

Explicit and Approximated Solutions for Heat and Mass Transfer Problems with a Moving Interface

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1. Introduction

The goal of this chapter is firstly to give a survey of some explicit and approximated solutions for heat and mass transfer problems in which a free or moving interface is involved. Secondly, we show simultaneously some new recent problems for heat and mass transfer, in which a free or moving interface is also involved. We will consider the following problems:

- I. Phase-change process (Lamé-Clapeyron-Stefan problem) for a semi-infinite material:
 - i. The Lamé-Clapeyron solution for the one-phase solidification problem (modeling the solidification of the Earth with a square root law of time);
 - ii. The pseudo-steady-state approximation for the one-phase problem;
 - iii. The heat balance integral method (Goodman method) and the approximate solution for the one-phase problem;
 - iv. The Stefan solution for the planar phase-change surface moving with constant speed;
 - v. The Solomon-Wilson-Alexiades model for the phase-change process with a mushy region and its similarity solution for the one-phase case;
 - vi. The Cho-Sunderland solution for the one-phase problem with temperature-dependent thermal conductivity;
 - vii. The Neumann solution for the two-phase problem for prescribed surface temperature at the fixed face;
 - viii. The Neumann-type solution for the two-phase problem for a particular prescribed heat flux at the fixed face, and the necessary and sufficient condition to have an instantaneous phase-change process;
 - ix. The Neumann-type solution for the two-phase problem for a particular prescribed convective condition (Newton law) at the fixed face, and the necessary and sufficient condition to have an instantaneous phase-change process;
 - x. The similarity solution for the two-phase Lamé-Clapeyron-Stefan problem with a mushy region.
 - xi. The similarity solution for the phase-change problem by considering a density jump;
 - xii. The determination of one or two unknown thermal coefficients through an over-specified condition at the fixed face for one or two-phase cases.
 - xiii. A similarity solution for the thawing in a saturated porous medium by considering a density jump and the influence of the pressure on the melting temperature.

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