Window Energy Analysis Using Occupant Comfort as the Guideline

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ABSTRACT

Windows historically have been the poorest performing elements of the building envelope. High heat loss during winter weather exposes the building occupant to cold interior glass surfaces. High solar gain in the spring, summer, and fall can lead to serious overheating on sunlit elevations. Today’s high-performance window systems greatly improve on cold weather comfort, but the designer must still choose the appropriate level of solar gain for year-round performance.

Most performance path analysis allows the designer to trade off good windows for other building improvements (i.e., higher efficiency mechanical systems) in an effort to get the same credit for less cost. However, the impact of poor glass on occupant comfort isn’t accounted for in the equation.

Below is a figure illustrating the range of inside surface temperatures for different types of glass at 0°F outside air temperature as well as three levels of insulation. The range of inside wall temperatures varies greatly with each type of glass. A designer may trade off good glazing without accounting for the negative impact on the temperature near the windows.

Common practice in building energy simulation work is to assume fixed thermostat settings, regardless of the components used in the thermal envelope. If the resulting design is uncomfortable, the occupant’s likely first response is to change the thermostat setting, which can invalidate the original energy analysis. At the very least, a building design should not be considered energy efficient unless it delivers adequate comfort as well.

This presentation will detail how window comfort modeling can be used to more accurately analyze the energy impacts of building occupant discomfort. With this perspective the building designer can avoid common errors made during trade-off efforts to optimize the structure for both first cost and operational cost. The calculations give the designer a tool to evaluate the comfort impact of window selection during the low-energy spring and fall swing seasons. And, finally, a comfort analysis of windows gives the designer the confidence that the building will be energy efficient under real user conditions and that the building occupants can point to that efficiency having tangible comfort benefits all year-round.

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Figure 1  Range of inside surface temperatures for different types of glass at 0°F outside temperature.