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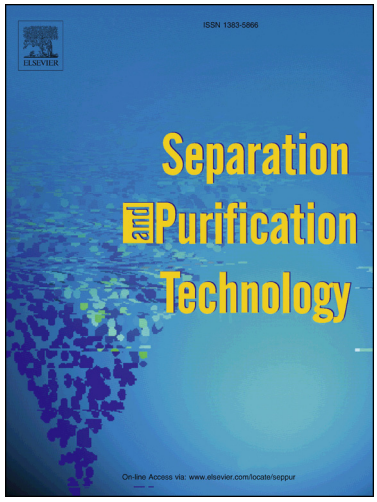

Multiscale modeling of a gas separation device based on effect of thermal transpiration in the membrane

Vasily Kosyanchuk, Valery Kovalev, Artem Yakunchikov

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Multiscale modeling of a gas separation device based on effect of thermal transpiration in the membrane

Vasily Kosyanchuk[a,b,*], Valery Kovalev[a,b], Artem Yakunchikov[a,b]

[a] *Laboratory of Nanomechanics, Institute of Mechanics, Lomonosov Moscow State University, Michurinskyi aven. 1, 119192, Moscow, Russian Federation*
[b] *Department of Mechanics and Mathematics, M.V. Lomonosov Moscow State University, Leninskie Gory 1, 119991, Moscow, Russian Federation*

Abstract

This article studies a novel approach to improve membrane separation efficiency – application of external physical influence (temperature difference across the membrane). Same directed pressure and temperature gradients in membrane establish a molecular exchange flow when two components of the binary gas mixture flow in the opposite directions through the membrane. The model of gas separator based on this effect is studied numerically at different scales. At microscale (in membrane channels) solution of the linearized Boltzmann equation is used. At macroscale (external part of the device) the system of Navier-Stokes equations for two-component gas mixture is solved using finite volume method adopted for low Mach number limit. Dependence of device efficiency on all of the defining parameters is studied and comparison with previous numerical simulation of the device is made. The key feature of the device is that it can produce output gas with any purity up to 100% with temperature difference of only $30K$ applied to the sides of membrane. Moreover, the device does not require any specific membrane material and operates at normal pressure and temperature conditions

Keywords: Green separation, Membrane gas separation, Thermal transpiration, Rarefied gas, Knudsen pump, Multiscale modeling, Low Mach

*Corresponding Author
Email addresses: vasiliy.kosyanchuk@gmail.com (Vasily Kosyanchuk), art-ya@mail.ru (Artem Yakunchikov)

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