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The Development of Innovative Hybrid Stove with Solar and Biogas for Rural Area

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Abstract- Induction heating is widely used now a day because of its high efficiency and clean operation. Induction heating system utilizes electricity for the generation of heat even though solar energy is the largely available energy source. The present work of combining solar energy with induction heat generation technique is the efficient solution for heat generation application. It is derived from the principle of electromagnetic induction. The solar energy is the main source used to produce heat but one cannot rely on solar energy throughout the year. This project helps to develop a model called HYBRID STOVE in which cooking can be switched to biogas during cloudy days or rainy seasons. The other thing which one needs to take care of while using gas is the possibility of gas leakage. The aim of this project is to build a stove with the energy coming from both solar source and biogas and if there will be any gas leakage, it will be detected by MQ5 sensor and notified to the user when the threshold limit is crossed using Arduino.

Keywords— Solar energy; biogas; MQ5 gas sensor; Arduino.

I. INTRODUCTION

Induction heating is the process of heating electrically ferromagnetic (conductive) materials by a process called electromagnetic induction. Induction heating is widely used in most of the domestic appliances because the cleanness is high, efficiency is high, safety is very high, and cost is low advanced power semiconductors and high performance. Even though solar energy is a renewable source of energy, it is not available for 24 hours which makes it merely impossible to use it in the night or cloudy days. Hence there must be an alternative way to cook during the times when solar energy cannot be obtained. There comes the use of biogas and cooking can be done using a gas burner with biogas as a fuel. Biogas, an alternative fuel that is both sustainable and renewable is produced from anaerobic fermentation of organic material in digestion facilities. The main influencing factors in using biogas as a combustible gas are gas/air mixing rate, flame speed, ignition temperature and gas pressure. Compared to liquefied petroleum gas, biogas needs less air per cubic metre for combustion. Solenoid valves are used as an interface between the induction stove and biogas burner, performing the switching action.

This paper is organised as follows: Section I contains the introduction, Section II explains the related works, the proposed methodology is described in Section III, Section IV contain the results and discussion, Section V concludes research work with future directions.

II. RELATED WORK

With reference to the reference paper indicated in [1], the electric energy which is obtained from the solar panel is utilized to charge the rechargeable lead acid battery bank. The charging of the battery must be monitored and controlled to avoid overcharging and to indicate the low voltage condition of the battery for which charge control unit is necessary. Pulse width modulation technology is used in solar charge control unit. Further referring to reference paper [2], a voltage regulator is used. A voltage regulator IC always maintains the output of voltage at a constant value of voltage 7805 IC, A member of 78xx series of fixed linear voltage regulators is always used to maintain the fluctuations; it is a well-known voltage regulator integrated circuit (IC). The xx in 78xx tells us the output voltage it is going to provide. 7805 IC will provide the +5 volts regulated power supply with the provision to add a heat sink. The reference paper [3] uses Quasi Resonant Topology where, quasi resonant converters are widely used in induction cooker for implementing power converters. Such converters are quite attractive for domestic induction heating because it requires only one switch, usually an IGBT, and only one resonant capacitor.

III. METHODOLOGY

A. Basic Procedure

The basic procedure of this system goes like this*:*

There are two primary input options in the system: (i) solar energy coming from the sun; it is received by the array of photovoltaic cell and further converted into electric energy

and (ii) biogas or LPG source. The overall block diagram of the system is shown in the Figure 1.

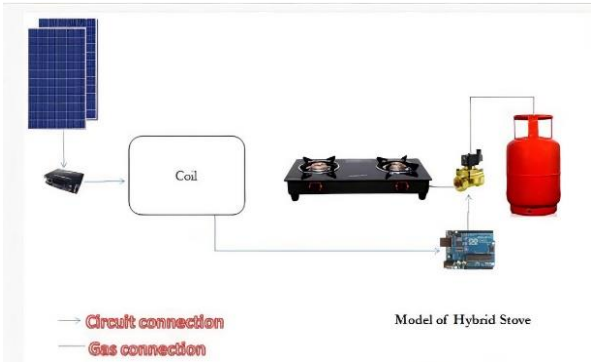

Figure 1. Basic structure of the system

The electric energy from the solar panel is given to inverter which then enables the flow of alternating current into the coil. In case the obtained power isn't sufficient to run the coil, a sensor is used to monitor the induction coil. In this paper, we are using voltage sensor for this purpose, this sensor gives a high output if the voltage in the coil becomes less than the required value. This measure is used to control the solenoid valve which controls the flow of gas to the other burner and a relay module which acts as a switch in between the sensor and solenoid valve. The sensor and relay modules are interconnected with the Arduino board which is a great tool for developing interactive objects, taking inputs from a variety of sensors and controlling the corresponding outputs. Finally, the solenoid valve is placed as an interface between gas source and the gas burner.

Since we are using gas supply, leakage might occur at some point of the operation. Hence, in order to provide maximum safety, gas leakage detection will be notified to the user with the help of a buzzer using a proper setup.
The components involved in predicting the parameters are described below:

a) MQ5 Gas Sensor

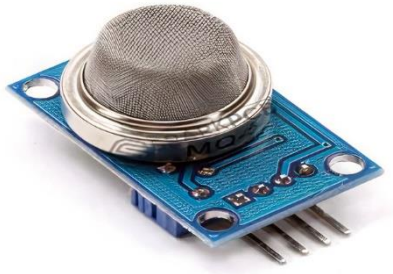

Figure 2. MQ5 Sensor

The MQ5 Gas Sensor module is useful for gas leakage detection. It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. When there is a combustible gas in the environment where sensor resides, the electrical conductivity of the sensor increases with the increase of the combustible gas concentration in the air. The change of electrical conductivity can be converted to the output signal corresponding to that of the gas concentration by using a simple circuit.

b) Voltage sensor

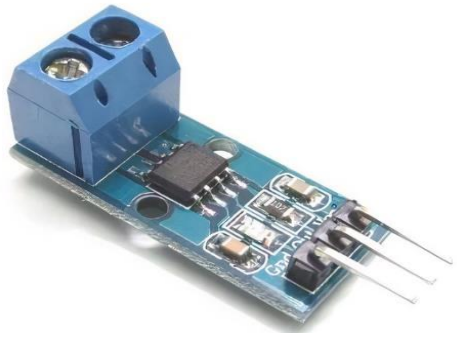

Figure 3. Voltage Sensor

A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage, whereas the output is the switches, analog voltage signal, a current signal, or an audible signal. This DC Voltage Sensor Module is essentially a 5:1 potential divider circuit built using precession resistors for high accuracy. The Arduino analog input is limited to a 5 VDC input.

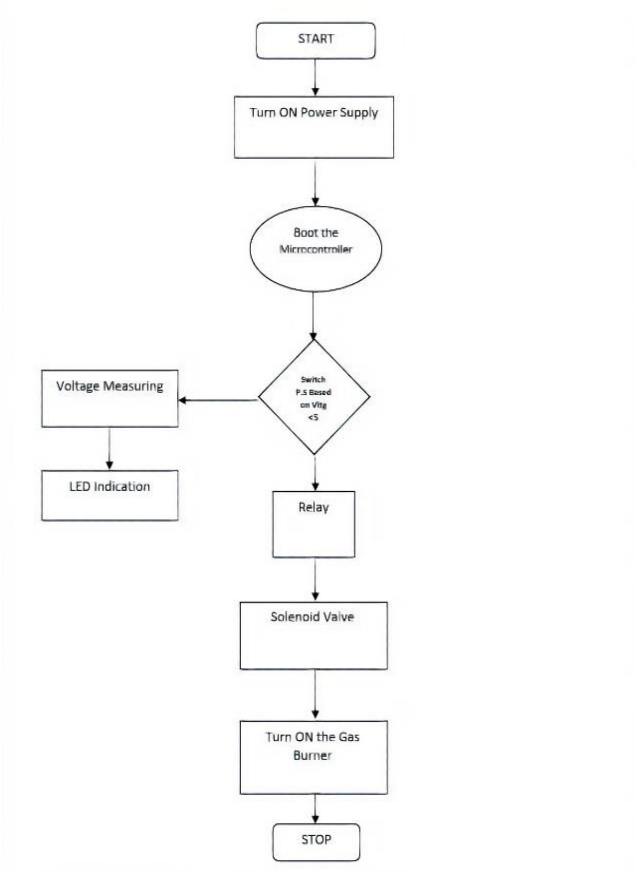

Figure 4. Flowchart of the system

The flow chart for the switching of solenoid valve which controls the flow of gas to the stove is shown in the figure (4). When the receiving voltage becomes less than the given voltage, the relay will switch which results in the opening of the solenoid valve thus allowing gas to reach the stove.

This will be done with the help of program code which we will be created specifically to control the switching of solenoid valve as well as for gas leakage detection. As per the condition we have given in the code, the gas movement to the stove is controlled and the leakage of the gas will be indicated with the help of buzzer and LCD display.

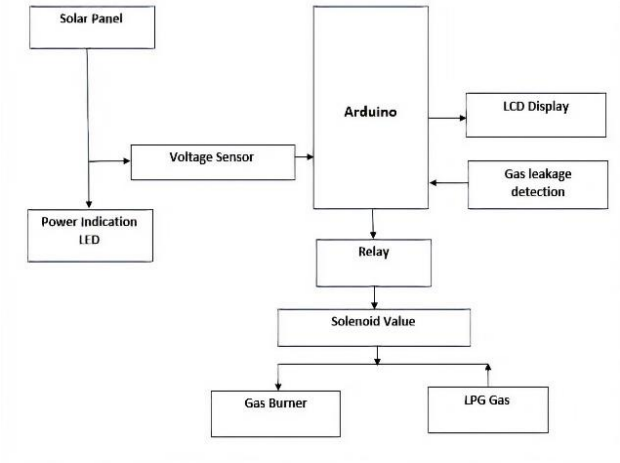

Figure 5. Block diagram of the system

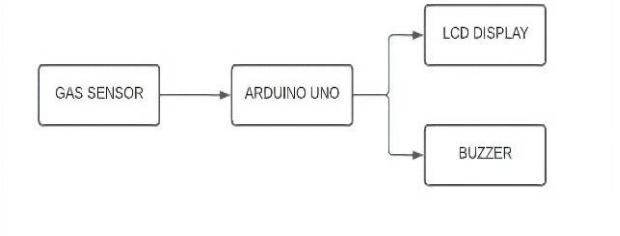

Figure 6. Block diagram of gas leakage detection

The basic block diagram of the system is shown in the figure 5. The solar energy will be converted to electrical energy which can be used for cooking and when the voltage is not sufficient automatic switching will be done using solenoid valve and Arduino. Moreover, any kind of gas leakage will also be detected and notified to user with the help of Arduino and a gas sensor. The use of a gas sensor (MQ5) is to mainly detect gases such as LPG which are prone to cause serious damage to the environment. This data from the gas sensor when leakage occurs is transmitted (in Volts) to the arduino. As a result, the buzzer signals an alarm sound and the LCD starts will display the image.

B. Conceptual Design

One of the most serious problems in the present days is the increasing cost and scarcity of cooking gas. An alternate method is to use electricity for that purpose. But the extensive upsurge in the price of electricity and the lack of availability of large amount of electricity forces us to think about yet another alternative. On the other hand, solar energy is a very clean source of energy available as well as it is a good source of energy which can be used for cooking. This process is based on the induction heating principle and implementation of induction heater using renewable source of energy as the Primary source of supply. The objective of the development of this hybrid stove solar energy and biogas is mainly to build a stove which is environmentally friendly and cost effective. The hybrid stove finds its major applications in rural areas where people can cook using the two cleanest sources with zero expenses**.**

IV. RESULTS AND DISCUSSION

This project provides a gas stove which can be used in the most efficient way. The solar energy is converted to electrical energy which can be used for cooking. This electric energy is given to inverter which then enables the flow of alternating current into the coil. A voltage sensor is used to monitor the voltage in the coil. This measure is used to control the solenoid valve and a relay module which acts as a switch in between the voltage sensor and solenoid valve. When the voltage is not sufficient automatic switching to the other burner is done using solenoid valve and Arduino. The voltage sensor and relay modules are interconnected with the Arduino board and solenoid valve is placed as an interface between gas source and the gas burner.

With the right use of renewable sources and Arduino, HYBRID STOVE is the perfect gas stove which can be used in both rural and urban areas. As the system does not include the use of electricity or conventional gas, it is safe and environment friendly. Since we are using gas supply, if there is a slight gas leakage it will be detected by MQ5 sensor. A physical alert in the form of a buzzer and a led is indicated to the user for preventive action before harm to surrounding.

V. CONCLUSION AND FUTURE SCOPE

The proposed system provides a two way sustainable structure for cooking. One way being use of solar energy to generate power for induction stove, and the other way is encouraging use of biogas burner. As explained, both the features cannot be used simultaneously. So the required switching action between the two has been the crux of the research work. Further research and development can be enabled into the domains of replacing biogas with other fuels other than petroleum derived ones like biodiesel, bio alcohol (methanol, ethanol, butanol), refuse-derived fuel, chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil, propane and other biomass sources etc. The stove can also be developed to work in real time environment with advanced features using embedded

systems and IoT, thus turning it into a smart stove. Innovations in quantum physics and nanotechnology can potentially increase the effectiveness of solar panels and double, or even triple, the electrical input of the solar power systems. Use of solar in tropical places would generally not pose a great extent of challenge as energy from the sun is available in ample amount. The results from the developed stove show the system is very much cost effective and a reliable one. The output of this model has been verified and the results are concluded to be of satisfactory level.

Figure 7. Proposed model

REFERENCES

[1].Vikash Kumar Singh, Md. Mumtaz Khan, Suresh Sevliya, "A Review on induction heating system, SSRG International Journal of Electrical and Electronics Engineering (SSRG-IJEEE) – **volume 3 Issue 5 May 2016**

[2].Ms.Shwetha Laxman Hajare, Ms.Narendra Navinkumar Jakka, Ms. Dipali Namdev Shinde, Ms. Kajal Jaiprakash Rajput, "A Review on Solar Based Induction Heater", IJIRT, **Volume 6, Issue 12, May 2020.**

[3]. Dr. Smt. G. PRASANTHI and Y.GURAVAIAH, "Fabrication of Solar Powered Automatic Induction Heater", **VOLUME 4 I ISSUE 4 I OCT. – DEC 2017.**

[4]. M Athish Subramanian, Naveen Selvam, Rajkumar S, R Mahalakshmi, J Ramprabhakar, "Gas Leakage Detection System using IoT with integrated notifications using Pushbullet-A Review".

[5]. V. Naren, P. Indrajith, R. Aravind Prabhu, C S Sundar Ganesh. *"*Intelligent Gas Leakage Detection System with IOT Using Esp. 8266 Module*"*. International Journal of Advanced Research in Electrical, **Vol. 7, No. 12, December 2018.**

[6]. Chaitali Bagwe, Vidya Ghadi, Vinayshri Naik, Neha Kunte. *"*IOT Based Gas Leakage Detection System with Database Logging, Prediction and Smart Alerting*"*. IOSR Journal of Engineering. **Vol. 13, pp 11-16, 2018.**

[7]. Anuge Sarine Francis, Bhavana Ffion, Faseen.K and Hema Mohan "Solar Based Induction Cook Top" 3rd International Conference on Electronics, Biomedical Engineering and its Applications (ICEBEA'2013) April 29-30, 2013 Singapore.

[8]. Mehmet Emin Tulu, Deniz Yildirim "Induction Cooker Design with Quasi Resonant Topology using Jitter Drive Method" 978-1-4673-3059-6/13/$31.00 ©2013 IEEE.

[9]. UR Prasanna and L Umanand. Modeling and design of a solar thermal system for hybrid cooking application. Applied Energy, **88(5):1740–1755, 2011.**

[10]. Jagan Nath Shrestha. Experiments on induction cooking using trojan battery and inverter. **2015.**

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