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On a Problem of Thermal Convection with Unset Flow Rate

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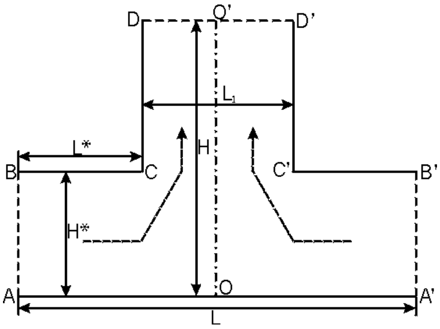
Abstract. In the two-dimensional region Ω, as shown in the figure, we consider a system of equations of thermal convection in the following dimensionless form /1/:



$$\frac{\partial \vec{u}}{\partial t} + (\vec{u}\nabla)\vec{u} + \nabla p = \frac{1}{\mathrm{Re}}\Delta\vec{u} - \frac{Gr\vec{g}}{\mathrm{Re}^2|\vec{g}|}T,$$

$$div\,\vec{u} = 0,$$

$$\frac{\partial T}{\partial t} + (\vec{u}\nabla)T = \frac{1}{\mathrm{Pr}\,\mathrm{Re}}\Delta T,$$

where $\vec{g} = (0,-g)$, $Gr = \frac{g\beta\Delta\theta L^3}{\nu^2}$, $\mathrm{Re} = \frac{L\sqrt{\rho\Delta p}}{\mu}$, $Pr = \frac{\nu}{\lambda}$

dimensionless parameters of Grashof, Reynolds and Prandtl, Δθ - a characteristic temperature difference, ν - kinematic viscosity, λ - coefficient of thermal diffusivity.

The boundary conditions are as follows:

on top of the solid wall (BC, CD):

$$u = v = 0, T = 0,$$

on the bottom wall (AA′):

$$u = v = 0, T = 1,$$

entrance boundary (AB):

$$v = 0,\ p = 1, \frac{\partial T}{\partial x} = 0;$$

on the outflow boundary (DO′):

$$u = 0,\ \ p = 0, \frac{\partial T}{\partial y} = 0\ .$$

On the basis of the proposed iterative algorithm /2/, carried out numerical calculations and obtained the flow pattern for different Grashof and Reynolds numbers. It was established that at sufficiently high Reynolds number *(Re(δp)=500-700)*, that is, for sufficiently strong flow, caused by the pressure drop, increasing the temperature difference between the walls (eg, numbers $Gr=5*10^5$) does not lead to a marked increase in flow rate.

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