International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Automatic Dosa Maker with Thermoelectric Generation

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Abstract - *Developing energy efficient end use devices are ineludible due to the higher use of energy for domestic purposes. Energy consumption increasing day by day while there is a shortage of fossil fuel, oil, gas, etc. burning of these fuels causes environmental problem like radio activity pollution, global warming etc. The product envisioned in this project, the Automatic Dosa Maker allows for the automation of Dosa making for Indian households along with production of electrical energy from waste heat. This product achieves energy efficiency via Thermo Electric Generator (TEG) modules to generate electrical power for small scale applications. This is a relatively new concept since many of the current automation arrangements are suited for large scale food processing while the former can be used in domestic scale. The final product is a combination of an induction heating mechanism complete with dispensers for batter, oil and water using solenoid valves that are electronically controlled. As this product uses induction heating mechanism, a fair amount of waste heat is generated which is used for energy production. The TEG modules are arranged in a series then parallel combination and the electrical output is stored in a battery which is then converted to AC using a 12V DC to 220V AC inverter.*

Key Words: **Automation, Solenoid valve, Microcontroller, Thermo electric generation, Inverter.**

1. INTRODUCTION

Dosa is an unavoidable part of south Indian breakfast. It has been used by people at different part of the world. Consuming too much time along with a lot of energy(thermal) makes the preparation difficult. Today we are largely depending on fossil fuels in order to produce energy which is depleting the reserves. Recent years the per unit cost of electricity has been increasing to high levels due to less availability of fossil fuels. An energy efficient end use device is required to automate the process so as to save the much-needed time and to reduce the human labour involved in the production. Using electronic circuits and some mechanical works, we created a new automatic machine for Dosa making procedure with waste heat harvesting to recover the heat that is being dissipated to the surrounding.

1.1 Electric Heating

An electric heating coil is used to heat the square pan in which Dosa making is carried out. Electric heating coil is made up of special heating element that is wounded spirally, when electricity passes through the spiral metal, it glows red hot converts the electrical energy in to heat. Nichrome is the heating element used in this project since it is having a high melting point an doesn't expand too much on heating.

1.2 Electronic Circuits

Solenoid valves, dc motor, microcontroller constitutes the electronic circuit. Solenoid valves are electromechanical devices that are used for the automatic control of flow of fluid. Here the solenoid valve controls the flow of batter, oil and water. When these devices electrically energized or deenergized it either shut off or allow the flow of fluid. DC motor used here performs the ejection mechanism. Once the dosa is produced in the pan it is taken out by the ejector. Microcontroller is programmed such that it provides required control for valves and dc motor.

1.3 Thermoelectric Generation

TEG modules are used for waste heat recovery. Thermo electric generator modules are capable of producing power from heat by converting temperature difference directly to voltage. Current will flow when there is a dissimilar temperature in both sides and the magnitude of current is directly proportion to the temperature difference. One side of TEG module is exposed to the hot side where the heat is being dissipated to the surrounding and the other side is provided with a low temperature by circulating water.

1.4 Mechanical Design

A cuboid structure of iron houses the whole parts. Tank containers are fixed at the top of the structure for batter, oil and water. Containers are in the form of hopper so as to lose the fluids and the flow is controlled by solenoid valves.

2. AUTOMATIC DOSA MAKING

Automatic dosa maker performs the production of dish in the pan that is fixed at the bottom of the whole apparatus. It

consists of different stages like electric heating, fluid flow control and ejection of dosa from the pan. The final dish is produced after a step by step procedure, introducing time delays between each step for desired output. Solenoid valves capable of controlling the fluid flow, DC motor, Gear and chain arrangements are used to automate the process.

2.1 Heating Pan

A square pan of mild steel is used for making Dosa as in fig2.1(a). It is then heated with an electric heating coil. The square pan is fixed at the bottom center of frame that houses the apparatus.

Fig- 2.1(a): Heating Pan of Mild steel

Electric heating coil at the bottom of the pan as shown in fig.2.1(b), heats the pan to the required temperature. Electric heater is equipped with a thermostat for setting the required temperature.

Fig- 2.1(b): Electric heater

The temperature required for making dish is obtained experimentally and energy required for the electric heater is taken from the AC supply.

2.2 Fluid Flow Control (Hopper Mechanism)

Tank containers in the form of hopper will be filled with dough, water and oil and they are fixed above the pan. Fluid flow from these hoppers are controlled by solenoid valves. Fig 2.2 shows a typical solenoid valve. Each solenoid valve is opened after a specific time delay. Solenoid valves are supplied with 12V DC supply, operated by separate relays and the relays will open and close based on the pulse from microcontroller. Time delays are provided in order to complete different stages of Dosa making.

Fig -2.2: 12V DC solenoid valve

2.3 Ejector

The ejector is one the most crucial elements of the whole apparatus. It removes the cooked dish from the cooking plane to the outside so that we can obtain it and also at the same time make space for the next dish. It is actuated by a 12V DC motor.

Fig -2.3(a): Ejector movement mechanism

It consists of a lead screw movement mechanism (fig 2.3(a)) and an inclined steel plate(fig2.3(b)) which scoops up the dish to be ejected. Motor is connected to the one end of lead screw and clockwise and anticlockwise rotation of motor

results in forward and backward movement of the steel plate. Motor is turned on and off each time after the dish is generated.

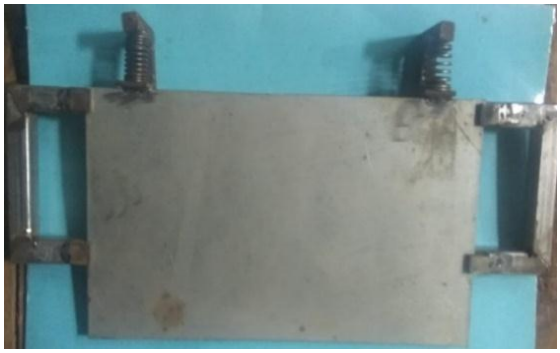

Fig- 2.3(b): Steel Plate with spring arrangement

3. THERMOELECTRIC GENERATION

Electric heater used to heat the pan, dissipates heat energy to its surroundings and this waste heat is used for thermoelectric generation. TEG modules are capable of generating electrical energy from temperature difference. When one side of TEG is exposed to high temperature and other side to low temperature TEG will produce power. As the heat energy flows from hot side to cold side, free charge carriers (electrons or holes) in the material are also driven to the cold side. The resulting voltage is directly proportional to the temperature difference. For a fairly high temperature difference (90-150 degree Celsius) between its two sides, a single module can produce up to 4 Watts.

3.1. TEG Module Arrangement

TEG Modules are arranged in series then parallel combination in this apparatus, and one side of every modules are arranged in square box of copper around the heater where the heat is getting wasted and the other side is circulated with water using a small DC Pump. Using theoretical values, it is estimated that 80 -100 Watts can be produced using this method if proper heat difference is provided. The output from this circuit is provided to charge control circuit then to battery and from the battery it is supplied to 12V DC to 220V AC. TEG arrangement is shown in fig 3.1(Drawn using fritzing software).

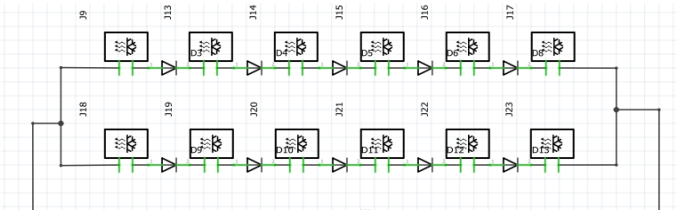

Fig 3.1- TEG Arrangement

4. POWER CONVERSION

The energy produced by the TEG modules will not be of constant voltage it will vary with the change in temperature. Back to back diodes are used in order to avoid reverse condition since it takes current and will produce cooling effect on reverse condition. In order to charge battery a steady output voltage is required. Whenever the TEG generates power the charge controller provides a regulated output of 14V. And this is then used to charge the battery. The output from the battery is 12V DC which can only be used for DC purposes. So, the output from 12V battery is taken out for converting it to 220V AC. For this, a 12V DC to 220V AC inverter is used.

The inverter consists of an oscillator of IC 4047 which can generate 50Hz square wave AC signal. An RC circuit is connected to IC 4047 for varying the frequency. The output of oscillator is not able to drive the transformer. So, the output Q and Q′ are used to drive power mosfets IRFZ44. The mosfet switches the 12V DC across the transformer which then produces AC at its output. The gates of two mosfets are connected to each output Q and Q′. The battery output 12V is connected directly to the center tap of the transformer primary. Each mosfet is able to withstand a current of 18A. The maximum power output required here is 300W.

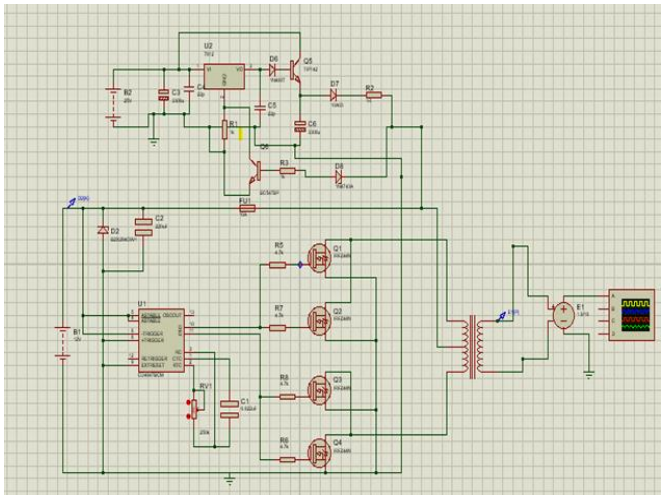

Fig-4: Inverter with charge controller circuit

No of mosfets connected in parallel=300/ (12x 18) =2

Two mosfets are connected for smooth operation. Switching of mosfets occur during each half cycle in primary and 220V AC will be generated at the secondary of transformer. Inverter circuit with charge controller is shown in fig 4.

5. SIMULATION RESULT

Simulation output of inverter circuit(Fig 4) is given in Fig-4.1. Circuit drawn in proteus software and the output from transformer secondary is connected to a DSO. Around 220V peak voltage is obtained (fig 4.1). For reducing the size of waveform, the secondary output is multiplied by a voltage gain of 0.10.

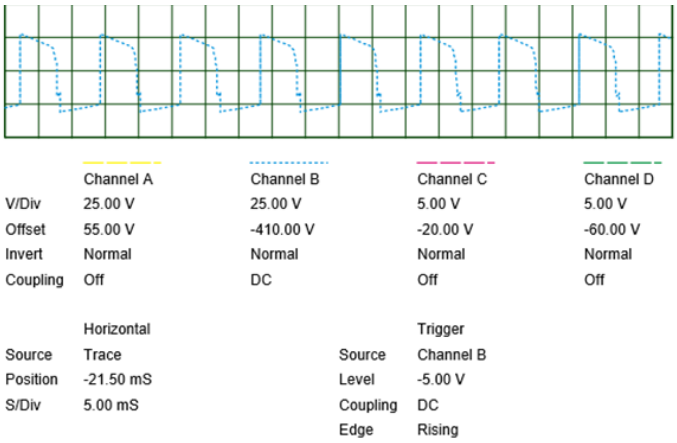

Fig-4.1: Simulation output

6. CONCLUSION

Automatic Dosa Maker is completely a new apparatus that is capable of producing Dosa dish along with generation of power from waste heat. This product replaces human effort in preparation of dish. By only providing the raw ingredients batter, water, and oil dish will be produced automatically. Thermoelectric generation as one entirely solid-state energy conversion device, directly transform thermal energy in to electrical energy. It does not have any moving parts and compact, quiet and environment friendly. Thermoelectric power converters require minimal maintenance and cheap. When compared to photovoltaic cells, TEG is very cheap and provides 10-11% efficiency. So TEG is a better alternative for solar power generation. The output power can be utilized for small power applications like charging phones, lighting purpose etc. In this paper we have done simulation of inverter that is used to obtain AC output so that we can use the energy for domestic purposes. The objective of this model was to generate power along with automating Dosa making process and we achieved it efficiently.

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