

Design and Experimental Validation of An Electromagnetic-Based Low-Cost Lightweight Polymer Fabricated Induction Stove

Raju Chintakindi^{1,*}, Prakash Kamiseti²

Abstract

Induction stoves are an innovative and energy-saving alternative to traditional gas or electric stoves. Traditional induction stoves, many of which are expensive, heavy, and bulky, require modifications to make them suitable for low-income households and small consumers. This work is unique in that it involves the design and validation of a low-cost, lightweight induction stove. With fewer components, this stove is a feasible and sustainable solution for high temperatures. The induction cooktop is built with meticulously selected components. Connectors, housings, wires, and cables all use high-performance polymers. It operates on the electromagnetic induction principle, producing an electromotive force in a conductor through the use of a changing magnetic field. The coil generates an electromagnetic field, which heats a metal pot on top of it. It heats the cookware by reducing heat loss and consuming less energy. It is free of gas and flames, which helps to keep the air clean. Because of these unique concepts in social and economic aspects, this induction stove has the potential to increase in both urban and rural general stores.

Keywords: Induction stove; induction coil; electromagnetic; electromagnetic induction heating; temperature; heat; energy; Polymers

INTRODUCTION

In 2020, the worldwide market value of induction cooktops was estimated at USD 18,667.8 million. During the period of 2021 to 2028, the industry is expected to experience a compound annual growth rate (CAGR) of 8.5%. The number of restaurants and eateries, together with the number of residential and non-residential construction projects, are driving the industry. Common people are becoming interested in newly created technology for food item production, both as residential and commercial customers. The public is particularly interested in innovative cooking techniques, such as induction burners, which are renowned for their quick, safe, and clean cooking principles. The market for

induction stoves, particularly in households, is expanding quickly as a result of steadily increasing fuel prices. Additionally, several induction-based kitchen modules are becoming more and more popular due to their novel features and benefits in terms of comfort and excellence. Figure 1 shows the North American Induction Cooktop Market Research Conclusion for 2021–2028 [1].

The induction cooktop's technological advances produce an electromagnetic field that immediately transfers heat to metal cookware made of ferrous metals like iron and steel [2]. The induction cooktop's remarkable success in its sector stems from its features, energy-saving technological

*Author for Correspondence

Raju Chintakindi

¹Assistant Professor, Department of Electrical & Electronics Engineering, Vaagdevi College of Engineering, Warangal, Telangana, India

²Professor, Department of Electrical & Electronics Engineering, Vaagdevi College of Engineering, Warangal, Telangana, India

Received Date: May 17, 2024

Accepted Date: July 17, 2024

Published Date: December 06, 2024

Citation: Raju Chintakindi, Prakash Kamiseti. Design and Experimental Validation of an Electromagnetic-Based Low-Cost Lightweight Polymer Fabricated Induction Stove. Journal of Polymer & Composites. 2025; 13(Special Issue 1): S261–S274p.

advances, and aesthetically pleasing design. In comparison to electric cookers, the induction cooktop market in India has significantly greater volumetric shares. In 2020–21, there was a rise in the number of induction cooktops, accounting for almost 10 million units. The market has become more appealing and well-liked due to the growing middle class, the need for modular kitchens, the cost of LPG fuel, the number of employed women, and greater accessibility [3].

Many people think that induction cooking is the best technology for cooking on the stove. Among the intrinsic qualities of home induction cooking technology are its high efficiency, automated cookware detection, non-contact heat transmission, and speed of operation [4]. The basis of this technology's magnetic induction concept is the production of eddy currents in ferromagnetic cookware using an oscillating magnetic field. Because of the Joule effect, these generated currents extract heat from the system, creating heat in the cooking dish itself. Therefore, the heating device and dishes should have low heat conductivity to minimize heat loss. Induction cooking employs the direct electrical induction heating technique rather than indirect radiation, convection, or thermal conduction [5]. Induction heating enables high- powered and rapid heat increase; users can alter heat settings instantaneously [6]. Induction cooking directly transfers the temperature from the stove to the vessel. This is one of the best technologies out there right now; it transfers power more than 80% of the time [7].

An induction stove utilizes induction heating to directly heat a cooking pot. An induction cooktop requires the construction of an appliance from ferromagnetic metal, a type of metal capable of magnetization. The cooking kettle on the stove sits beneath a coil of copper wire. An alternating electric current flows through the coil, causing the magnetic field to oscillate. This field subjects the pot to an electric current. As a result, the cooking pot's body will quickly heat up, effectively cooking the food inside. The induction cooktop utilizes meticulously selected components for construction. Connectors, housings, wires, and cables all use high-performance polymers. The mechanical qualities span a spectrum from very pliable to highly inflexible. These polymers must have the ability to endure temperatures much higher than 200°C. The materials must possess flame-retardant properties even at low wall thickness and resist arcing and tracking [8].

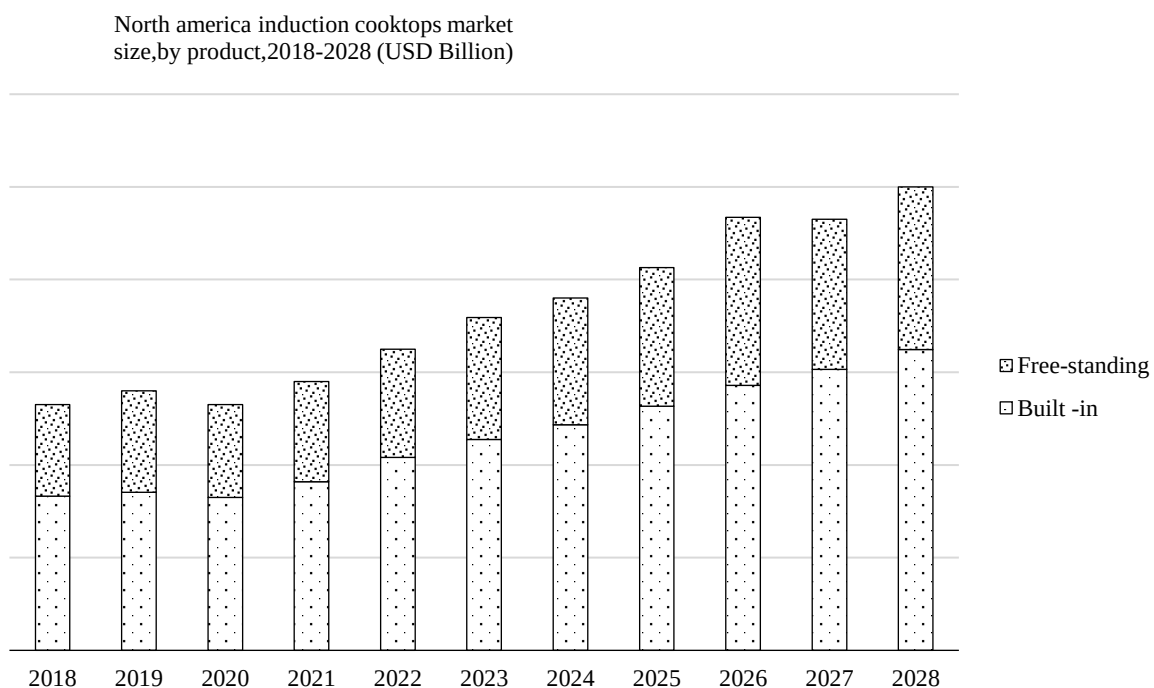


Figure 1. North American induction stove market research conclusion, 2021– 2028 [1].

Table 1 displays the energy consumption and cost analysis of cooking using liquid petroleum (LPG) gas vs induction cooktops in Bhutan currency [9]. This table makes it evident that cooking with an induction stove uses less energy and costs less overall than cooking with an LPG stove. This is what spurred designers to create inexpensive induction stoves. They generate an electric field that warms compatible magnetic cookware, resulting in efficient and uniform cooking.

The novelty of this investigation is to design and validate a low-cost, lightweight induction stove using induction technology with available low-cost components on the market. One of the key benefits of these stoves is their lower cost when compared to branded built-in induction cooktops. These stoves are ideal for consumers who have limited kitchen space, want a portable cooking alternative, or want an affordable induction cooking solution. They are appropriate for compact places such as student residences, hostels, offices, and domestic usage as an additional cooking option in a larger kitchen. Despite their cheaper price, these stoves still use induction technology to provide fast heating and accurate temperature control.

Table 1. Patterns of energy usage and the price of liquefied petroleum gas and induction cookers in Bhutan (9).

Cooking Item	Liquefied petroleum (LPG) gas cooking	
	Energy consumed in kWh	The overall cost of LPG in Nu
Rice, 500 Grams	0.39420	0.95280
Milk, 3 Liters	0.65690	1.58810
Milk, 5 Liters	1.05110	2.54090
Water, 2 Liters	0.39420	0.95280
Water, 3 Liters	0.52560	1.27040
Water, 5 Liters	0.91970	2.22330
Induction Cooking		
Cooking Item	Energy consumed in kWh	The overall cost of Induction Block
Rice, 2 Cups	0.28000	0.35840
Milk, 3 Liters	0.43300	0.55420
Milk, 5 Liters	0.51700	0.66180
Water, 2 Liters	0.30300	0.38780
Water, 3 Liters	0.39300	0.50300
Water, 5 Liters	0.48300	0.61820

The main outcome of this research is to provide the convenience and efficiency of induction cooking in small and economical packaging that will be available in local markets or street vendors. Section II covers the fundamental concepts of the induction stove, including a circuit analysis of the electromagnetic heating source, the creation of electromotive force, operation theory, and cooking methods. Section III covers the design and components of the low-cost lightweight model. Section IV discusses the Polymer mould induction stove casings and their characteristics and benefits. Section V presents the experiment's results and validation, along with a comparison of the price and weight of several branded induction stoves available on the market. Section VI covers the investigation's overall conclusions and suggests areas for future study.

THE FUNDAMENTAL THEORY AND CIRCUIT ASSESSMENT OF ELECTROMAGNETIC HEATING GENESIS

A high-frequency current is sent to a flat coil of wiring buried in the cooking pavement by the switching power- electronics system of a normal induction stove. The changing magnetic field magnetizes the cooking ware and connects it to the circuit. Connect the main and secondary coils of an electrical transformer in a similar way. Due to the minimal resistance of the material, current flows through the cooking pot. One can determine the power loss by calculating I^2R . This vessel's resistance

depends on its resistivity (ρ) and how magnetically permeable (μ) the cooking surface is, along with the excitation of frequency [10]. To make enough heat for cooking, it's crucial to use cookware that possesses excellent resistivity and permeability. The change frequency for most induction stoves ranges from 25 kHz to 50 kHz. Iron, cast iron, and some other stainless-steel substances are the only types of cookware that can work with the induction stove in this configuration. This means that the present induction cooking technological advances don't work with copper, aluminum, or stainless steel materials that aren't magnetic (6).

The wall outlet's AC power transmits electromagnetically to a metallic object, causing induction heating. A coil directs an electrical current to create a high-frequency, alternating electromagnetic field. Subsequently, the magnetic field couples with a metal object or vessel. Here, the alternating magnetic current induces a current flow through the object under Ampere's and Faraday's laws, producing heat according to Joule's heating principle [11]. The technique of creating a voltage or electromotive force (emf) through a conductor in a magnetic field that changes is known as the process of electromagnetic induction. In the 1830s, Michael Faraday discovered this phenomenon. When a conductor, such as a wire, interacts with a shifting magnetic field, it induces a current, as shown in Figure 2 [12]. In electrical and electronic systems, this theory underpins the functioning of generators, transformers, and inductors.

The Working Principle of An Induction Stove

The creation of an electric current across a conductor traveling through a magnetic field is known as electromagnetic induction. The technique of heating an electrically conducting material—typically a metal—by electromagnetically inducing eddy currents inside the material and resistance causes the material to heat up, as shown in Figure 3.

Cooking Method

An induction stove heats a cooking pot directly through induction heating. An appliance on an induction cooktop must be made of ferromagnetic metal. Under the cooking kettle on this stove lies a coil of copper wire, as shown in Figure 4. The coil receives an alternating electric current, which causes the magnetic field to oscillate. The pot experiences an electric current due to this field. Consequently, this will cause the cooking pot's body to heat up fast on its own, cooking the food within. Bakelite is the material used in the production of cooker and frying pan handles. Thermosetting plastic is a kind of polymer that has the ability to endure high temperatures without undergoing deformation. This is why it is used as handles for saucepans and cutlery. Additionally, it has excellent insulating properties and exhibits little heat conductivity. Therefore, manufacturers often use it in the production of electrical connectors and switches. The substance is a polymer made from phenol and formaldehyde.

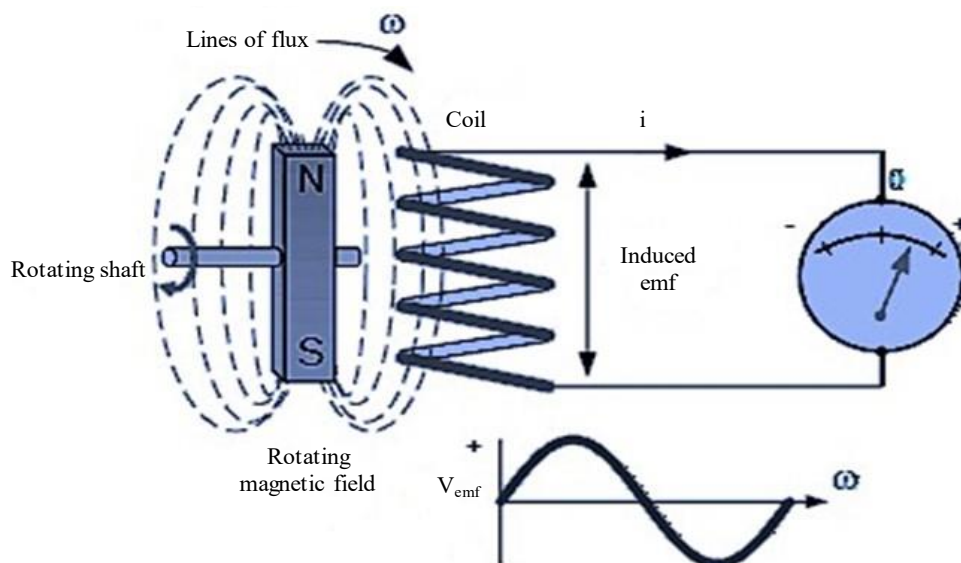


Figure 2. Electromagnetic induction is the process of generating an electromotive force (12).

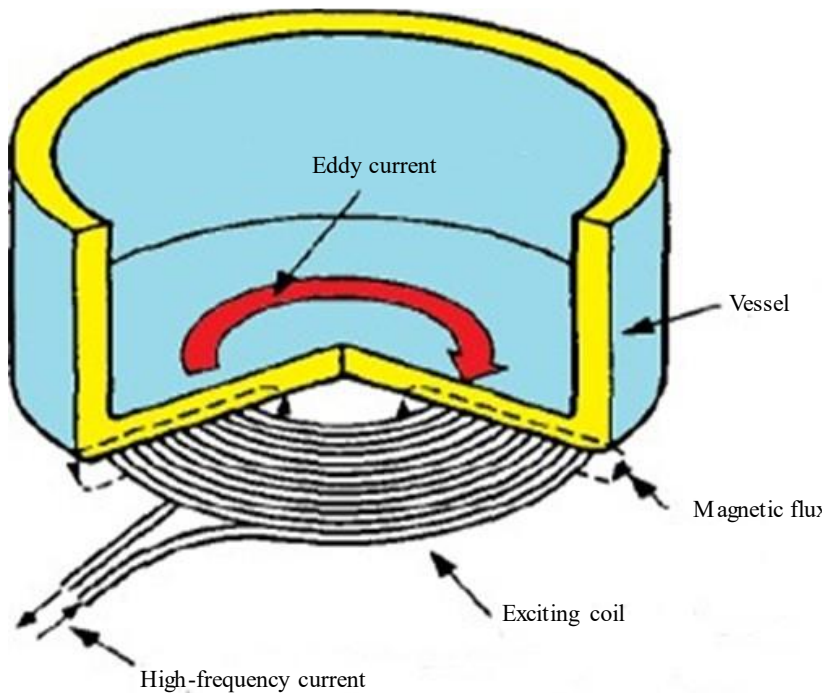


Figure 3. Eddy current and heat generation using the electromagnetic principle (7).

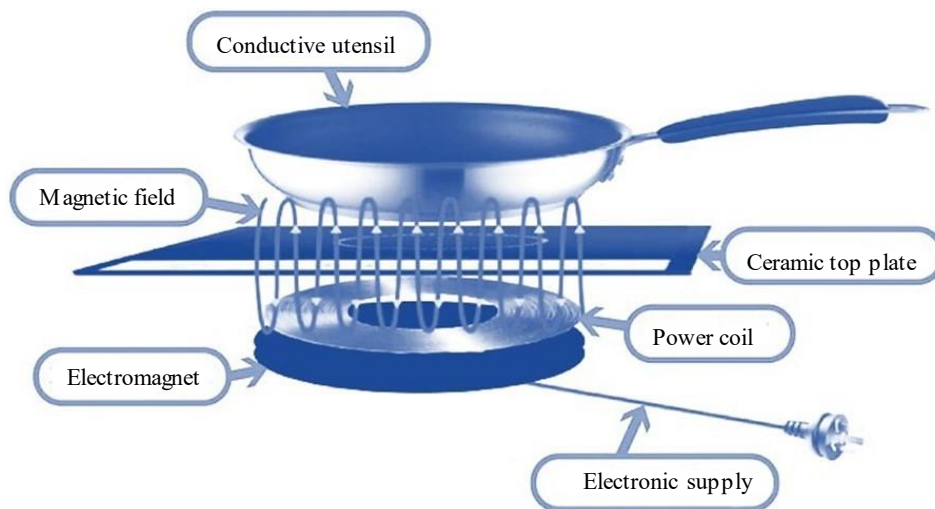


Figure 4. A scenario of an induction heating stove circuitry (11).

DESIGN AND COMPONENTS DESCRIPTION OF THE LOW-COST LIGHTWEIGHT MODEL

The application of induction heating in households is a continuously developing field. The uniqueness of this work lies in the creation and verification of an affordable and lightweight induction stove. This stove, with a reduced number of components, offers a practical and environmentally friendly option for high temperatures. In the past few years, initiatives to conduct research and development have concentrated on significant enabling technologies such as power electronic conversion devices, induction device system improvement, magnetic substances, control, and analysis blocks. Figure 5 shows electromagnetically powered, low-cost, lightweight induction stoves.

An induction stove's two primary parts are the power electronics conversion and the inductive load mechanism. Figure 6 shows the inductor-load system viewed electrically as two equivalent resistors (R_{eq} and L_{eq}) connected in series [13].

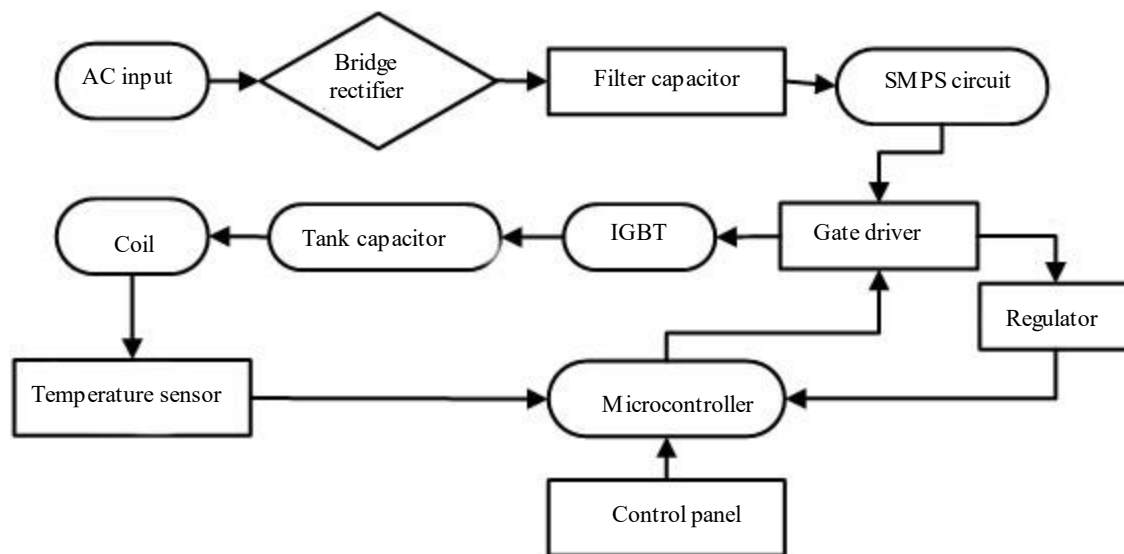


Figure 5. Block diagram of an electromagnetically-powered low-cost lightweight induction stove (14).

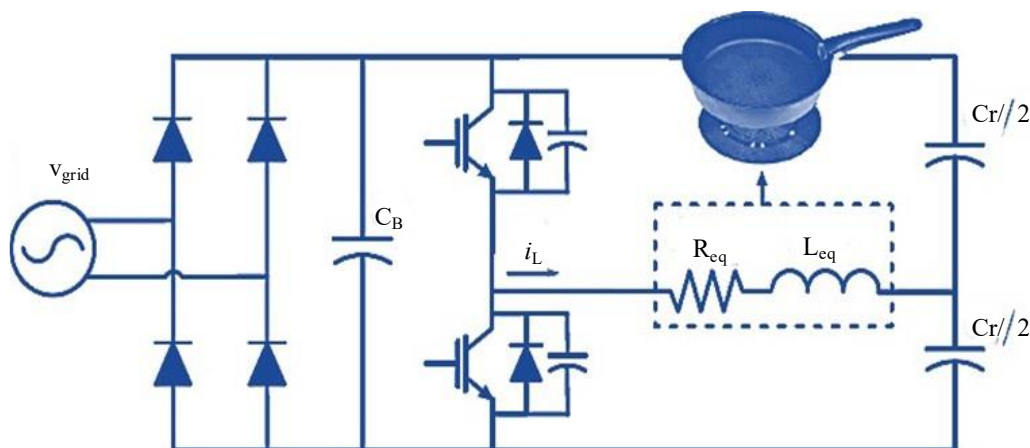


Figure 6. An illustration of the induction stove's basic parts and grid connection (15).

To support the cooperative design of the converter and induction arrangement, R_{eq} is the power loss and L_{eq} is the system's magnetic field. A 230V, 50Hz AC power source supplies the circuit. Discrete semiconductor modules are products such as D20SB10 model bridge rectifiers rated at 1 kV and 20 A, also called diode bridges. These devices transform AC electricity from the mains into a pulsing DC output, which powers devices. The 5 micro-farad, 275V filter capacitor transforms pulsing direct current into pure current. The device has a capacitance of 5 microfarads and can handle a voltage of 275 volts alternating current (or 400 volts direct current). It has a tolerance of $\pm 5\%$ and is classified as X2 for interference suppression. These are radial box-type capacitors made of metallized polypropylene film, often known as MKP capacitors. The resonant circuit in induction cookers is often wrapped using a polypropylene film dielectric. It is encased in polymer and sealed with epoxy glue. SMPS circuits employ high-frequency switching to quickly turn the input voltage on and off. An inverter then transforms the alternating current into a high-frequency AC signal, typically in the tens or hundreds of kilohertz range. This high-frequency AC is necessary for induction stoves to function because it generates an electromagnetic signal that warms the cooking vessels.

An essential part of an induction stove is the 1400W, 230V induction coil, also referred to as the heating element or induction coil. When electricity flows through it, it produces an alternating magnetic field with a high frequency. Electricity flowing through it generates electric currents in the ferrous

material of the cooking pot placed on top of the stove. The induced currents that create heat within the vessel allow for precise and effective cooking without overheating the coil, as shown in Figure 7. The winding coil ends are made of self-extinguishing silicon resin with an FG rating. At a high temperature, it braids the sleeve with non-alkali fiberglass and coats it with a specialized silicon resin. The sleeve exhibits favorable characteristics of Di electricity, self-extinguishing properties, exceptional softness, and elasticity. In H-class electrical gear, residential electrical appliances, heating electric equipment, and electric apparatus, it frequently serves as an insulator for wiring. It also serves to protect the gathered wire strands [16].

Induction cookers use temperature sensors to track the cooking surface's temperature. They aid in establishing and maintaining the ideal temperature ranges for cooking. By ensuring that the surface doesn't become too hot, these sensors help to provide a safe and comfortable cooking environment. They also help with precision temperature management, which enables users to precisely modify settings for different cooking requirements (2).

The control panel of an induction stove functions as the intermediary between the user and the stove's operations. It enables users to accurately regulate the power levels for each cooking zone, allowing them to establish the appropriate temperature or cooking intensity. It offers a user-friendly interface for managing many culinary activities, enhancing ease and adaptability in cooking. In addition, the control panel may provide error codes or warnings to notify users of any problems, thereby assuring operational safety. Insulating materials like fiberglass or plastic, which provide mechanical support, electrical connection, and insulation, typically compose control panel PCBs. These PCB substrates typically use materials such as FR-4, a composite of epoxy resin and fiberglass, and polyimide [18]. Polyimides are polymers composed of imide monomers. This heterogeneous assemblage of polymers encompasses a wide array of substances, including both organic and man-made compounds. Polytetrafluoroethylene (PTFE), sometimes known as Teflon, is a high-performance polymer used in printed circuit boards (PCBs) due to its exceptional electrical characteristics and low dielectric constant (Dk). PTFE is often used in high-frequency and microwave applications because of its little signal loss and exceptional electrical performance.

A microcontroller, also known as a microchip, manages certain electrical system functions as a small integrated circuit processor. On an individual chip, it integrates the memory, input and output interaction points, and a central computational unit. For the fabrication of microcontroller chips Silicon is the main material used. The wafers are obtained by cutting them from a huge, single-crystal, ingot of exceptional purity. Polycrystalline silicon, often known as poly or polysilicon, is used for creating short connections between the electrical contact and the contactor side of the gate [19]. Induction stove microcontrollers have numerous functions. Figure 8 displays the pin arrangement of the microcontroller chip from an outer view perspective. The microcontrollers regulate and manage the power supplied to the induction coils by altering the gate signal to the IGBT, ensuring accurate heating levels for various cooking demands. Furthermore, microcontrollers keep an eye on many variables, including voltage, current, and temperature, to guarantee reliable and secure functioning. They often oversee user interfaces, such as touch screens and displays. Microcontrollers manage and control the electricity supplied to the induction coils to guarantee accurate heating temperatures for various culinary requirements. These controllers precisely adjust the heat used for cooking by controlling the frequency and strength of the alternating current.

The bridge rectifier converts alternating current into direct current. It falls within the category of non-linear electronic rectifiers. Many electrical networks frequently use bridge rectifier circuitry. Bridge rectifiers commonly power a variety of fundamental electronic assemblies. The bridge rectifier's function is to convert AC power into DC electricity. Among the several rectifier circuits, this one is the most inventive. This circuit has a very efficient power conversion. Since it creates a circuit that resembles a bridge by using four diodes, we refer to it as a bridge rectifier. The circuit additionally includes a filter to enhance the bridge rectifier's output. Figure 9 displays the basic bridge rectifier, which uses at least four diodes in a bridge circuit design to change alternating (AC) current to direct

(DC) current. Silicon diodes are extensively used as rectifiers for lower voltages and powers, and have essentially supplanted other rectifiers. Germanium diodes provide a significant advantage over silicon diodes in low voltage circuits due to their much lower forward voltage (0.3V compared to 0.7V for silicon diodes). The rectifier bridge consists of four rectifier silicon chips connected in a bridge configuration, and is encased in insulating polymer [20].

Induction stoves employ Insulated Gate Bipolar Transistors, or IGBTs, to regulate the power going to the induction coil, which warms the cooking surface. These semiconductors control the high-frequency alternating current that produces the induction cooker's electromagnetic field. IGBTs assist in power management by successfully controlling large currents, enabling precise control over the heating process, and promising safety. The insulating substance is often composed of solid polymers that are prone to deterioration. Some advancements use an ion gel to enhance production processes and decrease the necessary voltage [21].



Figure 7. 2000 watts compact aluminum induction Cook-top Coil [17].

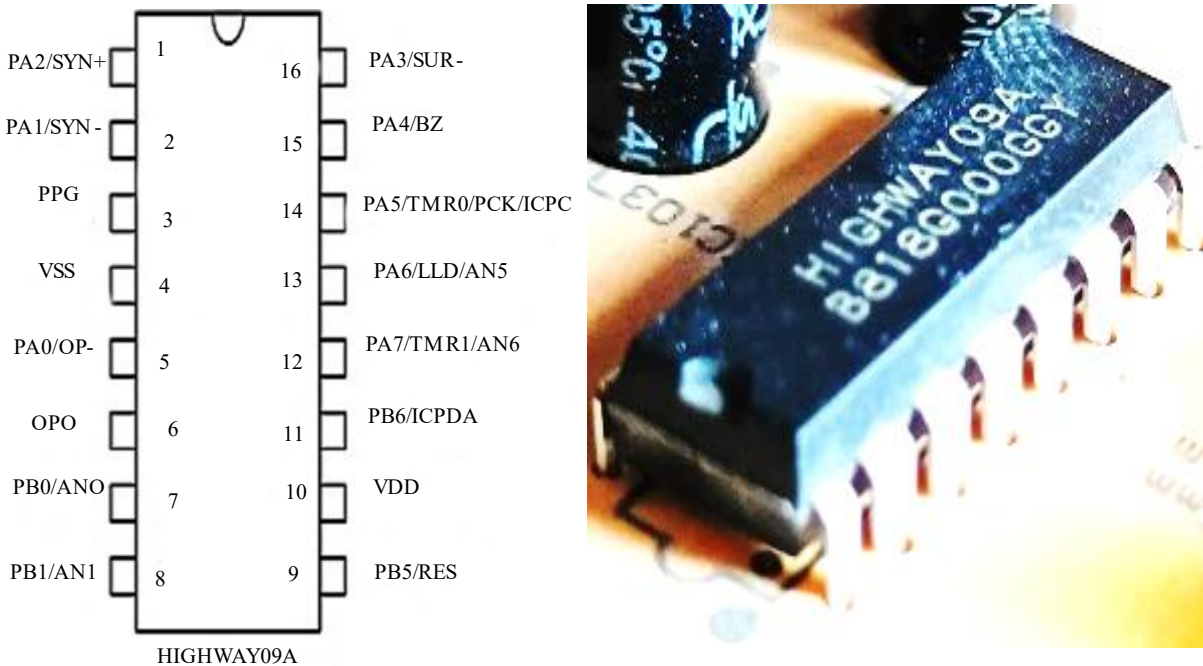


Figure 8. The pin arrangement of the microcontroller chip (HIGHWAY 09A) from an outer view perspective [19].

25N120 IGBT of 1200V, 50A is a power semiconductor technology that offers the benefits of metal-oxide- semiconductor field-effect transistors (MOSFETs) and bipolar junction transistors (BJTs). Its low saturation voltage, high input impedance, quick switching speed, and high voltage and current rating are all present. Electric cars, motor drives, amplifiers, and switching power supply applications extensively utilize it. IGBT power electronics modules are often encapsulated using silicone gels. The gel serves the purpose of protecting components and connections against moisture [22].

An essential component of the circuit's power transmission mechanism is a connected inductor. An inductor is normally composed of a coil made of conducting material, such as insulated copper wire, that is wound around a core. The core may be made of either plastic, which creates an air-core inductor, or a ferromagnetic (or ferrimagnetic) substance. When the core is made of a ferromagnetic material, it is referred to as a "iron core" inductor [23].

Coupled inductors are two coils, or inductors, connected via electromagnetic induction. When an alternating current passes through one coil, it connects the magnetic field to another coil and induces a voltage in that coil, as shown in Figure 10. This part is essential for controlling energy flow and guaranteeing effective power conversion. A coupled inductor, often designed like a transformer, delivers electricity from the SMPS circuit to the cooking pot on the stove. The transformer, frequently used as a coupled inductor, transmits power from the SMPS circuit to the cooking vessel set on the stove. Cookware generates heat through resistance, which is then utilized for cooking food. Coupled inductors are multiple inductors that have mutual magnetic coupling. When current passes through one coil and connects to the other, it creates an electromagnetic field that produces a voltage. In transformers, filters, and power converters, this coupling facilitates energy flow between the coils and is helpful for controlling voltage, current, or impedance.



Figure 9. Four-diode-based basic bridge circuit design (24).



Figure 10. Winding structure of the electromagnetic induction-principled 47 micro-Henry coupled inductors (25).

POLYMER INDUCTION COOKER MOULD

This induction stove polymer mold is known for its elaborate patterns and perfect fit. It is vital to mould induction cooker housings with exceptional structural and dimensional accuracy. Its zinc-coated surface and sturdy metal alloy construction provide corrosion resistance and longevity. This polymer mold is ideal for mass production, ensuring precise piece creation. A vented structure and an accurate ventilation section let this induction cooker polymer mold dissipate heat. Figure 11 illustrates the construction of the induction stove casing from polymer molding [26].

Polymers are made by polymer fabrication. Its intricately designed and exact induction cooker plastic mould is its pride. A strong metal alloy with a zinc finish ensures corrosion resistance and durability. Mass-producing this plastic mould ensures component precision. It makes an induction cooker polymer mould with a precise fan section and a vented structure for heat dissipation. The features of polymer mold induction stove casings include providing a sleek surface finish, being user-friendly, and ensuring no structural defects.

This article simplifies the process of finding the perfect polymer induction cooker mold. By beginning with the proposed design and material, it is possible to assess the appropriateness of injection molding and identify the optimal mold material. Both metal castings and molds made from different materials are available. In addition, it will enhance the mold until it is fully content with the final goods. Induction cooktops should never have plastic or paper goods put on them. These materials are susceptible to melting or igniting as a result of the elevated heat produced by the cooktop. This may result in harm to the cooktop and provide a risk to safety. Several varieties of cookware are incompatible with induction cooking surfaces. Products made of aluminum, aluminum clad, copper, copper clad, aluminum foil, glass/ceramic, and some stainless steel materials (since they do not possess magnetic properties) are not suitable for usage. In order for pots and pans to be suitable for use on an induction cooktop, they must be constructed from a magnetic substance, namely iron or iron-based materials like steel.

FINDINGS AND VALIDATION OF THE EXPERIMENT

The compact, inexpensive induction stove heats its surface when placed over the induction coil, utilizing the concept of electromagnetic induction. Induction cooking utilizes electrical induction to heat cooking vessels made of ferromagnetic metals like cast iron or stainless steel, rather than relying on thermal conduction from a flame or an electrical heating element. Due to the alternating magnetic field, an electric current moves in a back-and-forth motion. This phenomenon is often referred to as an eddy current, like the swirling motion. The metal exhibits electrical resistance, similar to that of an electric heater, resulting in the generation of heat. This heat is then transferred to the food via the metal of the pan. With this innovative induction cooking surface, it can boil water in just two minutes or less, whereas traditional cooking surfaces, such as gas, require 5-8 minutes. This results in decreased cooking durations and enhanced command over food preparation, leading to a reduction in cooking time.



Figure 11. Polymer mould induction stove casings (26).

This induction cooker technology enables sustained heating while working at a lower power level. In the case of a conventional single-IGBT induction cooker, when it is configured to function at a low power level, it requires intermittent operation [27]. This means that it operates for a duration of 0.2 seconds and then pauses for 0.8 seconds in order to reduce its average heating power. The control panel screen allows users to observe the temperatures, while the LED indicator light displays the power supply variations to the coil when the circuit's power source is changed. Poly (phenylene vinylene) (PPV) is the predominant polymer utilized for these devices. It has a bandgap of around 2.5 eV and is capable of generating yellow-green light. Polymer light-emitting diodes (PLEDs), a very promising technology in the display industry, have garnered significant interest from several research corporations. These devices are most suitable for various displays since they can be easily processed and provide mechanical flexibility. Seven-segment displays can employ various technologies to generate or control light for each segment, including liquid crystal displays (LCDs), light-emitting diodes (LEDs), electrochromic displays, cold cathode gas discharge (Panaplex), vacuum fluorescent (VFD), incandescent filaments (Numitron), and others [28]. Figure 12 illustrates the experimental validation of an electromagnetic-based, low-cost, lightweight induction stove.

Additionally, other induction stoves are compared to this innovative, affordable, and lightweight induction stove for the purpose of test case analysis and validation. The analysis includes a total of eleven cooking stoves, which include of the leading brands available in the market. Various power evaluations, weight assessments, and cost analyses are used for justifying purposes. The investigation concluded that the Prestige PIC 6.1 V3 PIC Induction Cooktop has the greatest power rating of 2200 watts and is priced at Rs. 3799. Additionally, it weighs 3.5 kg, which is rather high. Subsequently, it conducted an analysis on three Philips induction stoves with a power rating of 2100 watts. These stoves are priced between Rs. 3499 and Rs. 4625, and their weights range from 2.1 to 2.6 kg.

Upon evaluating all eleven induction stoves, it was determined that the new Electromagnetic-Based Low-Cost Lightweight Induction Stove outperforms the others. It operates at 1600 watts, weighs 0.75 kg, and costs just Rs. 1500. Undoubtedly, it excels in terms of being lightweight and affordable in terms of life span. This function is beneficial for customers and has been shown to be one of the top induction cooking stoves at local and street-level marketplaces throughout socioeconomic growth. Table 2 displays the comprehensive study results and validation, along with a comparison of the power ratings, price, and weight of several branded induction stoves now available in the market [29].

Table 2. Comparison of different induction stoves with price and weight (29).

S.N.	Product name	Power (Watt)	Cost (Rs.)	Weight (kg)
1.	Prestige PIC 6.1 V3 PIC Induction Cooktop	2200	3799	3.5
2.	Philips Viva Collection HD4928/01 2100-Watt Induction Cooktop	2100	3499	2.1
3.	Philips HD4929 2100- Watt Induction Cooker	2100	3650	2.1
4.	Philips Viva Collection Hd4938/01 Glass Induction Cooktop	2100	4625	2.6
5.	V-Guard VIC 25 Induction Cooktop	2000	2699	2.15
6.	iBELL 20-YO Induction Cooktop	2000	2089	2.17
7.	iBELL IBL30YO Induction Cooktop	2000	1767	1.39
8.	V-Guard VIC 1.8 EL Induction Cooktop	1800	2399	2.75
9.	Usha Cookjoy (Cj1600Wpc) Induction Cooktop	1600	2299	2.8
10.	Amazon Basics 1600 Watt Induction Cooktop	1600	2309	2.5
11.	Investigated Electromagnetic-Based Low-Cost Lightweight Induction Stove	1600	1500	0.75

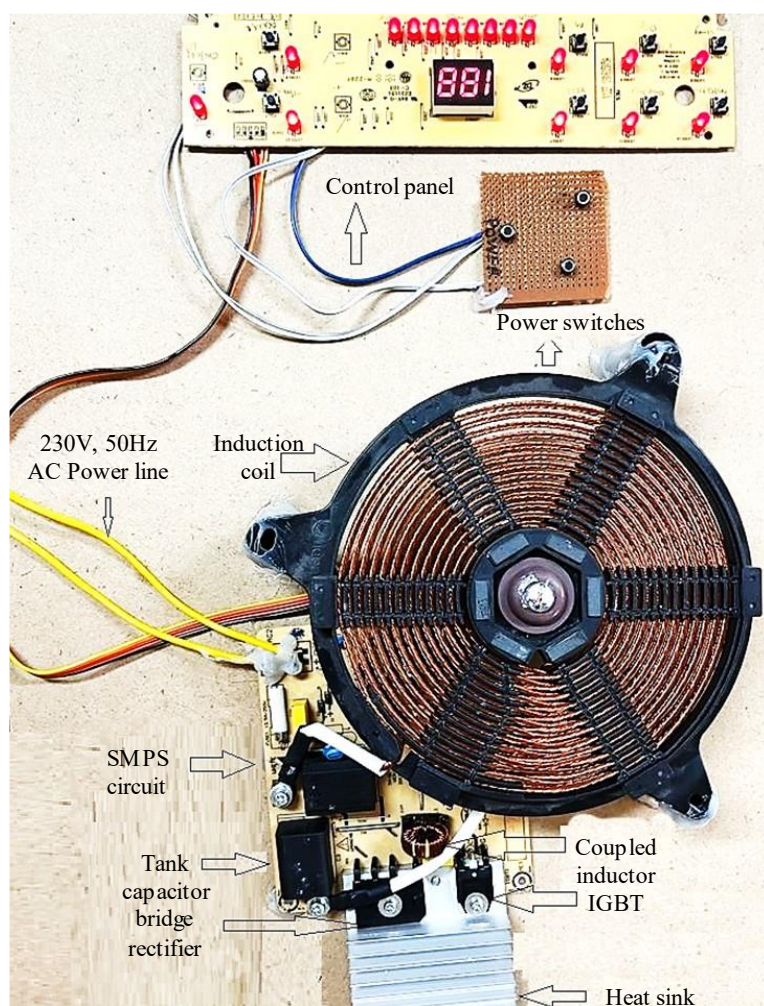


Figure 12. Experimental validation of an electromagnetic-based low-cost lightweight induction stove (14).

CONCLUSIONS

It is important to consider the style of induction cooking in terms of safety, energy bills, time savings, cost, and life span when deciding which is most appropriate. An induction cooktop may have a slightly higher initial cost but is a far better option long-term. Ceramic cooktops tend to be less expensive to purchase than induction cooktops. The induction cooktop is manufactured with specially selected components. Connectors, housings, wires, and cables all use high-performance polymers. Lightweight materials, such as high-performance polymers or sophisticated ceramics, play a critical role in weight reduction. These polymers must possess the capacity to withstand temperatures above 200°C. The materials must exhibit flame-retardant qualities, even when used in thin walls, and be resistant to arcing and tracking. In this research, the stove's total weight was considerably decreased without sacrificing performance or durability by using cutting-edge lightweight materials like high-performance polymers or sophisticated ceramics.

These findings enable safer and more energy-efficient cooking in both rural, urban, and hilly areas. The presentation of the design and validation experimental analysis of this induction stove, along with an assessment of the aspects of the present concepts effectively addressed. The investigated and validated experimental induction stove proved to be more inexpensive, portable, and light-weight than others available in Indian markets. With fewer components, this stove is a feasible and sustainable solution for high temperatures. Designed and validated, a low-cost, lightweight induction stove for those with limited incomes provides a chance to meet a critical demand for a cooking solution.

The analysis of this induction stove design and validation experiment can provide valuable insights for future investigations and idea generation in the field of stove development. There is a lot of future scope with improvements in design, materials, algorithms, and production techniques. There is great potential for the development of an affordable, lightweight induction cooker in the coming years. Furthermore, investigating other power sources—like integrating renewable energy or battery-operated alternatives—could increase the stove's usefulness, particularly in areas with erratic power sources.

REFERENCES

1. Grand View Research. Induction Cooktops Market Size, Share & Trends Analysis Report. USA; 20223.
2. R. Chintakindi, and Rajesh SPS. Vital role of FBG sensors — 2012 developments in electrical power systems. In: Proceedings of 2013 International Conference on Power, Energy and Control, ICPEC 2013. Dindigul, India: IEEE; 2013.
3. Research and Markets. India Induction Cooktop Market Overview,2021-2026. Research and Markets. 2023.
4. Jesus Acero; J. M. Burdio; L. A. Barragan; Denis Navarro; R. Alonso; Jose Ramon; Fernando Monterde. Domestic Induction Appliances. IEEE Ind Appl Mag. 2010;16(2):39–47.
5. M. H. Qais. Least Mean Square-Based Fuzzy c-Means Clustering for Load Recognition of Induction Heating. IEEE Trans Instrum Meas. 2022;71.
6. Micah Sweeney, Jeff Dols, Brian Fortenbery FS. Induction Cooking Technology Design and Assessment. 2014.
7. Diego Paul Chacón-Troya; Javier Quezada; Carlos Espinoza. Development and implementation of a smart induction stove. In: Brazilian Power Electronics Conference (COBEP). Juiz de Fora, Brazil: IEEE Xplore Press; 2017.
8. Daniel Stoecker. Pasta Bolognese and induction cooktops [Internet]. LinkedIn Corporation. 2018. Available from: <https://www.linkedin.com/pulse/pasta-bolognese-induction-cooktops-daniel-stoecker/>
9. Roshan Chhetri, Dawa Chhoedron, Tilak Sunwar DDR. Analysis on Integrated LPG Cook Stove and Induction Cooktop for Cooking Purposes in Bhutan. Int J Sci Res. 2015;
10. Eunsu Jang. Analysis and Design of Flexible-Surface Induction-Heating Cooktop With GaN-HEMT-Based Multiple Inverter System. IEEE Trans Power Electron. 2022;37(10):12865–76.
11. P. Sharath Kumar; N. Vishwanathan; B. K. Murthy; D. Vijaya Bhaskar. Class-D/E resonant inverter for multiple-load domestic induction cooking appliances. In: IEEE 6th India International Conference on Power Electronics (IICPE). Kurukshetra, India: IEEE; 2014.
12. Electronics Tutorials. Electromagnetic Induction [Internet]. Electronics Tutorials. 2023. Available from: <https://www.electronics-tutorials.ws/electromagnetism>
13. F. Forest et al. Principle of a multiload/ single converter system for low power induction heating. IEEE Trans Power Electron. 2000;15(2):223–30.
14. HOLTEK. Low Power Continuous Heating Single IGBT Induction Cooker. Vol. 10, Holtek Limited. Hsinchu, Taiwan; 2023.
15. ALBERTO PASCUAL et al. Electromagnetic Modeling and Analysis of Multimaterial Cookware for Domestic Induction Heating. IEEE Access. 2023;
16. Indiamart. Silicon Resin Coated Self-Extinguishable Fiberglass Sleeving [Internet]. IndiaMART InterMESH Ltd. 2024. Available from: <https://www.indiamart.com/proddetail/silicon-resin-coated-self-extinguishable-fiberglass-sleeving-2379079388.html>
17. Licate. 2000 Watt Induction Copper Heating Panel Coil Enameled [Internet]. Electronics. 2024. Available from: <https://licate.in/product/2000-watt-induction-copper-heating-panel-coil-enameled/>
18. Pentalogix. Materials used in printed circuit board substrates [Internet]. Pentalogix Inc. 2023. Available from: <https://www.pentalogix.com/blog>
19. Quora. What are the materials used to make a microchip? [Internet]. Quora. 2023. Available from: <https://www.quora.com/>
20. WEET. WEET Transformer Bridge Rectifier 35A 1000V BR3510 Specifications and Other Related BR Package Diode [Internet]. WEE Technology Company Limited. 2020. Available from: <https://www.smddip.com/?mod=pad&cate=10>

-
21. Wikipedia. Insulated-gate bipolar transistor [Internet]. Wikimedia Foundation, Inc. 2024. Available from: https://en.wikipedia.org/wiki/Insulated-gate_bipolar_transistor
 22. Lydia Feller et al. Evaluation of insulation material in advanced high power IGBT modules with extended operation temperature. In: 6th International Conference on Integrated Power Electronics Systems. Nuremberg, Germany; 2010.
 23. Wikipedia. Inductor. Wikimedia Foundation, Inc. 2024.
 24. TELoni. Rectifier Bridge 1kV 20A Plug-in D20SB100 [Internet]. Amazon. 2024. Available from: <https://www.amazon.com/TELoni-Rectifier-Bridge-Plug-D20SB100/dp/B0CM5VPN59>
 25. APVM. Coupled Inductors [Internet]. APVM Electronics & Digital Services, Inc. 2018. Available from: <https://apvm.com/Search/Summary?Menu=1027&Mname=Products&Cat=1170&CatName=Passive-Components&Sub=130&SubName=--Coupled-Inductors>
 26. Sharma SB. Induction Cooker Plastic Mould. IndiaMART InterMESH Ltd. 2024.
 27. F. Forest et al. Principle of a Multi-Load/Single Converter System for Low Power Induction Heating. IEEE Trans Power Electron. 2000;15(2):223–30.
 28. Wikipedia. Seven-segment display. In: Wikipedia. Wikimedia Foundation, Inc.; 2024.
 29. Deals E. Top 10 Induction Cooktops in India for 2023: A Complete Buyer's Guide [Internet]. Express Deals. 2023. Available from: <https://www.newindianexpress.com/>