

Theoretical Performance of Integrated Photovoltaic/Thermal Air Collector,
Earth-Air Heat Exchanger and Greenhouse with a Floor of Shape-Stabilized
Phase-Change Material: Evaluation by Energetic Analyses

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Abstract

The self-sufficiency of buildings is becoming increasingly important. Therefore, devices for natural ventilation, solar heating and cooling, ground cooling (earth-air heat exchangers), natural lighting, shading from the sun, and other devices that use a passive mode strategy have been developed. Sustainability-oriented choices that might in the past have been considered to be optional are now necessary. In this work, thin film photovoltaic technology is utilized in buildings. An integrated photovoltaic/thermal (PV/T) air collector to collect hot air and drive air flow, and mixing the air flow from earth-air heat exchanger (EAHE) and hot air flow to the floor that is made of shape stabilized phase change material (SSPCM) floor inside greenhouse, a SSPCM absorbs energy from solar light that enters through windows and solar panels. A piston cylinder air compressor adjusts the moderate control of air flow and the ambient temperature and temperature of room in the hybrid system. The hybrid system using natural ventilation in passive strategies designs an innovative HVAC system can be called “lung” of a building. The design process integrated with “whole building approach” and “new material” is used to analyze the theoretical performance of this building by energetic analyses for the weather in HsinChu. A mathematic model will be resolved by the helps of MATLAB 7.0 program and CFD software. The energy required by air-conditioning and thermal will be predicted. A finite difference-Fortran program (Hybrid-HVAC) is developed based upon the 2D unsteady heat equation with a Stefan moving boundary problem. This program is modified into a Hybrid-HVACP and should enable the hybrid system building with the PV/T, EAHE and SSPCM to be solved numerically with high accuracy. The simulation results

in this work reveal that if the difference between ground temperature and ambient temperature is less than 5 K, such as in HsinChu city, the HVAC results obtained using EAHE are unsatisfactory, and so EAHE yields better results in areas with large temperature differences.

Keyword : Photovoltaic/Thermal Air Collector, Earth Air Heat Exchanger, Shape-Stabilized Phase Change