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Analysis of Combined Heat Transfer through the Core Materials of VIPs with Various Scattering Properties

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Abstract : Vacuum insulation panel (VIP) can achieve very low thermal conductivity by evacuating its inner space. Heat transfer in the core materials of highly-evacuated VIP occurs by conduction through the solid structure and radiation through the pore. The effect of various scattering modes in combined conduction-radiation in VIP is investigated through numerical analysis. The discrete ordinates interpolation method (DOIM) incorporated with the commercial code FLUENT® is employed. It is found that backward scattering is more effective in reducing the total heat transfer while isotropic scattering is almost identical with pure absorbing/emitting case of the same optical thickness. For a purely scattering medium, the results agree well with additive solution with diffusion approximation, while a modified term is added in the effect of optical thickness to backward scattering is employed. For other scattering phase functions, it is also confirmed that backwardly scattering phase function gives a lower effective thermal conductivity. Thus, the materials with backward scattering properties, with radiation shields are desirable to lower the thermal conductivity of VIPs.

Keywords : combined conduction and radiation, discrete ordinates interpolation method, scattering phase function, vacuum insulation panel
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