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Design and Fabrication of Induction Heating Process by Solar Energy

Nbv Lakshmi Kumari[1], Mohammed Rehanuddin[2], Mohammed Ayazuddin[3], Salman Ahmed[4]

[1] *Assistant Professor, Mechanical Engineering Muffakham Jah College of Engineering and Technology, India*
[2]*Under Graduate Student, Mechanical Engineering Muffakham Jah College of Engineering and Technology, India*
[3]*Under Graduate Student, Mechanical Engineering Muffakham Jah College of Engineering and Technology, India*
[4]*Under Graduate Student, Mechanical Engineering Muffakham Jah College of Engineering and Technology, India*
Corresponding Author: Nbv Lakshmi Kumari

Abstract: Induction heating is a non-contact heating process. It uses high frequency electricity to heat materials that are electrically conductive. Since it is non-contact, the heating process does not contaminate the material being heated. 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. Solar energy is radiant light and heat from the Sun. The solar energy, the most common way is to use solar panels, a module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays.The preset research paper aims in designing an induction heating system which is powered by solar energy. The evaluation technique generally involves the implementation of conventional induction heating and combined with solar energy, initially the literature survey is done and the design is carried out and finally the fabrication is completed .The validation of the project is done by comparing the conventional induction heating process and solar induction heating .

Keywords: Induction Heating,Solar Energy ,PV modules,Design

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I. INTRODUCTION

Induction heating is the process of heating an electrically conducting object (usually a metal) by electromagnetic induction, through heat generated in the object by eddy currents. An induction heater consists of an electromagnet, and an electronic oscillator that passes a high-frequency alternating current (AC) through the electromagnet. The rapidly alternating magnetic field penetrates the object, generating electric currents inside the conductor called eddy currents. The eddy currents flowing through the resistance of the material heat it by Joule heating. In ferromagnetic (and ferrimagnetic) materials like iron, heat may also be generated by magnetic hysteresis losses. The frequency of current used depends on the object size, material type, coupling (between the work coil and the object to be heated) and the penetration depth.

The electricity requirement of the world is increasing at an alarming rate due to industrial growth, increased and extensive use of electrical gadgets. According to world energy report, we get around 80% of our energy from conventional fossil fuels like oil (36%), natural gas (21%) and coal (23%). It is well known that the time is not so far when all these sources will be completely exhausted. So, alternative sources should be used to avoid energy crisis in the nearby future. The best alternative source is solar energy

A source of high frequency electricity is used to drive a large alternating current through a coil. This coil is known as the work coil. The passage of current through this coil generates a very intense and rapidly changing magnetic field in the space within the work coil. The work piece to be heated is placed within this intense alternating magnetic field.The alternating magnetic field induces a current flow in the conductive work piece. The arrangement of the work coil and the work piece can be thought of as an electrical transformer. The work coil is like the primary where electrical energy is fed in, and the work piece is like a single turn secondary that is short-circuited. This causes tremendous currents to flow through the work piece. These are known as eddy currents.

In addition to this, the high frequency used in induction heating applications gives rise to a phenomenon called skin effect. This skin effect forces the alternating current to flow in a thin layer towards the surface of the work piece. The skin effect increases the effective resistance of the metal to the passage of the large current. Therefore it greatly increases the heating effect caused by the current induced in the work piece.

The proposed system converts AC mains supply to DC supply. The converted dc supply is fed to pulse generator. The generated pulses are fed to copper coil, which creates electromagnetic effect. When any conductive metal is placed in this strong electromagnetic effect, the current flow causes larger heat. The system depending on the charging circuit the battery can be recharged can be used for controlled the water heating system using relay switch. The solar power stores the energy to a battery and then runs the induction heater through the relay switch.

The project makes use of a solar panels. The solar energy obtained is stored to a battery. The battery supply is fed to pulse generator and in turn to a MOSFET which is capable of generating ON/OFF pulses of different frequencies. The generated pulses are fed to copper coil, which creates electromagnetic effect. When any conductive metal is placed in this strong electromagnetic effect, the current flow causes larger heat.

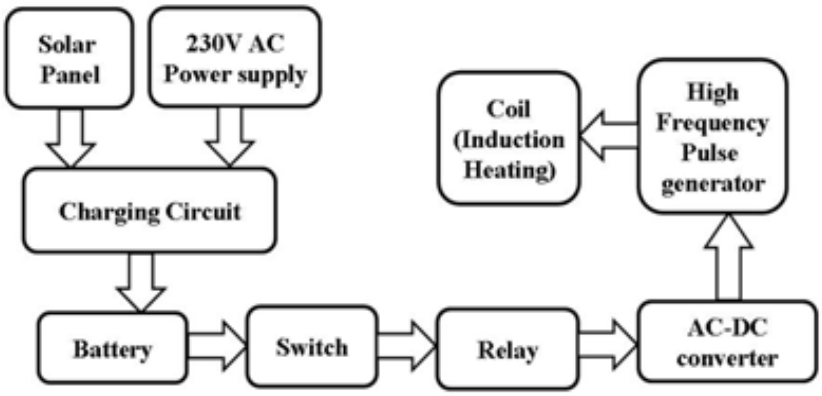

Fig1: Block diagram for Induction Heating using solar energy

II. METHODOLOGY

2.1 Hardware Description

2.1.1 The details of the circuit diagram are listed below ;

1. Battery power supply (RPS)
2. Polarity Corrector
5. Mono stable multi vibrator
6. Pot
7. MOSFET
8. Solar panel
9. Induction heater set up
10. Relay

2.2 REGULATED POWER SUPPLY: (AC to DC converter Circuit)

Block Diagram:

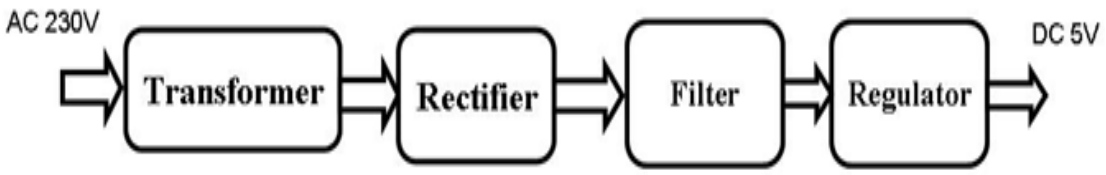

Fig 2 : Regulated Power Supply

The basic circuit diagram of a regulated power supply (DC O/P) with led connected as load is shown in fig: 3.3.1

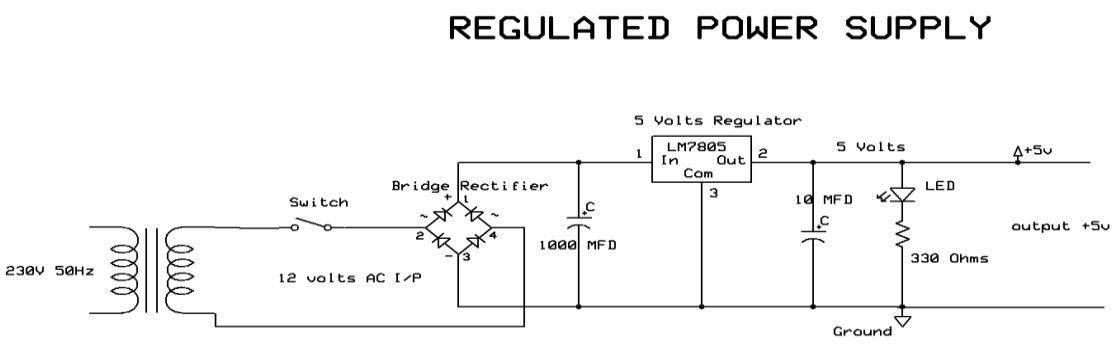

Fig 3: Circuit diagram of Regulated Power Supply with LED connection

The components mainly used in above figure are

- 230V AC MAINS
- TRANSFORMER
- BRIDGE RECTIFIER(DIODES)
- CAPACITOR
- VOLTAGE REGULATOR(IC 7805)
- RESISTOR
- LED(LIGHT EMITTING DIODE)
- **Solar Panel:**
- **Photovoltaic Cells: Converting Photons to Electrons**
- The solar cells that you see on calculators and satellites are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays.
- Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely.
- PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

2.3 INDUCTION HEATING SETUP

The project aims at designing an Induction heater through a very simple mechanism. The applications include melting, welding and brazing or metals, Induction cooking hobs and rice cookers, Metal hardening of ammunition, gear teeth, saw blades and drive shafts, etc

- Induction heating is a non-contact heating process. It uses high frequency electricity to heat materials that are electrically conductive. Since it is non-contact, the heating process does not contaminate the material being heated. 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.
- A source of high frequency electricity is used to drive a large alternating current through a coil. This coil is known as the work coil. The passage of current through this coil generates a very intense and rapidly changing magnetic field in the space within the work coil. The work piece to be heated is placed within this intense alternating magnetic field.
- The alternating magnetic field induces a current flow in the conductive work piece. The arrangement of the work coil and the work piece can be thought of as an electrical transformer. The work coil is like the primary where electrical energy is fed in, and the work piece is like a single turn secondary that is short-circuited. This causes tremendous currents to flow through the work piece. These are known as eddy currents. In addition to this, the high frequency used in induction heating applications gives rise to a

phenomenon called skin effect. This skin effect forces the alternating current to flow in a thin layer towards the surface of the work piece. The skin effect increases the effective resistance of the metal to the passage of the large current. Therefore it greatly increases the heating effect caused by the current induced in the work piece.

- The proposed system converts AC mains supply to DC supply. The converted dc supply is fed to pulse generator. The generated pulses are fed to copper coil, which creates electromagnetic effect. When any conductive metal is placed in this strong electromagnetic effect, the current flow causes larger heat.

2.4Basics of Induction Heating:

Induction heating is the process of heating conductors (usually metals), by inducing an electric current to flow in the object to be heated. Current is induced into the object in the same manner that current is induced into the secondary of a transformer. A high frequency source is used to drive a large alternating current through a coil. This coil is known as the work coil. The passage of current through this coil generates a very intense and rapidly changing magnetic field in the space within the work coil. The work piece to be heated is placed within this intense alternating magnetic field. Depending on the nature of the work piece material, the heat is produced in it.

Fig 4. Principle of Induction Heating

III. COMPONENTS OF INDUCTION HEATING

Theoretically there are three major sections in induction heating. They are:

a. "A source of high frequency electrical power supply".
b. "An induction coil (work coil)".
c. "An electrically conductive work piece".

3.1 Circuit Diagram of Solar Induction Heating :

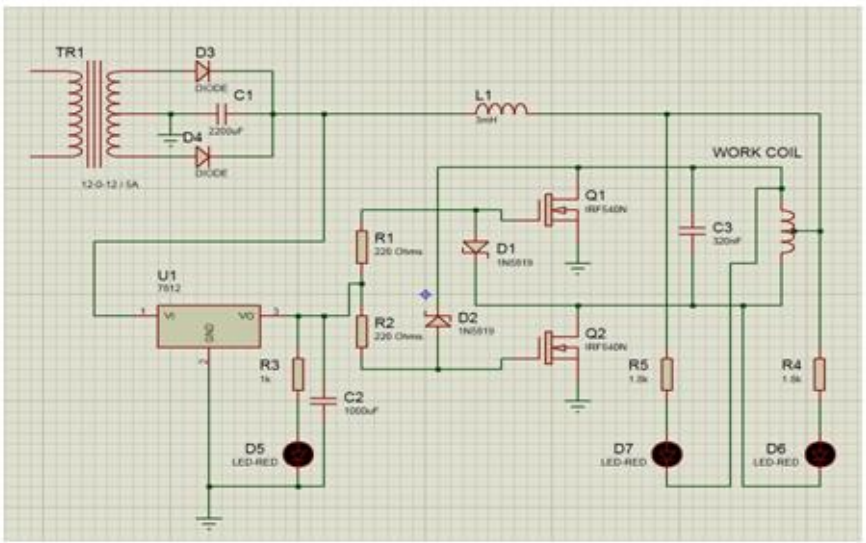

Fig.5: Circuit Diagram of Solar Induction Heating

3.3Relay Design

There are only four main parts in a relay. They are

- Electromagnet
- Movable Armature
- Switch point contacts
- Spring

The figures given below show the actual design of a simple relay.

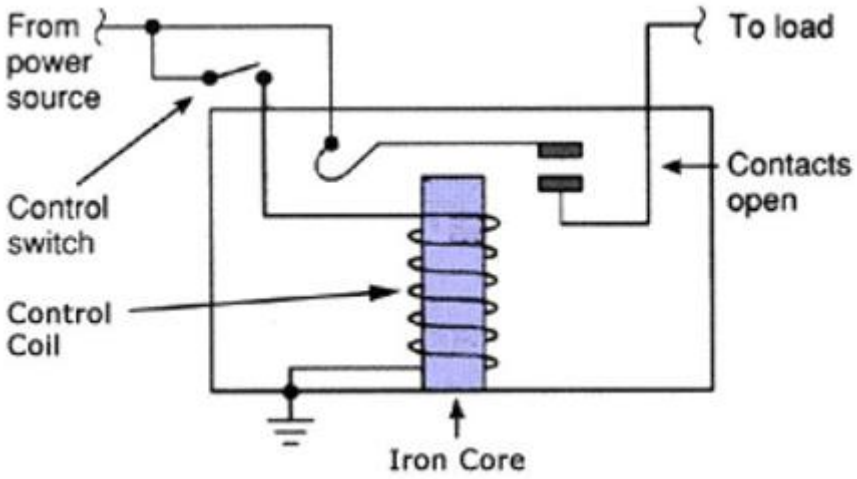

Fig 6: Simple Relay

IV. INDUCTION COOKING

1. In induction cooking an induction coil in the cook-top heats the iron base of cookware.
2. Copper-bottomed pans, aluminium pans and other non-ferrous pans are generally unsuitable.
3. The heat induced in the base is transferred to the food via (metal surface) conduction
4. Benefits of induction cookers include efficiency, safety (the induction cook-top is not heated itself) and speed.
5. Both permanently installed and portable induction cookers are available.

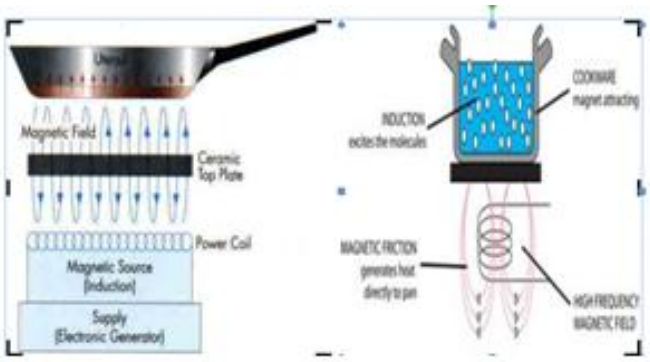

Fig 7 : Basic Induction Cooking

V. RESULT

Estimated Cost of the Induction Heating System Using Solar Energy :

S.No.	PART NAME	QUANTITY	COST
1	SOLAR PANEL	1	1000 /
2	BATTERY	1	3000/-

3	HIGH FREQUENCY PULSE GENERATOR	1	2500/-
4	COPPER COIL	1	1000/-
5	RELAY	1	200/-
6	SWITCH	1	50/-
7	REGULATED POWER SUPPLY KIT	1	500/-
8	LED	1	50/-

- **The Total Cost of the Solar induction Heating is Rs 8300/-**

➢ Solar panel power is calculated using the formula (1).

$$P_t = P_s \, x \, 8 \, x \, 0.85 \qquad (1)$$

Where; Pt = total power of system,
Ps= solar panel capacity.
The power needed to heat a work piece to desired temperature is calculated using the formula (2).

Pw = mc(Tfinal - Tinitial)/t (2)

Where; Pw= the work piece power, m = mass of the work piece,

T final = average values of final temperatures,

T initial = average values of initial temperatures. c = the average value of the specific heat of the

material.
t = the required heating time.
P=VI
where V=voltage of the battery
I=current in amps of the battery
Power = 12x14=168W

VI. CONCLUSION

The power consumption is 100W by an Induction heater compared to the conventional heating system. The power output generated by a solar panel is 168W .Time required for charging the battery is about 7 hours. Hence comparing the solar induction heating compared to the conventional heating system is found to be advantageous and can be used for heating application.

- The Capacity of the Solar Panel used in the project is 10Watts and with a dimension of 8.27 × 11.69 inches.
- The battery can be charged to a capacity of 12V using the solar energy .
- Compared to the output temperature generated by using conventional heat process is 150^0 Centigrade and by using Solar Energy is 200^0 Centigrade
- It uses a combination of two heating sources one is induction heating and the other is conventional heating .So, one source can compensate the absence of other source and continue generating power
- It is very eco-friendly and highly sustainable
- This system requires comparatively less investment and hence, is very economical Hence, due to all these features, Solar Induction Heating System can be considered as a capable alternative to replace the existing conventional heating systems in order to be both eco-friendly and efficient.

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