

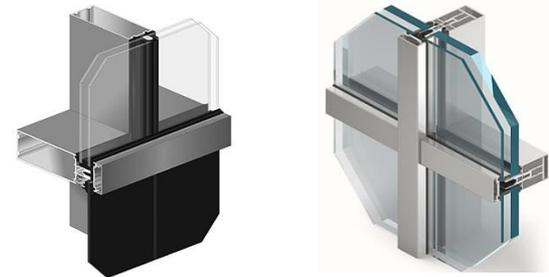
Impact of VIP envelope reflectance on the performance of curtain wall system

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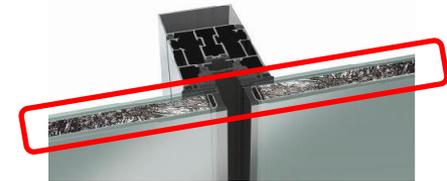
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Background

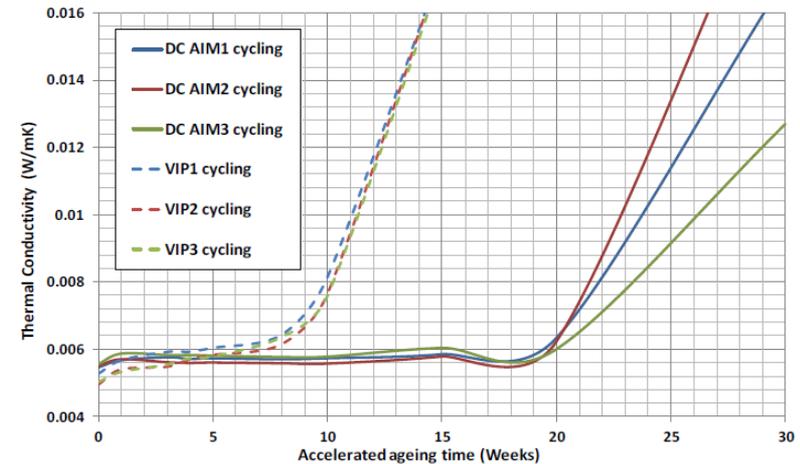
- Curtain walls are popular cladding and exterior wall components on many building types.
- Two main categories - glass curtain wall (100 % vision) and curtain wall system with spandrel and vision parts. Thermal performance issues, especially with glass curtain walls.
- The spandrel area, usually composed of opaque glass or metal or concrete panel (opaque material), curtails heat losses and gains.
- Can VIPs be used in spandrel part ?
- In a related study at accelerated aging cycling conditions of -20°C to 80°C temperature and 10% to 90% RH, VIPs integrated into glass unit cavity provided ten times protection to the VIP as compared to unprotected panel. (Gubbels et al., Durability of VIPs in the cavity of insulating glass units, J. Build. Phys., 2014).



Curtain wall systems with: vision and spandrel parts (left) and vision part only (right).



Dow Corning Architectural Insulating Module's (AIM) VIP spandrel.



F.D. Gubbels et al., Durability of VIPs in the cavity of insulating glass units, J. Build. Phys., 2014.

Aims

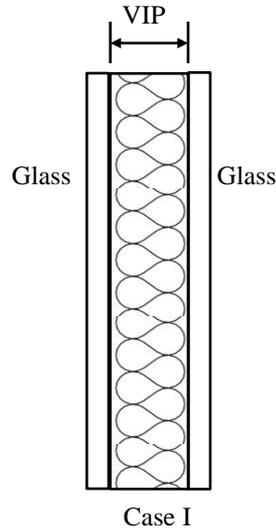
This study investigates façade application of VIP in spandrel part of curtain wall system. The specific aims of the study are:

- ① To investigate and differentiate the thermal characteristics and behavior of VIP spandrel (clear glass) and vision parts of a curtain wall system.
- ② To investigate building energy demand relative to the ratio of vision to spandrel areas.

Methods

- ① Model a unit baseline office building using EnergyPlus software.
- ② Model a south facing curtain wall system with VIP spandrel.
- ③ Run simulations.
- ④ Analyze results.

Modeling constraints and parameters

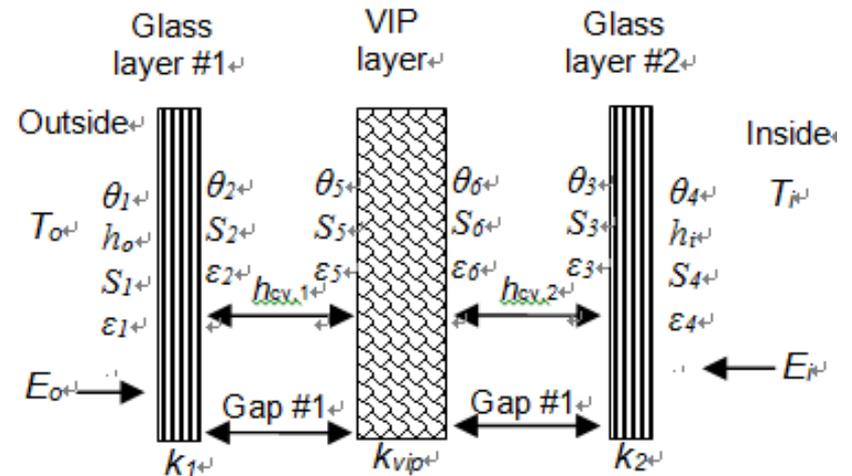
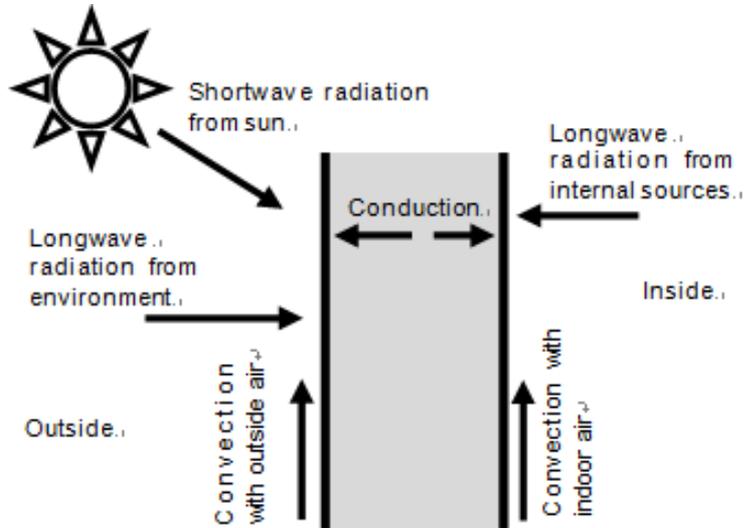


VIP spandrel: sectional view (left) and macrograph (right)

Parameter	Clear glass	VIP
Thermal conductivity (W/mK)	0.9	0.0045
Front side and back side solar reflectance	0.071	0.8
Solar transmittance	0.775	-
Front side and back side visible reflectance	0.08	-
Visible transmittance	0.881	-
Solar absorptance	-	0.02
Thermal emissivity	0.84	0.04
Density (kg/m ³)	-	240
Thickness (mm)	6	30

Material parameters

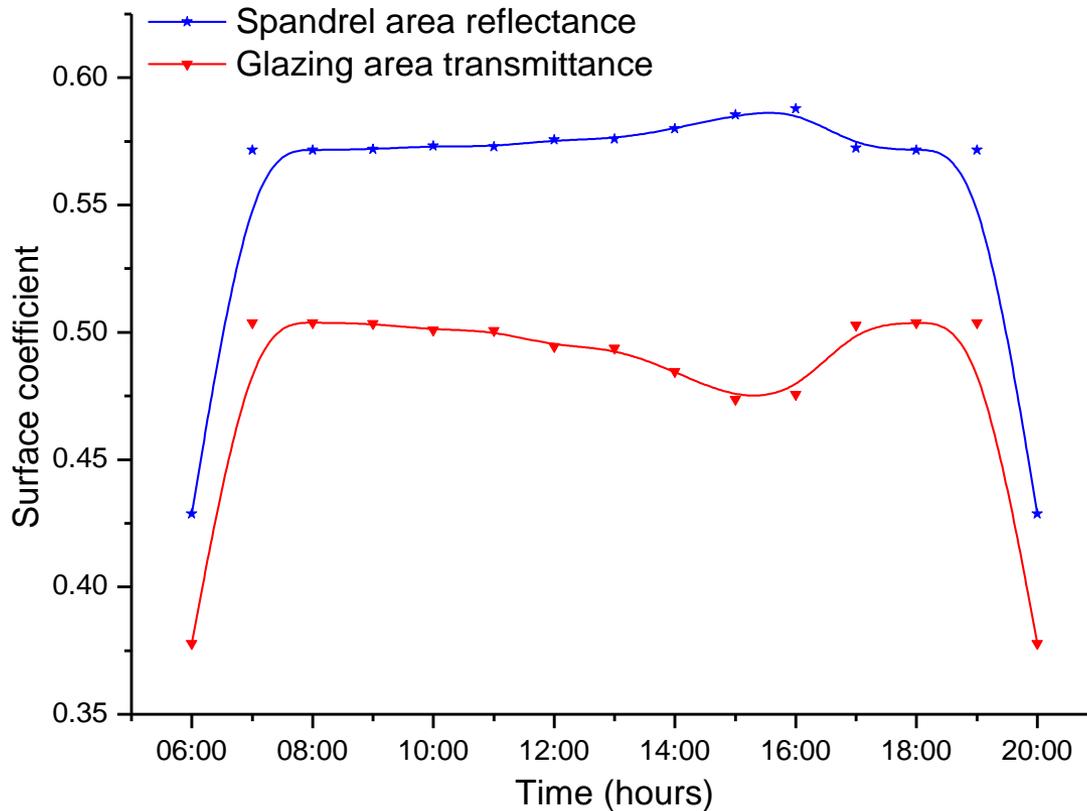
Heat transfer



Heat balance equation for VIP surface towards exterior

$$h_{cv,1}(T_{gap,1} - \theta_5) + k_{vip}(\theta_6 - \theta_5) + \frac{\sigma \epsilon_5}{1 - \rho_2 R_1} \cdot \left[\frac{\rho_2}{1 - \rho_5 \rho_3} (\epsilon_3 \theta_3^4 + \epsilon_6 \theta_6^4 \rho_3) + \epsilon_2 \theta_2^4 + \epsilon_5 \theta_5^4 R_2 \right] - \sigma \epsilon_3 \theta_3^4 + S_3 = 0$$

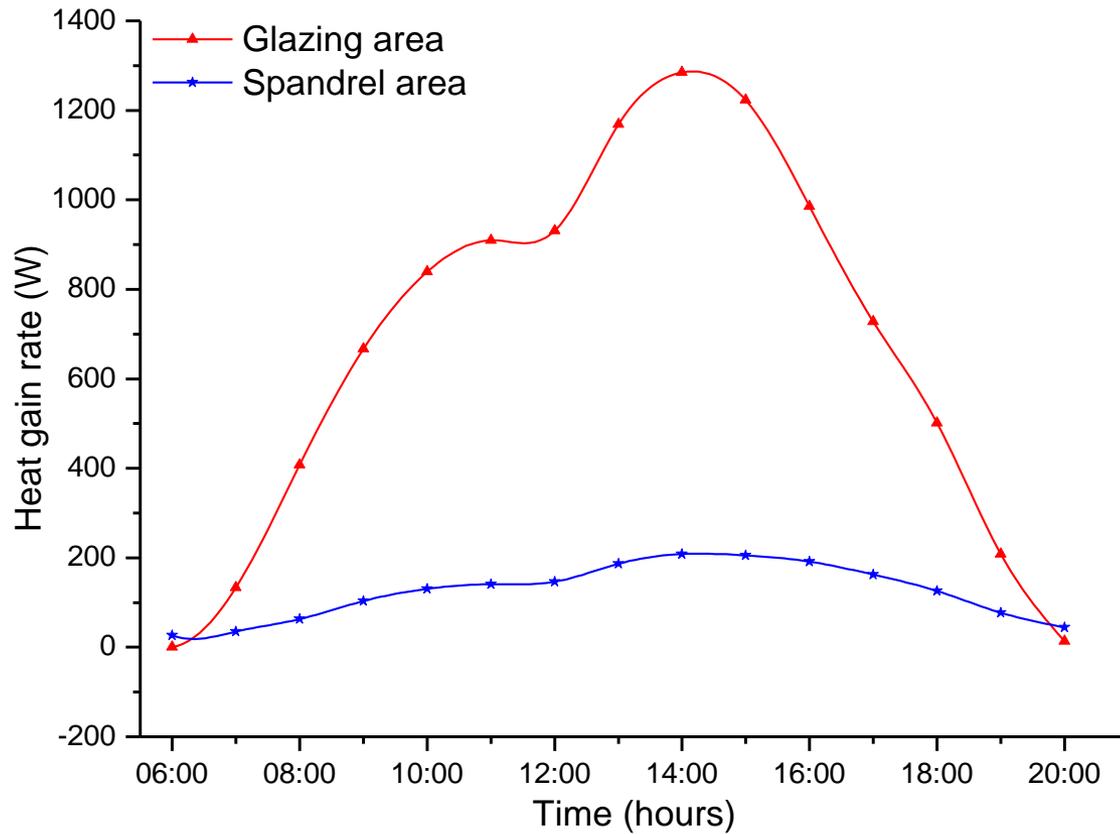
Results



- 21st June
- Mean VIP reflectance coefficient of 0.56
- Mean glazing transmittance coefficient of 0.48

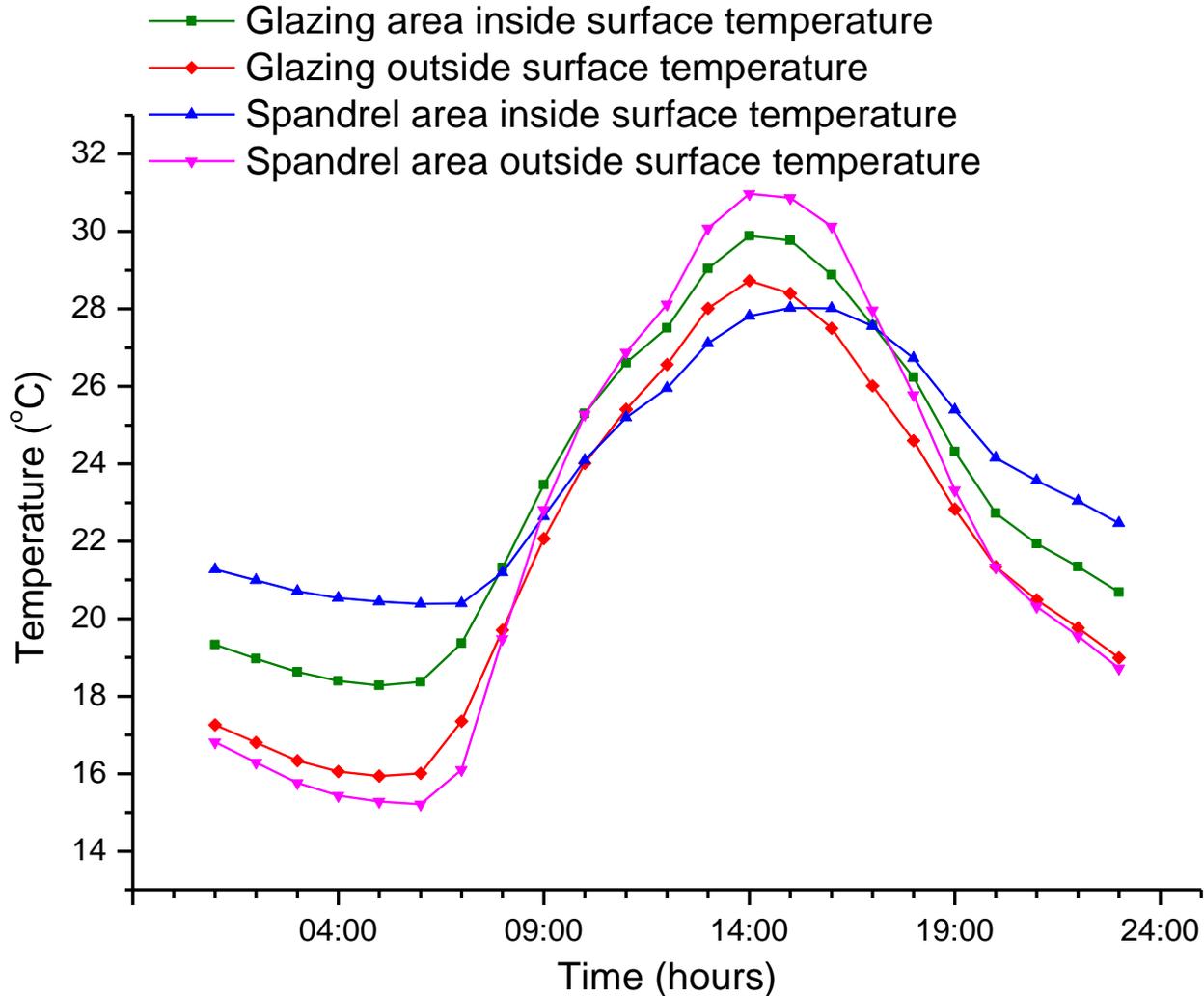
Surface reflectance coefficient of VIP spandrel area and transmittance coefficient of glazing area

Results



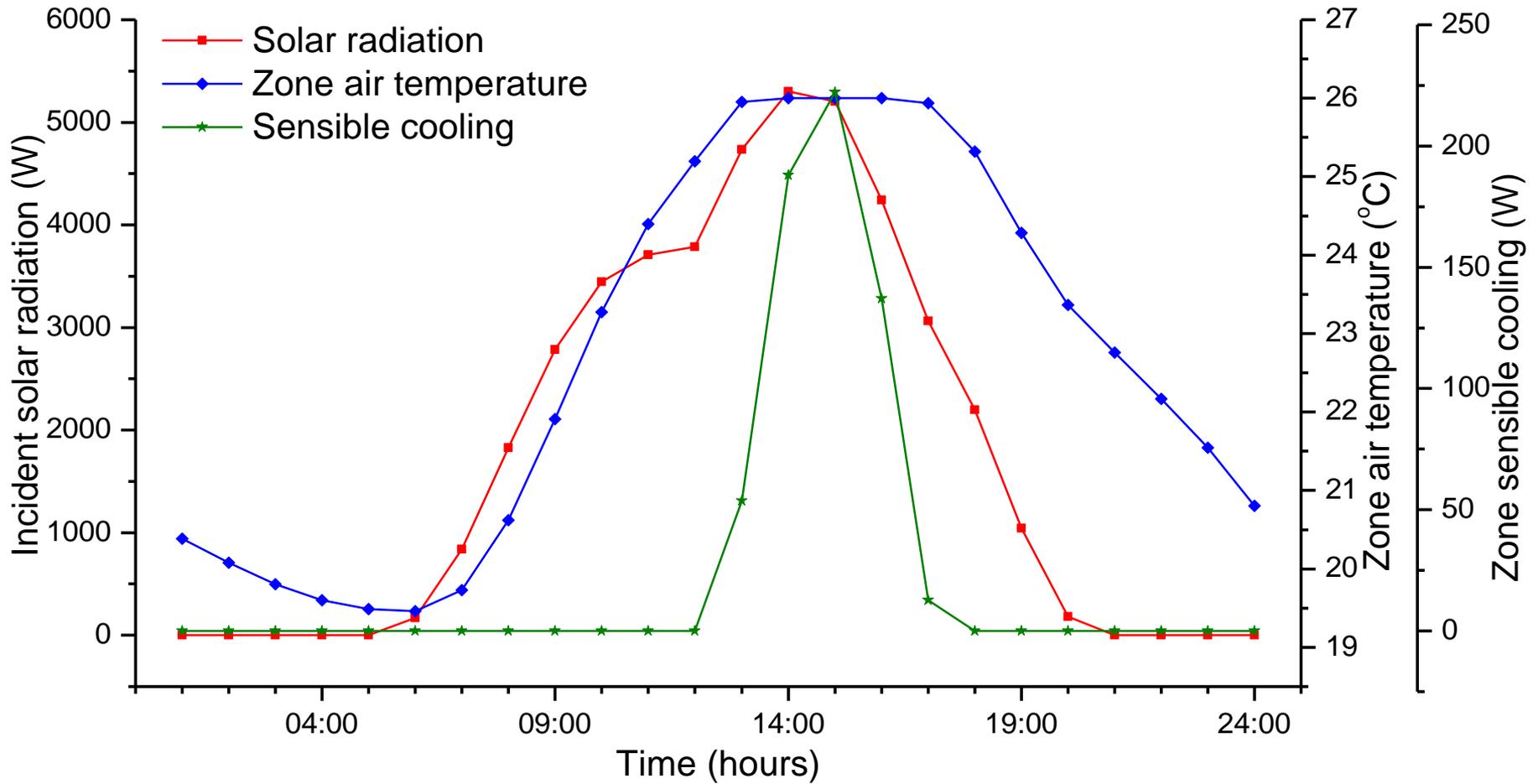
Heat gain rate

Results



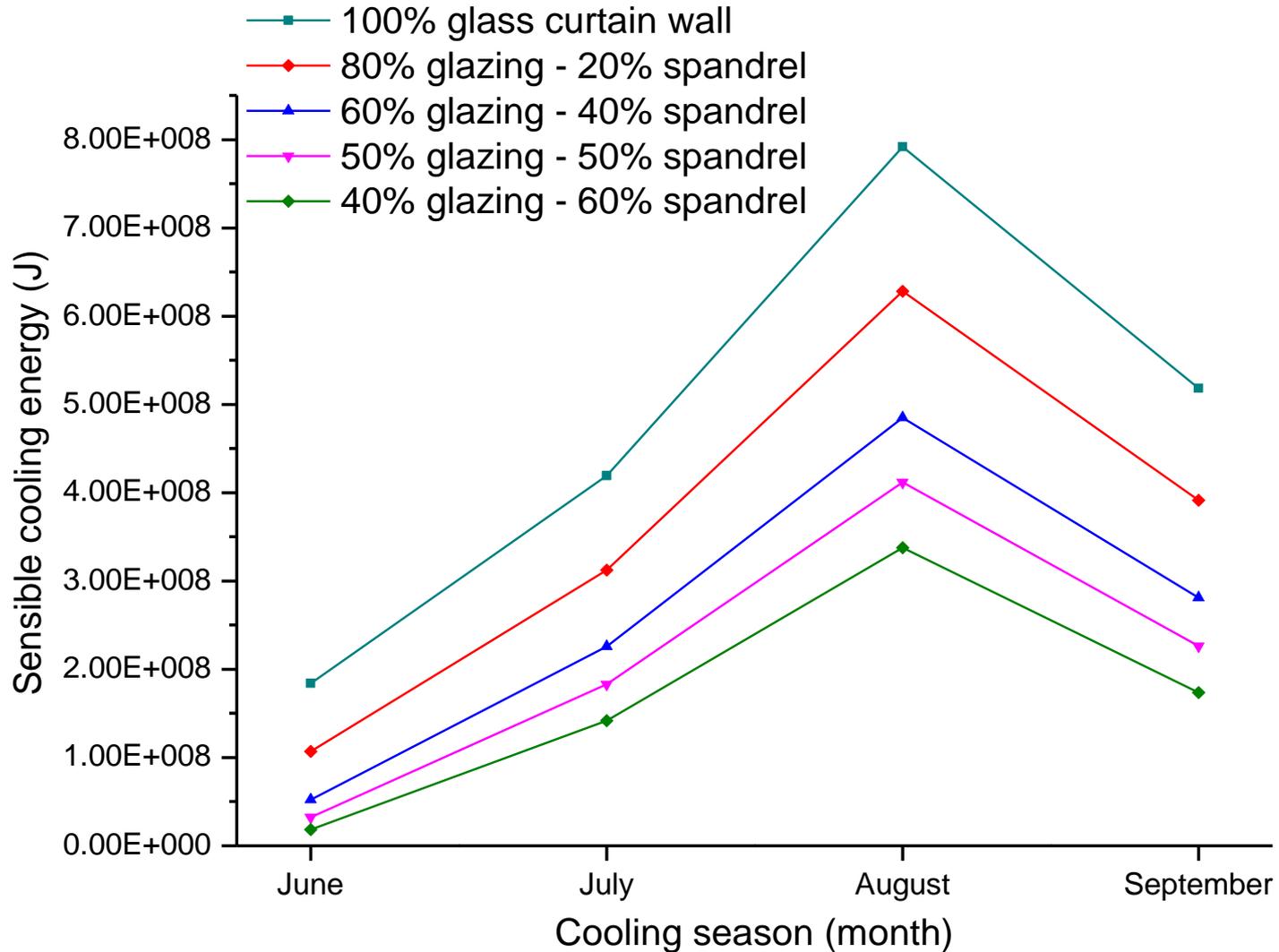
Surface temperature

Results



Zone air temperature dynamics

Results



Variation of sensible cooling energy demand with vision-spandrel configurations

Summary and outlook

- 1) In this study, the thermal characteristics and behavior of VIP spandrel and vision parts of a curtain wall system has been investigated using EnergyPlus software.
- 2) The mean reflectance coefficient for the VIP spandrel was 0.56, while the mean transmittance coefficient for the glazing area was 0.48; thus the glazing area transmits nearly as much incident solar radiation as the VIP spandrel reflects.
- 3) The VIP spandrel area reduced solar heat gain by 3-4 magnitude as compared to the solar heat transmitted through the glazing area.
- 4) Increasing the area of the VIP spandrel while decreasing the vision area reduced the sensible cooling load significantly.
- 5) Generally, results were agreement with findings in technical reports and literature.
- 6) Regulations on curtain wall configurations is needed.

Thank you for your attention