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Compressor-Less Refrigeration System

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Abstract: In Today's world global warming is being increasing year by year. There are many reasons like pollution, deforestation,water contamination, etc...In coming years the major problem before us is depletion of ozone layer which is caused by the release of CFC's. Some of the equipment which causes this effect is refrigerators, AC's. In this project we are mainly focusing on a solution to control this problem we have focused on refrigerators which releases CFC's. Here we are designing a mini solar based refrigerator which is cheaper as well as eco-friendly. In this project we are using solar panels for charging a Lead Acid Battery (12V, 1.2 Amp hrs), a pelteir thermoelectric device when connected to battery generates cool effect and hot effects depending on the mode required by the user. Since we are using this for fridge we need only cool mode. A peltier thermoelectric device is connected to the battery to generate cooling effect. We need to display the voltage for that we are using ADC0808 which is given to the controller. For this ADC we are giving a clock pulses through 555 timers to perform its operation. The aim of the project is to design and fabricate a compressor less refrigerator system flywheel. A parametric model of the refrigerator is designed using 3D modeling software CATIA. Catia is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design.

Keywords: CFC's, CATIA, VCRS, ADC.

I. INTRODUCTION

Evaporative cooling in refrigeration is an old idea but due to its dependency on outside environment (relative humidity, dry bulb temperature) it is limited to certain parts of world. Some of the examples for evaporative cooling are clay pots used in India for cooling the drinking water. In Mexico, fishermen use freezer to produce ice for storing fish. The Peltier effect is the heat liberation at one junction of thermocouple and heat absorption at the other, when an electric current flows into it. This effect is used in thermal analysis and also for heat flow compensation. With time many researches were conducted, many new theories and with them many new devices were put forth. Air Conditioner, Refrigerator etc. are few of them, where by the use of electricity, cooling is obtained. But in these devices cooling does not just takes place totally due to electricity (here for efficiency and fast rate of cooling Refrigerants), compressors are used. in which the refrigerant undergoes phase changes, is one of the many refrigeration cycles and is the most widely used method for air-conditioning of buildings and automobiles. It is also used in domestic and commercial refrigerators, large-scale warehouses for chilled or frozen storage of foods and meats, refrigerated trucks and railroad cars, and a host of other commercial and industrial services.

Fig1.Vapor-compressionrefrigeration or **vapor-compression refrigeration system (VCRS)**.

Oil refineries, petrochemical and chemical processing plants, and natural gas processing plants are among the many types of industrial plants that often utilize large vapor-compression refrigeration systems. Refrigeration may be defined as lowering the temperature of an enclosed space by removing heat from that space and transferring it elsewhere. A device that performs this function may also be called an air conditioner, refrigerator, air source heat pump, geo thermal heat pump or chiller (heat pump).

II. LITERATURE REVIEW

The current practice of solar-powered intermittent absorption refrigeration is exemplified in U.S. Pat. No. 4, 744, 224. This technology is simple, robust, and reliable. It meets the needs of lesser developed countries by being locally manufacturable and by producing ice at about one tenth the cost of production by photovoltaic refrigerators, for ice capacity in the range of 10 to 1000 kg per sunny day. Nevertheless, there still remain two limitations in the current practice of solar absorption refrigeration which have limited its spread. As with all solar technologies, high first cost is a problem. Any measures which would either

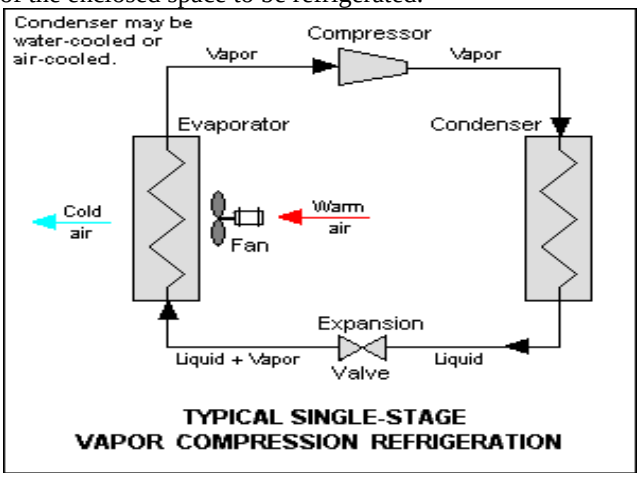
increase the solar aperture or increase the overall collection efficiency without increasing cost would have the beneficial effect of lowering the first cost per unit of ice produced. Secondly, the inherent functioning of solar intermittent absorption refrigerators is to produce ice at night, which requires evaporator temperatures on the order of - 10 degree C and then use stored ice by day to keep the cold box at slightly above 0.degree. C. In other words, the evaporator region inherently cycles between about -12.degree C. and about +4 degree c, depending on isolation and insulation. Clearly it would be possible to incorporate a separate thermostatic compartment cooled by storage ice which maintains a relatively constant +4.degree C and that would be useful for many refrigeration applications. However, there is another category of applications which require a relatively constant - 20.degree. C.

This is the temperature of the frozen food section of most domestic refrigerators, i.e., the "freezer compartment." Examples of commodities which require this level of refrigeration for long term storage include oral polio vaccine, measles, and yellow fever vaccines. Although conventional intermittent absorption cycles could easily be adjusted to yield -20.degree. C. at night, at some loss in efficiency, they have no practicable mechanism for maintaining that temperature by day. Multiple-staged absorption cycles are well-known in the art, especially for continuous cycles. See for example U.S. Pat. Nos. 4,402,795 and 4,475,361. Some previous work has also been done on intermittent cycles with multiple stages, for example the technical article by A. Mani and A. Venkatesh appearing at p. 271 of Vol. 26 No. 3/4 1986. Energy Conversion and Management entitled "A Two Stage Intermittent Solar Refrigeration System—Evaluation of Salient Parameters". In that article, a two-stage generator and absorber configuration is disclosed which enables use of much lower heat source temperatures (approximately 70.degree. C.), albeit at much lower Coefficient of Performance.

Solar energy applies energy from the sun in the form of solar radiation for heat or to generate electricity. Solar powered electricity generation uses either photo voltaic or heat engines (concentrated solar power). Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. India is densely populated and has high solar insulation, an ideal combination for using solar power in India. Much of the country does not have an electrical grid, so one of the first applications of solar power has been for water pumping; to begin replacing India's four to five million diesel powered water pumps, each consuming about 3.5 kilowatts, and off-grid lighting. Some large projects have been proposed, and a 35,000 km² area of the That Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 Gig watts.The Indian Solar Loan Programmed, supported by the United Nations Environment Programmed has won the prestigious Energy Globe World award for Sustainability for helping to establish a consumer financing program for solar home power systems.

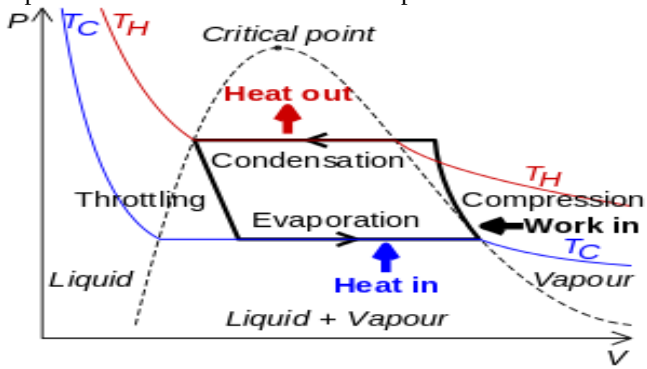
III. DESCRIPTION OF PROJECT

The condensed liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and vapor refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated.



TYPICAL SINGLE-STAGE VAPOR COMPRESSION REFRIGERATION

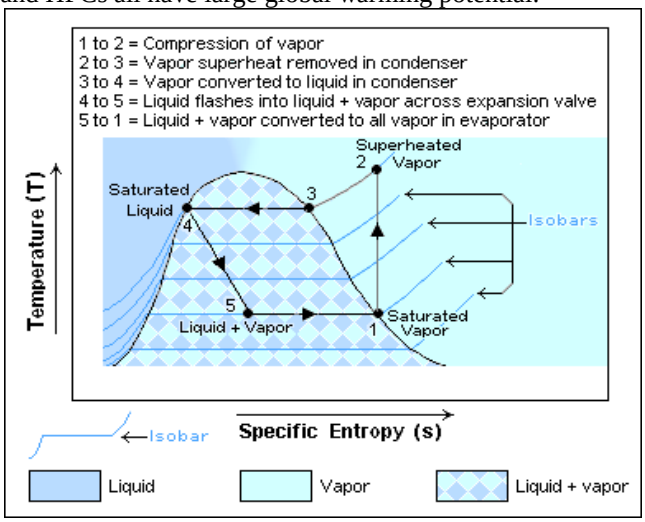
The cold mixture is then routed through the coil or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapor mixture. That warm air evaporates the liquid part of the cold refrigerant mixture. At the same time, the circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature. The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in the condenser and transferred elsewhere by the water or air used in the condenser. To complete the refrigeration cycle, the refrigerant vapor from the evaporator is again a saturated vapor and is routed back into the compressor.



A. Refrigerants

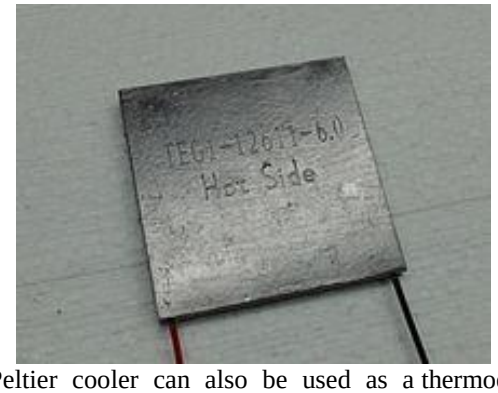
"Freon" is a trade name for a family of haloalkane refrigerants manufactured by DuPont and other companies. These refrigerants were commonly used due to their

superior stability and safety properties: they were not flammable at room temperature and atmospheric pressure, nor obviously toxic as were the fluids they replaced, such as sulfur dioxide. Haloalkanes are also an order(s) of magnitude more expensive than petroleum derived flammable alkenes of similar or better cooling performance. Newer refrigerants with reduced ozone depletion effect such as HCFCs (R-22, used in most homes today) and HFCs (R-134a, used in most cars) have replaced most CFC use. HCFCs in turn are being phased out under the Montreal Protocol and replaced by hydro fluorocarbons (HFCs), such as R-410A, which lack chlorine. However, CFCs, HCFCs, and HFCs all have large global warming potential.



IV. WORKING PRINCIPLE

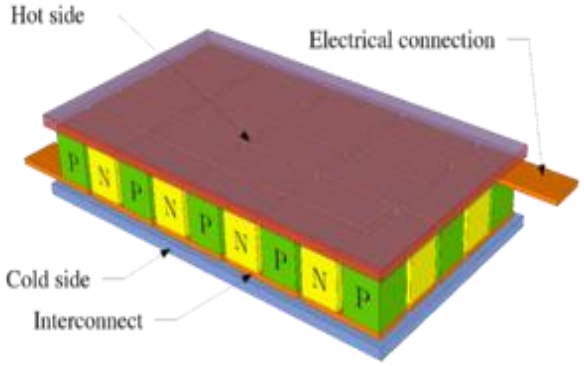
Thermoelectric cooling uses the Peltier effect to create a heat flux between the junctions of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). It can be used either for heating or for cooling,[1] although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools.



A Peltier cooler can also be used as a thermoelectric generator. When operated as a cooler, a voltage is applied across the device, and as a result, a difference in temperature will build up between the two sides.[3] When operated as a generator, one side of the device is heated to a temperature greater than the other side, and as a result, a difference in voltage will build up between the two sides (the Seebeck effect). However, a well-designed Peltier cooler will be a mediocre thermoelectric generator and vice versa, due to different design and packaging requirements.

B. Operating

Thermoelectric coolers operate by the Peltier effect (which also goes by the more general name thermoelectric effect). The device has two sides, and when a DC electric current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The "hot" side is attached to a heat sink so that it remains at ambient temperature, while the cool side goes below room temperature. In some applications, multiple coolers can be cascaded together for lower temperature.



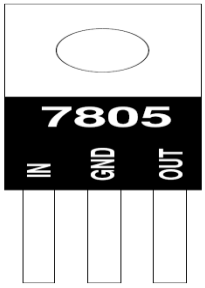
A single-stage TEC will typically produce a maximal temperature difference of 70 °C between its hot and cold sides. The more heat moved using a TEC, the less efficient it becomes, because the TEC needs to dissipate both the heat being moved and the heat it generates itself from its own power consumption. The amount of heat that can be absorbed is proportional to the current and time. Where P is the Peltier coefficient, I am the current, and t is the time. The Peltier coefficient depends on temperature and the materials the TEC is made of in refrigeration applications, thermoelectric junctions have about 1/4th the efficiency compared to conventional means (they offer around 10–15% efficiency of the ideal cycle refrigerator, compared with 40–60% achieved by conventional compression-cycle systems (reverse Rankine systems using compression/ expansion). Due to this lower efficiency, thermoelectric cooling is generally only used in environments where the solid-state nature (no moving parts, low maintenance, compact size, and orientation insensitivity) outweighs pure efficiency. Peltier (thermoelectric) cooler performance is a function of ambient temperature, hot and cold side heat exchanger (heat sink) performance, thermal load, Peltier module (thermopile) geometry, and Peltier electrical parameters.

V. COMPONENTS USED IN COMPRESSOR LESS REFRIGERATOR SYSTEM

A. Voltage regulator

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to

automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. The L78xx series of three-terminal positive regulators is available in TO-220, TO-220FP, TO-3, D2PAK and DPAK packages and several fixed output voltages, making it useful in a wide range of applications. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation.



Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1 A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

B. Solar Panel

A solar panel (also solar module, photovoltaic module or photovoltaic panel) is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each panel is rated by its DC output power under standard test conditions, and typically ranges from 100 to 320 watts. The efficiency of a panel determines the area of a panel given the same rated output - an 8% efficient 230 watt panel will have twice the area of a 16% efficient 230 watt panel. Because a single solar panel can produce only a limited amount of power, most installations contain multiple panels. A photovoltaic system typically includes an array of solar panels, an inverter, and sometimes a battery and or solar tracker and interconnection wiring.

Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most solar panels are rigid, but semi-flexible ones are available, based on thin-film cells. These early solar panels were first used in space in 1958. Depending on construction, photovoltaic panels can produce electricity from a range of frequencies of light, but usually cannot cover the entire solar range (specifically, ultraviolet, infrared and low or diffused light). Hence much of the incident sunlight energy is wasted by solar panels, and they can give far higher efficiencies if illuminated with monochromatic light. Therefore, another design concept is to split the light into different wavelength ranges and direct the beams onto different cells tuned to those ranges. This has been projected to be capable of raising efficiency by 50%.

C. Design Methodology

Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture.

VI. DESIGN METHODLOGY OF COMPRESSOR LESS REFRIGERATOR SYSTEM

The concept of CATIA V5 is to digitally include the complete process of product development, comprising the first draft, the Design, the layout and at last the production and the assembly. The workbench Mechanical Design is to be addressed in the Context of this CAE training course.

CATIA can be applied to a wide variety of industries, from aerospace and defense, automotive, and industrial equipment, to high tech, shipbuilding, consumer goods, plant design, consumer packaged goods, life sciences, architecture and construction, process power and petroleum, and services. CATIA V4, CATIA V5, Pro/ENGINEER, NX (formerly Unigraphics), and Solid Works are the dominant systems.

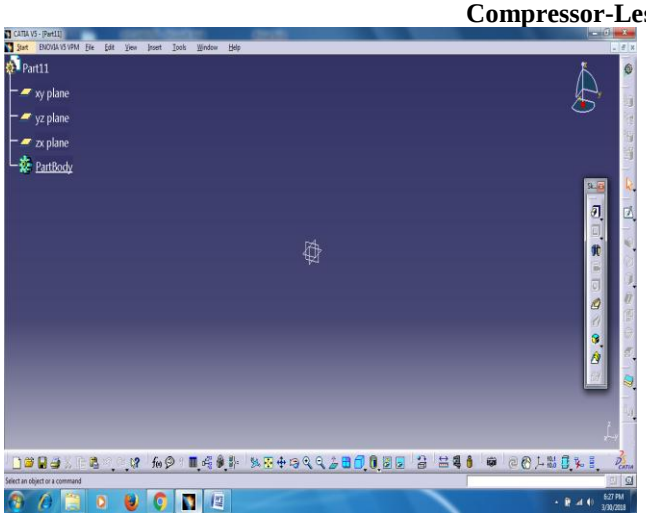


Fig6.1. Home Page of CatiaV5

A. Modeling of Compressor less Refrigerator System in CATIA V5

This Compressor Less Refrigerator System is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

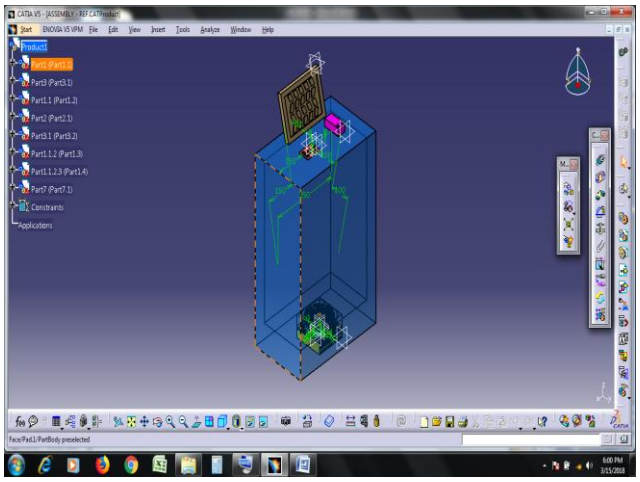


Fig6.2. Model design in CATIA-V5.

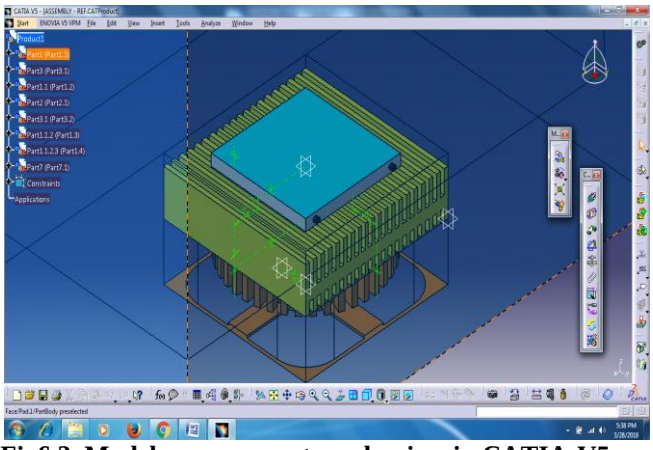


Fig6.3. Model arrangement mechanism in CATIA-V5.

VII. CONCLUSION

A thermoelectric refrigerator with an inner volume of 10litres has been designed and built. A more ecological system because it does not use refrigerants. More silent and robust since it minimizes the moving parts (it does not need a compressor). The advantage of the solar refrigerator is that the production of power is not uniform since solar energy is not available throughout the day and it also maintain in intensity by usage of battery during various times of the year. Hence, it can be used only in places where strong sun rays are available throughout the year and most parts of the day. A highly nonlinear model for the behavior of the compressor less refrigerator is considered. A parametric study to investigate the influence of the control parameters on the response is conducted. The final result positive manner .There is no problem while in Final assembly design; without failure. For proving that above design is carried out for applying fabrications for future works. Finally, I report that original manufactured assembly is fine and design model results are shown without any failure.

Advantages And Disadvantages

Advantages:

- Very mature technology.
- Relatively inexpensive.
- Can be driven directly using mechanical energy (water, car/truck motor) or with electrical energy.
- The TE module placed outside the cooling chamber
- The volume of the cooling chamber to be increased
- The TE module to work in a cycle mode
- The freezer/refrigerator acting autonomous
- Operating without moving parts
- Not being affected by the orientation within the field of gravity
- Noiseless operation
- Low mass and small size
- Portable solar fridges
- Ease of installation to save time and money
- Included mounting back plate
- Included communication ports

Disadvantages: Many systems still use HCFC refrigerants, which contribute to depletion of the Earth's ozone layer. In countries adhering to the Montreal Protocol, HCFCs are due to be phased out and are largely being replaced by ozone-friendly HFCs. However, systems using HFC refrigerants tend to be slightly less efficient than systems using HCFCs. HFCs also have an extremely large global warming potential, because they remain in the atmosphere for many years and trap heat more effectively than carbon dioxide.

Applications of Compressor Less Refrigerator System:

- It used for food storage in recreational vehicles.
- The principle can also be used to air-condition buildings using the waste heat from a gas turbine or water heater.
- Using waste heat from a gas turbine makes the turbine very efficient because it first produces electricity, then

hot water, finally, air-conditioning (called cogeneration/ tri-generation).

- Chilling cold drink cans
- For household applications
- For medical applications
- Can be used for instant heating applications

VIII. FUTURE SCOPE

Solar power nowadays is playing a major role in meeting the energy requirements of our country. It is being developed at a very fast rate and its applications in many areas are being explored. The fridge is intended at exploring the same and provides an efficient and economical solution to the areas where there is no electricity and cooling is required. This project main objective was to develop a mini compressor less solar fridge and this has been successfully done. The applications of this fridge are very wide and it can be used in various places for variety of operations. Also the main purpose for which this fridge is made is being fulfilled as the space inside the fridge is sufficient enough to cool appropriate amount of medicines and injections needed at the primary health care centre's in the villages where there is sporadic or no power supply. Though this fridge is working satisfactorily to its full capacity, still many changes and improvements can be done in this fridge to make it more users friendly and sophisticated in nature. For the further development of this project we can add GSM module to the current device if any temperature increases or refrigerator door is open for longer duration directly the call or sms will be forwarded to concerned person.

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