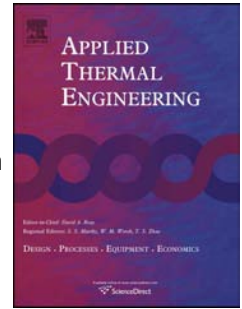


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An Ideal Nano-porous Insulation Material: Design, Modeling and Numerical validation

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Title Page

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Running title: An Ideal Nano-porous Insulation Material

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Abstract:

Based on the mechanisms of conductive heat transfer in nano-porous insulation materials, such as suppressed gaseous heat conduction at micro- and nanoscale, limited conduction through solid because of low volume fraction of solid and multi-layered thermal radiation shield resulting from porous structure of materials, a hollow spherical pellets packing stack nano-porous material is designed. Its effective thermal conductivity is derived based on the concepts of unit cell model and one-dimensional steady-state heat conduction, which is validated and improved by numerical simulation. Analysis on geometrical parameters, thermodynamic parameters and solid thermal conductivity indicates that hollow spherical pellets packing stack nano-porous material has excellent thermal insulation performance with effective thermal conductivity less than that of air at ambient temperature and atmosphere and can reach the order of about $0.01\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$, if properly designed.

Keywords:

nano porous materials; hollow sphere; effective thermal conductivity; numerical validation

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