the gas stove based on preinstalled programs combined with a few user inputs. Very basic parameters like time can be entered by the user to allow easy handling of the device. Since the AutoKnob is mounted directly on the gas stove, it will be cheaper than buying a new gas stove and hence more affordable. The detachable clips make it easy to remove for maintenance, thus if there is no disturbance caused in the normal usage during the breakdown (Mujeebu, *et al*., 2009; Mujeebu, *et al*., 2009; Mujeebu, *et al*., 2009; Mujeebu, *et al*., 2010). The product is designed in a way keeping the common man in mind and hence the operation is kept as simple as possible. There are very less chances that the electronic components may fail and the code being executed in a wrong manner. Also the user must operate a few times to get used to the operations. LPG consumption in India is forecast to surpass 35 million tonne by FY26. Growth in the country's LPG market over the past few years can be attributed to rising demand from residential and commercial segments in the country. Number of LPG consumers in India increased from 1387.3 million in FY13 to 2041 million in FY16. Moreover, introduction of Ujjwala Yojana is further expected to increase consumption of LPG in the residential segment across of the country (Jugjai, *et al*., 2002; Jugjai and Polmart, 2003; Jugjai and Phothiya, 2007; Jugjai and Phothiya, 2007; Homraruen and Jugjai, 2014; Vijaykant and Agrawal, 2007; Fuse, *et al*., 2003; Takami, *et al*., 1998). Under this scheme, around 5 billion free LPG connections would be offered to families that are below the poverty line in India. Thus, on account of aforementioned factors consumption of LPG in India is forecast to increase continuously through FY26. The LPG market in India was dominated by the residential sector in FY16, followed by commercial segment. Residential segment is expected garner highest market share in India LPG market through FY26 as well. Moreover, IOCL dominated LPG market in India in FY16, owing to the company's expansion plans and construction of new pipelines across various states in India. IOCL is planning to construct a pipeline of more than 2000 km from Kandla in Gujarat to Gorakhpur in Uttar Pradesh for transportation of LPG."Imports of LPG in India is forecast to almost double from 7.98 million t in 2015 to 15.50 million t by 2025, as the domestic requirement for LPG is not being meet through domestic production. Oil marketing companies such as IOCL, HPCL and BPCL are anticipated to remain major suppliers and importers of LPG in the country through FY26. Moreover, introduction of favorable government policies, rising per capita income and expanding distribution network are further projected to boost consumption of LPG in India during FY17 - FY26.", said Mr. Karan Chechi, Research Director with TechSci Research, a research based global management consulting firm (Kakati, *et al*., 2007; Sharma, *et al*., 2009; Sharma, *et al*., 2011; Sharma, *et al*., 2016; Barra and Ellzey, 2004; Delalic, *et al*., 2004; Indian Standard, 1999; Liu and Hsieh, 2004; Howell, *et al*., 1996; Lammers and Goey, 2003; Bakry, *et al*., 2011). "India LPG Market by End Use Segment, By Source, Competition Forecast and Opportunities, FY2012 - FY2026" has evaluated the future growth potential of India LPG market and provides statistics and information on market size, structure and future market growth. The report intends to provide cutting-edge market intelligence and help decision makers take sound investment evaluation (Kaplan and Hall, 1995; Pontree and Jugjai, 2014; Smith, *et al*., 2000; Kline and Clintock, 1953; Sanjay, 2017; Sivam, *et al*., 2015; Sivam, *et al*., 2015; Sivam, *et al*., 2016).

## INDIAN LPG MARKET

India is the second-largest domestic LPG (Liquefied Petroleum Gas) consumer in the world.

LPG consumption by households has reached 19 million tonne, registering an annual growth rate of 10% which is equivalent to 19 million tonne

(19,000,000 × 1000 kg). This means the consumption of around 1338028169 cylinders per year since one standard LPG cylinder has a capacity of 14.2 kg of fuel. The usage per day turns out to be 3665830 kg which is roughly around three cylinders per second usage on a daily basis (Fig. 1).

## SCHEMATICS AND WORKING OF AUTOKNOB

### Schematics

The schematics represents that the experimental setup of Auto knob is simple and has minimal components (Fig. 2 and 3).

### Working of AutoKnob

Quality The AutoKnob is clamped on the knob present on the stove with the help of flexible spring return clips. The clips are connected to the servo motor present inside the AutoKnob casing to provide the knob rotation. The casing contains the Arduino UNO board and the wirings. The Arduino is a programmable board and hold the program

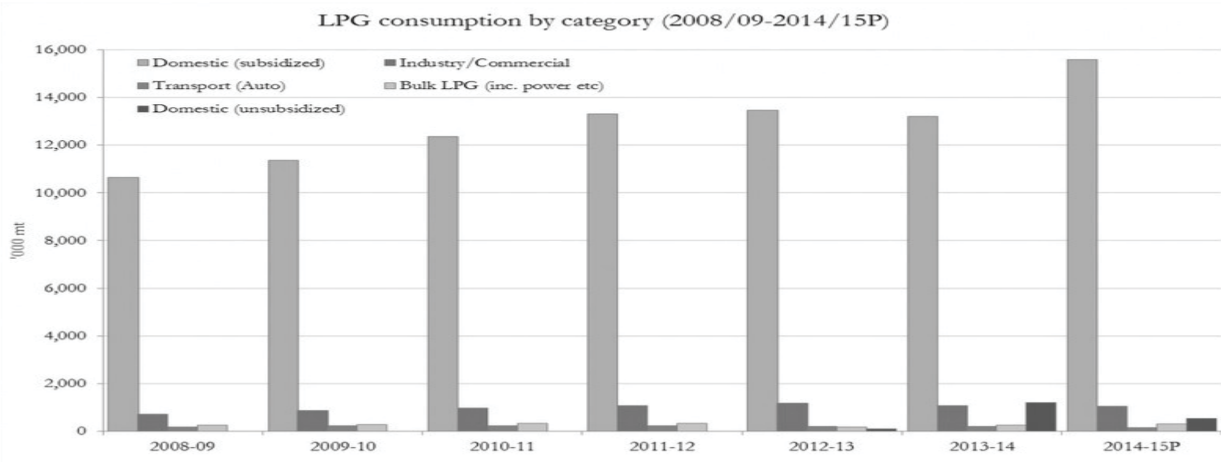


**Fig. 1** Domestic and industrial consumption of LPG across India [49] (Courtesy of The Times of India, Business).

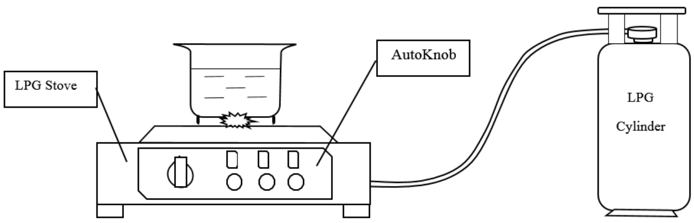


**Fig. 2** Circuit diagram of Autoknob.

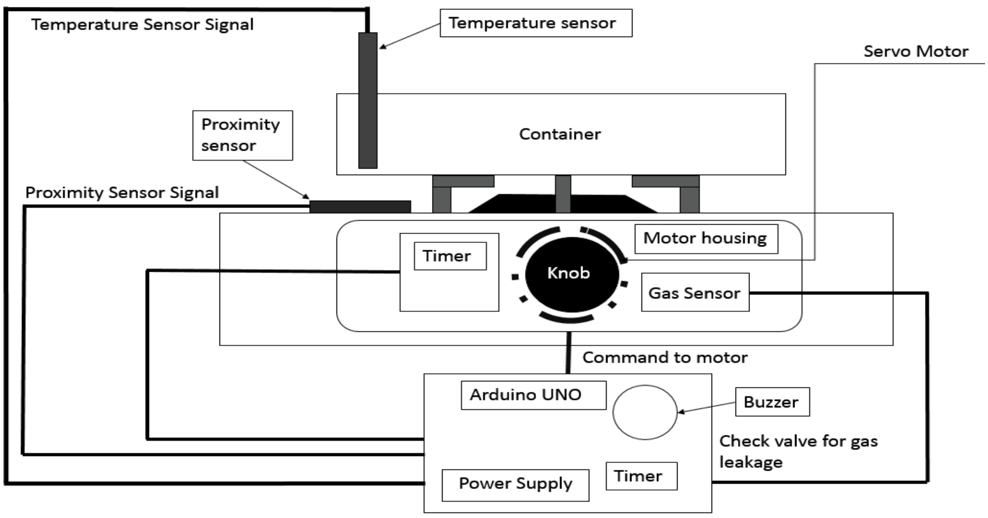


**Fig. 3** Circuit diagram of Autoknob.

necessary to control the knob functions. It can take both analogue and digital inputs allowing a wide range of inputs to be analyzed. The Arduino functions as the motherboard for the device. On the side facing the user, an external knob will be available to handle the knob manually according to necessity. Three control switches will be provided to adjust temperature, timing and amount of LPG flow. Through the proximity sensor, it will be possible to cut off the gas supply by turning the knob off whenever there is an absence of a utensil. The cooking process can be set according to temperature, time or both simultaneously. The setup will come with predefined settings which will ask the user to enter these data through the control switches and the process will begin. A buzzer is provided to give notification sound on initiation and completion of a task as well as in the case of emergencies. Apart from these, a gas sensor will detect a gas leakage and will cut-off the fuel supply and sound the buzzer. The buzzer sound will vary respective to each process in order to enable the user to differentiate between the processes from a distance. The AutoKnob will serve the purpose of providing enhanced flame control by pre-adjusted optimum knob rotate angle, enhanced safety as gas valve will cut off the gas supply when the flame unexpectedly goes out. The working will be quite convenient as thecooking timer with automatic switch off for each cooking zone and interlink between cook top and flame will provide safety. AutoKnob assisted burner system is excellent for a wide variety cooking style. The Proximity sensor will detect the presence and absence of a utensil over the burner and hence will switch the flame on or off. The metal casing is heat-resistant and easy to clean.

## METHODOLOGY

The experiment is conducted on the most basic use of the stove that is to boil water. A liter of water is boiled on the stove and the amount of gas consumed is measured. The weight of the cylinder is taken which comes to around 14.2 kg and is converted into liters. The calorific value of LPG is calculated the efficiency of the burner is taken. The energy required to boil one liter of water is taken and the difference is found between the energy from the LPG and the energy consumed by the water. This gives an estimate idea of the energy being consumed and that going waste Tables 1-4. The same method is used with the Autoknob mounted on the stove and the results are compared to get an estimate of the usage LPG. The data obtained is presented and comparison charts made, which show the advantage the Autoknob has over the simple gas stove (Fig. 4-7).

## CALCULATIONS

1 kg = 1.96 lit; 14 kg = 27.44 lit × 25 MJ; 686000J/Lit × 89.3%; LPG: 612598J/L; Water: 293.02 J/L

**Table 1.** Experimental analysis of LPG consumption and its comparison with and without Auto Knob using stainless steel.

| Serial No. | Utensil Used | Used Fluid (1 Litre) | Time taken without AutoKnob (min) | Time taken with AutoKnob (min) | Fuel Consumption without AutoKnob (Kg) | Fuel Consumption with AutoKnob (Kg) | Fuel Saved (%) |
|---|---|---|---|---|---|---|---|
| 1 | Stainless Steel | Water | 15:22 | 14:33 | 0.0139 | 0.0130 | 6.47 |
| 2 | Stainless Steel | Water | 15:16 | 14:29 | 0.0137 | 0.0128 | 6.56 |
| 3 | Stainless Steel | Water | 15:18 | 14:32 | 0.0137 | 0.0129 | 5.83 |
| 4 | Stainless Steel | Water | 15:24 | 14:33 | 0.0136 | 0.0127 | 6.61 |
| 5 | Stainless Steel | Water | 15:21 | 14.38 | 0.0138 | 0.0129 | 6.52 |
| 6 | Stainless Steel | Water | 15:20 | 14:29 | 0.0136 | 0.0129 | 5.14 |
| Average Fuel Saved | | | | | | | 6.18 |

**Table 2.** Experimental analysis of LPG consumption and its comparison with and without AutoKnob using copper.

| Serial No. | Used Fluid (1 Litre) | Time taken without AutoKnob (min) | Time taken with AutoKnob (min) | Fuel Consumption without AutoKnob (Kg) | Fuel Consumption with AutoKnob (Kg) | Fuel Saved (%) |
|---|---|---|---|---|---|---|
| 1 | Water | 15:18 | 14:29 | 0.0141 | 0.0133 | 5.67 |
| 2 | Water | 15:15 | 14:24 | 0.0138 | 0.0129 | 6.52 |
| 3 | Water | 15:11 | 14:27 | 0.0140 | 0.0131 | 6.42 |
| 4 | Water | 15:13 | 14:19 | 0.0135 | 0.0126 | 6.67 |
| 5 | Water | 15:10 | 14.20 | 0.0138 | 0.0129 | 6.52 |
| 6 | Water | 15:07 | 14:17 | 0.0135 | 0.0127 | 5.92 |
| Average Fuel Saved | | | | | | 6.28 |

**Table 3.** Experimental analysis of LPG consumption and its comparison with and without AutoKnob using Tin.

| Serial No. | Used Fluid (1 Litre) | Time taken without AutoKnob (min) | Time taken with AutoKnob (min) | Fuel Consumption without AutoKnob (Kg) | Fuel Consumption with AutoKnob (Kg) | Fuel Saved (%) |
|---|---|---|---|---|---|---|
| 1 | Water | 15:20 | 14:31 | 0.0140 | 0.0131 | 6.42 |
| 2 | Water | 15:19 | 14:30 | 0.0137 | 0.0128 | 6.56 |
| 3 | Water | 15:15 | 14:32 | 0.0139 | 0.0131 | 5.75 |
| 4 | Water | 15:21 | 14:35 | 0.0134 | 0.0125 | 6.71 |
| 5 | Water | 15:18 | 14.38 | 0.0141 | 0.0132 | 6.38 |
| 6 | Water | 15:20 | 14:29 | 0.0137 | 0.0129 | 5.83 |
| Average Fuel Saved | | | | | | 6.27 |

**Table 4.** Experimental analysis of LPG consumption and its comparison with and without AutoKnob using bronze.

| Serial No. | Used Fluid (1 Litre) | Time taken without AutoKnob (min) | Time taken with AutoKnob (min) | Fuel Consumption without AutoKnob (Kg) | Fuel Consumption with AutoKnob (Kg) | Fuel Saved (%) |
|---|---|---|---|---|---|---|
| 1 | Water | 15:24 | 14:37 | 0.0142 | 0.0133 | 6.34 |
| 2 | Water | 15:19 | 14:31 | 0.0140 | 0.0131 | 6.43 |
| 3 | Water | 15:21 | 14:33 | 0.0139 | 0.0130 | 6.47 |
| 4 | Water | 15:26 | 14:35 | 0.0137 | 0.0129 | 5.84 |
| 5 | Water | 15:23 | 14.32 | 0.0140 | 0.0131 | 6.43 |
| 6 | Water | 15:19 | 14:29 | 0.0136 | 0.0129 | 5.14 |
| Average Fuel Saved | | | | | | 6.11 |

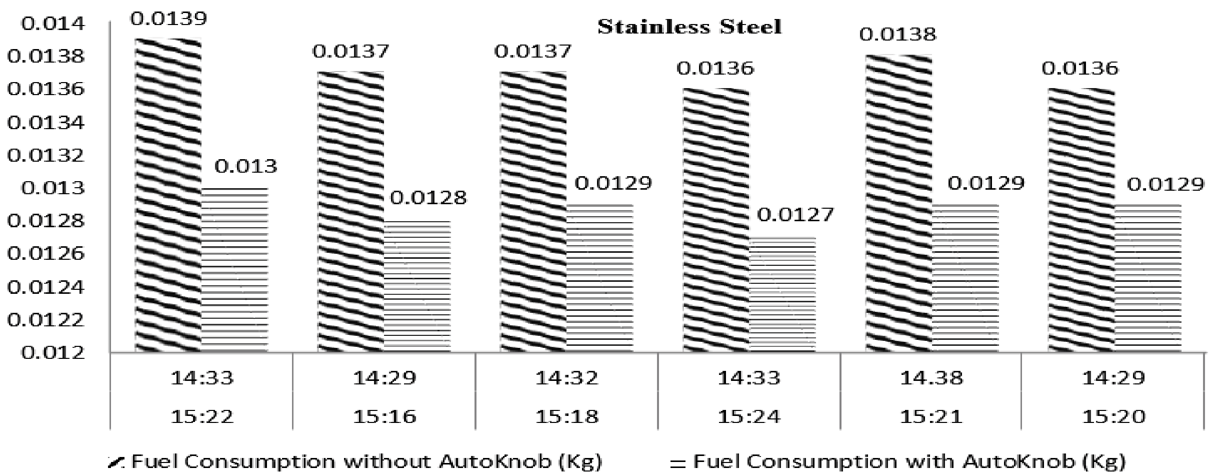


**Fig. 4** Comparison of fuel consumption with and without AutoKnobusing stainless steel.

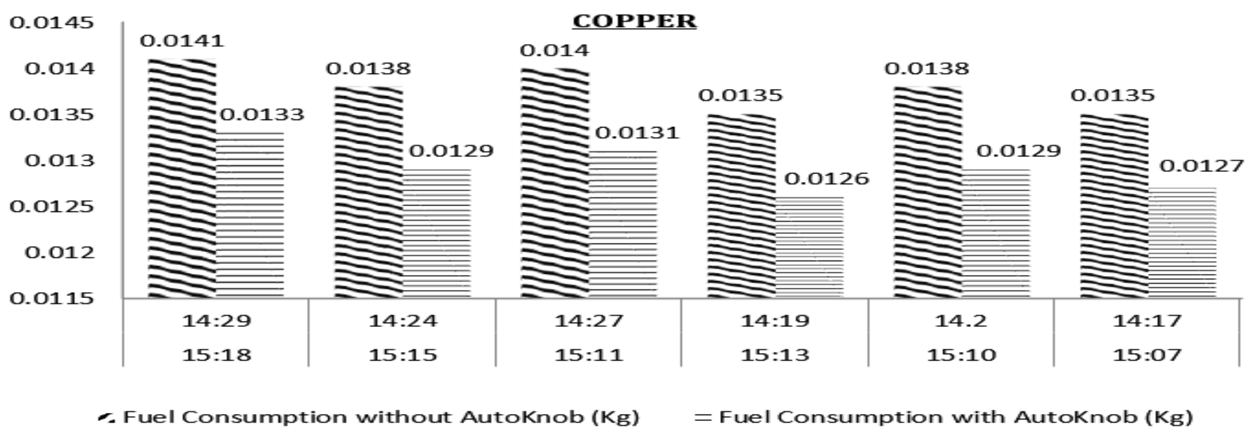


**Fig. 5** Comparison of fuel consumption with and without AutoKnob using copper.

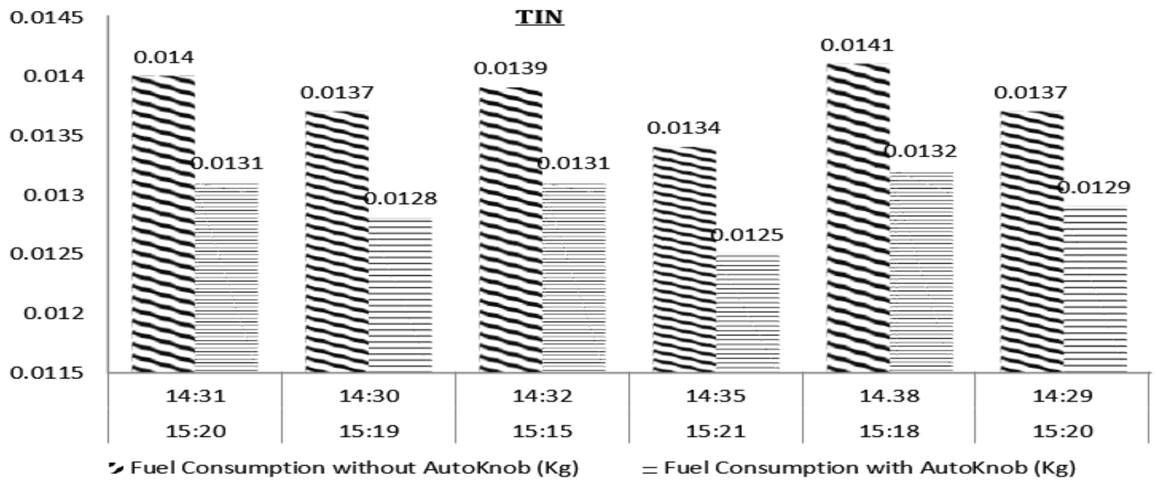


**Fig. 6** Comparision of fuel consumption with and without AutoKnob using Tin.

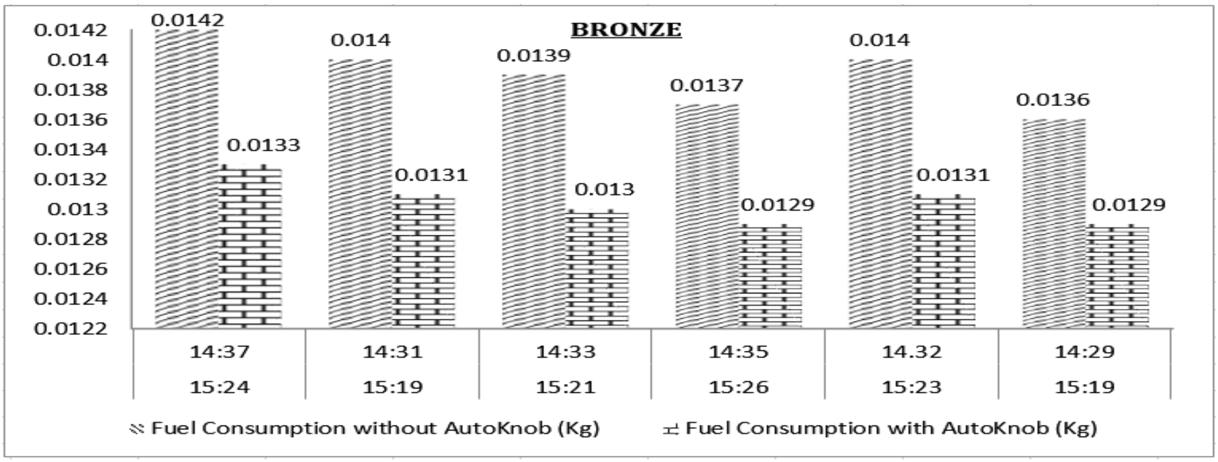


**Fig. 7** Comparison of fuel consumption with and without AutoKnob using bronze.

**Implementation**: Comparison of usage at room temperature of 31°C.

The Autoknob is made such that it can be used in wide varieties of fields. The main objective being to be able to consume less LPG by intelligently handling the operating knob. The experiments carried out on the stove have shown the optimum result which allows the conservation of LPG that would have otherwise gone waste.

## CONCLUSION

The Auto knob was tested on the gas burner. The simple daily chore of boiling water was done to test its effectiveness in saving LPG. The average percentage of fuel saved was then calculated to be somewhere around 6.18%. The calculated result comes from a single gas stove and LPG cylinder. This device if put to use can save a lot of fuel decreasing the consumption per household or the overall consumption of an industry. As suggested by the statistics the amount saved should be able to make quite an impact on the LPG demand and make it a bit more accessible. The simplistic design of the product allows it to be easily handled. The produced mostly from readily available components, the product also becomes cheap and affordable to all households that have a LPG stove. This design reduces the usage of LPG to a certain extent, however further improvement is anticipated with modifications in the code, sensors or a different approach to the same problem.

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