
The openpipeflow.org Navier–Stokes solver

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Abstract: The straight pipe of circular cross-section is a familiar simple set up, yet the flow of fluid through a pipe exhibits rich chaotic dynamics. It provides a popular setting, both for investigation of the principles of simulation, and for methods designed to probe the fundamental properties of dynamical systems. The openpipeflow.org code may be used for simulation and as a solver for relative equilibria (travelling wave) solutions and relative periodic orbits. This article describes the core numerical techniques that have been implemented. Problems associated with the boundary conditions for PPE formulations are bypassed by the influence–matrix technique, allowing one to solve for the ‘real’ pressure, whilst simultaneously opening up the possibility of arbitrary boundary conditions. Also presented are extensions ...

Keywords: Pipe flow code; CFD; boundary conditions; parallelisation;

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openpipeflow.org/index.php?title=File:TheOpenpipeflowSolver.pdf
(Please check openpipeflow.org for the latest citation instructions.)

Biographical notes: Ashley Willis received his PhD in Applied Mathematics from Newcastle University, U.K. in 2002 before holding research associate positions at Leeds and Bristol. He was awarded an IEF Marie Curie Fellowship to work on transitional shear flow at LadHyX, École Polytechnique, Palaiseau, France, and in 2010 joined the School of Mathematics and Statistics at Sheffield as a Lecturer.

1 Introduction

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2 Governing equations

3 Numerical formulation

3.1 Fixing the PPE formulation

3.2 Parallel framework

4 Extensions

4.1 The Newton–Krylov method

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References