Time-periodic Poiseuille-type solution with minimally regular flow-rate

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The nonstationary Navier–Stokes equations are studied in the infinite cylinder $\Pi = \{x = (x', x_n) \in \mathbb{R}^n : x' \in \sigma \subset \mathbb{R}^{n-1},\ -\infty < x_n < \infty,\ n = 2, 3\}$ under the additional condition of the prescribed time-periodic flow-rate (flux) $F(t)$. It is assumed that the flow-rate F belongs to the space $L^2(0, 2\pi)$ only. The existence and uniqueness of a time-periodic Poiseuille-type solution to this problem is proved. The time-periodic Poiseuille solution has the form $\mathbf{u}(x, t) = \big(0, \dots, 0, U(x', t)\big),\ p(x, t) = -q(t)x_n + p_0(t)$, where $(U(x', t), q(t))$ is a time-periodic solution of an inverse problem for the heat equation with a specific over-determination condition.

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