Solar Powered Induction Cooking System

Meenakshi Sundaram.R
UG Student
Electrical and Electronics Engineering
Mepco Schlenk Engineering College
Sivakasi, India
meenakshisundaram072@gmail.com

Lokesh S
UG Student
Electrical and Electronics Engineering
Mepco Schlenk Engineering College
Sivakasi, India
lokesh2161998@gmail.com

Sundaramahalingam S
Assistant Professor
Electrical and Electronics Engineering
Mepco Schlenk Engineering College
Sivakasi, India
sundarhve@gmail.com

***Abstract*—The Chulha cooking module used predominantly in rural parts of India uses firewood and dung-based fuel. Subsequently, they generate a lot of indoor pollution causing staggering damage to human health. More than 50 million people in India nevertheless use this cooking module whose effects are so detrimental. In a bid to replace this conventional methodology, a Solar Powered Induction based cooking system was proposed. This induction based heating being a non-contact heating technique can easily reach greater temperature within a shorter span of time. The subsequent system is more appealing by catering better efficiency, safety and accurate output control. For this research we have capitalized the solar energy as the fundamental source that powers the induction stove. The primary objective of this paper is to model an induction cooking system that capitalizes solar energy with the quasi resonant topology and control the output by using Pulse Width Modulation.**

Keywords—Chulha Cooking module, PV panels, quasi resonant topology, Battery.

I. Introduction

With cooking being an integral activity in our day to day life, it comes as no surprise that 70% of our residential load used primarily for cooking application. There is a lack of affordable and systematic supply of LPG that is causing a major hindrance for the people in rural areas. The Chulha cooking system used predominantly in rural parts of India uses firewood and dung-based fuel. These chulha‘s creates a lot of indoor pollution producing soot and other health-damaging pollutants like particulates, carbon monoxide, nitrogen oxides, benzene, and formaldehyde. Over 3.8 million deaths annually caused due to stroke, heart disease, tuberculosis and lung cancer are attributed to exposure to household air pollution. With Women and children being the worst affected. Subsequently, they generate a lot of indoor pollution causing staggering damage to human health. More than 50 million people in India nevertheless use this cooking system whose effects are so detrimental. In case of the urban Indian population there is a sharp increase in the number of LPG users that lead to the conditions like LPG shortage, with the energy crisis leading to frequent power cuts makes the induction stoves also worthless. Our aim lies in replacing these cooking systems with a Solar Powered Induction cooking system. This cooking system is designed by the quasi resonant topology that gives greater efficiency than a resonant inverter topology [1] and with the Incremental Conductance Algorithm used for the MPPT increases the reliability of this cooking system as the intermittency issue is solved. This cooking system when incorporated at a larger scale would probably aid them in leading a sustainable lifestyle and reduce the environmental impacts produced by the conventional system. In a bid to replace this conventional methodology, a Solar Powered Induction based cooking system was proposed. This induction based heating being a non-contact heating technique can produce very high temperature in a fraction of time [5]. For this research we have capitalized the solar energy as the fundamental source that powers the induction stove. The Maximum Power Point Tracking is utilized to tap in the maximum energy from the sun and this energy is used in charging the battery. The battery stores this solar energy that can be used during the night hours [4]. With this we can solve the intermittency issue that is quite prevalent in the renewables based cooking system.

II. Need for Solar powered system

A. Replacement of chulha system

The Chulha cooking system is predominantly used cooking system that is preferred by more than 100 million people living in the rural households of India. This Cooking System is the traditional cooking method that is highly utilized for indoor cooking. The Chulha is designed as a U shaped mud stove made from the clay. The main fuel that is used in this system is wood and animal dung. The animal dung is made in the form of cake, where a mixture of dung from cows, goat, buffalos etc is mixed with stalks of plant like Sarkanda and Tuhari. To work with this cooking system one must sit or squat near the stove. The fumes that is generated while cooking indoors is quite large and being in a position nearer to fume generating stove can cause a lot of health damages, respiration related ailments. The major concern that creates a need to replace this system is that as said before, it generates a lot of smoke and fumes inside the house due to the burning of solid fuels that has been used to ignite the system. As the food is cooked indoors this smoke may cause highly complex respiratory issues, chest discomfort, headaches and tuberculosis. More than two million people per year die of this cooking system in rural areas, the women and kids being the worst affected. The major objective of this paper is to find a renewable and less polluting alternative that can not only replace this detrimental system but also to empower their lives by leading a sustainable life in a highly sustainable way.

B. Cleaner Alternative

This calls for a newer system to replace the existing Chulha System. As still in many parts of rural areas in India electricity is not yet available as the electrification process hasn't reached the villages so the use AC Induction Cooking System goes out of the picture. So to replace this we need to power the system with a renewable energy source of supply like Solar energy [8]. As the sunshine hours in any place having a tropical climate has more than 10hrs of sunshine. So effortlessly the energy can be tapped in by the PV system. This energy can be utilised by a solar powered Induction cooking system and this paves the way for a renewable alternative to replace the detrimental Chulha Cooking System [2].

III. Block Diagram

A. Coventional Topology used in Induction Heating:

This is the Conventional Approach as shown in Fig 3.1, in which the battery is the main source of supply that is used [3]. The predominantly used Induction Cooking System are all working in the AC Supply. If the Induction Cooker is to be supplied through an Battery System then it should use high frequency DC/AC Inverter which turns the 12V battery into 230V AC System. This Figure represent the conventional approach that is utilized by caters usually. In this approach there is this internal conversion using the rectifier to convert the AC into DC supply, this conversion takes place only due to the powering process of the resonant converter. The conversion process using the Inverter outside and the internal conversion that happens inside makes the efficiency less than 100%. The operations of these blocks are completely redundant and this makes it a significant deal in lowering the efficiency of this system.

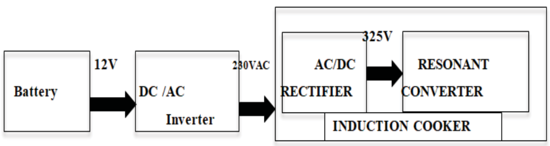

Fig 3.1 Conventional Topology

B. Modern Topology

This Figure 3.2 is the modern approach that is used by us in this Induction cooking system which is solar powered. This space of DC powered Induction cooking system is still emerging and its growth has not reached its peak. In this system we are using a 12V battery as DC source of supply. The one main advantage of using the modern approach is that the other auxiliary circuit that is used takes up very less current and the main resonant converter takes up the overall current sent through the battery, this shoots up the efficiency of this topology. Over 100W of energy is used by the Induction coil that is utilized in this system. The main limitation of this circuit is that it has a coil design that is so straight forward. It doesn't have the complexity that is there in the previous design with a control system fabricated that is so direct without any complications. The previous system that used DC conventional approach for cooking details of its progress is expressed in this report. Where two DC batteries of 12V 150AH is connected in series with 70A discharge capacity for an hour of discharge. In this system they have used an inverter with the rating of 2 KVA and the PV panels used is of 380 WP capacities. With this system we can easily cook for four members within a time span of 40 minutes, utilizing only 0.7 kWh of energy. The main limitation with this design is the 2KVA inverter which reduces the efficiency and causes over loss of power in this system.

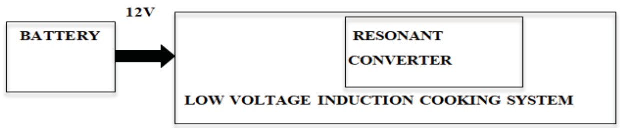

Fig 3.2 Modern Topology

C. Functional block diagram

As shown in Figure 3.3, the flow starts from the power supply which is given through the battery here the rating of the battery is it is 12V, 24AH. This power from the battery is directly supplied to the resonant converter as per this topology. If the half bridge topology is used it may cause a large amount of loss over the inverter side so the half bridge topology is neglected. We have used the quasi resonant topology where the direct supply of DC is given to the resonant converter then the power is made to flow through the Induction coil.

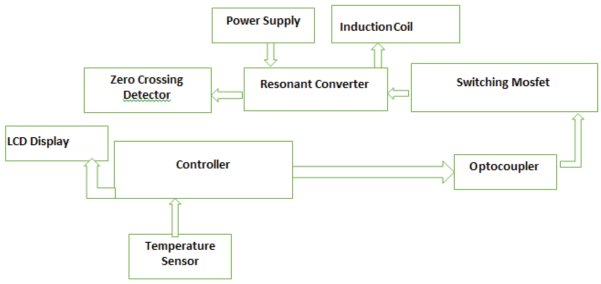

Fig 3.3 Flow Diagram of Solar Powered Induction System

Where as per the Induction principle when a high frequency AC current flow through the coil it generates a oscillating magnetic field. This will flow through the plate that has contact over the coil wound. This in turn makes the eddy current flow through the coil and the heat is generated according to this topology. The other parts are the auxiliary components that are utilized for certain purposes. The ZCD is utilized in detecting the capacitor terminal, when its crossing over zero. Here the temperature sensor used is LM 35 which is kept over the coil and under the heating plate to sense the temperature of the plate that is getting heated. The output is given to the micro controller. Here the program for the LCD display is also feed and dumped into the pic micro controller to sense the voltage and current that is inputted through an PV system and the current and voltage that is outputted to the induction coil is also measured through the current sensor and a voltage divider circuit. This is connected at appropriate ends to sense the voltage and current flowing through the ends of the circuit. The LCD displays four parameters the input and output side voltage and current with the set temperature that users holds the control. Where the user can set the desired temperature that is appropriate for cooking and also LCD displays the actual temperature that is measured through the temperature sensor that is feed back to the micro controller and that is displayed in the display nearer to the set value. The main working happens in the micro controller where the difference between the set and the actual temperature is found this difference makes the PWM (Pulse Width Modulator) generate signal to the optocoupler which is used to amplify and isolate signals and sends it to the Switching device that can be Mosfet or an IGBT. The optocoupler is connected to the gate of the Mosfet device where the ON time and the OFF time of the Mosfet is defined.

IV. METHODOLOGIES INVOLVED

In accordance to designing the Solar Powered Induction Cooking System Various Methodologies were involved, this subdivisions gives us a major insight to the process that were used to fabricate this intricate system.

A. QUASI RESONANT TOPOLOGY

This is the topology as shown in fig 4.1 that is used in the induction cooking system that is fabricated by us. This topology is preferred over the half bridge resonant inverter topology as the inverter side takes in maximum power leaving the induction coil with less energy so it makes the heating process take time and reduces the efficiency of the system. This Quasi Resonant topology (QRT) is widely used for implementation of power converters that is present in this system. These power converters are generally used in the Induction heating process that is used domestically. The main comparison between both these topologies lies in the number of switching devices that is needed by both. The QRT only uses one switching devices and the half bridge topology uses two switching devices that increases the loss in the system that makes Quasi Resonant Topology better. Also this system uses only one resonant capacitor that is in series connection with the inductance that makes the current from the battery directly flow into the circuit that increases the efficiency of this system and starts the heating process through the coil very easily. As said earlier the supply from the battery is directly given to the topology to avoid any kind of losses. The supply flows through the two 50µF capacitance that are connected in the parallel condition where the capacitance value of the single capacitor is taken into consideration as it is has a parallel connection. Then the capacitance is used to store the energy that is dissipated through the battery and uses it during the off time acting like a temporary storage pot. Then the energy through the battery

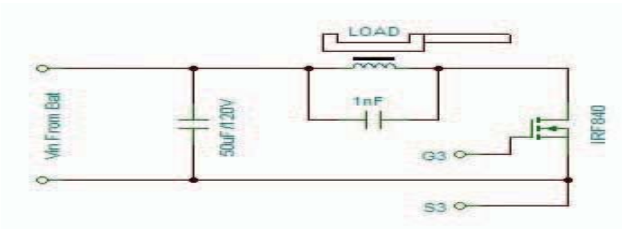

Fig 4.1 Circuit Diagram for Quasi Resonant Topology

flows through the 1nF capacitor that is in series connection with the Inductance coil that is wound, then the current flows through the load. This Circuit is fabricated as shown in fig 4.2 as per the design. The load can be a ferromagnetic material or a metallic material pan that is spread all over the coil so that the high oscillating magnetic field is produced then it paves the way for the eddy current to be produced and this makes the pan heat up and shoot up its temperature. The main signals are sent through the Mosfet to the coil with microcontroller using the PWM generates the signal based on the difference of the Set and the actual temperature that is available in the LED display.

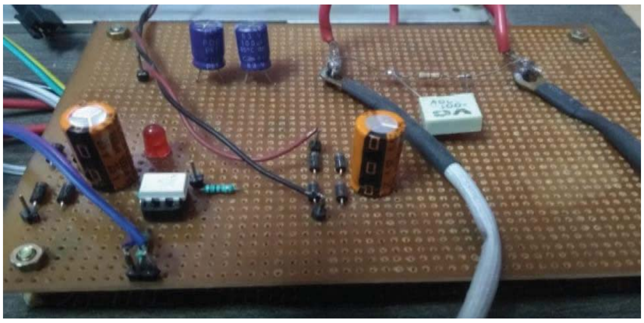

Fig 4.2 Fabricated Circuit for Quasi Resonant Topology

Here the Mosfet‘s drain is connected to the inductance and the source is connected to the negative terminal of the battery and also to the voltage divider is used to sense the voltage that is flowing through this circuit and the gate terminal is given to the opto coupler where it amplifies the given signal that is given by the PWM. The current sensor is just so placed just before the topology to sense the current flowing through the circuit. The temperature sensor is also present above the induction coil and below the heating pan to sense the temperature of the pan and the sensed output is feed through the micro controller to the LCD display based on the temperature input of the temp sensor for the actual temperature, The difference duly decrease in accordance with the set temperature and the PWM also varies decreasing the Mosfet‘s ON time.

B. INCREMENTAL CONDUCTANCE ALGORITHM

The Incremental conductance Algorithm is usually used for sensing the PV Array ‘s output voltage and the current. For sensing this they use two current and voltage sensors for the hardware setup of this algorithm. When the module reaches its maximum power point the slope of the PV curve reaches zero.

$$(dP/dV)_{MPP} = d(VI)/dV \quad (1)$$

This is the governing formula as shown in equation 1 for the Incremental Conductance Algorithm that is used. The instantaneous conductance of the Solar PV System is available on the Left Hand Side. At the point when this Value of Instantaneous Conductance breaks even with the conductance of the sun power, then MPP of the PV system is attained. Here we are detecting both the voltage and current at the same time. Henceforth the blunder because of progress in irradiance when it is duly increased is disposed of. The intricacy and the expense of executing this Maximum Power Point Tracking Algorithm increment with the usage of this Algorithm. When we move through the list of algorithm the rundown of calculations the unpredictability and the expense of usage goes on expanding which might be appropriate for an exceptionally convoluted framework. This makes these algorithm likes Perturb and Observe and Incremental Conductance Algorithm easy to use and all these features make them the most widely preferred algorithms for MPPT Calculations.

The Incremental conductance calculation depends on the way that the slant of the curve of the power versus voltage (current) of the Photovoltaic System is sensed to be zero during the Maximum Power Point Tracking. By looking at the augmentation of the power versus the augmentation of the voltage (current) between two tests that are taken completely simultaneously, the adjustment in the MPP voltage can be resolved by following through the process that is assessed above. The pace at which the Maximum Power Point is come to relies upon the measure of the addition of the reference voltage. The Higher the reference Voltage the swifter the MPP is reached. The downsides of these methods are mostly two. The first and principle one is that, without much of a stretch forget about the MPP if the illumination changes quickly. If there should be an occurrence of step transforms they track the MPP great, in light of the fact that the change is momentary and the bend does not continue evolving. Be that as it may, when the illumination changes following a slant, the curve in which the calculations are based changes ceaselessly with the light, as, so the adjustments in the voltage and current are taking place when they are in and around the point of MPPT.

As an outcome it isn't feasible for the calculations to decide if the adjustment in the power is because of its own voltage increase or because of the adjustment in the illumination. The other impediment of the two strategies is the motions of the measured electrical parameters around the MPP during the enduring state. This happens mainly because of control is being discrete and the voltage and current are not always at the MPP but rather wavering around it. The measure of the motions relies upon the extent of the rate of progress of the reference voltage. The more noteworthy it is, the higher is the abundance of the motion. Be that as it may, how quick the MPP is reached completely depends upon this rate of progress and this reliance is contrarily corresponding to the extent of the voltage increases. The customary arrangement is an exchange off: in the event that the augmentation is little with the goal that the motions decline, at that point the MPP comes in gradually and the other way around, so a trade-off arrangement must be found. The main advantage of using this algorithm is that this is the only algorithm that can sense both voltage and current that is flowing from the PV system, that is main reason behind implementation of this algorithm in this thesis. With their convergence speed for sensing the variation in the Photo Voltaic system is also good. With Increase in the lines of functional codes and the added parameter we can say that the complexity of the algorithm also increases.

C. BUCK BOOST CONVERTER CIRCUIT:

The Buck Boost converter is used for charging the battery system and to solve the intermittency issue to prolong the usage of this solar powered induction cook tops by using the stored energy of the solar power in the battery system. As said before the main use of this circuit is to charge the 12V battery during the peak sun shine hours during the day for usage at night time. The flow of this Buck Boost Converter circuit as per the diagram shown in Fig 4.3. It starts from the solar I/P the energy is transferred to a capacitor through the capacitor it flows to the Buck Switch. Where the Buck switch would turn on only when the solar I/P is more than 8V if it is less than 8V then the buck switch would be turned off and thus leads to no charging operation. The other case is that when the voltage is more than 14V then directly the voltage is used in charging the battery where the buck will not turn on for the safety of the circuit. Then after turning the buck switch on then the voltage through an Inductance of 40 mH is passed and again the voltage is passed through the boost switch where it is always in the turned on condition and the given voltage of around 8V gets boosted to 15V and the battery gets charged as the charging voltage is more than battery voltage.

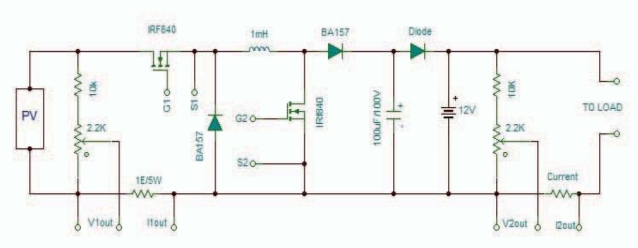

Fig 4.3 Circuit Diagram for the Buck Boost Converter

Explaining the flow as per the circuit diagram is the the PV input is given to the voltage divider to assess the input voltage produced by the PV system and the output of the voltage sensed is given to the LCD Display through the Micro Controller. Then the voltage from PV is allowed to flow through the buck switch where the Mosfet's gate is given to the Opto Coupler and the source S1 is given to the resistance. The opto coupler is used for the amplification of the signal given and then in series diode is connected to prevent fly back as it is used for free-wheeling purpose. Then it flows through the 1mH inductance and it flows through the other mosfet which acts as boost switch which is always at turn on condition and it boost the voltage that is above 8V that is flowing in, and again through a diode to avoid the voltage flowing backwards is kept and then connected to the battery for charging purpose. This is the overall flow of this Buck-Boost circuit that is present for charging purpose. This is fabricated as shown in Fig 4.4.

Fig 4.4 Fabricated Buck Boost Converter Circuit

The next figure 4.5 and figure 4.6 shows the testing phase of the buck boost circuit using the RPS Supply and also the battery is disconnected to see whether the buck boost circuit is working properly. Here for testing the RPS is set at 14V and the voltage that got boosted is cited around 24V and the testing was done successfully and this circuit was incorporated in to the main circuit.

Fig 4.5 Before Boosting with a supply of 14V from RPS

Fig 4.6 After Boosting to 24V

D. PIC MICROCONTROLLER CIRCUIT

The pic micro controller is mainly used because in this micro controller type only we can set the working frequency of the topology and also as it has many functional pins it can easily incorporate larger number of functions. The Pic Micro controller that is used here is the pic 16F877A. Here, the main supply is given through the transformer which steps down the voltage from 230V to 9V. This 9V is converted to 5V through the 9V to 5V converter where this 5V supply is given to the VDD. There are a total of four ports A,B,C,D. where the A port is used as the sensing port to sense, the Input and the Output Voltage and Current that is flowing through the circuit. The signal that's given to the LM 35 is given through the clock in and the supply of +5V is taken the signal that's given to the LM 35 is given through the clock in and the supply of +5V is taken through the 9V to 5V converter too. The second pin of LCD is connected to the LM 35 temperature sensor and the temperature under the heating pan is sensed and given to the LED display. The B port is used to connect to the LCD display interfacing with the Micro Controller the pin number 0 to 5^{th} pin of the Microcontroller is connected to the LCD display. The Buck switch gate and source is connected to the C port by connecting the gate through the optocoupler to the RC2 pin and Vss. The three optocoupler that are used in amplifying the signals is given to the Buck Switch, the Boost switch and at last the Switching Mosfet that is connected to the optocoupler to amplify the PWM Signal that is produced through the Micro Controller. The Mosfet is connected to the biggest heat sink as the Mosfet's running frequency about 25kHz when the difference between the set and actual temperature is quite large then Mosfet's turn on time increases and Mosfet's heats up and gets heavily damaged and this leads to the Mosfet becoming completely dysfunctional. So we have to replace the Mosfet and again take careful precautions in not leading up to these kinds of situations again.

E. INDUCTION COIL AND PAN CONFIGURATION

The Induction coil is one of the most important elements that are required by the cooking system as it only transfers the high frequency AC into oscillating magnetic field that allows the pan to make the eddy currents flow through the pan. So the significance of using the induction coil is far more important and needs to be carefully wound. The design of the induction coil is done through the analytical equation that is available from the paper by Sinha (2010). For this System more than 3 coils were designed and were tested. The first coil was wound small with a diameter 7cm and the inductance 78 mH and reached only a temperature of 50 °C within fixed time duration. At last we wound a coil of 15cm in diameter with an inductance value of 140 mH and this reached more than the desired temperature of round about 105°C. The main function of this induction coil is to make the eddy current flow through the pan and rising the temperature of the plate. The waveform that is taken through the Induction coil shows that before when the pan is touches every part of the coil then the ringing pulse is shown to be reduced as it makes the eddy current flow through the coil and as it is utilized for production of eddy current. The ringing pulse in the waveform is seen to be reduced. If the pan is removed from the coil then the waveform taken has more ringing pulses in it as it becomes unutilized in the generation of eddy current. The induction coil that is used in the system is shown in figure 4.7.

Figure 4.7 Induction Coil of 15cm in diameter with the temperature sensor

For the cooking vessel it should be made of ferromagnetic material (or) ever silver vessel pan type is used, as these are the most favorable materials which can produce eddy current effortlessly. The magnetic field that surrounds the coil, the change rate of flux produced and the conductor area is directly proportional to the eddy current produced by the coil and in the contrary all these parameters are inversely proportional to the resistivity of the material that is utilized in making the pan. These are the parameters that must be assessed before the material used by the pan. Due to the material used by the pan generally has a particular resistance this makes the pan get heated by the heating effect prescribed by Joules. Where the heat generation is given by the product of squaring I_{eddy} into the resistance of the pan used in the induction heating.

V. RESULTS AND DISCUSSION

A. ASSIMILATION OF OUTPUT THROUGH DIFFERENT INDUCTION COILS

As in this process of induction heating we have used more than three different coils in this process and testing which coils presents the desired output in less time [7]. As the induction coil is the most important element in the induction cooking, so we tried out different coils by trial and testing method and after more than three trials we found the coil which reached out to our desired output within the stipulated time frame.

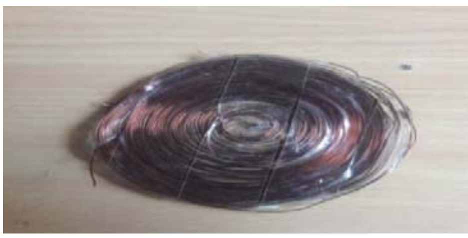

Fig 5.1 Induction Coil I

In coil number I as per the fig 5.1 we have wound an Induction Coil of 7 cm diameter using copper wire with an Inductance value of 78 mH with the number of turns being 48 turns it was closely wound no gaps was seen in between the copper coils. After a fixed time limit of 20 minutes the maximum temperature reached by the coil was 50 °C. This was mainly due to the coil being wound with a lesser diameter so the heat generation process took only lesser eddy current, which was flowing through the coil. That lead to lesser ringing pulses to be produced and this was utilized in taking the temperature till 50 °C this was the maximum capacity of that coil as for more than 5 minutes the same temperature was recorded by the temperature sensor. From this we inferred that we need to wind a higher diameter induction coil with larger inductance value also with a greater number of turns.

Fig 5.2 Induction Coil II

With the coil number II as per fig 5.2 this was wound for 18cm in diameter with the Inductance value of 180 mH the maximum temperature reached within the stipulated 20 minutes was only 40 °C the number of turns for which it was wound was 64. Here as the Increase in number of turns increased the complexity of the coil as there were gaps in the copper wire that was wound for the formation of Induction Coil. When heating process started only the brim of the pan was getting heated, as there was no eddy current flowing in the middle of the pan that was kept in the coil. But still every inch of the plate was covering the whole coil and the ringing pulse was generated during loaded condition was also less. This lead us to infer that we need to wind a medium sized coil with lesser number of turns with a slightly lesser diameter to eventually satisfy our needs of reaching the desired temperature within the stipulated time frame.

The coil number III as per fig 4.7 this was wound for 15cm in diameter with the Inductance value of 140 mH. The maximum temperature reached within the stipulated 20 minutes was more than 100 °C the number of turns for which it was wound was just 24 turns. This coil was wound closely to avoid the previously done mistake, here the pan of that diameter in size was kept over the wound coil and all the inner surface of the pan was touching the coil and this lead to the generation of the ringing pulse increase and when the pan was kept over the coil these ringing pulses was seen to be reduced in the wave form and this was used in generation of the eddy current that lead to the increase in heat generation over the pan. The ringing pulses generated were snapped and this is shown in the fig 5.3.

Table 1 Assessing three different coils based on various parameters for testing

Coil Number	Diameter (cm)	Inductance (mH)	Maximum Temperature Reached Within 20 minutes in (°C)	Number of Turns
Coil I	7	78	50	48
Coil II	18	180	40	64
Coil III	15	140	100	24

This ideal sized coil was chosen among the other two coils as it produced better eddy current compared to the other coils that was experimented.

Then Induction Coil III‘s ringing pulse is generally increased when there was no load. As shown in fig 5.3. When the Pan is placed over the coil this leads to the decrease in the ringing pulse as this pulses are used in generation of high oscillating magnetic that leads to eddy current generation in the pan that leads to heat generation in the pan. The overall assessment of the coil is given in Table 1.

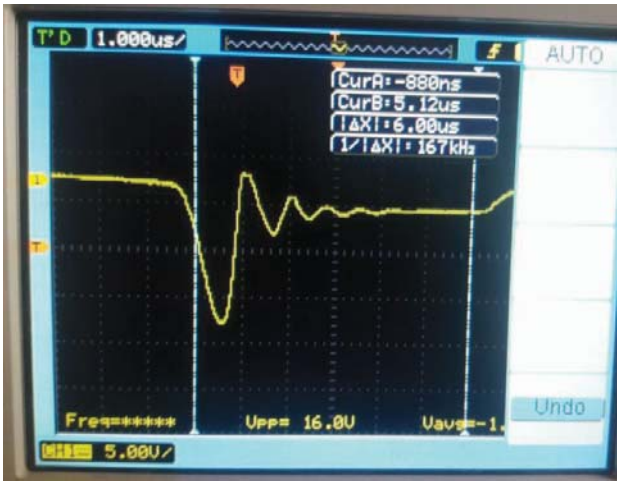

Fig 5.3 Ringing Pulse in the Induction Coil under loaded condition

B. COMPUTING ELECTRICAL PARAMETERS FOR INDUCTION COOKING SYSTEM:

Assessing the Limits of the current system based on the electrical parameters for a stipulated time limit has been tabulated. From the tabulation we can infer that after 4 min and 02 seconds we can see that the difference between Set and Actual temperature being 60 degrees, then the PWM generates signal to the opto coupler from the opto coupler the signal gets transmitted to gate of the Mosfet increasing its on time. Then the temperature reaches 50 °C after 8mins 13secs this would probably reduce the on time of the Mosfet as the difference is lowered. Then it reaches 100°C after 18mins and 32 seconds. As shown in Table 2.

Table 2 Assessing Electrical Parameters for reaching set temperature

SET TEMP	ACTUAL TEMP	OUTPUT VOLTAGE (V)	OUTPUT CURRENT (I)	POWER SUPPLIED(W)	TIME DURATION
100	40	12	3.6	43.2	4 min 02 sec
100	50	12	3.8	45.6	8 min 13 sec
100	79	11.9	3.8	45.22	12 min 42 sec
100	100	11.9	3.7	44.03	18 min 32 sec

The recordings at set temperature and actual temperature becomes equal sensing this the PWM would probably stop generating the signals that is would in turn lead to the actual temperature returning to 99°C and again sensing the difference the PWM generates the signal to the Mosfet and increases the temperature again to 100 °C and this process goes on but still as time lag for this generation of signal is very low the LCD Display will always display the temperature as 100°C only.

Fig 5.4 Solar Powered Induction Cooking System

VI. CONCLUSION

The solar powered Induction cooking system has been fabricated with different hardware design and implemented for getting the required output. The Size of battery used is 12V, 24AH, and only two panels of 20V; 50W is used to produce the described output that has been tabulated in the table given below. If two 12V batteries is connected in series and the 5 panels are connected in series and used to power this topology. Then the system can easily work more than 12 hours and the stored energy can supplement for 4 hours and this system can easily replace the age old chulha system and also help them leading a sustainable life style with an new age system that completely depends on the renewable source of energy. This system can be scaled up by increasing the panels in number with a higher capacity battery system. That could make the system capable of continuously running for more than 6 hours as the energy needs of the cooking top is satisfied. These systems, when incorporated at a broader scale in the rural areas can replace the chulha cooking system and support them in leading a sustainable life.

VII. FUTURE SCOPE

The system needs to be scaled up as with the present coil type and 12V 24AH battery, with this module connected only to two panels of 20V and 50W. The present system can power autonomously for 6 hrs. In order to work the system for more than 12hrs, in order to cook for a family of more than 10 people there is a high need for the system to be scaled up. So we need to connect more than 5 panels of the same rating 20V and 50 W is connected in series and the battery‘s capacity is raised up to 24V 60AH, this leads the battery system to be charged up during peak sunshine hours. During the night hours the system can take the required energy for cooking from the existing energy from the battery system. This increases the reliability of this system as the battery supplements the energy required by the solar powered induction cooking system. Even during diffused sunlight being produced in the rainy season or during winter season where there are very less sunshine hours. This system can easily overcome the shortcomings in the PV system as the capacity of the battery system is of the higher range that can autonomously work for a greater range of 8hrs. When the battery is completely discharged for more than 30% of its capacity it needs to be recharged otherwise the life time of the battery gets reduced. The battery can be recharged easily and after charging to its full capacity this can be used in the system. Till then it can be replaced for a shorter period by a 12V battery during the night hours when the 24V battery is getting recharged.

REFERENCES

[1] Anuja Prashant Diwan, R. Kanagaraj, "Implementation and simulation of high frequency series resonant inverter for induction heating application", International Journal of Science and Technology, vol. 8,Nov 2015, pp. 1-5.

[2] Design and Simulation of a Solar Electricity Based Induction Cooker using Quasi Resonant Topology Bikal Adhikari 1, Jagan Nath Shrestha 2, Shree Raj Shakya .

[3] Daniel J. Weber. Design of battery powered induction stove. Master of engineering in electrical engineering and computer science, Massachussets Institute of Technology, Massachussets, 2015.

[4] JaganNathShrestha. Experiments oninductioncooking using trojan battery and inverter. 2015.

[5] Kirubakaran D., Rama Reddy S., "Comparison of parallel resonantinverter and series resonant inverters for induction heating", Journal of Electrical Engineering, pp. 1-6.

[6] Masaki Miyamae, Takahiro Ito, Kouki Matsuse. Performance of a High Frequency Quasi-Resonant Inverter with Variable-Frequency Output for Induction Heating. 2012 IEEE 7th International Power Electronics and Motion Control Conference -ECCE Asia June 2-5, 2012.

[7]Sanjeev Maharjan. Thermal and electrical performance concerning cooking appliances in kathmandu. Technical report, 2016.

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