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An Infrared Thermography-Based Window Surface Temperature Database for the Validation of Computer Heat Transfer Models

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ABSTRACT

Fenestration heat transfer simulation codes are used in energy performance rating and labeling procedures to model heat transfer through window systems and to calculate window U-values and condensation resistance factors. Experimental measurements of window thermal performance can direct the development of these codes, identify their strengths and weaknesses, set research priorities, and validate finished modeling tools. Infrared (IR) thermography is a measurement technique that is well suited to this task. IR thermography is a relatively fast, non-invasive, non-destructive technique that can resolve thermal performance differences between window components and window systems to a higher degree than a conventional hot box test. Infrared thermography provides spatial resolution of system performance by generating surface temperature maps of windows under controlled and characterized environmental conditions.

This paper summarizes basic theory and techniques for maximizing the accuracy and utility of infrared thermographic temperature measurements of window systems and components in a controlled laboratory setting. The physical setup of a complete infrared thermographic test facility at a major U.S. national research laboratory is described. Temperature measurement issues, and accuracy limits, for quantitative laboratory infrared thermography are discussed. An external reference emitter allows test-specific correction of absolute temperatures measured with an infrared scanner, resulting in an absolute measurement accuracy of ±0.5°C. Quantitative IR thermography is used to form a database of window surface temperature profiles for the validation of finite-element and finite-difference fenestration heat transfer modeling tools. An IR window surface temperature database with complete technical drawings of the windows tested; specification of all test window dimensions, materials, and thermal conductivities; environmental conditions of the tests with associated measurement errors; and two-dimensional surface temperature maps and selected cross sectional temperature profiles in a spreadsheet database format on an electronic media are presented.

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