**VAPOUR COMPRESSION REFRIGERATION SYSTEM OPERATED BY SOLAR POWER**

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**ABSTRACT**

Solar refrigeration may have applications in both developed and developing countries. Applications in developing countries such as vaccine storage or large scale food preservation have been the subject of much research. Refrigerated storage, which is believed to be best method for storing the fruits and vegetables in fresh form, is not available in rural or remote locations where grid electricity is almost not available. So, without having a conventional energy source at these areas, the present study was taken up to design and fabricate a solar PV powered vapour compression refrigeration system to attain favourable conditions for fruits, vegetables and vaccine. It consisted of PV panel, lead-acid battery, inverter and the vapour compression refrigeration system consists of a drier-cum-filter besides the main components: compressor, condenser, expansion device, evaporator, and exhaust and evaporator fans.

The ﬁrst aim of this paper is to give an overview of the state-of-the-art of the different technologies that

are available to deliver refrigeration from solar energy. The second aims to compare the potential of these different technologies in delivering

Competitive sustainable solutions. Interest in utilizing solar-driven refrigeration systems for refrigeration or air-conditioning purposes has grown continuously. Solar cooling is comprised of many attractive features and is one path towards a more sustainable energy system. The refrigerator is able to operate directly by solar PV panels, with battery and is therefore suitable for locations where little maintenance and reliable operation is mandatory. Vapor compression technology is well established and recently used in electronics cooling. Refrigerators are cyclic devices that work with fluid refrigerants, having the objective to maintain the refrigerated space at a low temperature by removing heat from it.

**KEYWORDS**

Refrigeration, Solar energy Technology, storage, solar photovoltaic, solar refrigeration system,

**INTRODUCTION**

Solar refrigeration is a useful application in areas of the world with high insulation levels where there is a demand for cooling and there is no electricity to supply conventional power systems. Although the basic concepts of solar refrigeration appeared since about five decades, [1].

Energy is a vital input for sustainable development and economic growth of any country. Electrical energy is considered a most convenient form of energy sources in rural and urban areas. Rural inhabitants represent 70% of the total population in developing countries, or almost 50% of the world’s population,[2]. Energy crisis and global warming that resulted due to the excessive use of fossil fuels has promoted mankind to not only look of renewable, but also eco-friendly solutions to overcome these difficulties. Solar powered refrigerators are one such solution that is slowly being developed and implemented to combat energy crisis and global warming,[3].This system is perfect for transporting temperature sensitive vaccines and life-saving medical supplies because the portable units will maintain a constant temperature for the vaccines. Considering that cooling demand increases with the intensity of solar radiation, solar refrigeration has been considered as a logical solution.

 A solar electric refrigeration system consists mainly of photovoltaic panels and an electrical refrigeration device. Solar cells are basically semiconductors whose efficiency widely depending on the material and the manufacturing Methods they are made from. Photovoltaic systems sometimes called solar cells have found widespread application because they are simple, compact, and have high power-to weight ratio. The SPV system has no moving parts and probably yields the highest overall conversion of the solar energy into electricity. The cooling load to be met by the PV-generator depends essentially on: (a) the ambient temperature, (b) the refrigerator’s room temperature, determined by the special conditions the refrigerator has to operate, i.e. food preservation 10–20 ºC, preservation of vaccines 0–8 ºC [WHO, 1988], etc. (c) the size of the cooling space. (d) The matching conditions between the PV generator and the power consuming compressor,[2]**.**

**SYSTEM DESCRIPTION**

 Solar operated Vapour compression refrigeration system consists of solar panel and battery besides the main components: a compressor, a condenser an expansion device and an evaporator. It operates on 12/24 Volts DC with built in low voltage automatic disconnect for battery protection. R134a is used to serve as refrigerant for low, medium and high temperatures. It condenses at 1317.9kpa, [4]. Under normal atmospheric conditions and it is CFC free environmentally friendly refrigerant, [3]...

**Fig-1.1:-Line diagram of single stage vapour compression refrigeration cycle, operated by solar energy.**

 Solar freezers and refrigerators will operate on 75 watts of solar panels in most climates, [3]…

Table 1.1

|  |
| --- |
| Description of solar panel mount |
| Mounting Type | Side of Pole or Wall |
| Panel Type | 40 to 85 watts |
| Number of Panels | One |
| Setting Angle | 0 to 90 Degrees |
| Wind Load | 100 kph / 60 mph |
| Snow Load | 1.1 ken/m |

A **solar panel** (also **solar module**, **photovoltaic module** or **photovoltaic panel**) is a packaged, connected assembly of [photovoltaic cells](http://en.wikipedia.org/wiki/Solar_cell)

  Fig…solar cell Fig...Solar panel

The solar panel is used as a component of a larger photovoltaic system to generate and supply [electricity](http://en.wikipedia.org/wiki/Solar_power) .This electricity is further stored in lead acid battery and then supplied to the compressor of refrigerator.

**OPERATION**

Refer fig (1.1).

Solar panel is used to convert solar power into electricity.

The converted power in the form of Direct current, and it is stored in 12/24 V batteries (p-1).

This stored power is then transferred to 1250 VA Inverter, again in the form of Direct current (p-2). The function of Inverter is to convert the D.C supply to A.C supply and provide the required power to the compressor (p-3).

Here only the source of electricity is changed (i.e. from conventional source to unconventional source of energy).the further function of refrigerator is same as ideal cycle.

Ideal cycle

4-1 The working refrigerant, a saturated vapour, is carried through the suction tube to the compressor. The compressor compresses the saturated vapour into a superheated vapour which is then passed to the condenser.

1-2 The heat of the hot and high pressure vapour is released into the environment from the condenser. The working gas is transformed into a saturated liquid.

2-3 The liquid is pumped through a capillary tube or a thermal expansion valve into the evaporator, dropping significantly in temperature. The working fluid is a saturated mixture.

3-4 Heat flows into the evaporator from the heat source. The heat vaporizes all the working liquid (refrigerant), at the end of this stage the vapour is saturated, and the process repeats.

**MODIFICATION**

* Minimisation of the module area for specific climatic regions.
* Optimisation of the control strategy in order to minimise the needed PV-power.
* Further simplification and cost reduction of the construction

**APPLICATIONS**

* Folks who want to power their lives off the grid
* Folks who want to save money on refrigeration energy costs
* Remote homes, wilderness cabins, eco-resorts, research stations
* Boats, marine and recreational vehicles
* Missionaries and remote medical clinics
* Solar powered backup for hospitals
* Emergency responders operating in power outage areas
* Food and beverage vendors who have sunshine but no generator or plug in
* Emergency backup and disaster preparedness
* Ice making without fossil fuels or grid power
* Remote villages in areas of the world without grid electricity
* Farmer's markets and travelling vendors

**CONCLUSION**

Today, the demand for refrigeration for human comfort is growing rapidly and rarely influences the power supply structure in a negative manner. Solar cooling systems strongly depend on local conditions e.g. solar radiation, ambient temperature, or cooling load. Systems should therefore be specifically designed for each location; thereby obtaining the best performance. Here the vapour compression system is the most attractive options to reduce the cost of electricity and very advantageous for rural area. Battery based PV refrigeration technology is moderately developed in various country.

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