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EFFECT OF AIR GAP ON PERFORMANCE ENHANCEMENT OF BUILDING ASSISTED WITH PHOTO VOLTAIC SYSTEMS

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ABSTRACT

This paper investigates performance improvement of room assisted with Photo voltaic (PV) system by varying air gap and PV glazing type. PV panel was installed on the south side of the room as Photo Voltaic Trombe wall (PV-TW) and over the roof. Performance was evaluated in term of cooling load, energy consumption and PV efficiency. Three different types of PV glazing (i.e. Single Glazing, Double glazing, double glazing filled with Argon gas) was tested by changing air gap between wall and PV panel for Malaysian climate. TRNSYS building simulation software was used in which various input parameters were inserted to obtain the results. It was found that maximum PV efficiency was achieved in the case of Double glass filled with Argon PV-TW at air gap of 0.2 m and roof pitch angle 20 degree. Ventilated PV-TW and PV panel installed over the roof also reduces cooling load of the room. Among all the three types of glazing, room assisted with Double glass filled with argon PV panel shows highest reduction in cooling load at air gap 0.2m and roof pitch angle 20 degree. Also cooling load of room reduced significantly with the increase in roof pitch angle upto certain critical angle which is different for different PV glazing.

Keywords: cooling load, photovoltaic trombe wall, TRNSYS, glazing type.

INTRODUCTION

Last few decades, there is a cumulative demand for development of sustainable buildings. Increase hazard of global warming and annihilation of fossil fuels has generated a necessity environment to develop eco-friendly natural energy systems in the buildings. The use of building integrated photo voltaic systems (BIPV) is gradually encouraged by national regulatory bodies, these system utilizes solar energy for heating and cooling of buildings [1,2,3]. PV-TW is the typical BIPV system which consists of south facing massive wall and PV panel, installed a few inches in front of the wall. The performance of PV devices is approximately inversely proportion to the cell temperature. Therefore, it is important to provide an adequate air gap behind the PV modules installed, either on the wall or over the roof of the buildings. This air gap will act like a ventilation in BIPV system. These types of ventilation not only reduce the temperature of PV panel, but also carry away the heat accumulated behind PV panel.

In the existing literature, there is no significant study has been done on air gap and its effect on the performance of BIPV systems. In practical the length of the air gap is not calculated with empirical relation rather it has been taken from earlier experiences. Researchers suggested that the minimum air gaps is roughly varies from several centimeters [4], with a minimum of 15cms gap [5]. There is no clear study has been done on the optimum air gap size for efficient PV performance. Guiavarch *et al.,* [6] also found that an air gap of 0.1 m enhanced the efficiency of PV panels as compared with the PV panels without any air gap. Summer thermal loads can also be reduced by implementing ventilated walls, facades and roofs. The combination of PV and ventilated roofs not only improves the PV transformation efficiency, but also drops the cooling load through the roofs [7]. Brinkworth *et al.* [8] found that there was a substantial increase in the electrical output of PV panels and also reduction of heat flux inside the building when air flow was induced by buoyancy in a duct behind the PV component which further reduces PV temperature up to 20K. Yang *et al.* [9] shown that the cooling-load component through a PV roof with the ventilation gap is reduced about 35% as compared with the load of a conventional roof. Mei *et al.* [10] described different behavior and found that, the cooling loads are slightly higher in case of ventilated PV façade for nearly all locations considered, whereas the impact of the façade depends critically on location in case of heating load.

The literature on the thermal performance of BIPV façade and roof system is more, but the effect of air gap behind different types of PV glazing attached over and besides the buildings on thermal load and PV efficiency has not been considered. The objective of this study is to evaluate the effect of the air gap between PV module and TW in PV-TW. Also to evaluate the effect of air gap for PV module and roof, similarly in the case of PV panel installed over the roof of the building on cooling load PV efficiency and energy consumption by using TRNSYS software. The study has been carried forward to evaluate the effect of air gap in different type PV panel's Single glass, Double glass and Double glass filled with argon, installed over the roof and wall.

METHODOLOGY

The first step in establishing a simulation predicated optimization control, is computing a dynamic model that virtually performs as an authentic building. Therefore, dynamic simulation software was needed with the ability to compute the thermal behavior of the building, with a degree of flexibility and user-graphical interface. For this reason, TRNSYS (TRaNsient SYstem