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Investigation on a photovoltaic thermoelectric ventilator

ZhongBing Liu, Ling Zhang * , YongQiang Luo, Jing Wu, FangFang Meng

College of Civil Engineering, Hunan University, Changsha, China, 410082, P.R. China

Abstract

A novel photovoltaic thermoelectric ventilator (PV-TEV) was proposed and investigated in this paper. In PV-TEV system, the outdoor fresh air is firstly heated up by PV airflow channel, and then heated up further when it flows through the hot side heat sink of thermoelectric ventilator into the indoor room. At the same time, the exhaust air cooled down the heat sink on the other side of the TEM when it is pumped out of the indoor environment. The electricity power of PV array is storage in battery, which can used to power the thermoelectric ventilator through voltage controller. The PV-TFAV system model was set up to calculate system performance with the actual solar radiation intensity and environment condition. The results show that the COPs and the fresh air temperature supplied for indoor is increased as the solar radiation intensify increase. The COPs are between 2.90 and 3.35 and the fresh air temperature is between 18.3 ℃and 31℃. This simply and environmentally friendly system is promising and worthwhile being applied to for low carbon buildings fresh air supply.

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Keywords:Photovolatic; Thermoelectric heating; Coefficient of performance; Numerical simulation

1. Introduction

The indoor air quality has attracted more and more attention in recent years. To improve the indoor air quality, outdoor air is brought into the indoor environment by ventilating or simply opening windows. However, this increases the energy consumption of buildings. In recent years, fixed-plate heat recovery ventilators, run-round coil ventilators, and rotary wheel ventilators are employed to recover heat from exhaust air in buildings [1]. These heat recovery ventilators are driven by the temperature and humidity difference between the fresh air and exhaust air. As a result, those conventional heat recovery ventilators only provide a passive way for heat recovery from the exhaust air, and have a relatively limited contribution for reducing the energy consumption for air conditioning system.

* Corresponding author. Tel.:+86-133-1955-8612; fax: +86-0731-88822610.
E-mail address: lingzhang@hnu.edu.cn.

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Solar tthermoelectric cooling systems have no mechanical moving parts and do not employ working fluids, which transfer heat of the cold side of the modules to the hot side with consumption of electricity [2-3]. Thermoelectric cooling systems can be powered directly by a photovoltaic (PV) without the help of AC/DC inverter, which greatly reduces the costs. Moreover, these systems are Freon free, causing no harm to the environment. Due to the advantages such as high reliability, low weight, and flexibility in packaging and integration, solar thermoelectric cooling systems have been widely used in air conditioner, building envelope and industrial products [4-7].

In this paper, a novel photovoltaic thermoelectric ventilator (PV-TEV) is proposed and investigated in this paper. In winter, the outdoor fresh air is firstly heated up by PV airflow channel, and then heated up when it flows through the hot side heat sink of thermoelectric ventilator into the indoor room. At the same time, the exhaust air cooled down the heat sink on the other side of the TEM when it is pumped out of the indoor environment. The electricity power of PV array is storage in battery, which can used to power the thermoelectric ventilator through voltage controller.

2. The system working principle

Fig.1 depicts the prototype photovoltaic thermoelectric ventilator (PV-TEV) system. As shown in Fig.1, the PV-TEV system mainly consists of photovoltaic thermal system, airflow channel, and thermoelectric ventilator. PVT air collector consists of an air duct directly beneath a photovoltaic array, which are used as external shading devices and can reduce energy use in buildings in summer. In winter, the PVT air collector is used to heat the fresh air for indoor room. The thermoelectric ventilator is divided fresh air part, the TEM parts and the exhaust air part. The outdoor fresh air is firstly heated up by PV airflow channel, and then heated up when it flows through the hot side heat sink of thermoelectric ventilator into the indoor room. At the same time, the exhaust air cooled down the heat sink on the other side of the TEM when it is pumped out of the indoor environment. The electricity power of PV array is storage in battery, which can used to power the thermoelectric ventilator through voltage controller.

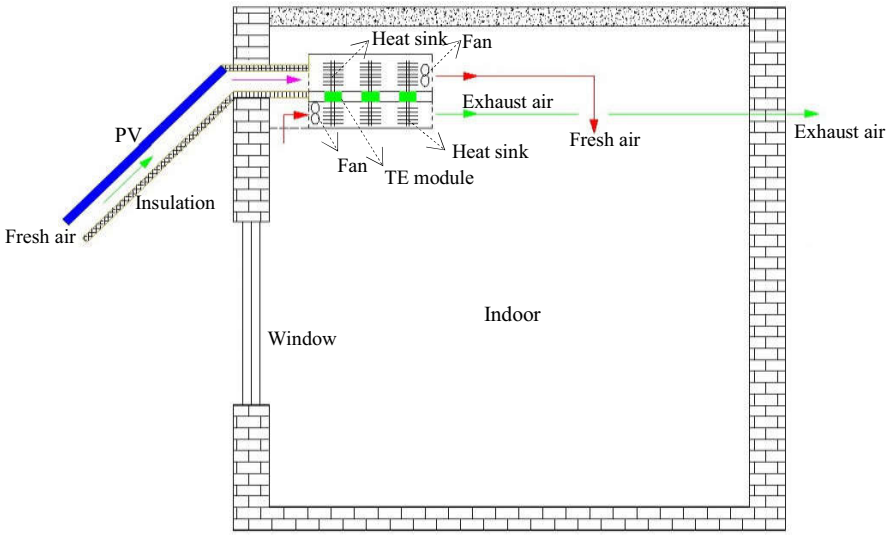

Fig. 1. Schematic of the photovoltaic thermoelectric ventilator (PV-TEV)