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Design and Fabrication of Solar Powered Induction Cooker

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Abstract: *Many people in the developing areas of the world struggle to cook with stoves that emit hazardous fumes and contribute to greenhouse gas emissions. Electric stoves would alleviate many of these issues, but significant barriers to adoption, most notably lack of reliable electric power, make current commercial options infeasible. However, a stove with an input power of 24V DC elegantly solves the issue of intermittent power by allowing car batteries to be used instead of a grid connection, while also allowing seamless integration with small scale solar installations and solar-based microgrids. However, we have worked on materials for the manufacturers to produce in an economical way and consumers to buy on budget whether the buyers are from rural or urban areas. This stove is the one of its kind and represents a new contribution to both the field of induction cooking and the field of clean cooking solutions for the developing world. The findings of this study demonstrate that induction cooking is not always more efficient that conventional electric (resistive) technology. The energy savings potential of induction cooking is found to be greatest when used with small cookware. The impact of these findings on standard test procedures is discussed, and recommendations for improvement are suggested. Finally, a prototype cooker design is presented, with a discussion of the limitations of current designs that prevents their operation with non-magnetic cookware.*
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Keywords: Solar, Induction, stove, battery

I. INTRODUCTION

The continuous exhaustion of conventional energy sources and their environmental impacts have created an interest in choosing renewable energy sources such as solar photovoltaic, solar-thermal, and wind energy, producer gas and biomass sources to power induction heating system. The need for the optimum utilization of water and energy resources has become a vital issue during the last decade, and it will become more essential in the future. The availability of renewable energy sources such as solar photo voltaic, solar thermal, wind, biomass and various hybrid forms of energy sources provides good solutions for energy related problems in India. To meet the energy demands and reduce the environmental impact, the idea of integrating renewable energy sources such as solar photo voltaic, solar thermal, wind, and biomass and hybrid forms of energy with induction heating has been proposed by many researchers around the world. Solar energy is a good and clean source of energy, which can help the world in experiencing the dirty and short of non-renewable resources, such as coal, etc. In case of rural area, cooking is heavily dependent on inefficient biomass based cooking. The main problems include the time that is needed to collect the firewood and other biomass by the people, indoor air pollution induced health hazards and various other environmental concerns. Cooking using electricity is one of the most clean and efficient method of cooking as compared to biomass and other method of cooking. At present only few people in the urban area use solar PV technology for cooking purposes. In their system, solar charged battery in used in conjunction with inverter to run induction cooker. The solar powered induction cooking is technically feasible but the use of inverter has reduced efficiency. Therefore, there is a need to explore the possibility of induction cooking using solar powered DC batter

The DC system not only increases efficiency but also eliminates large and costly inverter that is required for cooking purpose using existing AC induction cooker. Induction heating is widely used nowadays in domestic appliances because of it cleanness, high efficiency, safety, low cost advanced power semiconductors and high performance. Induction heating is commonly used in industries for melting, hardening and brazing. High efficiency comes with the idea that all the magnetic

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field created between the coil and the pan is at least 80% transferred to the coil. The cooker presents the quick warming energy saving with high speed cooking with many temperature ranges. Domestic and commercial cookers work in the same principle and the performance is identical. Induction heating is the process of heating electrically ferromagnetic (conductive) materials by a process called electromagnetic induction. One of the many applications of induction heating is cooking.

II. General Approach

Our approach addresses these problems by undertaking the design of a high efficiency induction stove powered by 24V DC. This represents a previously un-researched area as there are currently no commercial induction stoves or literature available in academia regarding induction stoves powered from a low voltage DC power source. Such a stove would address the challenges highlighted in the previous section by utilizing a 24V DC power source. A 24V DC power supply could take several forms a cheap and readily available form of a 24V DC supply is the connection of two car batteries in series. This addresses the problem in each of the three cases above. Instead of relying on flaky grid power a home could instead charge two car batteries off the grid when power is available and use the stored power for cooking in the event of a brownout or similar electrical interruption. Furthermore 24V is an extremely common output for solar installations and one of only a few standardized output voltages for photovoltaic panels. This makes it appropriate for direct integration with a roof top solar installation or solar based micro grid traditionally to hookup an electric appliance such as an induction stove an inverter is connected to the solar battery to produce mains AC voltages. This step is usually at most 90% efficient and frequently significantly less. Then the stove internally must rectify the AC voltage back to DC to use it again with a loss of efficiency

III. Literature Survey

The most popular types of electric heating can be classified mainly into two types. First one is resistance heating and second one is induction heating. Resistance heating has the advantages of low cost and easy maintains but, the disadvantage is its low efficiency. Considering induction heating, an inverter topology supplies a high frequency current to an induction coil, producing an alternating magnetic field. If this field is applied to a ferromagnetic pan, it produces eddy currents, and magnetic hysteresis, which heat up the pan. Recently, domestic induction hobs have become increasingly popular owing to their specifications such as quick warming, energy saving and high efficiency [1]. Consequently, the research on induction cookers has attracted the attention of theory specialists and practical engineers. For increasing the efficiency and reducing the switching loss and power factor class E resonant inverter is used for the induction cooker, in which only single IGBT is used for reducing the cost.

The effort to increase the efficiency and the energy saving during a cooking process using an induction hob has been mainly focused on providing to the pot the maximum power in the more efficient way [2], for instance, designing highly efficient resonant inverter topologies, modulation strategies, and inductors. By controlling the Pulse Width Modulation using micro controller the temperature of the induction is control. It is important to know that the heating efficiency of induction cooker is usually from 80% to 90% or above, which is significantly energy saving comparing to the gas burner. Furthermore, the electricity for the operation of the induction cooker can be generated by sustainable energies such as solar and wind. The domestic and commercial induction cooker systems are similar in the operation theory as well as the configuration.

IV. Problem Statement

Developing countries and rural areas in developed countries present unique challenges to the design of any electric stove. The largest hurdle to overcome is the lack of readily available and reliable electric power. Consider India as an example. Many areas outside of the city have access to 220VAC wall outlets. However, they experience frequent power outages, interruptions, and poor power power quality [1]. Further outside the city in rural areas there may be no grid connection whatsoever. For electricity, these areas might rely on small solar installations, or town size “micro-grids”. Finally, any solution must be relatively low cost, or it will not be adopted. These challenges are not adequately met by available electric stoves. Resistive element electric stoves suffer from low efficiencies. A single low efficiency stove may overwhelm a home solar installation, while a number of them drawing power at the same time may overwhelm a microgrid. Commercial induction stoves have high efficiencies, but even higher efficiencies are desirable. No existing solution is capable of coping with an intermittent grid connection. The proposed thesis project aims to address these shortcomings.

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4.1 Objectives

- The main objective of this project is to reduce the use of conventional energy consumption.
- The maximum renewable energy should be in use for cooking purpose.

V. PROPOSED SYSTEM

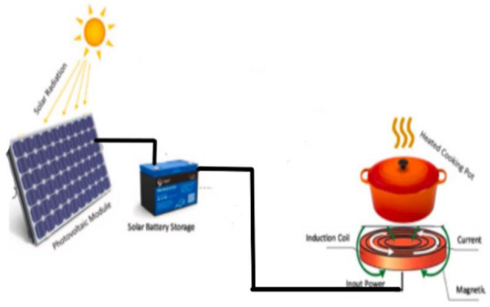

Figure 1: Block Diagram of Solar cooker

With the help of Arduino Uno we are going to measured temperature, voltage and current of shegadi. Induction cooking heats a cooking vessel by electrical induction, instead of by thermal conduction from a flame, or an electrical heating element. The cooking vessel must be made of or contain a ferromagnetic metal such as cast iron or stainless steel. Heat is coming from within the pan, making this method of cooking a lot more efficient. You therefore need to ensure that your pans are suitable to use on an induction hob. Copper or aluminum pans would not work unless they have additional layers added onto the bottom that are magnetic. The best way to check if your pans are viable is to see if a magnet will stick to the bottom of the pan. An induction hob contains a coil of copper wire underneath the ceramic plate, and when a cooking pot is placed on top an alternating electric current is passed through it. The resulting oscillating magnetic field induces a magnetic flux, producing an eddy current in the ferrous pot, which acts like the secondary winding of a transformer. The eddy current flowing through the resistance of the pot heats it. To find out what an eddy current is, see below. Energy transfer with induction hobs is around 84 percent compared to around 74 percent for gas or ceramic electric so there are good energy savings. Safety is an important aspect too – there is no naked flame so fire is extremely unlikely.

A pan of water will boil in nearly half the time that it would on a normal gas hob. An induction hob will also ensure the longevity of your pans because they have more contact with the heat below, and the current is running all the way through the pan. This will stop your pan from developing hot spots which in turn, will burn or scorch food

5.1 Solar Panel

Figure 2: Solar Panel

Solar panel coverts the sunlight into electricity, sunlight was collect either directly by using photovoltaic or indirectly using concentrated of solar energy. A solar cell works on the principle of photo-voltaic principle, the photo-voltaic solar energy conversion is one of the most attractive non-conventional energy sources of proven reliability from the micro to the Megawatt level.

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5.2 Battery

To reach the backup required for cooking we choose 12v 26Ah two batteries connected in series connection as it gives 1.5hr backup for 750W heating coil.

Advantages

- Direct room temperature conversion of light to electricity through a simple solid state device
- Absence of moving parts
- Ability to function unattended for long periods as evidence
- Modular nature in which desired currents, voltages and power levels can be achieved by more integration
- Maintenance cost is low as they are easy to operate
- They do not create pollution
- They have a long effective life, and
- They are highly reliable

Disadvantages

- Distributed nature of solar energy,
- Absence of energy storage. While the first disadvantage can be party overcome by concentration, the second is an inherent disadvantage overcome in PV systems by the use of conventional storage batteries. Efforts are being made worldwide to reduce costs per watt through various technological innovations.

VI. RESULT

Figure 3: Solar Induction Cooker

VII. CONCLUSION

The 24V DC cooker presents as a well-made appliance that would safely deliver a cooking experience. However, this unit will likely be used by rural households who are used to gathering firewood, preparing a fire, waiting for the fire to get to heat and then cooking – and when considering the total time required for cooking, the appliance will likely give a much appreciated reduction in overall time. It will also give a clean, convenient (the unit can be left while cooking) and aspirational experience. Some types of frying may not be possible – further research is required. As a DC appliance it is a

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very welcome addition to the toolkit of off-grid appliances that can work on solar home systems where there is no grid connection. It can be considered an energy efficient appliance, that utilises cooking to reduce cooking times for 'long cook' foods such as beans. As a DC appliance it alleviates the need for battery and appliance, and may enhance system efficiency

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