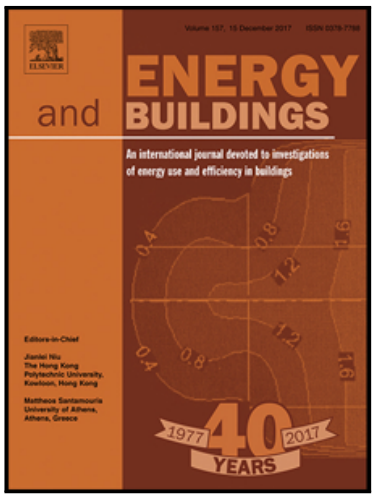

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Revisiting the use of globe thermometers to estimate radiant temperature in studies of heating and ventilation

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Abstract

The globe thermometer has been considered a reliable instrument to quantify mean radiant temperature (MRT) ever since Bedford & Warner corrected its readings from air movement in their 1934 paper so that radiation alone can be quantified. Recent expanded use of radiant heating and cooling systems has presented new challenges for the usage of globe thermometers in the built environment by introducing additional radiant asymmetries and performance expectations. This motivates our replication of the original Bedford & Warner's work to reconsider and develop a more holistic understanding of its performance and the determination of MRT in buildings. We recreate the MRT and air temperature separation to investigate the accuracy of globe thermometers on measuring MRTs. A radiantly heated open-plan laboratory and a radiantly cooled conference room were selected and measured with multiple globe thermometers and non-contact infrared sensors. The globe temperature results were then corrected with air movement to produce MRTs and compared against MRTs simulated from surface temperatures. We demonstrate a significant impact of air speed on the MRTs obtained from globe thermometers. We also illustrate a less-investigated spatial variation of MRTs of up to 5 °C at the same height. We believe the increasing capability of digitally logging sensor data may create new challenges for using globe thermometer to measure MRTs, since fluctuating readings may camouflage potential MRT changes. Validating our spatial MRT distribution with experimental results, we also believe there is a need for better apparatus that could spatially resolve MRTs, and recognize issues with both air speed and emissivity.

Keywords: mean radiant temperature, globe thermometer, radiant heat exchange, built environment

1. Introduction

Motivated by increased popularity of high performance radiant heating and cooling systems today, we revisit the study by Bedford & Warner in 1934 [1] because it presented the original method of determining mean radiant temperature (MRT) from a globe thermometer. Presently, the globe thermometer is considered the most common method of measuring MRT [2]. MRT is a widely used and important variable that helps quickly characterize the radiant heat transfer potential. MRT is defined in standards as the uniform temperature of a hypothetical and homogeneous black sphere that surrounds and exchanges the same amount of heat with a human body as the actual surroundings [3].

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