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Measuring air temperature in glazed ventilated façades in the presence of direct solar radiation

Olena Kalyanova[1], Fabio Zanghirella[2], Per Heiselberg P[1], Marco Perino[2], Rasmus Lund Jensen[1]

[1]Aalborg University, Aalborg, Denmark
[2]Politecnico di Torino, Torino, Italy

Corresponding email: fabio.zanghirella@polito.it

1 Introduction

A distinctive element of buildings with a double glazed façade is naturally or mechanically driven flow in a ventilated cavity. Accurate air temperature measurements in the cavity are crucial to evaluate the dynamic performance of the façade, to predict and control its behavior as a significant part of the complete ventilation system. The presence of direct solar radiation is an essential element for the façade operation, but it can heavily affect measurements of air temperature and may lead to errors of high magnitude using bare thermocouples and even adopting shielding devices.

Two different research groups, from Aalborg University (AAU) and Politecnico di Torino (POLITO), tested separately various techniques to shield thermocouples from direct irradiance, in order to achieve an accurate and reliable way to measure the air temperature reducing the error caused by radiation.

2 Methods

Aalborg University experimental setup included 11 thermocouples: bare thermocouples, thermocouples shielded differently from the direct solar access, shielded and ventilated thermocouples and differently shielded silver coated thermocouples. Politecnico di Torino experimental setup consisted in 5 thermocouples: bare thermocouple, naturally ventilated shielded thermocouple, mechanically ventilated thermocouples with single or double shielding devices from solar radiation.

3 Results

In both experiments the evaluation of the results in the absolute terms was not possible as there is no knowledge available about the true air temperature. The thermocouple with the minimum mean temperature and the standard deviation was considered as the less affected by solar radiation, and thus the most reliable one.

On the basis of AAU investigations the silver coated thermocouple with a silver coated shielding tube ventilated by a mini fan was chosen as the most suitable. POLITO investigations lead to the choice of the single shielded and ventilated thermocouple as the most reliable one.

The two best performing techniques were tested together and the experiment shows a good correspondence of the results (Table 1).

Table 1. Experimental data from the cross-test

Shield. technique	Mean temp. [°C]	STD [°C]
POLITO	22.59	1.62
AAU	22.50	1.80

4 Conclusions

Bare or shaded and naturally ventilated thermocouples turned out as unsuitable to obtain reliable temperature values and a mechanically ventilated shielding pipe was chosen by both groups. Nevertheless, the solutions adopted to avoid the common problem of the overheated shield were based on different approaches. The highly ventilated POLITO approach is mainly focused on increasing of the convective coefficient on the sensible part of the measurement probe, while AAU solution is based on a smaller ventilation flow rate and on a stronger reduction of the radiative heat flux. Even if based on different approaches, the two techniques lead to the similar outcome.
Although some results are available and can be implemented in practice, there is the need for further investigations and the possibility for improvements of the air temperature measurements in the direct solar access.