

Convective Instabilities During Solidification of a Mushy Layer

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During solidification of binary alloys, a mushy layer of dendritic crystals is often formed by constitutional supercooling. The convective instabilities in the mushy layer solidified from a bottom boundary are analyzed under linear stability theory. By using a similarity variable, the time-dependent disturbance equations for the liquid and mushy layers are transformed to the self-similar stability equations. The critical Rayleigh numbers based on the mushy-layer thickness are found numerically for various Lewis numbers, Darcy numbers, and superheats. The critical conditions at the onset of convection in the mushy layer are predicted for the solidification system of aqueous ammonium chloride solution.

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