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Research Note

Solar PV Based Chilled Storage System for Preservation of Fresh Fish

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Fish is a highly perishable and deteriorates quickly after capture because of bacterial and enzymatic activities. Chilling or refrigeration reduces these activities and delays spoilage. Different species have different refrigeration requirements (Stocker, 1998). Most conventional refrigeration systems operate with electricity, however there are regions where there is no electricity. In addition, the cost of generating electricity is high, both economically and ecologically. Solar refrigeration is considered to be an alternative for conventional refrigeration equipment or make refrigeration possible in areas without electricity (Lingeswaran & Hemalatha, 2014). Photovoltaics (PV) involve the direct conversion of solar radiation to direct current (dc) using semiconducting materials. In concept, the operation of a PV-powered solar refrigeration cycle is simple. Solar PV panels produce DC electrical power that can be used to operate a DC motor, which is coupled to the compressor of a vapor compression refrigeration system. The major considerations in designing a PV-refrigeration cycle involve appropriately matching the electrical characteristics of the motor driving the compressor with the available current and voltage being produced by the PV array. The rate of electrical power capable of being generated by a PV system is typically provided by manufacturers of PV modules for standard rating conditions, i.e., incident solar radiation of 1 000 W m^{-2} and a module temperature of 25°C (Sanfold & Douglas, 2005). The battery also provides electrical storage so that the system can operate at times when solar radiation is unavailable. In the vapour compression cycle the compressor is the major power consuming device for its operation and consumption increases as the size of the refrigeration system increases. In case of the vapor compression refrigeration system, the compressor can be run by electric power supply only. These days the electric power has become very expensive, hence the running cost of the vapor compression refrigeration system is very high. The light energy can be effectively utilized to convert into electric current hence solar energy systems are becoming popular day by day. Majority of people believe that solar energy systems such as "solar panels" are going to be the source for future energy requirements. It is thus a renewable energy source and does not cause any kind of pollution to the environment. Hence, Solar Energy is both CLEAN and GREEN Energy (Deshmukh & Kalbande, 2013).

A small prototype of refrigeration system for chilling of fresh fish using solar PV has been developed at Central Institute of Fisheries Technology Cochin. The system consists of cooling chamber made up of GI sheet (18 gauge), condensing unit and PV panels with batteries. Condensing unit is having a DC compressor and DC fan with condenser (Table 1). The capacity of the chamber was 30 l. The cooling chamber was in the shape of inverted frustum of cone wrapped around copper cooling coils with 4" Thermocol/PUF insulation. Power for the chiller is tapped from solar radiation through photovoltaic panels (250 W). Two batteries (12V, 100 Ah each) connected to the panels were used to perform the trials. Panels are connected to DC drive of the compressor through batteries for operating the refrigeration cycle of the system (Fig. 1). An alternate option would be to utilise DC electrical power by converting it to AC through inverter for running AC compressor for vapour compression refrigeration system. Three Kilogram fresh Mackerel

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(*Rastrelliger kanagurta*) of size 20-25 cm length was collected from local fish market. Trial was conducted for 1 h for 3 times with same load. Temperature scanner with thermocouples (Ellab TM9616, Denmark) was used to record the temperature of fish core and the cooling chamber. Four thermocouples were used for recording the temperature i.e. two for fish core and other for cooling chamber at two different points.

Preliminary trials on prototype of solar chilling unit were performed for 3 kg fresh Mackerel (*Rastrelliger kanagurta*) loaded inside the cooling chamber and temperature data were recorded. It is found that with 3 Kg of Mackerel the cooling chamber temperature reduced to -2°C from ambient within one hour. The average ambient temperature was found 32°C (Fig. 2). Fish core temperature is reduced below 10°C from 22°C within 45 to 50 min. There was no change in fish core temperature at the beginning of the experiment and it started declining after 5 min of trial run. The core temperature was reducing without much variation at different time intervals i.e. 20°C, 15°C and 10°C during 13^{th}, 27^{th} and 43^{rd} min respectively and continued to 9°C at 50 min (Fig. 2). The temperature inside the cooling chamber was observed at two different points i.e. top and bottom. There was significant reduction in the temperature of cooling chamber between 5 to 20 min of time and it was reduced to 5°C from initial i.e. 29°C. After 20 min of running it took more than 30 min. to reduce the temperature from 5°C to 0.2°C. Average air temperature inside the cooling chamber with load was found 0.45°C after 45 min of the trial. Shelf life and quality of fish in terms of hygiene was found better than the fish preserved with crushed block ice.

Table 1. Technical specification of prototype

Component details	specification
Cooling Chamber (GI)	18 gauge (0.0516" thick)
Insulation (Thermocol/PUF)	4" thick
Photovoltaic Solar panels	250W, 24V (0.99 m X 1.63 m)
Storage Batteries (Tubular)	12V, 100 Ah
Cooling coil (Copper)	Ø 5/16"
Condenser (Copper)	Ø 1/5" (300 mm X 225 mm)
Compressor with DC drive	24V

Significant shelf life enhancement and reduction in spoilage can be expected as 12-14°C temperature reduction of fish core was observed during trial.

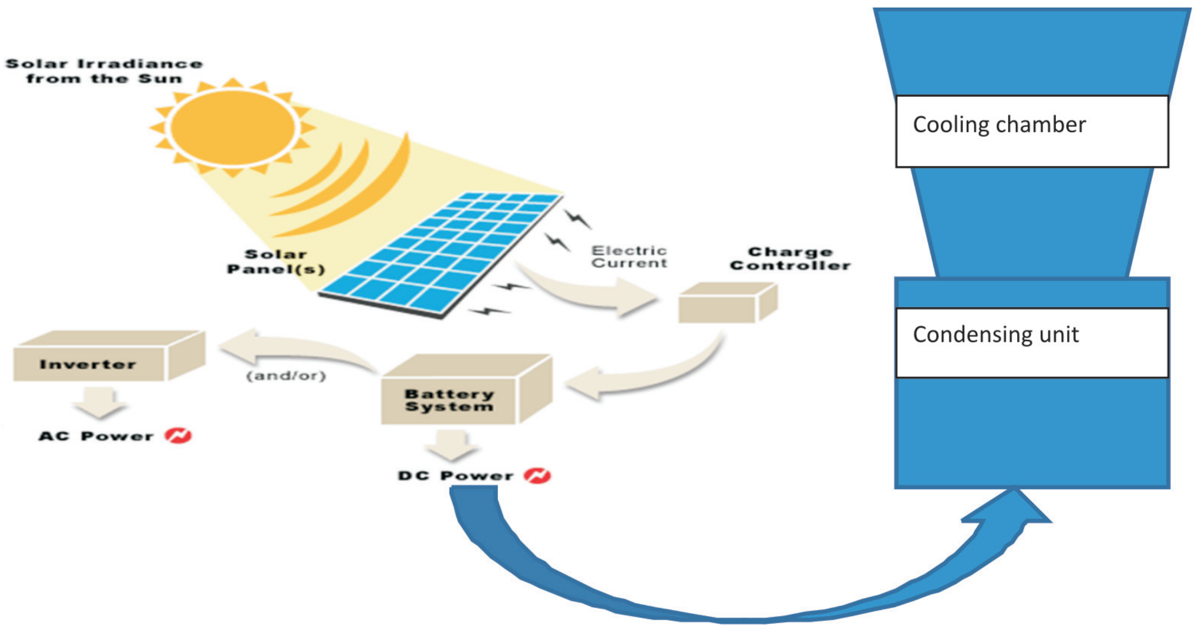

Fig. 1. Illustration of Solar refrigeration using PV

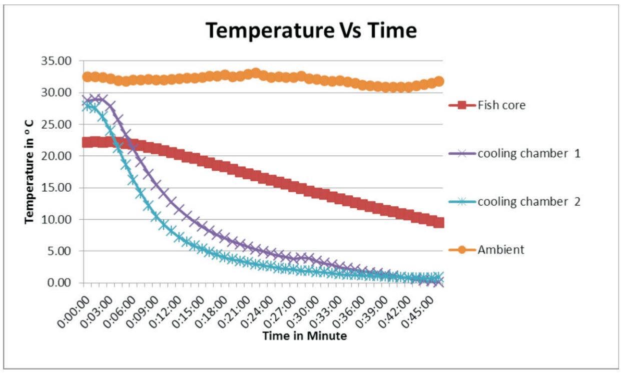

Fig. 2. Temperature (°C) variation w.r.t. Time (Minute)

References

Stocker, W. F. (1998) Refrigeration and freezing of food. In: Industrial Refrigeration Handbook (Wilbert, S. F., Ed), pp: 567-597, McGraw-Hill companies

Lingeswaran, K. and Hemalatha, C. (2014) Experimental Studies on Solar Powered Diffusion Absorption Refrigerator. Middle-East J. Sci. Res. 20 (7): 876-880

Sanford, A. K. and Douglas, T. R. (2005) Solar refrigeration: ASHRAE J. 47(9)S26-S30

Deshmukh, S.D. and kabande, S.R. (2015) Performance Evaluation of Photovoltaic System Designed for DC Refrigerator. Int. J. Sci. Res. 4(2): 18-22

Hassan, F., Joshy C. G. and Mathew, S. (2013) Quality evaluation of batterd and breaded seafood product under chilled storage. Fish. Technol. 50(2): 139-145

Clucas, I. J. and ward, A. R. (1996) Post-Harvest Fisheries development: A guide to handling, Preservation, Processing and quality, pp: 73-141Natural Resources Institute, Chatham, Maritime, Kent ME4 4TB, UK