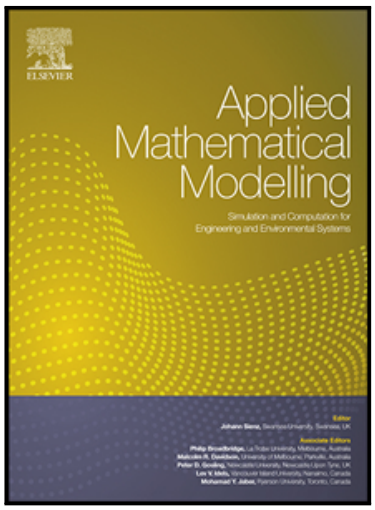

Numerical simulation of oxidation processes in a cross–flow around tube bundles

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Numerical simulation of oxidation processes in a cross–flow around tube bundles

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Abstract

An oxidation process is simulated for a bundle of metal tubes in a cross–flow. The fluid flow is governed by the incompressible Navier–Stokes equations. To describe the transport of oxygen, the corresponding convection–diffusion equation is applied. The key point of the model is related to the description of oxidation processes, taking into account the growth of a thin oxide film in the quasi–stationary approximation. Mathematical modeling of oxidant transport in a tube bundle is carried out in the 2D approximation. The numerical algorithm employed in the work is based on the finite–element discretization in space and the Crank–Nicolson discretization in time. The tube rows of a bundle can be either in–line or staggered in the direction of the fluid flow velocity. The growth of the oxide film on tube walls is predicted for various bundle structures using the developed oxidation model.

Keywords: Cross–flow around tube bundles, oxidation of metals, parabolic kinetics, Navier–Stokes equations, convection–diffusion equation, finite–element discretization, finite–difference schemes
2010 MSC: 76D05, 76R50, 65M32

1. Introduction

Many industrial applications involve fluid flows through tube structures. An example is the heat exchange equipment for nuclear power plants. A study of heat and mass transfer in these systems is of great practical interest [1, 2]. In addition to large–scale experimental studies [3, 4, 5], computational technologies

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