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Design Conceptualization & Prototype Development of Induction Heated Domestic Water Geyser

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Abstract:
The geyser is cynosure of this paper. A new concept is proposed, one that uses induction heating to heat water as opposed to the conventional resistive element heating. The heating mechanism of this geyser is based on the Faraday's principle of electromagnetic induction. The electromagnetic induction coil is used as a heating element to heat the water. This concept heats the same amount of water as a conventional geyser, which makes this geyser a competition to the conventional geysers, this new product assures the new dimensions and provide us with better efficiency, less time consuming, moreover less energy consumption, so basically it will help to give relief to the geyser users in their monthly electricity bills.

Keywords: *Geyser, induction, coil, split-design*

1. Introduction

As the human needs are increasing day by day, in parallel technology is also developing at a fast rate. Both technological development and consumption of natural resources are increasing at a high rate. The development of technology is needed, but the usage of resources has to be cautiously considered for the future, in order to ensure the safety of natural resources for future generations. This paper envisages the technological developments in domestic water heating measures and the steps taken to improve its efficiency and conserve energy. In order to limit the usage of electricity and make the water geysers more efficient, manufacturers have tried approaches like, wrapping with an additional layer of glass wool thermal insulation and using an auto cut system. However, there is still more to be done, which is discussed in this paper.

In the past, water heating was started by burning the coal or cow dung and heating the water containing vessel, whereas after having technological advancement electric geysers superseded this unfriendly to atmosphere method and in later advancements brought the electric geysers to the market with better insulation, auto-cut facility and even water hardness removal to get the better result. In addition, gas geysers came to the market, which surpassed electrical geysers' efficiency. However, maximum efficiency is still yet to achieve and time taken to heat the water is to be reduced. In order to achieve that, we can shift towards Induction water geyser. This is an innovative method of using the induction process of heating the water that has maximum possible efficiency in comparison to the rest of the methods. This helps to heat the water with $1/3^{rd}$ power consumption of electric geyser and that too in less time in comparison to the conventional geysers. Hence, energy consumption can be reduced by this new proposed design and construction of the Induction water geyser.

The aim of this work is to propose a design of a water geyser which is less time consuming, under the same electric load in comparison to the conventional electric geyser, which will ultimately lead to the saving of electricity. As per the survey of market requirement of electric geysers shown below in the table, being done by www.moef.nic.in shows the immense requirement of geysers in the future. This clearly shows there will be a huge energy source requirement, which is consequentially deteriorating with time. Therefore, Induction water geyser could get us the benefit of consuming less energy and even get faster results.

2006	2011	2016	2021	2026	2031
2.8	4.1	6.0	8.2	10.0	11.7

Table 1: Annual Sale of Electric Water Heater (millions)

2. Induction Heating

The idea for Induction water geyser is inspired by induction cooker, which works on induction heating mechanism, which is fast and less power consuming when it comes to consider the energy being used per hour ratio. Whether it's an induction geyser or an induction cooker the word "Induction" is a simple way of saying "electromagnetic induction." In a nutshell, induction means generating electricity using magnetism. It stems from the simple fact that electricity and magnetism aren't separate, unconnected things (as we originally learn in school) but two facets of the same underlying phenomenon: Electromagnetism. Induction heating is

the process of heating the electricity conducting object (usually a metal) by electromagnetic induction, through heat generated in the object by eddy currents (also called Foucault currents). An induction heater consists of an electromagnet, and an electronic oscillator that passes a high-frequency alternating current (AC) through the electromagnet. Moreover, Induction heating can be explained by Faraday's principle which states that a change in the magnetic environment across a conductor will result into a current being induced in that conductor and vice versa. In induction heating, this induced current is opposed by the resistivity of the material and this opposition to the induced current leads to extensive heat generation in a relatively short period, which depends on the number of turns in the coil. An important feature of the induction heating process is that the heat is generated inside the object itself, instead of, by an external heat source via heat conduction. Thus, objects can be heated very rapidly.

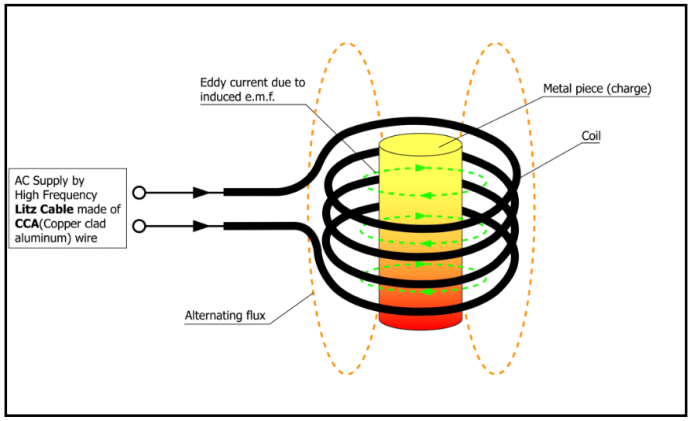

Figure 1: Induction coil

Induction heating can be explained with this figure shown above. When Alternating current (AC) is applied to a coil surrounding the work (metal), a magnetic field is generated by the current flowing in the coil, and induced loss (hysteresis loss) is generated causing a heat. At the same time, in the magnetic field which alternates with the AC, a spiral current (eddy current) is generated by the electromagnetic induction. This eddy current generates Joule heating, and a heat loss of the electromagnetic energy (eddy-current loss) will be caused.

3. Proposed Design

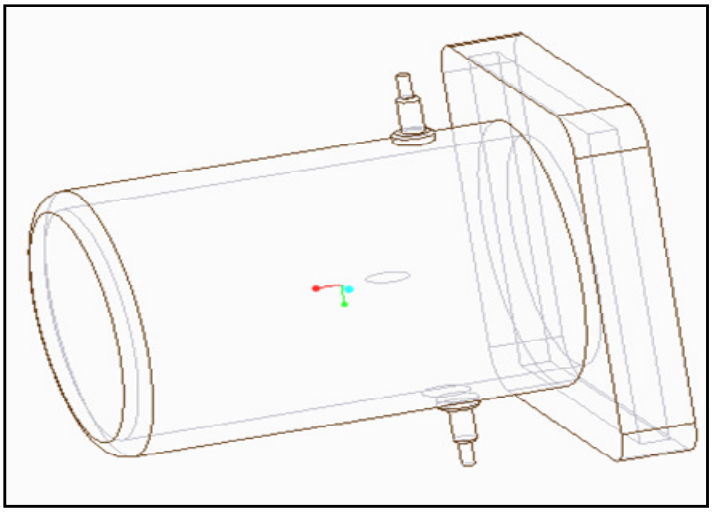

Figure 2: Wire framed model of an induction geyser

4. Design Explanation

The Geyser is split into two parts, therefore can be known as split design:

- First is the Heating source, which includes several components-

4.1. Induction Coil

An induction coil or "spark coil" is a type of electrical transformer used to produce high-voltage pulses from a low-voltage direct current (DC) supply. To create the flux changes necessary to induce voltage in the secondary coil, the direct current in the primary coil is repeatedly interrupted by a vibrating mechanical contact called an interrupter.

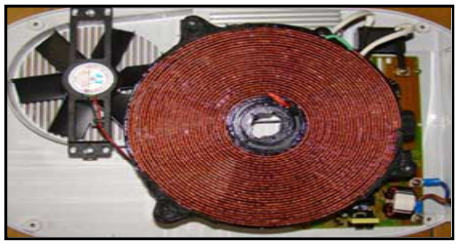

Figure 3: Induction Coil

4.2. PCB

A printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. Components — capacitors, resistors or active devices — are generally soldered on the PCB. Advanced PCBs may contain components embedded in the substrate.

Figure 4: Induction Coil
**Thermostat*

A thermostat is a component of which senses the temperature of a system so that the system's temperature is maintained near a desired set-point. The thermostat does this by switching heating or cooling devices on or off, or regulating the flow of a heat transfer fluid as needed to maintain the correct temperature.

Figure 5: Thermostat

- SECOND is Storage Tank which is connected with the heat source because of which water is being heated. Heat being generated by the coil is given to the middle layer of the tank which is shown with heating tank in the diagram.

4.3. PCV Valve (for inlet and outlet each)

Control valves are valves used to control conditions such as flow, pressure, temperature, and liquid level by fully or partially opening or closing in response to signals received from controllers that compare a "set-point" to a "process variable" whose value is provided by sensors that monitor changes in such conditions. Control Valve is also termed as the Final Control Element. The opening or closing of control valves is usually done automatically by electrical, hydraulic or pneumatic actuators. Positioners are used to control the opening or closing of the actuator based on electric, or pneumatic signals.

4.4. Glass Wool

Glass wool is an insulating material made from fibers of glass arranged using a binder into a texture similar to wool. The process traps many small pockets of air between the glass, and these small air pockets result in high thermal insulation properties. Glass wool is produced in rolls or in slabs, with different thermal and mechanical properties. It may also be produced as a material that can be sprayed or applied in place, on the surface to be insulated.

Figure 6: Glass Wool

4.5. Inner Casing

There is one non-corrosive layer (either protective polishing or a different metal sheet which reacts as a non- corrosive layer to water) which will protect the inner structure of the tank.

4.6. Outer Casing

Protecting the released heat from the tank will also give better results in the efficiency and will also help to maintain the water at the higher temperature for the longest time. Outer casing or the last layer would provide the strength to the tank. It plays the role of the base, on which the Geyser will be hanged and also behaves as the strongest layer in the tank for protecting the geyser from external forces as well.

4.7. Water Temperature Sensor

Storage tank also has its own temperature sensor, whose signal will be sent to the PCB card, which further does the auto-cut mechanism when desired temperature of water is obtained, according to the set value given by the help of push buttons.

Figure 7: Water temperature sensor

4.8. Water Detection Sensor

Storage tank also has water sensor, which detects water in the tank. Only if water is present, the induction coil starts, until then a very small amount of electricity is consumed to keep the PCB active and to run the indicators.

Figure 8: Water detection sensor

5. Working

Geyser is first installed by the trained engineer because it does involve plumbing and electrical work, who does the balancing of geyser over the wall or wherever the customer requires it to be according to the space where it has to be installed. Before installing it requires the water pipe line from the home water storage and also the 15A socket.

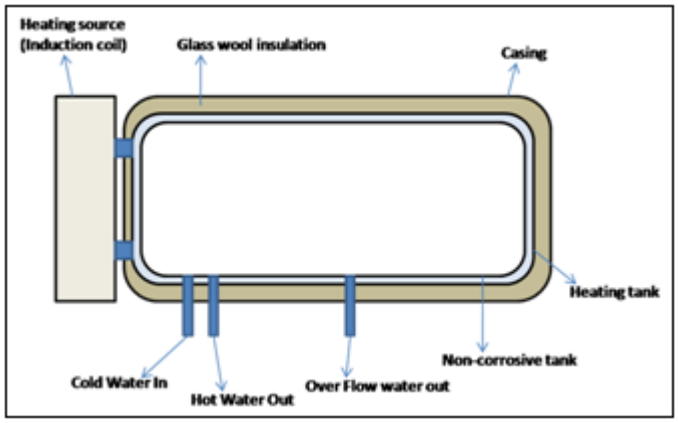

Figure 9: Proposed design

The geyser is being installed with both inlet and outlet water pipes and electricity supply. Now user needs to select the temperature, according to which PCB will do the monitoring. As the water enters into the tank, water sensor sends the signal to PCB circuit which will forward the signal to coil, to start. Water starts to heat until the temperature set by the user is obtained by the storage tank. After that, an indicator will glow, so that user can open the outlet valve to get the hot water out from the geyser.

6. Advantages of Split Geyser

Induction Geyser's price which is going to be somewhat equal to the price of electric geyser or maybe more, according to the manufacturer who is going to use the parts according to its limitations. Though, the product should be made with good quality parts, for the user's safety and ensuring the quality of the product, the servicing of the Geyser is also meant to be considered.

As the product is in regular use, the accidental cases or manufacturing defects leads to fault or failure of parts of any product. If any component of the split-geyser fails, then instead of replacing the whole geyser, that particular component which has stopped working properly or has failed can be replaced.

7. Conclusion

The main purpose of the design of such simple and cost effective induction water geyser is to build a market of cheap and less time consuming water geysers for the common man. This module proves far simpler in design as well as in electronics.

Due care was taken during the design of the proposal so that the actual real time problems during the working of this geyser can be tackled and rectified. This Geyser can be available at the same price as that of the electric geysers. However, the price range can vary according to the dimensions and quality of the components used. In addition, the price may seem similar to the electric geysers, but in the longer run it will save money in terms of electricity bill due to less time consuming process of Induction Water Geysers. Hence, introduction of Induction water geysers would be a huge success in the market, not only for the manufacturers but for the customers too.

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