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Modeling and Simulation of Turbulent Double-Diffusion in Highly Porous Materials

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Processes involving coupled heat and mass transfer are found in various branches of science and engineering. When occurring within porous substrates, research on such double-diffusive systems have a wide variety of applications spanning from environmental flows to biomedical research. If fluctuations in time are also of concern due the existence of turbulence in the intra-pore space, a variety of mathematical models have been published in the literature in the last decade. One of such views entails simultaneous application of both time and volume averaging operators to all governing equations [1]. Extension for treating turbulent natural convection in cavities using thermal equilibrium [2] as well as a two-temperature model [3, 4] has also been documented. In the literature, the use of the two-energy equation model has been considered for passive heat transfer across differentially heated cavities [5]. Earlier [6], numerical modeling for turbulent double-diffusive natural convection in porous enclosures has been presented, discussing the stability of mixtures under temperature and concentration gradients. Later [7], the effects of opposing and aiding drivers on double-diffusive convection, using laminar and k-ε high Reynolds turbulence models, were discussed upon. However, the work in [7] was limited to one single porosity value and one unique thermal conductivity ratio for the solid and fluid phases. Therefore, this lecture discusses the extension of the early study in [7] on double-diffusive convection in porous media, combined now with the two-temperature approach of [3, 4], covering a wider range of porosity and thermal conductivity ratio, encompassing, by that, analyses of flows in porous cavities with a number of practical engineering applications.

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