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Performance Analysis of Air-Cooled Flat Plate Solar Photovoltaic/Thermal (PV/T) Systems: A Review

Anil Kumar[1], Minakshi Rathore[2], Anil Baliram Ghubade[3], Mahipal Singh[4], Nikita Jain[5], Aditya Mishra[6]

[1,3,4]Assistant Professor, School of Mechanical Engineering, Lovely Professional University, Phagwara, Punjab-144411, India.
[2]Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh-462003, India
[5,6]Assistant Professor, School of Mechanical Engineering, Career Point University, Kota, Rajasthan-324005, India.
Email: anil.20296@lpu.co.in[1], rathore.minakshi66@gmail.com[2], anil.18325@lpu.co.in[3] , mahipal.17711@lpu.co.in[4] , nikitaj822@gmail.com[5] , aditya.1989mishra@gmail.com[6]
Corresponding Author*: anil.20296@lpu.co.in , Ph. No.: +91-9672978974.

Abstract: Energy is limited and can't produce more with traditional methods which leads researchers and scientists to find the more effective use of Solar power systems. Photovoltaic-thermal systems can give the best performance with in the same type of systems available. However available Photovoltaic and thermal systems need much improvement in various aspects. This review paper covers several articles to do the performance analysis of a flat plate which is air-cooled for Photovoltaic-thermal systems. The authors concluded that individual processes and overall efficiency can be affected by various parameters. It also concluded that efficiency along with the system's performance can improve and can be used in a cold climate also.

Keywords: Photovoltaic, Photovoltaic-thermal systems, fins, hybrid Photovoltaic, solar-powered collector, PV/T air collector.

Introduction:

Sun powered vitality is one of the most significant roots of sustainable power sources that the world needs. Broadly two categories may be formed on the basis of significant uses of sunlight based vitality i.e. Photovoltaic framework (PV) cell and Thermal framework (T). after considering the traditional Photovoltaic Framework (PV), high occurrence sun based radiation on the Photovoltaic Framework board produce more electrical yield. In any case, the high occurrence will build the temperature of the sun-powered cells and that will diminish the effectiveness of the board. In this manner, to accomplish both higher cell productivity along with higher electrical yield, heat should remove which leads to cools the cells. Consequently so as to reduce the temperature of the cells in Photovoltaic Framework (PV), incorporation of the photovoltaic board of sunlight based air gatherer/collector).

Photovoltaic Thermal Collector (PV/T) or hybrid (PV/T) framework always has favorable position, for example, it tends to be utilized to produce both thermal and electrical vitality all the while, reducing the heat of Photovoltaic improves effectiveness, for heating and drying heat may use, which will have cheap with respect to other two separate units.

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This article examines a few plans for sun-powered PV/T air authority and its presentation.

Adel A. Hegazy*[1] et al. He studied and investigated all the various significant parameters of electrical, hydraulic, thermal, and whole effectiveness of PV/T Air Collectors. They advised in total four well known plans with the air owing through some models i.e. Model I (which is considered upper-side of absorber), Model II (which is considered lower side of absorber), Model III (which is considered in a single pass of the absorber at lower and upper sides), Model IV (which is considered in a two times pass fashion. Impacts of air explicit stream rate along with a selection of the safeguard plate and Photovoltaic Cells on the effectiveness have measured. It has been noted and discovered that taking the comparative operational conditions, the Model I gatherer has less efficiency, whereas different models display tantamount warm along with electrical yield gains. By the Model III gatherer requests to less fan control, trailed by Models second as well as fourth. Hence it indicated stating specific parameters are unseemly for these Photovoltaic - thermal (PV/T) Air Collectors because of effective decrease in produced PV vitality, particularly at fewer stream rates.

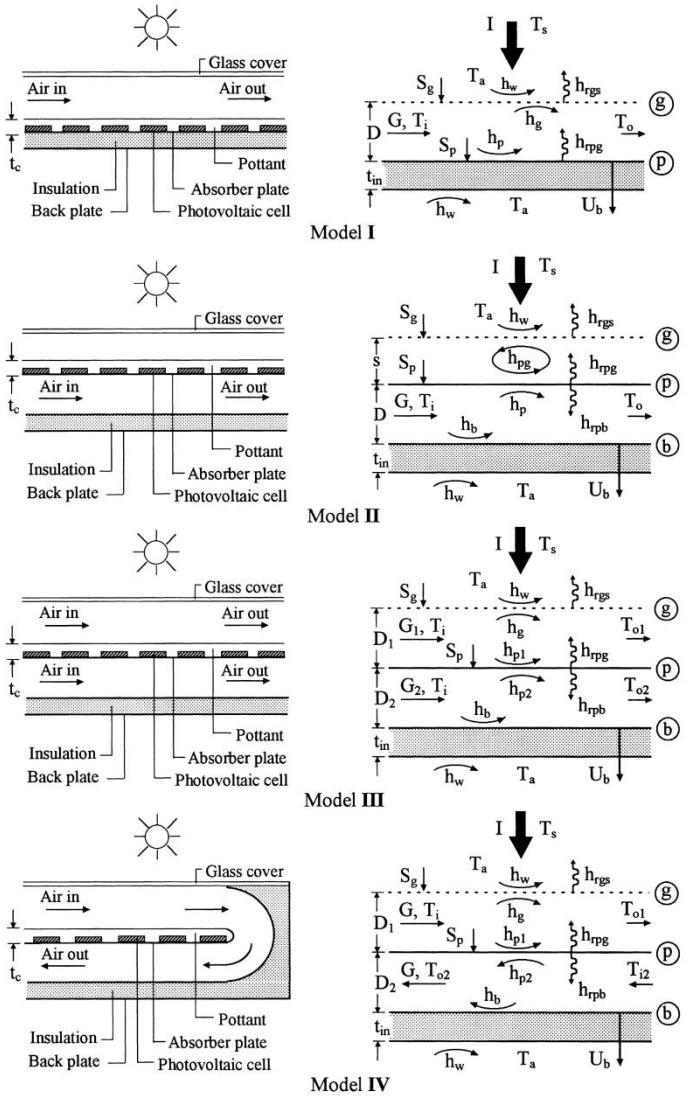

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Fig 1: Schematics of the different PVT models and coefficients for heat transfer**[1]**

Arvind Tiwari[2] et al. built up an explanatory articulation for general effectiveness has been inferred by utilizing vitality balance condition for every part. Exploratory acceptance of the photovoltaic/thermal hybrid thermal system (PV/T) design was done. It is observed that a reasonable understanding of hypothetical and exploratory perceptions exists. In his test, it is discovered that the thermal efficiency of the PV/T framework is altogether expanded because of the use of thermal energy in the PV module. There is a reasonable understanding among test and hypothetical outcomes for top and back surface and Temperature in the outlet air with relationship factor/constant (r) of 0.97–0.99 and root mean square percent deviation (e) of 7.54–13.89%. Increment has been noticed in the general productivity of the hybrid Photovoltaic/thermal framework by 18% because of thermal energy accessible notwithstanding electrical energy.

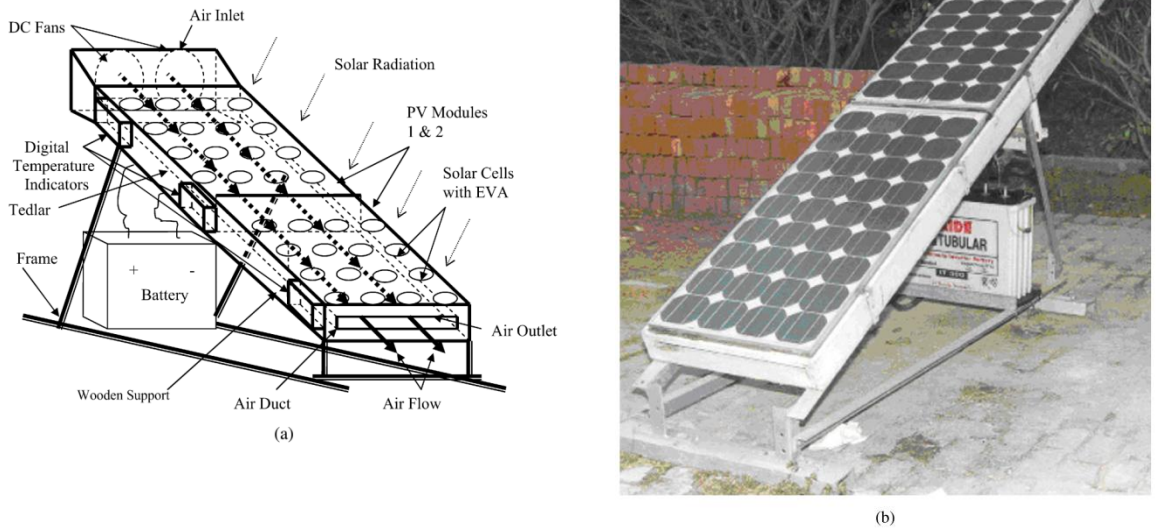

Fig 2: (a) Hybrid PV / T air collector schematics. (b) A real picture of the installed project at IIT Delhi**[2]**

Niccolo` Aste[3] et al. assessed the test and hypothetical aftereffects of an innovative work program on the design structure, completed at the Politecnico di Milano, advancement along with execution observing of hybrid Photo-voltaic Air Collector. The principal results of the exploration comprise a reproduction (simulation) model for the expected outcome of the framework. This Research and Development program prompted the advancement of the tetto integrale solarizzato (TIS), for example, incorporated sun based rooftop), an inventive innovative framework for building joining of hybrid breed Photo-voltaic Air Collector. The recreation model, completed in the same program which produced well the electrical and thermal exhibition of a Photo-voltaic Air Collector. Experiment model, as a rule, can be used for any arrangement of plan and operational parameters to examine output of front side cover direct stream/flow Photo-voltaic Air Collector, semitransparent with various sun oriented cell density (for example,

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proportion between the absolute cover surface and the region of the cells) or totally dark (for example standard PV overlay like those utilized in the exploratory crusade introduced.

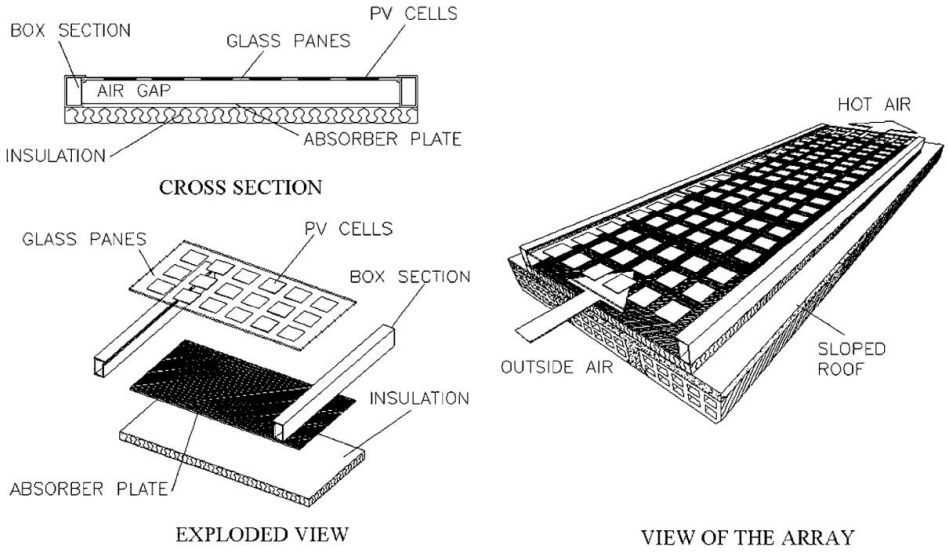

Fig 3: The collector's early drawings**[3]**

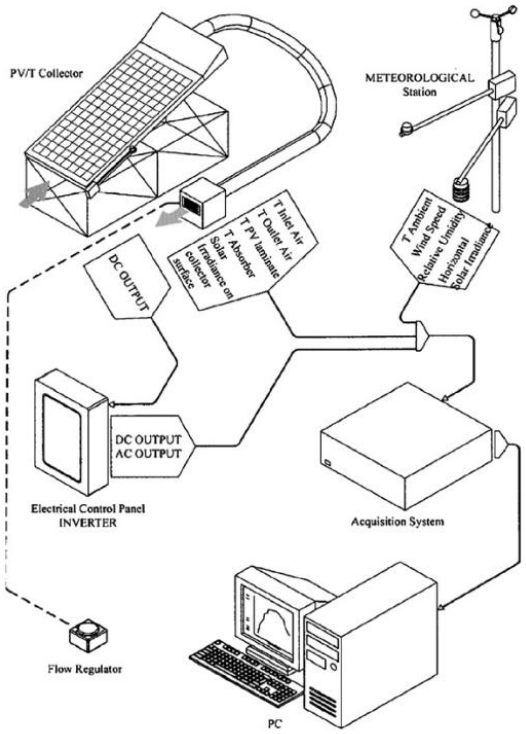

Fig 4: Program for data control and device screen**[3]**

Ebrahim M. Ali Alfegi[4] et al. Installation of an individual photovoltaic-thermal collector (PV / T) with a compound-parabolic-concentrator (CPC) and blades together with both sides of the absorber / collector to evaluate the desired thermal and integrated thermal performance of the

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system.. The air flows between safeguard (absorber/collector) plate and top glass and among safeguard (absorber/collector) and base plates. Circled air's temperature as a component of separation exists in the stream bearing for the two sides are anticipated. Output at sunlight based radiance of 400W/m^2display the combination photovoltaic-thermal-collector (PVT) productivity is found expanding from 26.60 % to 39.13% at mass stream rates fluctuates in range within 0.0316 to 0.09 kg/s.

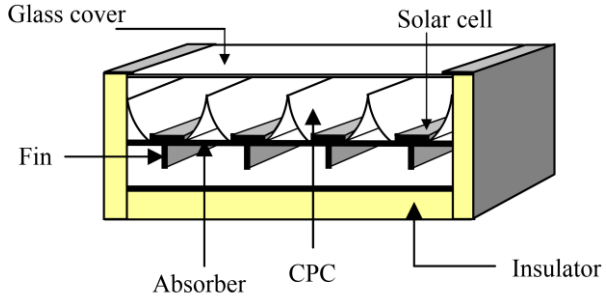

Fig 5: Proposed structure to find all the Photovoltaic-Thermal 1-pass component**[4]**

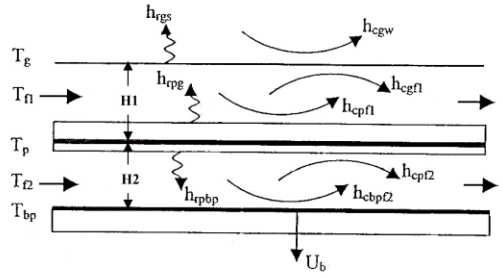

Fig 6: Photovoltaic-Thermal Collector Schematic Diagram**[4]**

Y. Tripanagnostopoulos[5] et al. introduced an ease improvement tending to the heat exchange is exhibited here. A flat metal plate of less thickness (TFMS) is kept in between the air passage till the last point. Alteration and experimentation conducted in the research lab of the University of Patras. An analytical model also created for air-cooled photovoltaic-thermal V/T frameworks have changed and adjusted to explain the altered photovoltaic-thermal framework which utilizes the TFMS at the University of New South Wales. The outcomes tell an acceptable understanding of exploratory information along with reproduced values. Exploratory and analytical outcomes from the photovoltaic-thermal framework with and without incorporation of the TFMS change are broke down and affirms the fruitful use of the proposed examination.

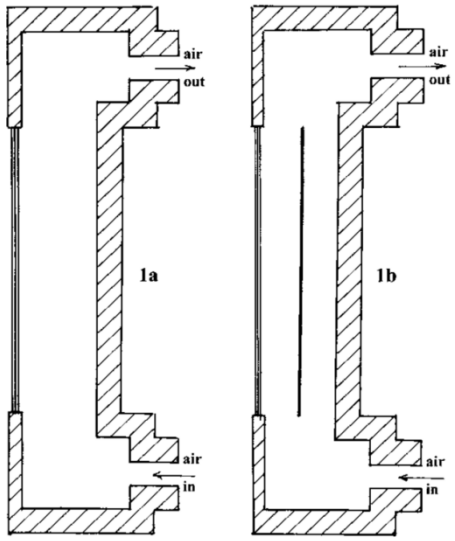

Fig 7: Cross-section experimental designs**[5]**

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S.C. Solanki[6] et al. A standard indoor testing strategy for both electrical and thermal testing of photovoltaic-thermal PV / T collectors associated with the arrangement has been established. To accomplish it, a PV/T sun oriented air radiator was planned, created and the efficiency of various working parameters was contemplated. In view of the conditions of energy balance, a thermal model has been created. Correlation between exploratory and hypothetical outcomes was additionally been completed.
Various efficiency has been measured of the sun based radiator at indoor condition i.e. The thermal efficiency is 42%, electrical efficiency is 8.4% and the whole efficiency is 50%.

Fig 8: Image of the Photovoltaic-Thermal Solar Heater experimental set-up**[6]**

Piotr Matuszewski[7] et al. look into the solar air collector and to perform potential advancements of it. In the first step of this study, the authors did the estimations concerning collectors like the flow of air, air temperature in the collector and loss of pressure were performed. Moreover, parameters portraying climate like the speed of air; sunlight based radiation and outside temperature are checked. At the same time, the power created by sun based cell is likewise estimated. In the second step to check the exhibition of the collector, the heat balance and productivity are resolved. So as to improve the performance a few changes are made on the collector, for example, changing the size of the inlets. Then based on estimations and DRY record yearly execution of the collector was acquired. Moreover, results from the estimations are checked in comparison with the help of simulations.

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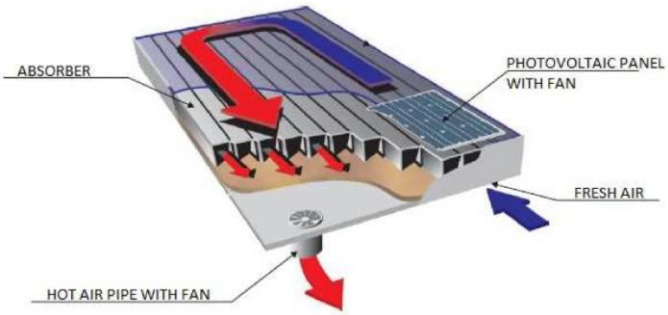

Fig 9: Solar Air Collector of Twin and Top**[7]**

Fig 10: Solar Air Collector of Jumbo Type**[7]**

A. Shahsavar[8] et al. exhibited a model of a direct-coupled photovoltaic-thermal (PV/T) air collector that was kept structured, constructed, and was tested in Iran at a geographic area of Kerman, Iran. This photovoltaic-thermal (PV/T) framework, an aluminum sheet of very little thickness kept at the center of the channel of air, is utilized to allow for the expansion of HES (heat exchange surface) which results in more reduction of heat from photovoltaic boards. The photovoltaic-thermal framework was used in regular convection (natural convection) also in the constrained convection (forced convection) with more fans working (i.e. two, four and eight fans). Its precarious outcomes are exhibited in both combinations with glass cover cases and also without glass cover cases.

Comparisons have been done among electrical execution for a distinctive method of procedures and the ideal number of fans to achieve the greatest electrical efficiency is reasoned. Testing and hypothetical results for airflow rate, outlet air temperature and photovoltaic board temperature with ratio coefficient (R) are well understood, which value is maintained between 0.95 to 0.99. and similarly, other important factors i.e. standard rate deviation mistake (e) is also considered in between from 0.78 to 7.4%. On account of the constrained convection procedure of radiation, the airflow rate diminishes while keeping a layer of glass on PV boards. Although another technique is applied, setting glass cover prompts increases in airflow level. Thermal efficiency increases with the increase of the air mass flow rate due to the increased coefficient of thermal transfer. It tells that an ideal no. of fans makes the greatest electrical productivity.

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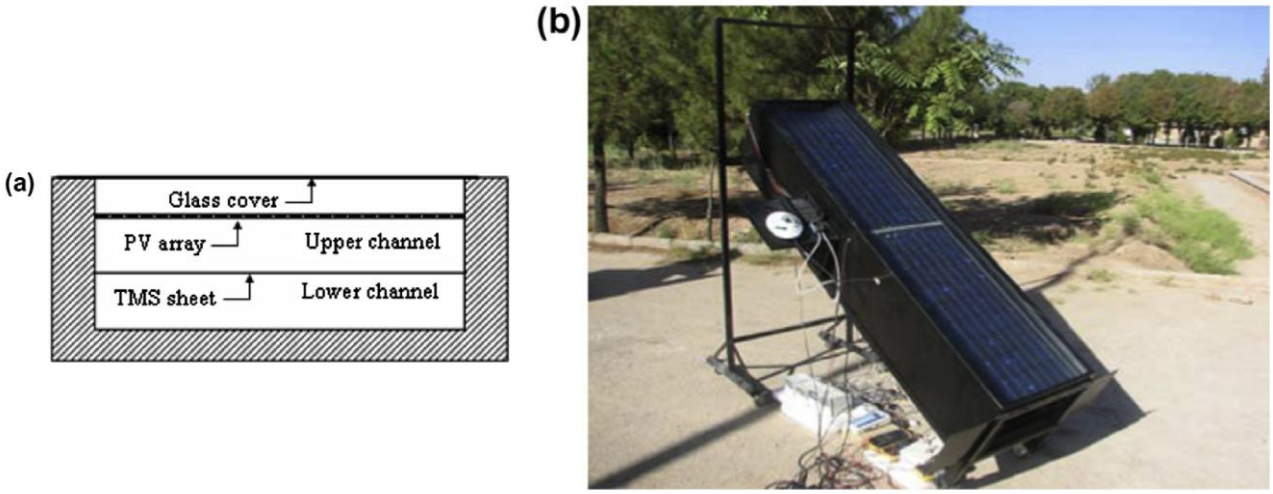

Fig 11: (a) Cross-sectional view of PV/T air collectorand (b) Real image of PV/T air collector installation setup being tested in the University campus of Shahid Bahonar, Kerman**[8]**

F. Sarhaddi[9] et al. built up an itemized model of the electrical and thermal model to figure out various parameters of the electrical and thermal of an ordinary Photovoltaic air collector. The parameters of electrical and thermal of a Photovoltaic-thermal air collector incorporate sunlight based cell temperature, the temperature of the back surface, temperature of the air at the outlet, short and open-circuit voltage, most extreme power point voltage, greatest powerpoint current, and so forth. A few remedies are captured on coefficients of heat loss, hence to improve the photovoltaic thermal model. A software imitation system is created to show the parameters of a PV / T air collector, i.e. thermal and electrical parameters. The consequences of analytical recreation are shown great concurrence by doing trial estimations. It is likewise discovered that thermal effectiveness is about 17.18%, electrical proficiency is about 10.01% and whole energy productivity of photovoltaic-thermal air collector is about 45% has been recorded of design and operating parameters for a climate sample.

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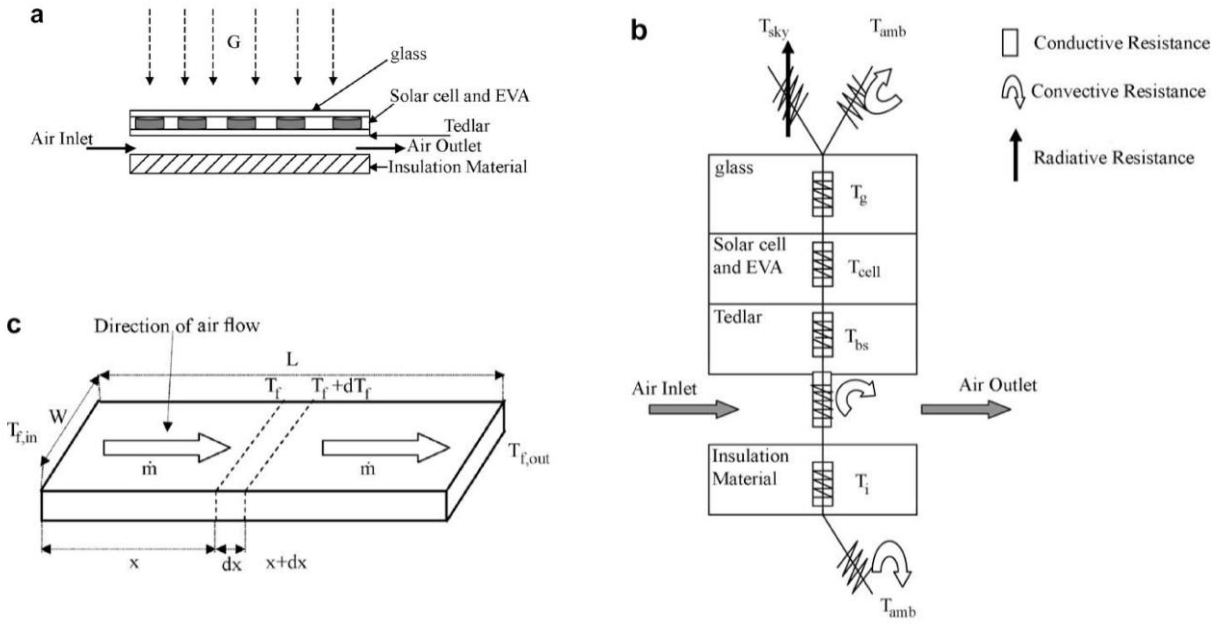
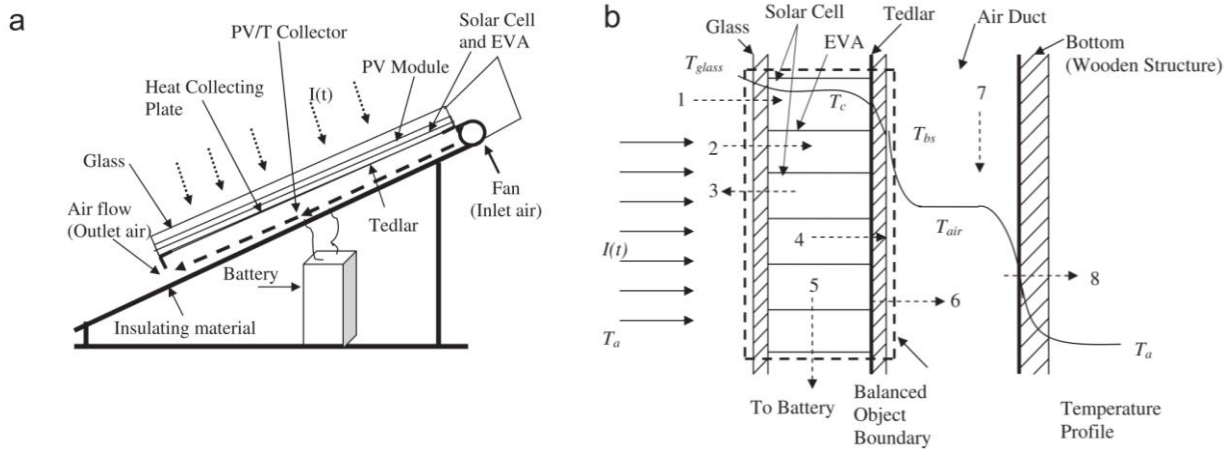


Fig 12:PV / T air collector's (a) cross-sectional view, (b) resistance circuit diagram and (c) the 'dx' elemental flow duct length**[9]**

Anand S. Joshi[10] et al. assessed exergy investigation for the cold climatic state of India (Srinagar) of a hybrid photovoltaic–thermal (PV/T) parallel plate air collector. The weather information of this state of India noted from the premier metrological organization of India (at IMD, Pune)from 1998 to 2001 and characterization has been done of climatic conditions. The effectiveness of a hybrid Photovoltaic-thermal parallel plate air collector was used to record climatic conditions and afterward exergy efficiencies captured and seen a prompt vitality with exergy productivity of Photovoltaic-thermal air radiator shifts between 55–65% and 12–15%, individually.



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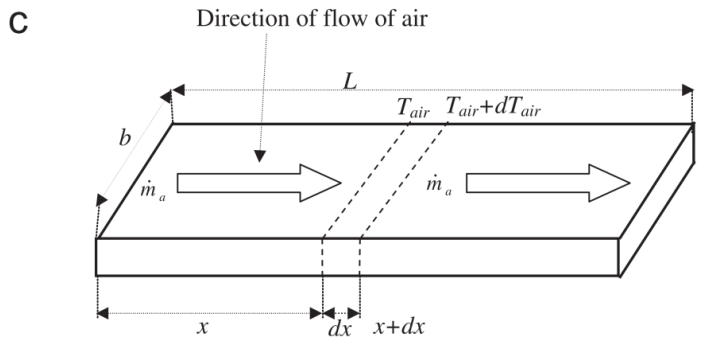

Fig. 1. (a) Integrated PV/T (IPVTS) schematic diagram with the medium used as air (b) cross-sectional view of Hybrid PV/T air collector (c) Elementary length ' dx ' indicates the airflow pattern below Tedlar**[10]**.

CONCLUSION

The target of this audit is to examine different structures executed to improve the exhibition and effectiveness of different air-cooled sunlight based PV/T frameworks. This survey covers diagnostic and numerical models, reproduction and testing, and subjective evaluation of heat/electrical output. PV / T collectors based on air-cooled sunlight are instruments that constantly change the energy of the sun into heat and power. The accessibility of electrical vitality can be utilized to run electrical machines and heat energy can be used in drying or space warming reason. At the same time, it cools the sun based board by separating heat from the surface, expanding its productivity.

The objective of this review is to analyze various designs implemented to improve the performance and efficiency of various air-cooled solar PV/T systems. This review covers the analytical and numerical models, simulation and experimental work, and qualitative evaluation of thermal/electrical output. Air Cooled solar PV/T collectors are devices that simultaneously converts solar energy into electricity and heat. The availability of electrical energy can be used to run electrical appliances and heat energy can be utilized in drying or space heating purposes. Simultaneously its cools the solar panel by extracting heat from the surface, increasing its efficiency.

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