

热对流边界条件下含球形空洞流体饱和多孔介质的应力分析

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Analysis of Thermal Stresses around Spherical Cavity in Saturated Porous Medium under Convective Heating/Cooling Boundary Conditions

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摘要 基于热局部非平衡条件下饱和多孔介质热弹性理论, 研究含球形空洞流体饱和多孔介质在热对流边界和完全接触型(固定)边界条件下的温度、孔隙压力以及固相热应力.应用Laplace变换法获得了它们在Laplace变换域中的表达式, 数值分析和考察了在球形空洞边界附近处的温度、孔隙压力以及固相热应力的热局部非平衡影响效应.数值结果表明, 对于热对流边界条件情况,热局部非平衡影响效应是非常明显的, 特别在Biot数为中等值时, 热局部非平衡条件下孔隙压力以及径向应力和切向正应力绝对值的峰值都显著高于热局部平衡条件下所对应的值.

关键词: [饱和多孔介质](#) [热局部非平衡](#) [Laplace变换](#) [孔隙压力](#) [热应力](#)

Abstract: Based on the local thermal non-equilibrium (LTNE) saturated thermo poroelasticity theory, temperature, pore pressure and thermal stresses around a spherical cavity in an infinite fluid saturated porous medium are investigated, subject to convective heating/cooling on its impermeable and fixed boundary. Solutions of LTNE saturated thermo-poroelasticity are obtained by Laplace transform. Numerical analysis is performed to examine the effects of LTNE under convective heating/cooling boundary conditions on temperature, pore pressure and thermal stresses around the cavity. The results show that the LTNE effects become more pronounced when convective heat transfer boundary conditions are used. Thermally induced pore pressure and the magnitude of thermal stresses are significantly higher than the corresponding ones in classical saturated thermo-poroelasticity. This is particularly true under convective heating/cooling boundary conditions with moderate Biot numbers.

Keywords: [saturated porous medium](#), [local thermal non-equilibrium](#), [Laplace transform](#), [pore pressure](#), [thermal stress](#)

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