EFFECT OF DISTANCE OF PV MODULE FROM VERTICAL BUILDING WALL ON TEMPERATURE OF MODULE'S REAR WALL

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ABSTRACT

The paper presents experimental research results allowing to estimate the effect of distance of PV module from vertical building wall on mean daytime temperature of module's rear wall. Analysis of research results shows that the lowest values of excess temperature in relation to the air temperature at the input are obtained at longest distance values under research, that is 0,12 m.

INTRODUCTION

Solar power engineering, and in particular photovoltaics, is one of most dynamic fields in modern power engineering. Direct generating the electric power from solar radiation reduces the number of power transformations in the process of power conversions. Unfortunately, efficiency of presently applied power converters, PV modules, is relatively low. Consequently, at high costs of PV installations, effectiveness of investments is diminished.

In spite of the above facts, PV installations are built and mounted both in the open and in buildings. PV modules are increasingly mounted on building walls directed to the sun. They are mounted on special frames. There occurs an air space between the PV module and the building wall. In PV module, part of energy is converted to heat. Heat flux is transferred from the module to the air at its rear, and, as a result, temperature of the PV module, as well as temperature of air between the module and the building wall, increase. Higher temperature of PV module, and thereby of p-n junction, causes drop of instantaneous electric power of PV module. At the same time, temperatures difference between the above mentioned air space and environment causes convectional movement of the air. Overflowing the rear wall of PV module by air allows a better heat off take from PV module. The heat transfer process can be intensified, if movement of the air is constrained by a fan.

On the grounds of analysis of research results on mean daytime temperatures of rear walls of PV modules mounted on a vertical building wall, when one of them is implemented with lateral protective channel and the other one is not protected, it is stated in paper that in summer, it is better to leave a free space in the rear of PV module. Research shows that during the day, natural convection of the air cooling the PV module is obviously strongly related on irradiance.

The aim of the present paper is to investigate how distance of PV module from the building wall affects the mean daytime temperature of module's rear wall. Research has been carried out for PV module without lateral covers.

METHODOLOGY

Measurements of working parameters for PV module were carried out in periods:

- from 12.03 to 15.04.2015, by distance 0,08m,
- from 16.04 to 13.05.2015, by distance 0,10m,
- from 13.05 to 15.06.2015, by distance 0,12 m.

Both characteristic temperatures and irradiance on horizontal surface were measured every 3 minutes. Next, times of sunrise and sunset were determined for each day, in the site of PV installation. Then, measurements results made each day were arranged in two groups: the ones made in daytime and the ones made at night. In the next step of calculations procedure, only measurements for daytime were accounted for in order to determine mean values of characteristic parameters. Calculation results are given in Figs 2-4.

TEST STAND

PV module of type SV65P, produced by SELFA GE S.A. was mounted on south-west wall of the building of West Pomeranian University of Technology, Department of Heat Enginnering. PV module was mounted on the frame that allowed its movement in relation to the building wall (Fig.1). In research, the distance of PV module to the building wall equaled respectively: 0,08, 0,10, and 0,12 m. Five sensors of type Pt100, connected to data collector of type APAR206, were applied to measure temperatures of PV module's rear wall. The sensors were fastened in corners and in the middle of PV module. Sensors for temperature measurements were also fastened on input and on output of the open channel formed between the PV module and the building wall.

Pyranometer of type LB-900, with sensor of type CMP-3, was used to measure the irradiance. Also environment parameters were monitored.

a) b)

Fig. 1. View of test stand

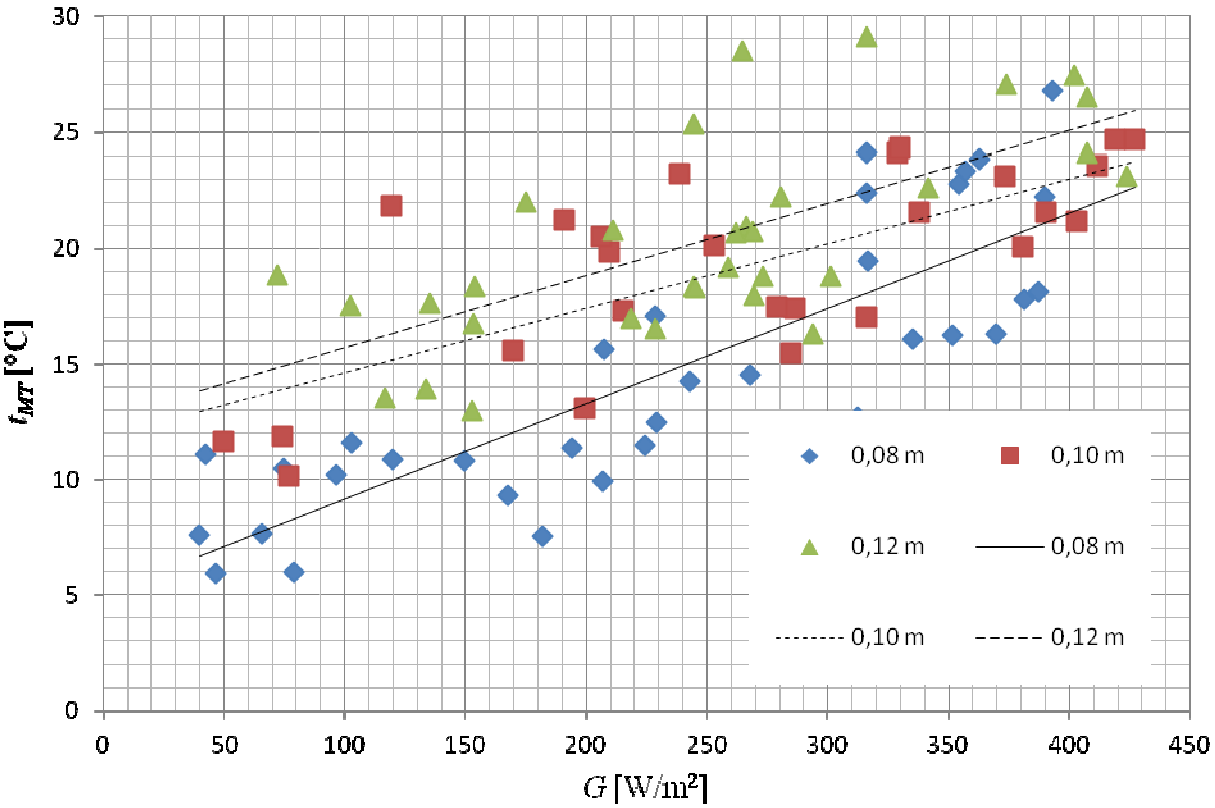

Fig. 2. Mean daytime temperature at PV module's rear wall in function of irradiance on horizontal surface for investigated distances of mounting

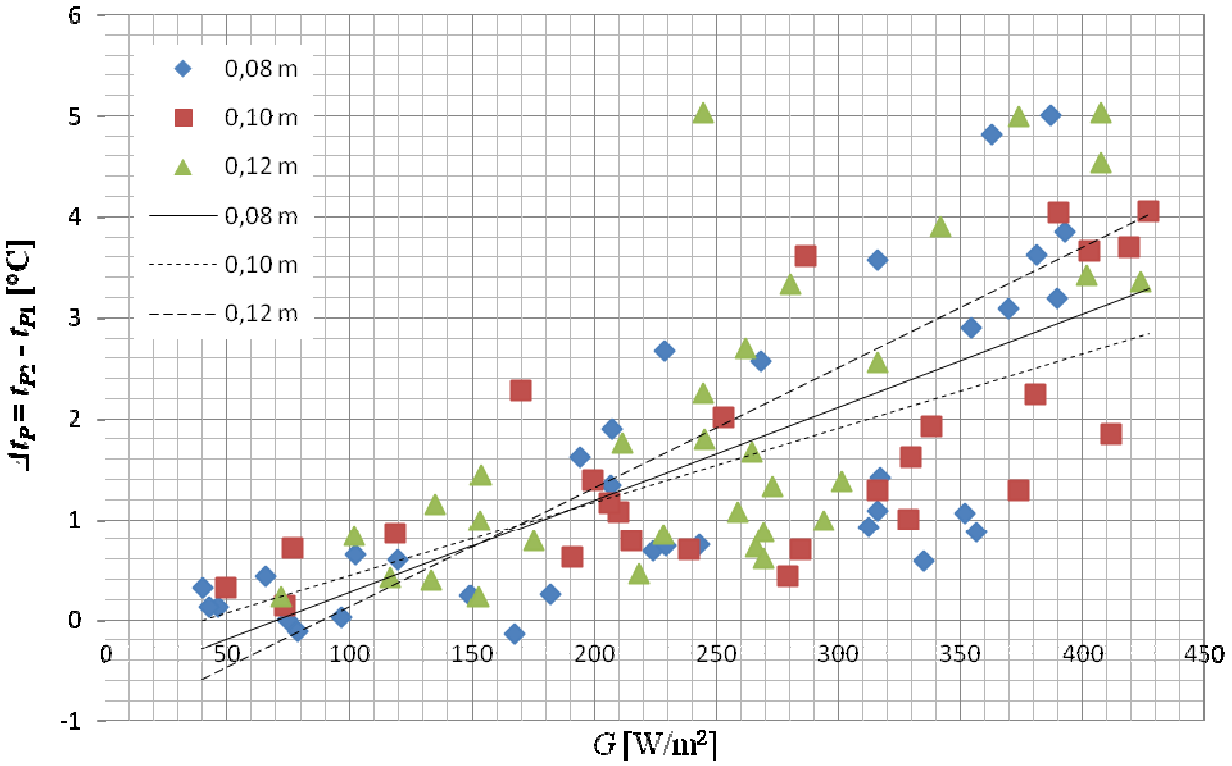

Fig. 3. Mean daytime temperatures difference of the air at output and input in function of irradiance on horizontal surface for investigated distances of mounting

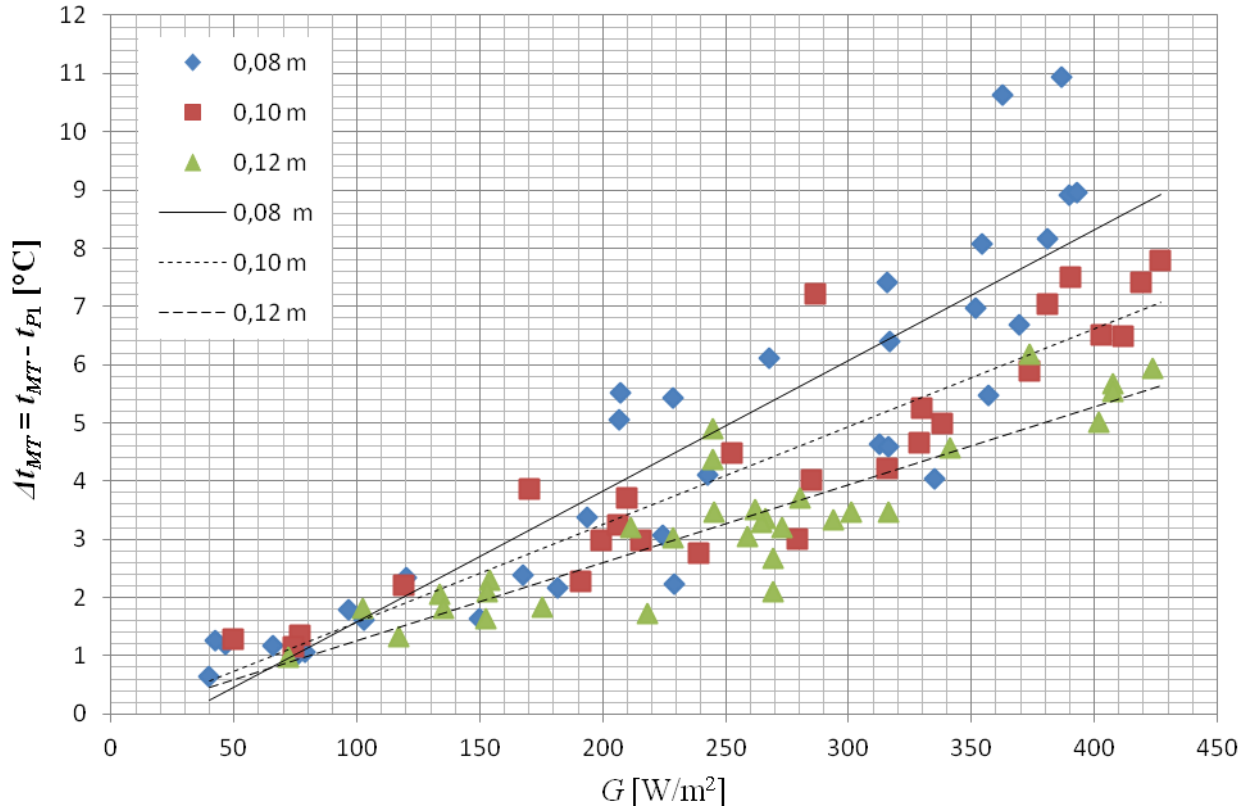

Fig. 4. Mean daytime excess of temperature at module's rear wall and of air temperature at input in function of irradiance on horizontal surface for investigated distances of mounting

On the basis of analysis of data presented in Fig. 2, it can be stated that the lowest mean daytime temperatures at rear wall of PV module occur at its distance from the building wall equal with 0,08 m. However, the cause of lower values of the above temperatures was not the channel's geometry,

but the season of the year. The research was carried on in various seasons of the year, for various distances of mounting, and mean monthly outdoors temperatures were higher month by month. March was characterized with much lower outdoors temperatures in comparison with June, therefore temperatures measured at rear wall of PV module were respectively lower.

In turn, analysis of data given in Fig. 3 showed that change of distance of PV module from the building wall only insignificantly affected the change of growth of air temperature between input and output from the channel. The growth reached about 1,2°C for highest values of irradiance.

The best way to estimate the effect of distance between PV module and vertical building wall on mean daytime temperatures of module's rear wall was to analyse temperature increase $\Delta t_{MT.}$ The increase was defined as difference between mean daytime temperature of module's rear wall and mean daytime temperature of air that reached the channel. The analysis showed that it was more advantageous to assume the bigger distance between PV module and vertical building wall. For highest observed values of irradiance, the increase was lower even by 5,2°C. The reason for better heat off take from PV module's rear wall was the higher air flow rate in the channel caused by natural convection.

CONCLUSIONS

On the basis of analysis of research results, it can be stated that:

1) by the highest value of distance of PV module from the building wall (0,12 m), the most favourable conditions of heat off take from its rear wall are obtained,
2) change of distance between PV module and building wall only insignificantly affects the value of output temperature of the air flowing from the created channel,
3) more favourable cooling conditions occurring by the highest value of distance of PV module from the building wall are caused by increased flow rate of the air in the channel due to natural convection.

NOMENCLATURE

G	irradiance reaching horizontal surface	W/m^{-2}
t	temperature	°C

Greek symbols

Δt	temperature increase	°C

Subscripts

1,2	input, output
MT	rear wall of the module
P	air

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