International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

Solar Induction Cooker using Mazilli Driver Circuit

Mr. Amit Bajpai[1], Ms. Anvika Bhende[2], Mr. Saurabh Krishna[3],

Mr. Shubham Isadkar[4]

Guided By: Prof. Prasad Soman[5]

[1,2,3,4] *Rajiv Gandhi Institute of Technology, Juhu Versova Link Road, Andheri (West), MUMBAI 400053*

---***---

Abstract*- In the context of falling global solar panel prices and different subsidy given by government, recent advancements in battery technology and rising charcoal/fuel wood prices in severely deforested regions, the door is opening for a potentially transformative alternative: battery- supported electric cooking. Initial investigations focused on a configuration comparable to the popular Solar Home System, referred to here as PV-SIC, and consisting of a cooking device, battery storage, charge controller and PV array. The speed and degree to which this concept is taken up is expected to vary widely across this culturally and physically diverse continent, however its potential impact is considerable. SIC systems could play a major role by facilitating access to affordable, reliable, sustainable modern energy for all in relation to cooking. The concept of SIC has been possible since the advent of solar photovoltaic panels. With enough panels and large enough batteries, a system could deliver enough energy for cooking for domestic and commercial purpose. However, until recently, such a device would have been unrealistically expensive for families across the developing world. However, continued falls in the price of the two main cost components, PV and batteries, over the last decade mean that a solar PV based SIC system could be cost effective in some markets.*

1. INTRODUCTION.

The first use of solar energy was used to light fires with a magnifying glass. The use of sunlight was used to power ovens during the long journey overseas. The first Silicon photovoltaic cells were discovered at the Bell labs in 1954. The first solar oven was invented by Horace de Saussure, in the year 1767, which probably had no idea that his invention would help people up too much great extent in the future.1839 marks an enormous year in history because Edmund Becquerel, a French physicist, discovered that there's a creation of voltage when a material is exposed to sunlight.

The project, is an attempt to integrate solar energy with modern-day induction cooking systems so as to attenuate the utilization of electricity and make efficient use of solar energy for cooking at cheaper rates in rural areas. The conventional solar cooker uses the concept of converting light energy to heat. Solar cookers concentrate sunlight onto a receiver like a pan. The interaction between the sun energy and therefore the receiver material converts light to heat and this is often called conduction. The conversion is maximized by using materials that conduct and retain heat at the required application. Also as retention of warmth energy, thanks to solar panels within the battery would further be useful in many applications as possible. Therefore solar energy would be used efficiently without been relied on LPG cylinders for household cooking.

2. LITERATURE SURVEY.

This project is based upon the concept of integration of two technologies i.e. Solar panel technology and induction stove. In this system, since solar energy is to be first stored in the battery and then discharged in the form of DC current to the induction stove, therefore, it required proper research on how will the current be stored in the battery. Also, the induction stove works on a very high-frequency current and cannot be easily operated on DC supply. To overcome these problems of storage and constant voltage supply to the induction stove the detailed study of each problem and its solution was undertaken. [1] Design and construction of power grid for heating (IH) cooking using a resonant converter (2008), the rectifier module is taken into account as a full-bridge rectifier. The merits of this research are, IH cookers are often developed due to having less energy consumption, safe, efficient, quick heating, and having an efficiency of 90% or more. Heat by the present and eddy current created on the surface of a conductive object (according to Faraday's Law and therefore the skin effect) when it's placed within the magnetic flux, formed around a coil, where the AC current flows through (Ampere's Law). The elemental theory of IH, however, is analogous to a transformer. [2] Solar Based heating System (2014), Induction cooking is that the highly efficient technique for cooking purposes when it combines with the system it'll provide the longer-term solution for the cooking technology. Although solar based cooking may have a high initial cost, over an extended-term it's a cost-effective solution. Heating may be a well-known technique to supply very heat like in melting steel. [3] Zero Voltage Switching Driver and Fly back Transformer for heating (2017), In this, the circuit consists of a resonant inverter of Zero Voltage Switching

(ZVS) circuit with 12Vdc input voltage which is then coupled to a fly back transformer for the generation of high voltage output up to 24.5 kV. The simulation on the waveforms generated from the ZVS circuit correlated well with the particular voltage measurement at the output of the ZVS circuit. The higher voltage dropped across a parallel capacitor coupled to the fly back transformer is equal to 36 V.

3. OBJECTIVES.

1. Replacing the conventional LPG cylinders used for cooking with Solar Induction Cooker. As there is shortage of conventional resources of power, SIC will provide easier and safer means of cooking.

2. To provide safer, cost effective and easier ways of cooking in rural areas where people can't afford LPG cylinders or other conventional resources.

3. To protect the harm caused to human health due to smoke emission from wood, coal, biogas and other resources.

4. To save the power generated from solar panels into the battery, so that the reserved power can be used later in the night or when the days are not so bright.

5. To look for further applications of the stored power in the battery generated due to solar panels.

4. PROPOSED METHODOLOGY.

4.1 Working Principle

To actualize the objective our project SIC, it will be completed in two major parts:

1) Design of power generation system.

2) Design of converter and induction system.

Power generation stage includes the harnessing of power from solar panels, charging of battery by power drawn from the solar panels with the use of charge controllers.

In converters and induction system design stage the power stored in battery will be drawn to the circuit via boost converter and using Mazilli driver circuit, it will generate the induction in litz wire coil.

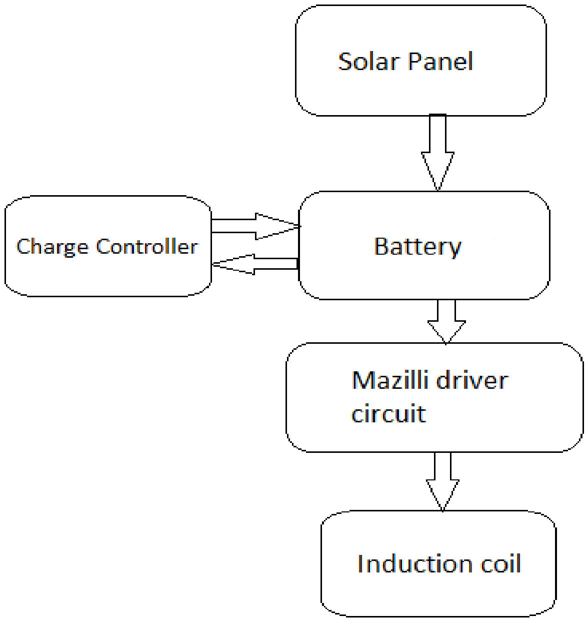

Fig 1: Block diagram of Solar Induction Cooker.

4.2 Technology Developed and Adopted

As shown in the block diagram below a high duty lead acid battery will be used to power the following assembly:

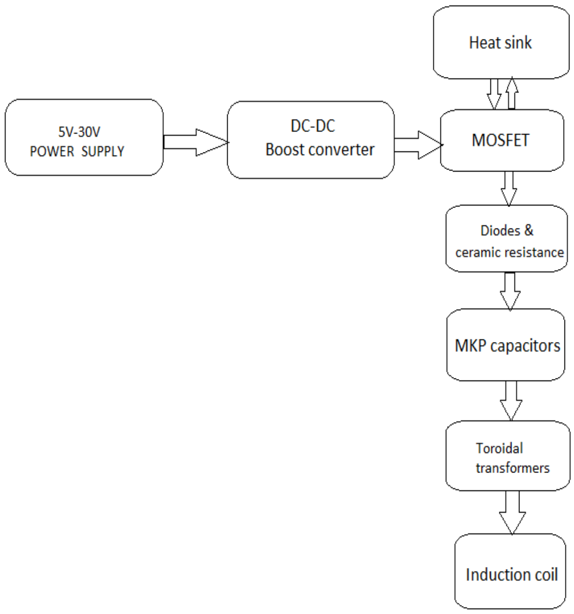

Fig 2: Block diagram of ZVS Fly back Mazilli driver circuit.

As shown in the above block diagram a combination of electrolytic capacitor and boost converter will be used to provide a steady flow of current to the circuit.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

The circuit will consist of power feed to MOSFET as well as to toroid simultaneously to work out the phenomenon of zero voltage switching. Thus MOSFET connection is further connected with MKP capacitors and through the transformers the alternating current will be fed to the coil.

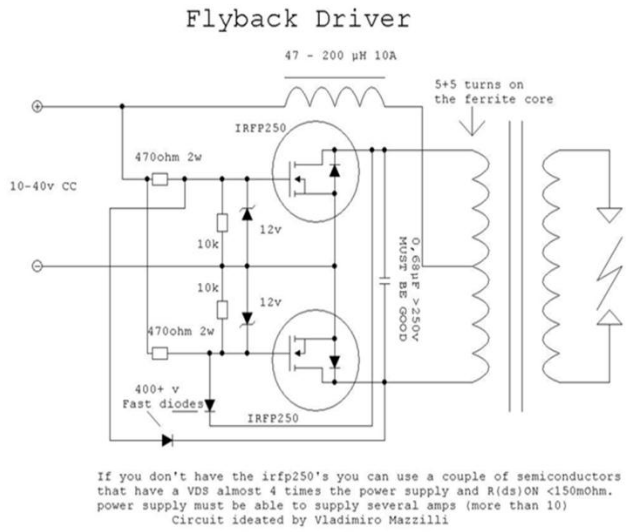

Fig 3: Mazilli ZVS Fly Back Driver Circuit

Mazilli's circuit:

A low DC voltage source at 3A current rating using similar resonant inverter or zero voltage crossing switching circuit (ZVS) developed by Vladimir Mazilli. Its derivative of L-C MOS oscillator, well known for its simplicity to generate voltage ranging from 20-40V.

In this work, circuit was used with modification of components to suit availability and costing of the project.

Mazilli driver is a self-resonant, push-pull, free running oscillator that uses a transformer to generate high voltage. Output of ZVS is matched to a fly back transformer for further stepping up to high voltage. The alternating pulses or a resultant generate enough potential to derive assembly at 27 kHz resonant frequency.

ZVS (Zero Voltage Switching) means that the power to the load is switched on or off only when output voltage is zero volts. It is used to extend the life of controller and of the load being controlled. Controllers with ZVS use trials instead of mechanical relays.

Here with DC power; as in thermoelectric controllers DC voltage is first converted by controller to DC PWM. Lowest voltage of DC pulses is zero and so this power source for a load can also be switched on or off when voltage is zero. Frequency of pulses is high enough that a pettier device considers DC PWM power to be simple DC power.

Fly back driver circuit:

Primary winding of fly back is driven by a switch from a DC supply here the ZVS circuit. When the switch is on, primary inductance causes the current to build up. When the switch is turned off current in primary winding falls to zero. The energy stored in magnetic core is released to secondary as magnetic field in core collapses. Voltage in output winding rises quickly (usually in microseconds) until it's limited by load condition. Once voltage reaches such load to allow secondary current, charge flow is in the form of a descending ramp, cycle on then be a repeater. It secondary current is allowed to discharge completely to zero which means transformer, works in discontinuous mode (DCM).

The Mazilli ZVS fly back driver as shown in Fig. 1 consists of two parts. The first part is a switching circuit with a pair of MOSFETs (IRFP260) and UF4007 diode that step up the input 12 V DC, 3A into high frequency sinusoidal signals which drives a fly back transformer. The switching voltage which turns on and off the MOSFET drops at a 0.66 uF capacitor rated at 1200 V DC and 200 uH inductor that are parallel to the primary winding coil of the fly back transformer. Upon application of power, current flows through both sides of the MOSFET's drains. One of the MOSFETs turns on faster than the other and more current draws to this MOSFET. This causes the other MOSFET to be turn off.

The voltage starts to rise and fall sinusoidal. When Q1 turns on, the voltage at drain of Q1 will be ground while voltage at source of Q2 rises to a peak and drops back down during the one half cycle of LC tank. As voltage of the source of Q2 drops to zero, the gate current to Q1 is also removed and as a result, Q1 turns off. This causes the drain voltage of Q1 to rise and Q2 turns on. The MOSFETs switch when there is least power induced.

The same process repeats for the second half cycle. To prevent the oscillator from drawing huge peak currents and explodes, L1 is placed in series with the power supply functioning as a choke to mitigate current spikes. R1 limits the current that charges the gates to avoid damage of over current at the MOSFET. 10k resistor pulls the voltage down to ground to avoid latch up. The UF4007 diodes regulate the voltage at 18 V. D1 and D2 ensures the gates voltage down to ground when the voltage on the opposite leg of the tanks is at ground.

4.3 Design

To avoid the noise generated within audio frequency band, the resonant frequency is set at over 24 kHz.

During this process, taking resonant frequency is 27 kHz to operate in the circuit.

$$I = \frac{2\pi * P_{avg}}{V_{peak}} = \frac{2\pi * 24}{32 * \sqrt{2}} = 3.33A$$

$$C = \frac{I}{2\pi f V} = \frac{3.33}{2\pi * 27 * 10^3 * 32 * \sqrt{2}} = 0.43\mu F$$

The inductance of the load coil is calculated from

$$L = \frac{1}{(2\pi f)^2 * C} = \frac{1}{(2\pi * 27 * 10^3)^2 * 0.43 * 10^\wedge - 6} = 80.11\mu H$$

To calculate number of turns of coil

Use $L = \frac{a^2 N^2}{9a + 10b} \mu H$

Where, L= inductance (80.11 uH)

a = diameter of coil (6 inches)

b = height of coil (0.5 inches)

N = number of coil

$$80 = \frac{6^2 * N^2}{(9 * 6) + (10 * 0.5)}$$

N^2 = 11.45 turns

I.e. approximately 12 turns

Calculation of Solar panel:

Required size of solar panel = $\frac{\text{electrical load}}{\text{avg.sunshine(time)}} *$ correction factor =

$\frac{1500}{8} * 1.2$ = 225 Watt

If we use 250 Watt 24V solar panel in series parallel connection

No. of strings of solar panel = $\frac{225}{250}$

= 0.9 or 1.

No. of solar panels in each string = $\frac{\text{solar system volt}}{\text{each solar panel volt}} = \frac{48}{24} = 2$

Total no. of solar panels = No. of string of solar panel * No. of solar panel in each string

= 2 * 1.

Total no. of solar panels = 2.

5. CONCLUSION.

The project, was an attempt to develop a solar induction stove. These type of induction stove are easy to make, efficient and run on solar energy. The induction stove can solve a lot of problem in the villages and rural part of India where villages depend upon firewood for the fuel.

The project is a genuine attempt to integrate two things with battery i.e. solar energy and induction stove which can give a new dimension to cooking food with the help of renewable energy.

Fig 4: Implementation of SIC.

REFERENCES

1. M. Nawaz, M.A. Saqib, S.A.R. Kashif, "Model predictive control strategy for a solar-based series-resonant inverter in domestic heating", Electronics Letters, vol. 53, no. 8, pp. 556-558, 2017.

2. Hariprasad Dande S.D.Markande "Solar Based Induction Heating System" Institute of electrical and electronics engineers, Electronics Letters, vol. 28, no. 8, pp. 446-447, 2014

3. A. D. J. Kaasjager and G. P. G. Moeys, "A Hot Plate Solar Cooker with Electricity Generation - Combining a Parabolic Trough Mirror with a Sidney Tube and Heat Pipe," 2012 IEEE Global Humanitarian Technology Conference, Seattle, WA, 2012, pp. 6-11.