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Similarity solutions for unsteady flows near front and rear stagnation points

Unsteady flows near stagnation points on a cylindrical body immersed in a viscous incompressible fluid are considered. This problem admits similarity solutions, which are exact solutions of the Navier-Stokes equations, having a boundary-layer character similar to that of classical steady forward stagnation point flow. The velocity profiles are obtained by numerical integration of a non-linear ordinary differential equation. A wide range of possible behaviour is revealed, depending on the flow direction and acceleration. For the forward-flow situation, the solution is unique for the accelerating case, but bifurcates for modest deceleration, while for sufficient rapid deceleration there exists a one-parameter family of solutions. For the rear-flow situation, a unique solution exists (remarkably!) for sufficiently strong acceleration, and a one-parameter family again exists for sufficient strong deceleration.