

# FRESH JUICE CHILLER USING THERMOELECTRIC REFRIGERATION MODULE (Instant)

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## Abstract

The fresh juice is often chilled by adding ice into it. Adding ice not only diluted the juice but may also add impurities to the juice as the commercial ice making process is always under question mark about hygiene. The other way of chilling the juice is by storing it in a refrigerator which consumes time and affect the freshness of the juice. To overcome this, a novel instant juice chiller is developed in the present project work using Peltier modules based on the concept of Thermo-electric refrigeration. The cooling chamber design integrates thermoelectric modules which operate on the Peltier effect to cool juice down. To make the chilling process more economical a solar PV panel is integrated for input energy provision. This unit provides a low energy and affordable solution to a conventional way of drinking cold juice.

**Keywords:** *Thermoelectric Generator, Aluminium Water cube, Aluminium Tank, Cool Juicer etc.*

## I. Introduction

From last century till now refrigeration has been one amongst the foremost important factors of our day to day life. this tendency of the primary world is to appear at renewable energy resources as a source of energy. this is often finished the subsequent two reasons; firstly, the lower quality of life because of air pollution; and, secondly, because of the pressure of the ever increasing world population puts on our natural energy resources. From these two facts comes the belief that the natural energy resources available won't last indefinitely.

the essential thought is usage of photovoltaic riven refrigerating framework controlled from DC source or sunlight based cluster (when required) with electric battery bank. The conventional cooling systems are used now a days are requires the refrigerant whose state change takes place in heat exchanging and compressor are required for the compression of the refrigerant. The compressor required more power and space. The refrigerant is moreover not eco-accommodating and builds the world warming and consequently the significant purpose behind ozonosphere consumption. The mini Eco-friendly solar based juice chiller relies on the PELTIER EFFECT and a thermoelectric device called Peltier device is employed for the cooling purpose. within the MEF-Refrigerator there's no need of compressor and refrigerant. Semiconductor thermoelectric coolers (also referred to as Peltier coolers) off temperature control ( $< \pm 0.1$  °C) may be achieved with Peltier coolers. However, their efficiency is low compared to traditional refrigerators. Thus, they're employed in niche applications where their unique advantages outweigh their low efficiency. Although some large-scale applications are considered (on submarines and surface vessels), Peltier coolers

are generally employed in applications where small size is required and therefore the cooling demands don't seem to be too great, like for cooling electronic components. This project integrated a chiller into a juicer filtration unit to be installed under a typical place. the planning utilized thermoelectric modules to cool down the chiller during a chamber. The project was designed to eventually be compatible with commercially available filters. Lastly, the planning of the system had to be convenient. rather than constantly filling up a TEG walking over to the cooling fridge, the system needed to supply a convenient thanks to obtain cold drinking potable. This project aimed to interchange the normal juicer dispensers in refrigerators by integrating a chiller into a juicer filtration unit attached to the liquid line and tap. The juice utilizes low-powered thermoelectric modules to cool down the temperature. By replacing the juice and ice dispenser, this unit has the potential to avoid wasting the user money, yet as reduce the carbon footprint of the patron. This unit provides a low-energy and affordable solution to a traditional way of drinking cold juice. This project answers a necessity for fast cold potable while reducing the burden on our planet.

## II. Literature Review

**Jean Peltier et. al.[1834]**noted that when an electrical current is applied across the junction of two dissimilar metals, heat is removed from one of the metals and transferred to the other. This is the basis of thermoelectric refrigeration. Thermoelectric modules are constructed from a series of tiny metal cubes of dissimilar exotic metals which are physically bonded together and connected electrically. When electrical current passes through the cube junctions, heat is transferred from one metal to the other. Solid-state thermoelectric modules are capable of transferring large quantities of heat when connected to a heat absorbing device on one side and a heat dissipating device on the other. The Koolatron's internal aluminium cold plate fins absorb heat from the contents, (food and beverages), and the thermoelectric modules transfer it to heat dissipating fins under the control panel. Here, a small fan helps to disperse the heat into the air.

**Mathieu Cosnier et.Al. [2008]** presented an experimental and numerical study of a thermoelectric air-cooling and air-heating system. They have reached a cooling power of 50W per module, with a COP between 1.5 and 2, by supplying an electrical intensity of 4A and maintaining the 5°C temperature difference between the hot and cold sides.

**Adam Grosser et.Al.[2007]**More than a billion people lack access to electricity and refrigeration, which means they also lack access to important vaccines that need to be kept cool. Non profits are pouring millions into developing vaccines that don't need refrigeration, but tech venture capitalist Adam Grosser has a different idea: change the fridge.

**Mayank Awasthi** "Design and Development of Thermoelectric Refrigerator ", International journal of mechanical engineering and robotics. From above research paper we have studied about thermoelectric component like heat sink. The design requirements are to cool this volume to temperature within a less time period and provide retention of at least next half an hour. The design requirement, options available.

## III. Methodology

In order to totally understand key features needed to be applied to the system, three commercially available systems were researched and analyzed. it absolutely was observed that while each of those systems possessed valuable features, they also lacked other important functions. Overall, the success of the project was measured on the premise of functionality. The unit must effectively produce cold filtered fruit juicer while consuming an occasional amount of power. As there's no product on the market that substantially cools filtered water in an energy efficient manner,

success of system parameters were created supported existing average output temperature, power consumption, and size of potential competitors. These potential competitors fell under the categories of refrigerator dispensers, tanked liquid cooling, and filtration units. The system was designed to be used in residential homes to supply a low-powered alternative to costly and high energy consuming refrigerator dispensers, tanked liquid cooling, and filtration units.

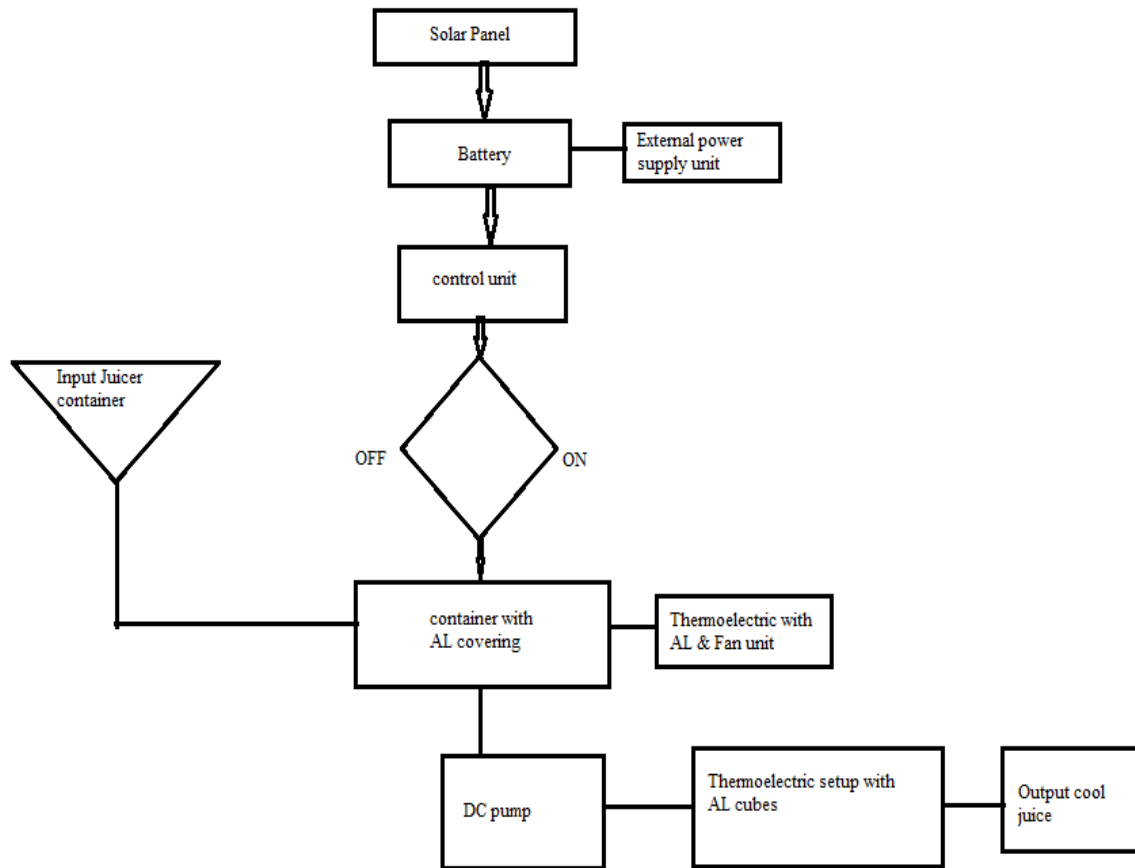
#### IV. Problem Identification

The system was designed with size in mind. the most liquid line would branch off and feed into the filtering system. The filtered drink then enters the QuikChill chamber which utilizes thermoelectric modules to chill the juice. Thermoelectric modules (TEMs) operate supported the Peltier Effect wherein a temperature difference is formed across the module when a current is applied. Heat is absorbed from the water on the cold side, while simultaneously being rejected on the recent side of the module. TEMs were utilized in place of compressors and condensers as they're low-maintenance and solid state, making them applicable to small scale cooling. After the drink has been cooled, the user can deplete the chamber to urge cold filtered juicer from the portable machine.

#### V. Objective

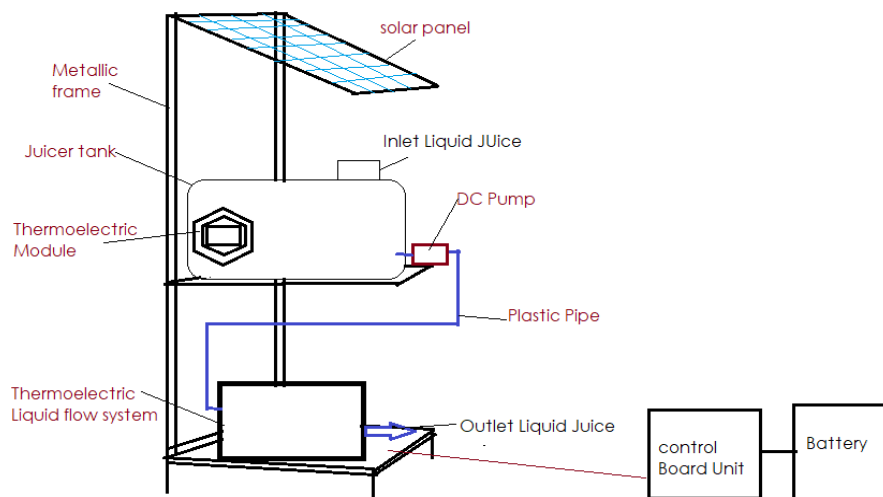
The main project objective was to attain desirable drinking temperatures for the user resembling the established cooling methods like the fruit juicer, water and ice dispenser. After cooling abilities were met, the unit was designed to be low powered. Creating a low-powered system was important in reducing the quantity of energy consumed, which can successively create a more sustainable future. The system was also designed to be compact in size to suit well underneath during a corporate offices, shops, kitchen etc. The project was designed to eventually be compatible with commercially available filters. Lastly, the planning of the system had to be convenient. rather than constantly filling up a TEG walking over to the cooling fridge, the system needed to supply a convenient thanks to obtain cold drinking fruit juice.

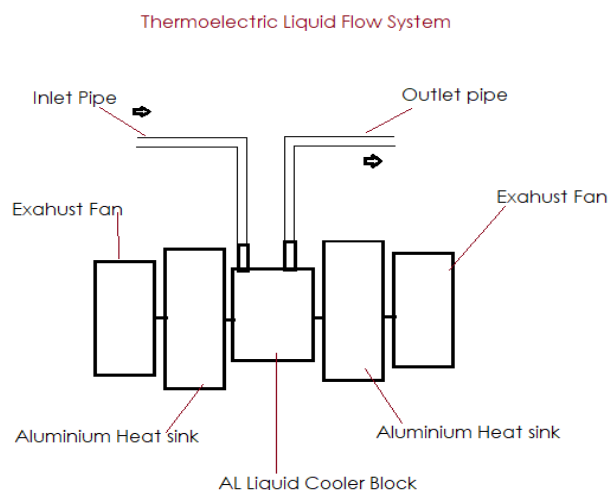
**Working flow diagram**



**VI. Experimental setup**

SOLAR POWERED THERMOELECTRIC JUICER CHILLER SYSTEM





## VII. Working Principle

- Renewable energy source like, solar energy is used in this project. Solar panel of 12v 25 w used to extract the solar energy and convert into electric energy.
- This electric energy is stored into battery of 12v , 8 Amp. Whole system is operate with this power stored energy.
- Also external power source added advantage for emergency situation when their is very less energy available min battery.
- The control unit also provide to operate each function. When liquid juicer is insert into input unit. It circulate through pipe. And stored into container.
- This container is covered with aluminium sheet. To mention the temperature inside the container. Thermoelectric unit (with aluminium block , aluminium sink and exhaust fan) is covered both side of container.
- And try to cool down the internal juice temperature. Also copper tubes are added to internal unit of container for flow of juice.
- After this DC pump which is already present into container extracted this juice and circulate it through copper pipe.
- Another two thermoelectric unit is placed with alluvium blocks at outside of container. When pump is circulate the juice , it passed through this thermoelectric unit. So that temperature of juice is again cool down.
- And finally through output , we obtained cool juice. We can measured the temperature of input juice and output cool down juice with the help of temperature sensor. We occurred the temperature difference in input and output juice.

## VIII. Construction

Refrigeration is also defined because the process of achieving and maintaining a temperature below that of the environment, the aim being to chill some product or space to the specified temperature. The Seebeck coefficient is that the ratio between the electrical field and also the gradient or the ratio between the voltage difference and temperature difference between the ends of the sample. The Peltier coefficient of the junction could be a property betting on both materials and is that the ratio of the facility evolved at the junction to this flowing through it. The Thomson coefficient is that the ratio of the facility evolved per unit volume within the sample to the applied current and gradient.

The construction setup of the refrigerator is as follows,

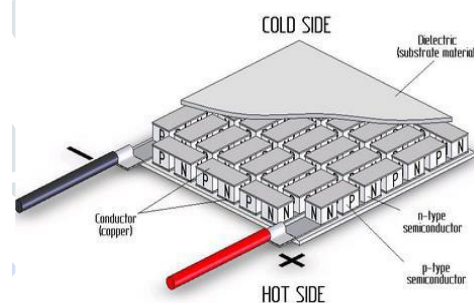
- a) Thermo-electric module
- b) Refrigeration chamber

- c) Battery
- d) Solar cell
- e) Charge controller

#### A. Thermo-electric module (Model no. – TEC1- 12706)

A thermo-electric module (TEM) is a strong state flow gadget, which, if power is applied, move heat from the virus side to the hot side, going about as a warmth exchanger. This bearing of warmth travel will be turned around if the current is switched. Blend of numerous sets of p and n semiconductors permits making cooling units - Peltier modules of generally high force

As shown in the model no. there are 127 number of p–n coupling Specification, 1) Material used- Silicon - Bismuth To accomplish the goal of cooling fruit juice in a low-powered compact manner, thermoelectric modules (TEMs) where implemented to the design. Thermoelectric cooling works based on the Peltier effect. When a current is passed through a junction of two dissimilar materials heat is absorbed at one side and released on the other. Thermoelectric modules consist of many pairs or junctions of two dissimilar materials set up electrically in series and thermally in parallel. When a current is passed through the module, heat is absorbed at one end of the module and released at the



other. An illustration of a thermoelectric module can be seen in Figure.

#### B. Refrigeration chamber

The chamber utilized is same as that of the chambers utilized in regular refrigeration. The chamber can be of any volume, shape and size.

We have used 1L capacity cooler box. For experimentation purposes the volume of the chambers is kept low. Insulation provided to the chamber is done by polystyrene. And aluminium casing is done in the inner side of insulation to provide better cooling. Thermoelectric unit is also attached to this container. Inside the chamber copper pipe is used to circulate the flow of juice.

#### C. Battery

The battery is an electrochemical converting chemical energy into electrical energy. The main purpose of the battery is to provide a supply of current for operating the cranking motor and other electrical units. Specification,

- 1) Voltage 12 V
- 2) Current 8Ah

#### D. Solar cell

The direct conversion of solar energy is carried out into electrical energy by conversion of light or other electromagnetic radiation into electricity.

- 1) Voltage – 12 V dc

- 2) Current – 8 amp
- 3) Power – 25 W
- 4) Solar irradiation – 1000 W/m<sup>2</sup>
- 5) No. of subcells – 72

### **E. Charge controller**

A charge controller is a fundamental piece of sun oriented refrigeration framework that charge battery. Its motivation is to guard a battery appropriately took care of and as long as possible. The fundamental capacity of a controller are very straightforward.

Whenever the sunrays fall on a solar panel then there is a fluctuation of solar rays on solar panel.

To keep away from the change of sunrays on sun powered board, we use charge controller in sun powered refrigeration framework.

Also, charge controller prevent battery overcharge and electrical overload. We are using MPPT(Maximum Power Point Tracking) base solar charger in our solar juice chillier system.

### **IX. Approach**

Based on the motivation, QuikChill could have potential application in India and other developing countries in two ways: through Fruit juice, beverages, milk refrigeration and filtered, cold water dispenser. Both systems would require power to make the system usable. Since the unit only requires 25W a photovoltaic panel attachment of about 0.1 m<sup>2</sup> could be used to power the system.

### **X. Advantages**

We believe that thermoelectric cooling offers a number of advantages over traditional refrigeration methods, as:

1. No moving parts, eliminating vibration, noise, and problems of wear.
2. No Freon's or other liquid or gaseous refrigerants required,
3. High reliability and durability.
4. Compact size and light weighted,
5. Relatively low cost and high effectiveness,
6. Eco-friendly C-pentane, CFC free insulation
7. Reversing the direction of current transforms the cooling unit into a heater.

### **XI. Disadvantage**

1. C.O.P. is less as compared to conventional refrigeration system.
2. Suitable only for low cooling capacity.

### **XII. Conclusion & Future work**

From this project we can conclude that without the use of Compressor and the Refrigerant It is possible to cool the system. There are several different types of cooling devices available to remove the heat from industrial enclosures as well as medical enclosures, but as the technology advances , thermoelectric cooling is emerging as a truly viable method that can be advantageous in the handling of certain small to medium applications. Juice temperature at input

side and juice temperature at output side gives much more differences. We conclude this we obtained desired output from this project experiment.

As the efficiency and effectiveness of thermoelectric cooling steadily increases, the benefits that it provides including self contained, solid-state construction that eliminates the need for refrigerants or connections to chilled water supplies, superior flexibility and reduced maintenance costs through higher reliability will increase as well. it can use in ambulance for storing medical equipment can use in remote area for storing medicines, etc. Blood plasma and antibiotics are manufactured using a method called freeze drying. To build a real time model replacing both air conditioner & room heater in one system i.e. thermoelectric hot & cold room conditioner.

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