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A Theoretical Model for Thermal Conductivity of Fibrous Porous Media

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Thermal conductivity is a fundamental physical property in porous media, and is critical to various industrial applications. Most existing theoretical models appeal to estimate thermal conductivity with isotropic assumption and the applicable conditions are relatively rigorous. This paper introduces a theoretical model that evaluates the thermal conductivity of fibrous porous media. The model is based on Fourier's Law and involves a complex thermal resistance circuit analysis, considering the direction of heat flux originating from the X, Y, and Z axes within the Cartesian coordinate system. The proposed model was found to be reasonable upon comparison with existing models. By comparing the effective thermal conductivity calculated by the model with results obtained from Computational Fluid Dynamics (CFD) and discrete numerical solution methods, the high accuracy of the model has been validated. The extension of the proposed model based on fractal theory was also discussed. It is anticipated that the proposed model will offer an alternative approach to computing the thermal conductivity and figuring out the mechanism of heat transfer behavior in fibrous porous media.

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