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AN ITERATIVE ALGORITHM FOR NUMERICAL SOLUTION OF HEAT CONVECTION EQUATIONS

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The report focuses on the numerical solution of stationary differential problems in the region $D = \{0 < x_\alpha < 1, \alpha = 1, 2\}$ for two-dimensional heat convection equations can be written in the following form [1]:

$$\left(\omega \frac{\partial \psi}{\partial x_2}\right)_{x_1} - \left(\omega \frac{\partial \psi}{\partial x_1}\right)_{x_2} = \frac{1}{Re} \Delta \omega - \frac{Gr}{Re^2} \frac{\partial \theta}{\partial x_1} + f(x_1, x_2), \quad (1)$$

$$\Delta \psi = \omega, \quad (2)$$

$$\left(\theta \frac{\partial \psi}{\partial x_2}\right)_{x_1} - \left(\theta \frac{\partial \psi}{\partial x_1}\right)_{x_2} = \frac{1}{Pr Re} \Delta \theta + g(x_1, x_2), \quad (3)$$

here Pr - Prandtl number, Re - Reynolds number, Gr - Grashof number, Δ - Laplace operator.

Considered an iterative algorithm of the type of variable directions, using by conducting auxiliary function of the vorticity with homogeneous boundary values in the following form:

$$\frac{\omega^{n+\frac{1}{2}} - \omega^n}{\tau} + L_{h,\psi}(\omega^n) \psi^{n+\frac{1}{2}} = \frac{1}{Re} \Delta_h \omega^n - \frac{Gr}{Re^2} \theta^n_{x_1} + \rho_h \psi^{n+\frac{1}{2}} + f_h, \quad (4)$$

$$\Delta_h \psi^{n+\frac{1}{2}} = \omega^{n+\frac{1}{2}}, \quad (5)$$

$$\frac{\omega^{n+1} - \omega^{n+\frac{1}{2}}}{\tau} = \frac{1}{Re} \Delta_h (\omega^{n+1} - \omega^n), \quad (6)$$

$$\Delta_h \psi^{n+1} = \omega^{n+1}, \quad (7)$$

$$L_{h,\theta}(\psi^n) \theta^{n+1} = \frac{1}{Pr Re} \Delta_h \theta^{n+1} + g_h, \quad (8)$$

here $L_{h,\psi}, L_{h,\theta}$ - symmetric differential operators corresponding to the approximation of the convective terms in the equations of motion and temperature, $\rho_h > 0$.

An iterative algorithm of variational type minimal corrections for implementation of auxiliary non-self-adjoint grid equations was considered [2]. On example of the differential problem with boundary conditions:

$$\begin{aligned} x_1 = 0, 1; \quad 0 \leq x_2 \leq 1 : \psi = \frac{\partial \psi}{\partial x_1} = 0, \quad \theta = x_2, \\ 0 \leq x_1 \leq 1, \quad x_2 = 0 : \psi = \frac{\partial \psi}{\partial x_2} = \theta = 0, \quad 0 \leq x_1 \leq 1, \quad x_2 = 1 : \psi = \frac{\partial \psi}{\partial x_2} = \theta = 1, \end{aligned}$$

discussion of the calculation result and software implementation details of the algorithm on a multi-processor cluster was conducted.

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