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Experimental Investigation of Thermal Dispersion Within Porous Media Under Natural Groundwater Flow Conditions

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Recent studies in the field of shallow geothermal applications emphasize the crucial role played by mechanical thermal dispersion as a fundamental heat transport mechanism within saturated porous media. However, Previous studies have overlooked or underestimated mechanical thermal dispersion, leading to a scarcity of information on thermal dispersivity in the literature. This study experimentally and numerically investigates the validity of general assumptions concerning mechanical thermal dispersion within a porous medium. For this purpose, comprehensive laboratory experiments were conducted using heat and solute tracers across various porous materials at different background flow velocities (Re < 0.52). The analysis results suggest that water injection induces substantial mechanical dispersion, even at low flow velocities. Additionally, the thermal dispersivity ratio may deviate from the assumed value, underscoring its importance in the environmental impact assessment of the thermal use of shallow aquifers. Our experimental findings also suggest that thermal dispersion is affected by both local thermal non-equilibrium and small-scale heterogeneity.

Keywords: Thermal dispersion; Water injection; Thermal dispersivity ratio; Local thermal non-equilibrium; Small-scale heterogeneity

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