519.63+533.6

EQUATION OF CONTINUITY IN THE CYLINDRICAL COORDINATES SYSTEM

A. G. Obukhov, N. V. Chunikhina

Key words: the complete system of Navier — Stokes equations; the equation of continuity; partial derivatives, a cylindrical coordinate system

[1–9]

[4–7]

[8, 9]

[2]:

$$\begin{cases} \rho_t + \vec{V} \cdot \nabla \rho + \rho \operatorname{div} \vec{V} = 0, \\ \vec{V}_t + (\vec{V} \cdot \nabla) \vec{V} + \frac{T}{\gamma \rho} \nabla \rho + \frac{1}{\gamma} \nabla T = \vec{g} - 2\vec{\Omega} \times \vec{V} + \frac{\mu_0}{\rho} \left[\frac{1}{4} \nabla (\operatorname{div} \vec{V}) + \frac{3}{4} \Delta \vec{V} \right], \\ T_t + \vec{V} \cdot \nabla T + (\gamma - 1) T \operatorname{div} \vec{V} = \frac{\kappa_0}{\rho} \Delta T + \frac{\mu_0 \gamma (\gamma - 1)}{2\rho} \left\{ [(u_x - v_y)^2 + \right. \\ \left. + (u_x - w_z)^2 + (v_y - w_z)^2] + \frac{3}{2} [(u_y + v_x)^2 + (u_z + w_x)^2 + (v_z + w_y)^2] \right\}. \end{cases} \quad (1)$$

$$\begin{aligned} (1): \quad t & \text{ — } & x, y, z & \text{ — } & \rho & \text{ — } & - \\ ; \quad \mu_0 & \quad \kappa_0 & \text{ — } & & & & \\ & & & \vec{V} = (u, v, w) & \text{ — } & & - \\ & & & T & \text{ — } & & - \\ & & & \gamma = 1, 4 & \text{ — } & & ; \\ -2\vec{\Omega} \times \vec{V} & = (av - bw, -au, bu) & \text{ — } & & & & , \\ a = 2\Omega \sin \psi, \quad b = 2\Omega \cos \psi, \quad \Omega = |\vec{\Omega}|; \quad \vec{\Omega} & \text{ — } & & & & & - \\ ; \quad \psi & \text{ — } & O & \text{ — } & Oxyz, & & - \\ & & [8, 9] & & & & - \\ & & & & & & - \end{aligned}$$

$$(1) \text{ — } \quad (1),$$

$$\rho_t + u\rho_x + v\rho_y + w\rho_z + \rho(u_x + v_y + w_z) = 0. \quad (2)$$

$$[10] \quad r, \varphi, z \quad u, v \quad \zeta \text{ — } \eta \text{ — } :$$

$$u = \zeta \cos \phi - \eta \sin \phi, \quad v = \zeta \sin \phi + \eta \cos \phi. \quad (3)$$

$$: \quad \frac{\partial}{\partial x} = \cos \phi \frac{\partial}{\partial r} - \frac{\sin \phi}{r} \frac{\partial}{\partial \phi}; \quad (4)$$

$$\frac{\partial}{\partial y} = \sin \phi \frac{\partial}{\partial r} + \frac{\cos \phi}{r} \frac{\partial}{\partial \phi}. \quad (5)$$

$$\begin{aligned} & z & & - \\ & (3), (4), (5) & (2) & - \end{aligned}$$

$$\begin{aligned}
& \rho_t + (\zeta \cos \phi - \eta \sin \phi) \left(\cos \phi \frac{\partial \rho}{\partial r} - \frac{\sin \phi}{r} \frac{\partial \rho}{\partial \phi} \right) + \\
& + (\zeta \sin \phi + \eta \cos \phi) \left(\sin \phi \frac{\partial \rho}{\partial r} + \frac{\cos \phi}{r} \frac{\partial \rho}{\partial \phi} \right) + w \frac{\partial \rho}{\partial z} + \\
& + \rho \left(\cos^2 \phi \frac{\partial \zeta}{\partial r} - \sin \phi \cos \phi \frac{\partial \eta}{\partial r} - \frac{\sin \phi \cos \phi}{r} \frac{\partial \zeta}{\partial \phi} + \frac{\sin^2 \phi}{r} \frac{\partial \eta}{\partial \phi} + \right. \\
& + \frac{\sin^2 \phi}{r} \zeta + \frac{\sin \phi \cos \phi}{r} \eta + \sin^2 \phi \frac{\partial \zeta}{\partial r} + \sin \phi \cos \phi \frac{\partial \eta}{\partial r} + \\
& \left. + \frac{\sin \phi \cos \phi}{r} \frac{\partial \zeta}{\partial \phi} + \frac{\cos^2 \phi}{r} \frac{\partial \eta}{\partial \phi} + \frac{\cos^2 \phi}{r} \zeta - \frac{\sin \phi \cos \phi}{r} \eta + \frac{\partial w}{\partial z} \right) = 0.
\end{aligned}$$

(2)

$$\rho_t + \zeta \rho_r + \frac{\eta}{r} \rho_\phi + w \rho_z + \rho \left(\zeta_r + \frac{\zeta}{r} + \frac{\eta_\phi}{r} + w_z \right) = 0. \quad (6)$$

3023).

1. // , 2013. – 51. – 4. – 567-570.
2. , 2013. – 215 .
3. Bautin S. P., Obukhov A. G. Mathematical Simulation of the Near-Bottom Section of an Ascending Twisting Flow // High Temperature. – 2013. – V. 51. – No. 4. – P. 509–512.
4. // , 2014. – 3. – 88-94.
5. // – 2014. – 7. – 157-165.
6. // , 2014. – 5 – 57-62.
7. // , 2014. – 12, 3. – 116-122.
8. // , 2014. – 6 – 65-70.
9. // , 2015. – 53, 6. – 961-964.
10. , 2008. – 96 .

Information about the authors

Obukhov A. G., Doctor of Physics and Mathematics, professor of the chair «Business-informatics and mathematics», Industrial University of Tyumen, phone: 89220014998, -mail: aobukhov@tsogu.ru

, . . . , *Chunikhina N. V., Candidate of Science*
 « - in Sociology, associate professor of the chair
 », - «Business-informatics and mathematics», Industrial
 , . , 89129264066, University of Tyumen, phone: 89129264066,
 -mail: nv1406@rambler.ru -mail: nv1406@rambler.ru