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Prediction of the Effective Thermal Conductivity of various powder Insulations

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Thermal insulation plays an important role on energy conservation. Powder insulation method is widely used in structure and cryogenic systems, such as transportation and storage tank of cryogenic liquefied gases. Powder insulation layer is constructed by small particle powder with light weight and some residual gas with high porosity. So far, many experiments have been done to test the thermal performance of different kinds of powder, such as perlite, microsphere, expanded polystyrene (EPS) and so on. However, it is still difficult to predict the thermal performance of powder insulation by calculation due to the complicated geometries, including various particle shapes, wide range of powder diameter distribution and different pore sizes.

In this paper, the effective thermal conductivity of powder insulation has been predicted based on the ETC prediction model of porous packed beds. The calculation methodology was applied to the insulation system with perlite and microsphere at cryogenic temperature and various vacuum pressure. The calculation results were further compared with the previous experimental data. Moreover, the additional experimental tests were carried out at cryogenic temperature in this research paper. The calculation results showed good agreement to the experimental results. Also, the fitting equations of the deformation factor at Area-contact model are presented for microsphere and perlite.

keywords: powder insulation, the effective thermal conductivity, thermal performance prediction

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