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Boundary Layer Development in Unsteady Flows

Andrei Camyshev, Andrei Kolyshkin, Inta Volodko

Riga Technical University, Riga, Latvia

The paper is devoted to the study of rapidly changing unsteady viscous flows in cylindrical channels of constant cross-section. Applications include flows in water supply systems, natural gas pipelines, blood flow in arteries. Suppose that an infinitely long horizontal cylinder of constant cross-section is filled with a viscous incompressible fluid. The flow is assumed to be fully developed. Starting from time $t = 0$ the flow is rapidly decelerated. The sudden change in pressure generates additional vorticity near the wall. As a result a boundary layer starts to develop near the wall. The method of matched asymptotic expansions is used to construct an approximate solution for the velocity distribution. Methods of linear and weakly nonlinear stability theory under a quasi-steady assumption are used to investigate stability characteristics of the flow. It is shown that the evolution of the most unstable mode is governed by the complex Ginzburg-Landau equation.

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