Fabrication of Solar Powered Automatic Induction Heater

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ABSTRACT *Induction heating system utilizes electricity for the generation of heat, where as solar energy is largely available energy source for generation of heat. The present work is combining solar energy with induction heat generation technique is the efficient solution for heat generation application. It uses high frequency electricity to heat materials that are electrically conductive. It is also very efficient since the heat is actually generated inside the work piece. The components in this system are solar panel, rechargeable battery, switch, AC-DC converter, thermostat, high frequency pulse generator and induction coil. In this proposed system the temperature of the induction coil automatically controlled by the thermostat. The experimental results of box type natural solar heating and solar induction heating are compared. It shows that present work, improves heating performance compared to box type solar heating system.*

Keywords *: Solar panel, Thermostat, MOSFET, Relay, Induction coil.*

I INTRODUCTION

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 for 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 the largely available source which can be used for cooking but this energy is not available for 24 hours so it is not possible to use it in the night. So this energy has to be stored in the battery. This stored energy can be used to produce the electricity and further for induction heating.

Induction heating is a well known technique to produce very high temperature such as in melting steel. The technique requires high frequency current supply that enables to induce high frequency eddy current circulating in the target object. In general, two methods are used to generate high frequency current namely hard switching and soft switching technique. Hard switching has disadvantage of the higher power frequency in the LC circuit and it produces positive cycle as switching losses in the switching devices. Using power MOSFET can solve this problem. However, it requires devices with low on state power losses. So MOSFET is preferred for switching operation.

II EXPERIMENTAL SETUP & METHODOLOGY

2.1 Components

A. *Thermostat* the temperature of a system so that the system's temperature is maintained near a desired set point.

A thermostat can often be the main control unit for a heating or cooling system, in applications ranging from ambient air control, to such as automotive coolant control, but is also used in many other applications, such as an electric clothes iron. It is a "closed loop" control device, as it seeks to reduce the error between the desired and measured temperatures. Sometimes a thermostat combines both the sensing and control action elements of a controlled system, such as in an automotive thermostat.

B. Solar panel

Fig 2.1.1: Solar panel

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Assemblies of cells are used to make solar panel, solar modules, or photovoltaic arrays. Photons in sunlight hit the solar panel and are absorbed by semi conducting materials, such as silicon. Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. Due to the special composition of solar cells, only allow the electrons to move in a single direction. The complementary positive charges that are also created (like bubbles) are called holes and flow in the direction opposite of the electrons in a silicon solar panel. An array of solar panels converts solar energy into a usable amount of direct current (DC) electricity. Solar cells can also be applied to other electronics devices to make it self-power sustainable in the sun. There are solar cell phone chargers, solar bike light and solar camping lanterns that people can adopt for daily use.

C. Induction heating

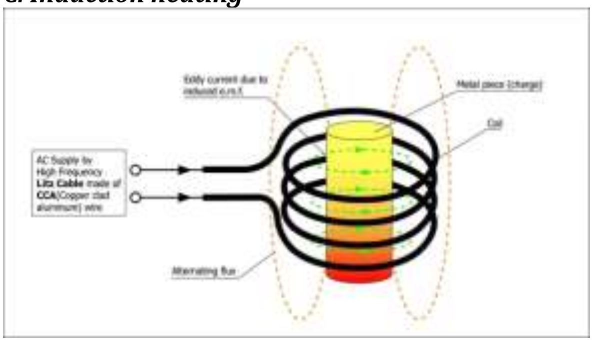

Fig 2.1.2: Induction heating

An induction heater is a key piece of equipment used in all forms of induction. Three main component in this systems form the basis of a modern induction heater.

i. Induction coil

Also known as the inductor, the coil is used to transfer the energy from the power unit and work head to the work piece. Inductors range in complexity from a simple wound solenoid consisting of a number of turns of copper tube wound around a mandrel, to a precision item machined from solid copper, brazed and soldered together. As the inductor is the area where the heating takes place, coil design is one of the most important elements of the system and is a science in itself.

ii. Rechargeable battery

A rechargeable battery, storage battery, secondary cell, or accumulators a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinationsof electrodematerials and electrolytes are used.

Fig 2.1.3: Rechargeable battery

iii. Relay

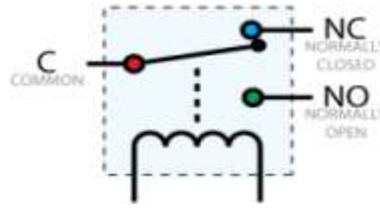

Fig 2.1.4: Relay circuit

Fig 2.1.4 shows the Relay. Relay is an electromagnetic switch. It consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a movable iron armature, and a set, or sets, of contacts; two in the relay pictured. The armature is hinged to the yoke and mechanically linked to a moving contact or contacts. When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact.

2.2 Block Diagram Of Solar Powered Automatic Induction Heater

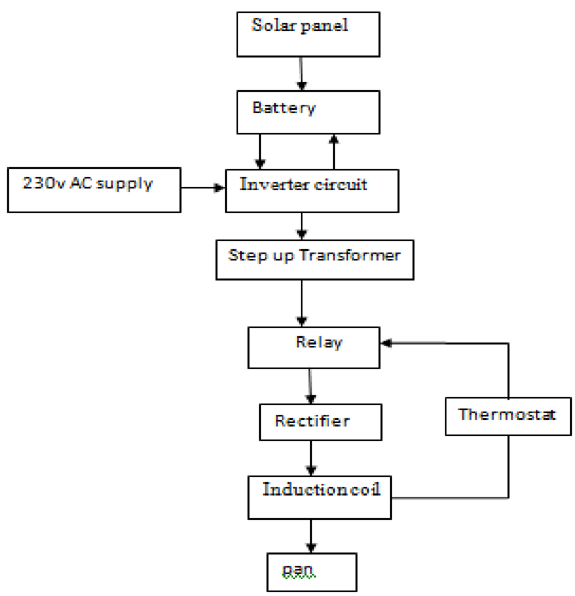

Fig 2.1.1: Block diagram of solar induction heating system

Fig 2.1.1 shows the block diagram of fabrication of solar powered automatic induction heating system. It uses high frequency electricity to heat materials that are electrically conductive. Combining solar energy with induction heat generation technique is the efficient solution for the heat generation application. The present system presents an effective control scheme incorporated in half bridge series resonance induction heating by using solar energy. Pulse width modulation technology is used for charging the battery from photovoltaic array. The simulation and implementation of system is done. The experimental result of conventional solar heating and solar induction heating are compared. It shows that proposed system, improvises heating performance compared to conventional solar heating system

Fig 2.2.2: Solar powered automatic induction heater without bowl

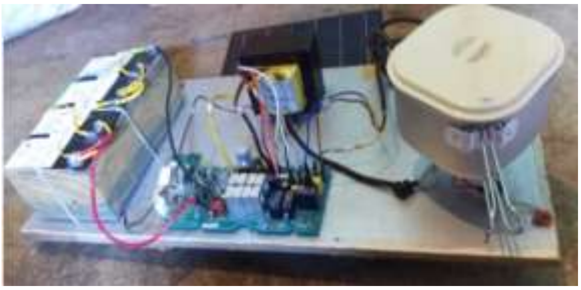

Fig 2.2.3: Solar powered automatic induction heater with bowl

It is also very efficient since the heat is actually generated inside the work piece. This can be contrasted with other heating methods where heat is generated in a flame or heating element, which is then applied to the work piece. For these reasons induction heating lends itself to some unique applications in industry. In the present work thermostat is used to sense the temperature. The resistance of the thermostat changes with the temperature. Induction heater is used to heat the bowl. The temperature of the boiler is constantly given to the thermostat, when excess heat is produced in the boiler, the resistance of thermostat increases and the relay is turned OFF and the heating of the bowl should be stopped.

2.2 Box Type Solar Cooker

Solar box cookers (sometimes called solar ovens) are the most common and inexpensive type of solar cookers. These box cookers have a very simple construction and they are made of low cost materials. The outer box is often made of thin metal sheet. The inner box is made of insulating material, which is covered with clear glass or with plastic, and often has a reflector of aluminum.

Fig 2.3**:** Box type solar cooker

2.4 Methodology

The fabrication of solar powered automatic induction heater experiment was carried out with

1.The bowl is filled with water with different quantities are like 100 ml,200ml,300ml,400ml and 500ml. Power supply is given by switching on the induction heater. The temperature readings are noted for every 5 mints upto five readings.

2. In the box type solar cooker, the bowls are filled with similar quantities of water used in induction heater and placed to the direction of sun. The temperature readings are also noted for every 5 mints upto five readings.

3. The temperature readings are noted in tabular columns and compared the performances with respective time and temperatures for a conventional solar cooker.

III Results and Discussion

The present work of solar based induction cooker is implemented for 500 watts power. Input to system is solar energy which is used to charge four 12 volts batteries. Stored DC energy is converted to AC voltage using inverter circuit. It is efficient technique for the control of the temperature and for the solar charge control of the battery. Comparing box type natural solar heating system with solar induction system has various advantages such as performance in terms of time. For heating 500ml water upto 34^0c by natural solar system takes 20 min, whereas it can be done within 5 -6 min using solar induction heating system seen in the table 3.1 and table 3.2. Solar induction system is easy to clean and having thermal safety. Solar induction system can be utilized during the day as well as night time. Also, it has optional electric charging system so that it can be used during rainy season.

TABLE 3.1: TEMPERATURE READINGS OF SOLAR NATURAL HEATING PROCESS (BOX TYPE SOLAR COOKER)

S.NO	TIME	QUANTITY OF WATER				
		100 ml	200 ml	300 ml	400 ml	500 ml
1	1.00 pm	32⁰c	32⁰c	32⁰c	32⁰c	32⁰c
2	1.05 pm	34⁰c	32⁰c	32⁰c	32⁰c	32⁰c
3	1.10 pm	36⁰c	34⁰c	33⁰c	33⁰c	32⁰c
4	1.15 pm	39⁰c	36⁰c	35⁰c	34⁰c	33⁰c
5	1.20 pm	40⁰c	34⁰c	36⁰c	35⁰c	34⁰c

TABLE 3.2: TEMPERATURE READINGS OF SOLAR POWERED AUTOMATIC INDUCTION HEATER

S.NO	TIME	QUANTITY OF WATER				
		100 ml	200 ml	300 ml	400 ml	500 ml
1	1.00 pm	32⁰c	32⁰c	32⁰c	32⁰c	32⁰c
2	1.05 pm	46⁰c	44⁰c	42⁰c	40⁰c	38⁰c
3	1.10 pm	56⁰c	54⁰c	52⁰c	50⁰c	48⁰c
4	1.15 pm	62⁰c	60⁰c	58⁰c	56⁰c	54⁰c
5	1.20 pm	63⁰c	62⁰c	60⁰c	59⁰c	58⁰c

IV CONCLUSION

After implementation of solar induction heating prototype and comparing it with box type natural solar heating system following conclusions are drawn.

1. Proposed System has 80% efficiency due to inverter circuit if compared with the conventional solar heating system the efficiency is only 50% without an inverter circuit.
2. System can be used during day as well as night and can be used in rainy season by using electrical charging option.

It can be further extended to higher power rating and used for commercial heating applications such as water heating for industrial purpose, for food cooking in hotels as well as for household purposes.

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