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Mobile Charging By Waste Heat Energy Of Compressor Based On Thermoelectric Device

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Abstract: Presently, the most common compressor found in manufacturing plants is the rotary screw unit supplied as a packaged compressor. In these compressors, approximately ninety percent of the heat is rejected in the lubricant cooler. Most of the remaining heat is rejected in the aftercooler, with a small percentage rejected in the form of heat radiated from the compressor housing and lubricant separator receiver. A thermoelectric device is a solid state device that can be used to convert the waste heat into electricity which can be used to drive other loads. When there is a temperature difference between the two plates of the thermoelectric device it starts to produce electricity, similar to Seebeck effect. A compressor has an operating temperature of around 50° to 80°C at its outer surface. In our proposed project a thermoelectric module is used to produce a steady current at this temperature with a voltage up to 16V, which can be boosted using a SEPIC converter and used to charge the battery of a mobile. In Industries those use compressors, most of the cost consumption is due to the operation of compressors. During the operation of the compressor almost 90% of input energy is liberated as heat from the compressor. It clearly shows that most of the power spent is gone waste in the form of heat. This heat can be extracted and converted into electrical energy and used. The efficiency of heat conversion can be improved using more number of modules. From this energy the ac motor can be controlled using inverter design.

Keywords: Peltier module, Compressor, waste-heat recovery, SEPIC converter, seebeck effect.

I. INTRODUCTION

Nowadays the electricity demand is seeing a steep increase with the growing industries. To fulfill these requirements different energy sources including conventional and non-conventional resources like coal, water, wind and solar energy are employed at a very high cost. Though all these sources provide energy to be extracted and utilized, the demand for power is still large. Today's world is fast changing with the irony of having many villages and far flung areas where electricity is unreachable. From any of the energy transferred from one form to another, heat is the main byproduct obtained. This heat is simply wasted into the environment in many of the energy conversions taking place day to day. If such heat can be converted even in a small milliwatt range, it can be reused in domestic low power lighting and in running low power consumption electronic products. According to the law of conservation of energy, energy can neither be created nor destroyed but it can be transformed from one form to another. A design flow is suggested for the proposed network. Analysis is conducted regarding aspects of the design flow. Several state-of-the-art thermoelectric materials are analyzed for the purpose of power generation at each waste heat harvesting location on a compressor. A compressor compresses the fluid sent through it which means the volume of the fluid decreases thereby according to the Kinetic Theory of Gases pressure increases and the temperature also increases.

Therefore much of the input power given to the compressor is wasted as heat [7]. Optimal materials and TE couple configurations are suggested. Besides, a comparison of prevailing DC-DC conversion techniques was made with respect to applications at each conversion level within the

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network. Furthermore, higher level design considerations are discussed according to system specifications. Finally, a case study is performed comparing the performances of the proposed network and traditional single-stage system.

II. Peltier Module

Research work has been carried out recently by experts to generate electricity from heat as a source. When one side of the Peltier module is heated and the other side being attached with a heat sink, a dc voltage is obtained as reported by [1]. Another way of harvesting power during day time is by using highly concentrated solar disc to heat the hot junction which is kept at the focus of the parabola dish as suggested by [2]. To overcome the problem of charge depletion from the battery of mobile phones while travelling, body heat can also be converted into voltage to charge the battery. And moreover in cooking gas the upper flame of the burner is use for conducting heat and the surrounding part of the flame around the burner is comparably at a lower temperature. This wasted heat can be converted into electrical energy as presented by [4].

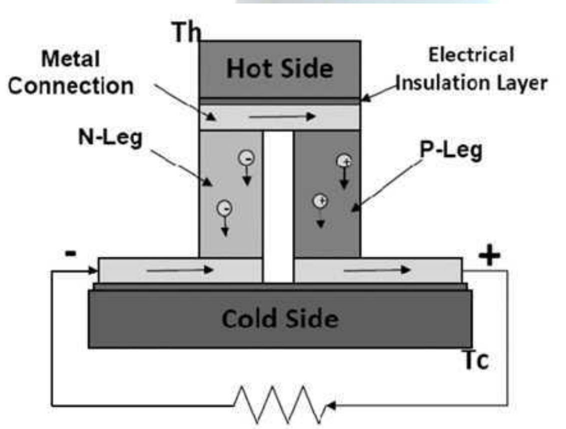

Figure 1.1 Simplified illustration of TEC.

III. Existing Methods

- The reserves of fossil fuels will soon be depleted, since oil is a limited resource.
- Over the years, the cost of electricity has risen to unprecedented levels due the limited supply of oil and economic and political factors.
- Wind energy, hydro energy along with other technologies have their own limitations, making them insufficient for wider usage.
- The most important factors for choosing the kind of renewable generators are location, time and user needs.
- Location associates information about climate, energy sources availability and environment conditions, this information is very important to decide.

IV. Proposed Method

- In this project it is proposed for the conversion of waste heat from the compressor into generate electricity by using thermoelectric Cooler (TEC).
- Waste from the refrigerator, especially waste heat that is liberated from the compressor can be used as an input source to generate electricity and it can charge directly a mobile battery and also stored in a rechargeable lead acid battery for further usage.
- And also as the compressors are used widely in industries, this large amount of heat emitted from compressors can be stored in batteries to serve some power demand.

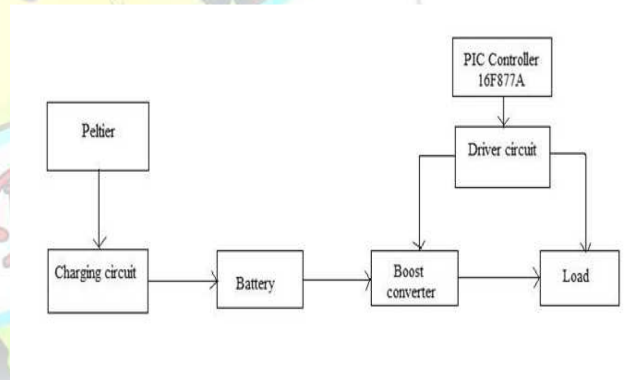

Fig: 4.1 System Block Diagram

4.1 Working

- When the two sides of semiconductor are maintained at different temperatures, an EMF is induced across the output circuit.
- As the heat moves from hot side to cold side, the charge carriers moves in the semiconductor material and hence the potential difference is created.
- The electrons are the charge carriers in the case of N-type semiconductor and holes in P-type semiconductors.

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- In a stack, number of P-type and N-type semiconductors are connected.
- A single PN connection can produce a Seebeck voltage of 40 mV.
- The heat source such as natural gas or propane are used for remote power generation.

4.2 Hardware & Software

1. PIC 16F877A
2. Peltier Plate
3. Driver Unit
4. Transformer
5. MATLAB
6. Embedded C

V. GENERAL REVIEW OF DC-DC CONVERTERS

5.1 Principle of DC-DC Converters.

There are two major concerns in the design of DC-DC converters: efficiency and regulation. The issue of efficiency arises since almost all circuits have resistive components or parasitic resistors, which are power consuming during the functioning of the converter. That is to say, designers need to optimize the efficiency of the Converter although can never reach 100% efficiency. The issue of regulation is caused due to the fact that all power sources are not absolutely constant; however, many electronics require a certain level of stability of power supply. Up until now, there are already various design techniques and optimized components addressing these issues.

The general principle of DC-DC converters is the storage of electrical energy into components, like capacitors and inductors. Later the stored energy is released into the loads. The average load voltage level can be either higher or lower than the voltage level of the power source. This is done by controlling the time for energy storage and its release.

The switching devices carry out the rotation of energy storage state and energy release state. Nowadays, the most common switching device used in DC-DC converter is transistor. The length of time for each state within one switching period is reflected by the duty cycle of the signal fed to the gate of switching transistors. Almost all modern DC-DC converters utilize pulse-width-modulation (PWM) signal as the switching control signal for its advantage of linear control over the load power [30]. If we denote the switching period as Ts, and the on-time of the switching transistor Ton, the duty cycle of the PWM signal is thus

$$\alpha = Ton/Ts$$

5.2 SEPIC Converter

The single-ended primary-inductor converter (SEPIC) is a type of DC/DC converter that allows the voltage at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor.

A SEPIC converter acts mainly as a boost converter followed by a buck-boost converter, so it can be considered similar to a buck-boost converter. A SEPIC converter has the advantages of getting an output that has same polarity of voltage as the input. A series capacitor is used to couple energy from the input to the output so that the converter responds better to a short-circuit output. It is also capable of true shutdown that is, when the switch is turned off, its output drops to 0 V.

SEPIC converters are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. The output voltage of a SEPIC converter is similar to that of a buck-boost converter and is given by,

$$(VOUT + VD1) / VIN = \alpha / (1 - \alpha)$$

where α is the duty cycle ratio
VOUT is the output voltage
VD1 is the diode voltage
VIN is the input voltage

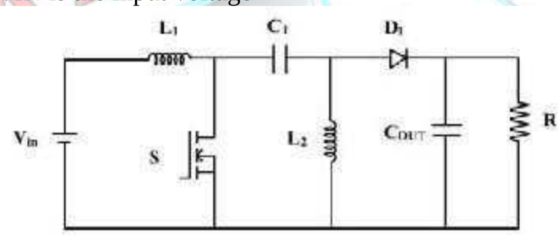

Fig.5.2.1 Circuit diagram of SEPIC Converter

The capacitor C1 blocks any DC component between the input and output. D1's anode, however, must connect to a known potential. This is accomplished by connecting D1 to ground through a second inductor (L2).The switch S of SEPIC and Cuk converters is a N channel MOS transistor that needs a Low Side driver, when the ZETA converter has a P channel MOS transistor that needs a High Side driver. The purpose of the output capacitor (COUT) is to average the current pulses supplied by D1 during Toff. The current transitions are brutal, so COUT should be a high-

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performance component like the one used in a flyback topology.

5.3 SIMULATION RESULTS

The simulation of the SEPIC converter considering the expected peltier input was simulated using MATLAB software and the results are as follows:

Input voltage

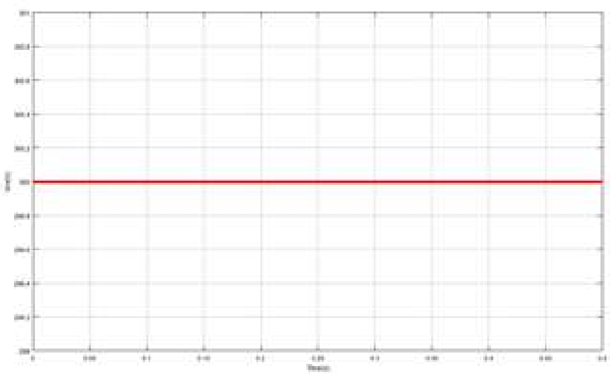

Fig: Input Voltage vs Time

Output voltage

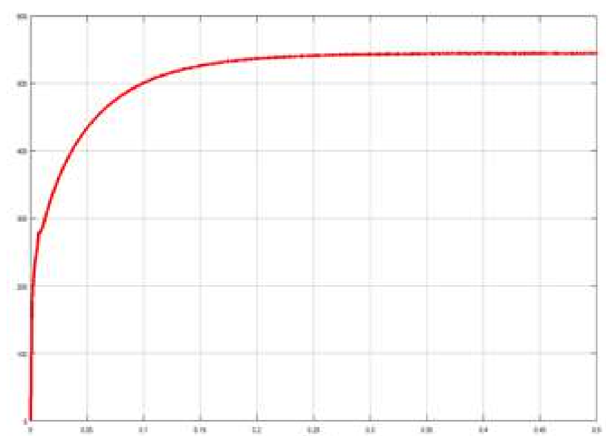

Fig: Output Voltage vs Time

A comparative study of DC-DC converters in SEPIC, Cuk and ZETA topologies and the simulations of these converters in the same work conditions gives that it is preferable to use a SEPIC converter for these working conditions compared to a ZETA converter with a constant output voltage and variable input voltage and load.

5.4 Pulse width modulation

Output voltage from an inverter can also be adjusted by exercising a control within the inverter itself. The most efficient method of doing this is by pulse-width modulation control used within an inverter. In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. This is the most popular method of controlling the output voltage and this method is termed as Pulse-Width Modulation (PWM) Control.

VI. CONCLUSION

The Seebeck effect-based thermoelectric power source using TEC module has been presented in this paper. One great advantage of the designed concept is that the TEC energy harvester can be employed to recover waste heat in industries that use compressors as large units as a renewable energy source and green technology. Experimental results confirm that the designed SEPIC converter is able to produce the desired output voltage for powering other electronic circuit. Another DC-DC boost converter can be added to the designed one if higher output voltage is required. Thereby the proposed concept allows energy conservation by saving the electricity used in industries providing an alternate source that is obtained from the waste heat.

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