Evaluation of Six Greenhouse Covering Materials for Energy Performance

Enhe Zhang, ekz5068@psu.edu, Penn State University

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Summary

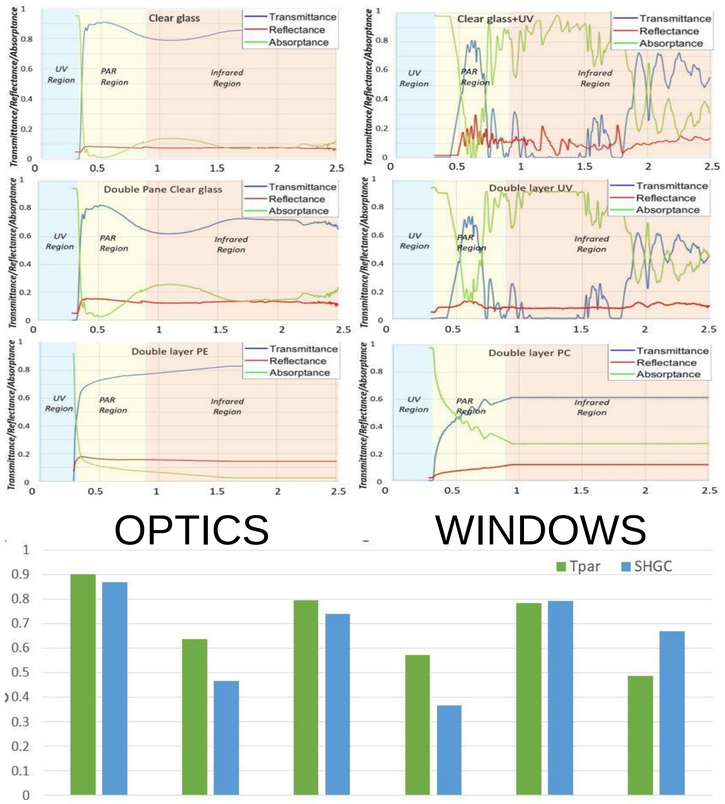
Investigation of Six Greenhouse Coverings: This study explores various greenhouse coverings, including diverse glass types, polyethylene (PE), and polycarbonate (PC) layers, with a focus on their optical and thermal properties. Spectrum data collection and optical data simulation were performed using LBNL software OPTICS and WINDOWS.

Energy Efficiency Assessment: The study utilized SHGC and U-factor to evaluate the energy efficiency of the greenhouse cover materials. A Sketchup established model was employed to assess the performance, and EnergyPlus software was utilized for model simulation. The research was conducted in State College, PA, which falls under the 5B climate zone.

Comparative Analysis: Annual energy consumption, specifically total energy usage, heating through natural gas, and interior lighting, was compared and analyzed in the context of the different greenhouse coverings.

Notably, double-pane structures exhibited similar U-factors but displayed significant differences in PAR transmittance and SHGC.

All transparency surfaces with raised roofing. Specific features and controls were added, such as daylight control maintaining setpoint lux and DGI levels, a lighting system operating for 14 hours daily, and adjusted HVAC settings.



Results

UV-coated materials show high PSG values, indicating superior photosynthetically active radiation transmission with reduced solar heat gain. Double-layer PC exhibits a lower PSG value, reducing light transmission and increasing heat gain. PAR transmittance varies among materials, with clear glass having the highest value and UV-coated clear glass reducing SHGC by 46.2%.

Double-layer PE and PC show remarkable energy savings of 10.1% and 7.9% compared to single-pane glass. Double-layer PE and PC also demonstrate substantial reductions in heating energy consumption by approximately 26.9% and 25.2%, respectively.

PAR transmittance on interior lighting is relatively minimal, with double-layer PC resulting in a slight 4.61% increase in interior lighting usage due to reduced PAR transmittance compared to clear glass.

Conclusions

In total and heating energy consumption, with double-layer PE and PC materials showing high energy efficiency. The U-factor played a critical role in energy consumption, while the interplay between U-factor, SHGC, and PAR transmission was important to consider. Moreover, the study found that PAR transmittance had a relatively minor impact on interior lighting.

Enhe Zhang,
Department of Architectural Engineering
Penn State University, University Park, PA, USA 16802
e-mail: ekz5068@psu.edu

Md Anwar Jahid,
Department of Architectural Engineering
Penn State University, University Park, PA, USA 16802
e-mail: mmj5702@psu.edu

Julian Wang *
Department of Architectural Engineering
Penn State University, University Park, PA, USA 16802
e-mail: julian.wang@psu.edu

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